UNIVERSITY OF THE STATE OF MISSOURI.

REPORT

BY THE

CURATORS TO THE GOVERNOR,

CONTAINING

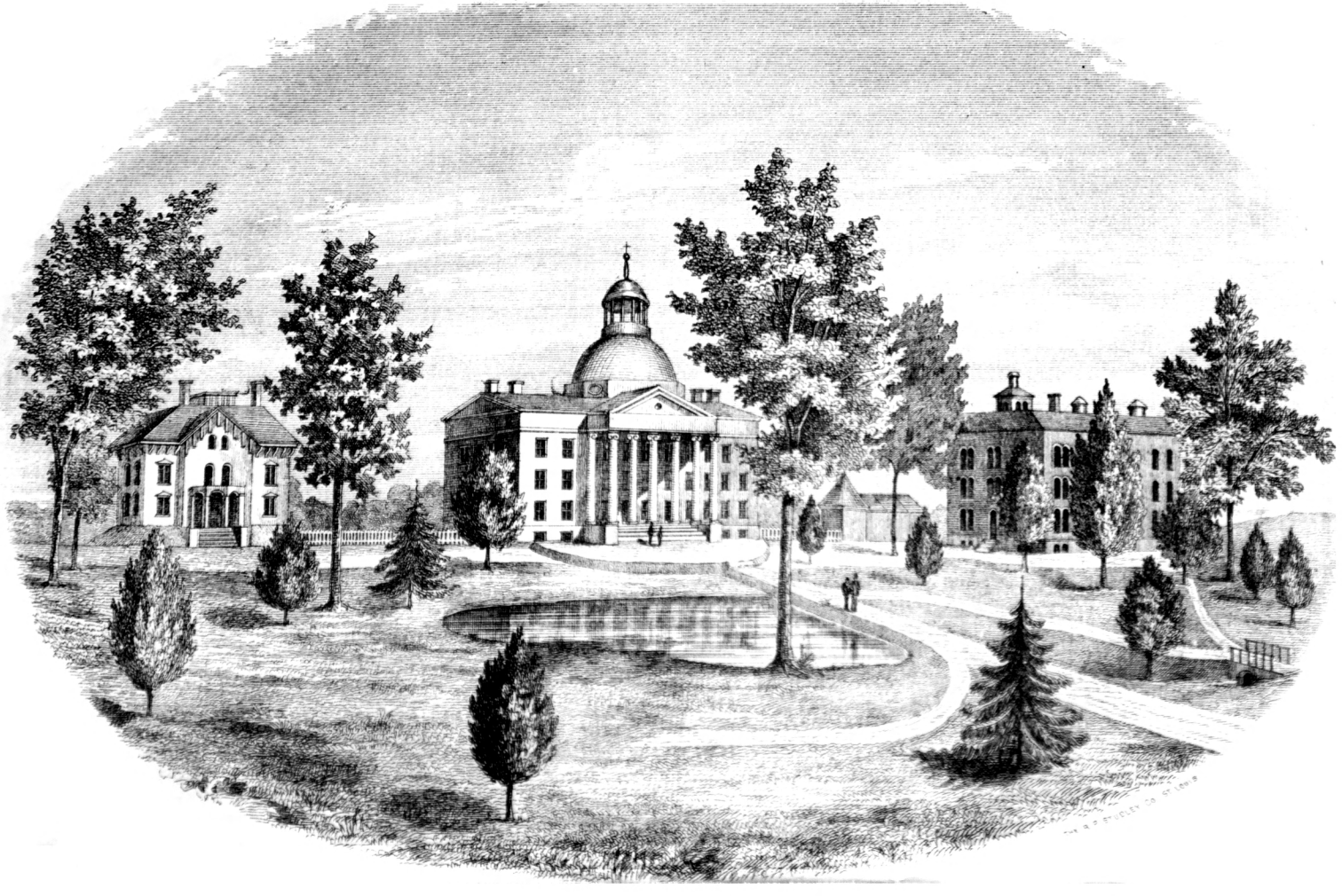
CATALOGUE, ANNOUNCEMENTS,

AND

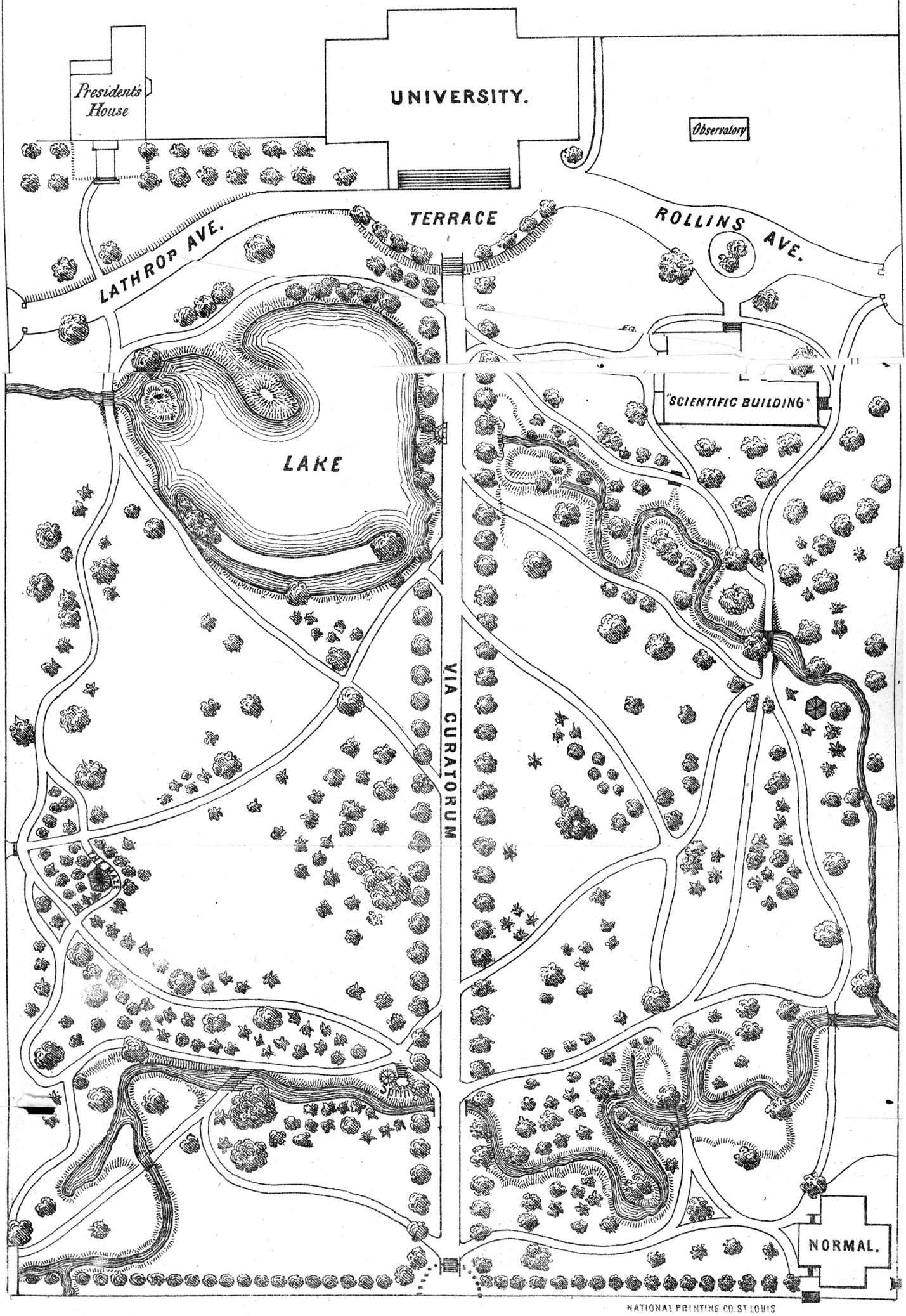
OTHER MATTER PERTAINING TO THE UNIVERSITY,

YEAR ENDING JUNE 24, 1875.

JEFFERSON CITY:
REGAN & CARTER, STATE PRINTERS AND BINDERS.
1875.



PLAN OF CAMPUS



NATIONAL PRINTING CO. ST LOUIS

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From "An act donating public lands to the several States and Territories," etc.

"SEC. 5. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results, and such other matters, including State, industrial and economical statistics, as may be supposed useful; one copy of which shall be transmitted by mail, free, by each, to all other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior."—*Laws of the United States* (1862), CHAP. CXXX.

From "An act to locate and dispose of the Congressional grant," etc.

"SEC. 14. At the close of each University year, the Board of Curators shall make a report, in detail, to the Governor, exhibiting the progress, condition and wants of the several colleges or departments of instruction in the University, the course of study in each, and the number and names of the officers and students, the amount of receipts and disbursements, together with the nature, cost and results of all important experiments and investigations, and such other matters, including State, industrial and economical statistics, as may be thought useful. The Governor shall cause the same to be printed for the use of the General Assembly and the people of the State, and shall cause one copy of the same to be transmitted, free of expense, to all the colleges which may be endowed under the provisions of the act of Congress, approved July 2, 1862, hereinbefore referred to, and also one copy to the Secretary of the Interior, and one copy to the Commissioner of Agriculture at Washington City."

REPORT.

COMMUNICATION OF THE PRESIDENT OF THE BOARD OF CURATORS.

To His Excellency, Gov. Charles H. Hardin:

Sir: In compliance with the law of the State, as well also as a requirement of the act of Congress, donating land to the several States and Territories for the benefit of Agricultural and Mechanical Colleges, it becomes the duty of the Board of Curators, at the close of each year, to submit a report to the Governor, exhibiting "the progress, condition and wants of the University," and likewise "improvements and experiments made," which Report he is to cause to be printed for the use of the General Assembly and the people of the State, and "to be transmitted by mail, free of expense, to other similar institutions, to the Secretary of the Interior and Commissioner of Agriculture."

The educational reports of the present year will have a special interest from the fact that they are to form a part of the great National Centennial Exhibition of 1876.

In the review of the year, we are happy to be able to state that it has for the most part been one of steady work and continued prosperity, notwithstanding drawbacks, in consequence of great suffering throughout the State, from the drought, the plague of insects, and the stringency of the money market, as well as sickness affecting many counties and prevailing largely among the students. More than thirty cases of severe sickness, mostly of the typhoid cast, occurred among the students, and three deaths. This is entirely exceptional, as the health of students in years past has been remarkably good; nor could the sickness at this time be traced to any particular cause.

The number of entrances of course was diminished by these conditions. That the numbers in the various departments have been so

well maintained, under circumstances as adverse as will ever be likely to occur, is proof that the Institution rests upon the firm basis of public confidence.

REDUCTION OF THE BOARD.

The reduction of the Board of Curators by an act of the last General Assembly, from the cumbersome and expensive number of *twenty-four* to *thirteen*, is manifestly a great improvement in the external government of the University, tending to promote that harmony, stability and uniformity of action so essential to anything like the success and respectability of a great institution of learning.

NO INDEBTEDNESS TO BE INCURRED HEREAFTER.

By the same law the Board is also absolutely prohibited from incurring debt beyond the income of the year. This provision will protect the Board from an undue pressure for improvements, which, however desirable, are not within the limit of the means at their disposal. It will also throw directly upon the General Assembly the responsibility of sustaining the University according to the advancing demands of modern education, and in a manner worthy this great and enlightened State. It is to be hoped it will bring the University within the immediate and constant fostering care and protecting influence of the Legislature.

MEETING OF THE BOARD.

In obedience to the call of your Excellency, the new Board of Curators met in the Library Hall of the University on the second day of April, and organized as a Board by making the classification of members for terms of office, as required by law, and by the election of their President. James S. Rollins, of Boone county, was chosen by a unanimous vote to preside over the body.

BUSINESS OF THE BOARD.

The session of the Board lasted three days, and the time was spent in making a careful examination of the buildings, grounds, and the various appointments belonging to the several departments, in visiting the recitation rooms, in forming the acquaintance of Professors and teachers, in considering plans of improvement, and the means of economizing resources and retrenching expenses so far as practicable. Committees were also appointed with a view to the effective administration of the business of the Board, and with special reference to the annual meeting to be held in June.

PURCHASE OF BUILDING FOR SCHOOL OF MINES.

A most important item of business was transacted in the completion of the purchase of the public school building in the town of Rolla, for the use of the School of Mines, at a cost of $25,000. The building has heretofore been occupied by the School, and thus becomes its property, and at a price considerably below actual cost.

HARMONIOUS FEELING AND ACTION OF THE BOARD.

It is already evident that the new Board will prove a most harmonious body, working together without a selfish or discordant element, for the great State interest committed to its charge. Some of the new members of the Board expressed their surprise and gratification at the excellent condition of things, and not less their amazement at the prejudices which have been stirred up, for which there seemed little or no reason. There was a pretty general expression that the officers and employes of the Board must be protected from vague and general charges, by means of immediate investigation and the demand of proofs; and that evils and short-comings, if really existing, are to be corrected as is done in all reputable institutions of learning, in a quiet and dignified manner, and without resort to newspaper wrangling or neighborhood abuse.

RESPONSIBILITY OF CURATORS.

It is very evident that none can so well understand the workings of the University as the Curators themselves, its appointed guardians, and none can have so deep an interest in its prosperity; none others have resting upon them the responsibily of administering its affairs; none others give the same time and thought to its concerns, and there are none others to whom the public can or will look with the same confidence. Yet it is lamentable, the new Board had hardly separated before it became the object of attack and outcry, through newspaper articles sent abroad, and manifestly from well known sources, having little character or influence at home. It is well known that almost from the beginning one of the greatest evils and hinderances which the University has had to encounter, has been the strife or distrust which a few evil-minded persons around it have endeavored to foment. The atmosphere of literary and educational success is one of peace and quiet always. This must be fully understood at Columbia, and acted out by the most positive discouragement of a contrary temper. General vituperation and abuse, originating in petty malice or personal designs, and sent abroad to poison the public mind, are

equally disgraceful and injurious. None are or can be so anxious to correct real evils as the Board itself, and here is the proper tribunal for investigation and trial.

GENERAL GOOD FEELING AT COLUMBIA.

Yet it is evident, that with the great body of the people at Columbia, the disposition toward the University, and its administration, is most excellent. They speak of the prosperity of the Institution with pride and satisfaction, and in the most commendatory terms of those whose labors have made it what it is.

IMPROVEMENTS OF THE YEAR.

Among the improvements of the year is to be named the very thorough repair of the Hudson house, which had become necessary—equally for its preservation and proper use.

WAITING ROOM FOR LADIES.

The fitting up and furnishing, in neat and appropriate style, a room in the main University edifice as a waiting-room for the use of the lady students, is a great addition to their comfort and means of improvement, and is not to be passed by in the mention of our progress.

LIBRARY.

It is much to be regretted that the regular additions to the general library, by annual purchase, have been discontinued, on account of a want of means. There have, however, been expended, during the year, about four hundred dollars in the purchase of books for special departments. Perhaps there is not a single feature which more strikingly characterizes an improving institution of learning than its increasing libraries. Books are, in fact, the very tools, both of students and professors, and any institution of learning without the means of the regular increase of libraries, is wanting in an essential element of prosperity.

REVIEW OF PAST DIFFICULTIES.

In order to present the University in a proper manner, it is necessary to look back upon the past, as well as forward to the future, to consider what has been done, and the means by which it has been done, as well as what remains to be done, and how continued progress and success are to be secured.

It is difficult for those men who have borne "the heat and burden of the day"—recent as are the events—fully to realize the labor, anxieties and struggles which they themselves have encountered to place the University on its present foundation; for others, it is impossible.

It is more than the old story of poverty-smitten institutions, for there was debt without the means of payment, unless by stopping the Institution, and that was its death.

Even two years after the war, not a dollar came to the University from the Seminary Fund; the Institution had to be run almost wholly upon credit. Professors had to be paid by warrants, which were sold at a large discount, and these, even, they received but once in six months. This state of things, evidently, could not continue. The building was deplorably out of repair in consequence of having been occupied by troops during our late civil war, and having received no repairs after an occupancy of *twenty-five years*. The roof leaky, the plastering falling from the ceilings of the rooms, the President's house in ashes, the fences around the campus falling down, the walks of oak board hardly passable! Many thousand dollars were required to put the University building in decent repair, to say nothing of other requirements, as furniture, library, apparatus and additional teachers; and the debt amounted to near $20,000.

BITTER PREJUDICES OF THE TIMES.

There were still other difficulties, if possible, even more discouraging. The most bitter prejudices existed against the Institution and the section of the State where it was located, with the political party then in power. It was almost impossible to find a hearing in its behalf before the Legislature; and, in fact, there had never been the habit of doing anything whatever for the Institution, and, beyond the gift of the Statutes and session acts, which were awarded equally to justices of the peace, *no appropriation had been made for the University of the State;* on the contrary, the very expenses of Curatorship had been charged to and paid from its small and inadequate income.

There had yet been established but the single department (the college, with the preparatory); and the number of students was so small that they assembled, at the morning meeting, in one of the recitation rooms, and the total entrances during the year (1867) were but eighty-seven!

REFUSAL OF THE CONSTITUTIONAL CONVENTION OF 1865 TO RECOGNIZE THE INSTITUTION, AS THE UNIVERSITY, TO BE SUPPORTED UNDER THE NEW CONSTITUTION.

The Constitutional Convention of 1865 had refused, by a large vote, to declare the University at Columbia the State University, to be recognized under the Constitution, and established and maintained as therein required. The purpose was to establish a new institution as such, elsewhere, upon the basis of the agricultural college land grant of 1862.

DEATH OF DR. LATHROP. NON-ACCEPTANCE OF DR. READ.

In August, 1866, occurred what seemed the crowning calamity, in the death of its excellent President, Dr. Lathrop. The present incumbent, Dr. Read, was soon after elected President; but without resigning the University chair, which he held elsewhere, came on to look over the ground, and, from his own observation, to judge as to acceptance. After spending some time in making his examination, when the Curators came together, in an exhaustive report, he showed, by an ample presentation of facts, statistics and arguments, what a State University, to be such in reality, must be; what kind of an endowment the State must give it; what the number of professors and departments of instruction it must have; and that, as the University had no funds to support it as such an Institution, he must decline to accept the place. He agreed, nevertheless, at the request of the Curators, to make the same presentation before the Legislature, and if that body would recognize the University as the Institution required, with departments under the Constitution, and also make a beginning toward establishing and maintaining it, he would accept. After making his appeal, he resumed his former position in another State, with little or no expectation that his requirements would be met.

GLOOMY APPEARANCES.

To those who understood the real condition of things, the aspect was, in the last degree, forlorn and hopeless. Where is the legislator so bold as to attempt to save the University from its fate, by any aid which can be secured under such circumstances? Can a Legislature, adverse in politics and in party sympathy, be induced, by any power of persuasion, to do for it what its party friends, in all past time, would never do, even in the smallest amount? Can the unfriendly feeling be removed? Can the evil spirit be exorcised? Yet it was done.

Let all credit be given to a Legislature which could rise above their party and political prejudices to advance a great cause.

FIRST GRANT EVER MADE BY THE LEGISLATURE.

The grand and notable day in the history of the University, ever to be remembered and celebrated as such, is March the 11th, 1867, when first the State recognized its obligation to render aid to the University, in the bill which then became a law, giving to the Institution $10,000 to rebuild the President's house, and appropriating for its support one and three-fourths per cent. of the State revenue, after deducting twenty-five per cent. for the public school fund. By this act, in the form in which it was made, there was given to the University an annual amount ranging from $12,000 to $14,000, a sum more than double its previous endowment. Soon after the Board of Curators were called together, and Dr. Read made his final acceptance of the Presidency. Whilst this appropriation was by no means sufficient to support such a University as required by the State Constitution, or by the demands of the age, it inspired hope and confidence, and was the beginning of the success and progress which since that time have attended the University in so remarkable a degree; and but for this appropriation, it may be safely said, there is little probability that subsequent grants would have been obtained, or the means secured for the improvements and enlargements which have so rapidly followed.

PROGRESS.

It is difficult to enumerate with the brevity necessary in this paper, the various steps of progress which have been made within the eight years since the State gave this its first aid, and we present some of them only for the purpose of encouragement and as a stimulus for continued and increased efforts.

The same progress maintained but for a brief decade of years will give Missouri a University which will stand with the very foremost of our country, and this surely ought to be the aim.

PRESIDENT'S HOUSE, NORMAL BUILDING, LIBRARY HALL, SCIENTIFIC BUILDING, ETC.

Within a shorter period in the past than a single decade, the main University building has been put in repair, at a cost, with its furnishing, of near $20,000; the Library Hall, a spacious and elegant room, has been fitted up and furnished; the Normal building has been constructed; the President's house has been erected; six club houses

have been built in order to afford the means of cheap boarding; the scientific building, one of the most valuable and elaborate structures of the kind in the country, has been built and equipped; the campus and gardens have been much improved.

INCREASE OF INSTRUCTIONAL MEANS.

The more direct means of instruction have been greatly enlarged. The library has grown from 2,000 volumes to 9,000; apparatus has been increased in a yet greater ratio, and some of this equal to any known to the scientific world; the number of professors and instructors has been increased, so that from five, it has increased to twenty-three at Columbia, and five in the School of Mines, at Rolla—making twenty-eight instructors connected with the University; the number of students has increased to more than 500—over 400 at Columbia, and over 100 at Rolla—and representing 80 counties in the State, instead of 20, whilst the increase in the age of students has been an average of not less than two years.

INCREASE OF ENDOWMENT.

The agricultural grant, after an unparalleled struggle, with the Boone county bonus, of 640 acres of land, including the Hudson house and other buildings, and also an adjustment of the trust fund held by the State, giving the Institution $6,000 a year increase of fund, are also amongst the fruits of this period—making a total present annual income of near $45,000, wholly the growth of these years of prosperity, except only the Seminary Fund of $6,000 per annum.

NOT SUFFICIENT FOR THE WORK UNDERTAKEN.

But when there is considered the work undertaken, the departments of instruction established, the means of instruction accumulated, the University was never so poor. The pressure upon its resources has been constant and extreme; nor was the University ever so pressed for means as at the present time. Indeed, in this general expansion, in the finishing and equipment of the scientific building, in the purchase of necessary apparatus, and the building of cottage houses for the accommodation of students of limited means, a debt of near $25,000, and which now rests upon the Institution, has been created. The rate of tuition also, it is to be borne in mind, has been so reduced, in order to bring the advantages of the University to the greatest number, that the increase of students brings comparatively but little increase of funds to the Institution. Besides, great liberality has been extended to those unable to pay anything.

EXISTING DEPARTMENTS OF INSTRUCTION.

The Schools or Departments of instruction constituting the University, which have within the period specified, been from time to time established, are the following, viz.: 1. The Normal or College of Instruction, opened September 16, 1868. 2. The Agricultural College, September, 1870. 3. The School of Mines at Rolla, November, 1871. 4. The Law College, October, 1872. 5. The Medical College, February, 1873. 6. The Laboratory for Analytical and Applied Chemistry, May, 1873.

With the enlargement of our Institution, and the increase of its departments its expenses must necessarily increase. A large *personnel* of instructors is required, more ability, and more instructional appointments in every direction. Harvard, and Yale, and Columbia College at New York, expend fourfold the amount they did *but ten years since;* and in their rapid advance, are more pressed for means, than ever before. No institution is stationary in its expenditures, except such as are non-progressive and *mediæval* in character.

RAPID PROGRESS, YET MUCH TO BE DONE.

We by no means assume to present an Institution perfect in its organization, or complete in its equipments, but we claim that there is no Institution in the country which has made more rapid progress towards a full University organization, or with the same means accomplished so much in the same time, and under more difficult circumstances. There is not a visitor of candor and intelligence who does not express astonishment and gratification at the accumulation of instructional means and forces here found. Yet there is much to be done. We have foundations good and strong. Columbia is a most excellent site, central in the State, accessible, already having many of the elements of a University town.

Additional means are indispensable to progress and development. *We have reached our utmost limit with our present means!* We are in the condition of many business establishments, which are crippled and half ruined for the want of a very small addition of capital. An addition of but one-fourth to our present income would not merely double our capacity of usefulness—it would make it fourfold greater than at present.

We wish to disguise nothing, but would make a true and faithful representation of facts. The people of Missouri must understand that they cannot have a University worthy of themselves, and abreast with the times, except at the cost required for all such institutions wherever existing.

EXAMPLES OF OTHER STATES.

Not only Michigan, but the whole West, indeed the whole country is proud of Michigan University. But what has made that Institution? It has an income of more than $100,000 a year, and besides has had large gifts from the State for special objects. We have precisely the departments of instruction which Michigan has, but not her means and equipments. Wisconsin makes the income of her University $61,000 a year, and gave it the last year $80,000, and two years before $50,000. She is treading closely upon the heels of Michigan, and in this noble race of intellectual renown, promises even to pass her. Not a legislature of Illinois has a session without making an appropriation to her University. It is not merely to the blind, the deaf and dumb, the lunatic, the demented, that this State makes her contributions; she extends the helping hand also to the youth of the State, who are to control her destiny, and make her as a commonwealth, whatever she is to be amongst the free States, and in the scale of civilization.

INCENTIVES.

Missouri has every incentive to furnish the highest literary and scientific instruction within her own borders. In the first place, we as a people, are sending, according to population, fewer of our youth abroad for higher education than any other State. The catalogues and statistics of the colleges and universities of the country show this. Let us then give to them the best advantages at home.

In the second place, there is not a State which has more riches in her soil, her minerals, her rocks, and her waters, the full development of which high science alone can give. Instruction of this character, required by our own wants, is the most costly of all in men and material of instruction. The number and cost of the teachers, the apparatus and machinery must be large in experimental and scientific education. The economic interests of the State, were there no other in the question, require that the University should be liberally endowed and sustained. The direct question of pecuniary results was well put some three or four years since by the chairman of the faculty of the Virginia University, in the following statement in regard to that university: He says, the grand total of all the expenditures of the State of Virginia for her University amounted to $1,044,304, while the amount brought into or retained in the State, by the University was $4,476,800. No investment ever made by that noble old State ever equalled that which she made in her University, estimating it by the moneyed standard alone.

There is not to-day an investment to any reasonable amount which Missouri can make, which will yield so large a return as judicious investments toward building up her University and sustaining its different departments.

The expenditure of Yale College last year was something over $253,000; that of Harvard much more; that of Columbia College, city of New York, over $200,000; the income of the two great English universities, Oxford and Cambridge, with their several colleges, was, as reported by the crown commissioner on the first of January, 1872, £754,405, or upwards of $3,500,000 in gold per annum! Does any one suppose that even these immense expenditures tend to impoverishment or deterioration?

INDUSTRIAL EDUCATION IN THE UNIVERSITY FOR THE PRODUCING CLASSES.

We have not the space to go into an argument in favor of industrial education and the sciences especially pertaining thereto, which form a leading object of our University. Something has been done by Congress in the land grant of 1862 toward the encouragement of this great national interest, and it is hoped that more will still be done. The bill introduced into the Senate by Hon. JUSTIN S. MORRILL, of Vermont, and now pending before Congress, making the grant of public lands for the common schools and for industrial education, and prepared with the greatest possible care, is one of the most enlightened and far-sighted measures ever proposed in Congress. Were indeed the whole national domain remaining unsold, excepting that reserved for actual settlers, sacredly appropriated, as provided in the Morrill bill, what nobler or more American-like disposition could be made of this great national trust?

A few statements, mostly selected and abridged from the address of the Hon. A. D. White, President of Cornell University, will come home forcibly to every thoughtful mind. Look at the U. S. census of 1870. The manufacturing product of that single year is there given at a grand total of ($2,053,996,000) more than two thousand millions of dollars, and there are more than two millions of persons employed in manufactures. Can education be made useful to this vast interest? How can it be made so? Look at the actual process. Young men come wishing to make themselves first-class mechanical engineers, or master mechanics; they are taught Mathematics in all their relations to Mechanics; in one room they are taught Mathematical and Mechanical Drawing; in another Free-hand Drawing; then they go into

the laboratory for chemical work—and a certain number of hours each day in well-worn aprons and rolled up sleeves they give to the work-shops and the handling and use of machinery, from the simplest to the most complicated. This is the plan actually carried out at Cornell and Illinois Universities. A part of this work is done here as well as it can be done anywhere, but we fail in essential parts. We want shops and machinery. We have sent out some of the very best engineers; and the Missouri State University is even now represented in the U. S. Coast Survey by one of the ablest and most scientific employes of that important national service! Will any one at this day presume to say, "can we afford in the University a place or the means for the kind of education represented in this department of industry?" Does this education represent a sufficient number of our people, or a sufficient tax-paying power, or sufficient respectability? Shall we not thrust it down and aside for a more elegant culture? Yet who is there understanding the progress of the world, that does not know that here is required the very highest science, as well as the most scientific application.

Again, the value of agricultural capital, according to the same census (that of 1870), was then the astounding sum of near ten thousand millions of dollars, and there were employed in agricultural industries six millions of the people of the United States! Can specific education do anything for this vast interest? If so, does it deserve any outlay of public means? One of the great dairymen of New York said to President White: "Prof. Caldwell's experiments on the Chemistry of the Dairy are worth more to the State than your whole endowment," and yet this is one of the smaller of the agricultural industries benefited. But some are pleased to say, industrial education does not benefit agriculture—it is of no use to the farmer. If this were so, agriculture is the pursuit least worthy a human being. But it is a slander upon the noblest of human pursuits. In no other pursuit is so wide a range of knowledge required—in no other pursuit does science yield so rich and ample fruits.

The whole history of agriculture shows the immense results of science upon this industry, which, in Missouri, employs more hands and minds, fourfold over, than all other industries and professions united. Yet, strange to say, there are men who presume to deride all efforts to make this pursuit more scientific. When Dr. White went abroad and brought home with him the most eminent veterinary surgeon of the world, Dr. LAW, formerly of the Royal Veterinary College,

as a Professor for Cornell University, it was said in derision: "Dr. White went to Europe to get a horse doctor." Yet, in New York there were over 800,000 horses, as there are, in Missouri, over 600,000. No one in New York, at this day, derides Dr. White's horse doctor. He has, by his instructions, illustrations and information, disseminated knowledge and conferred a benefit hardly to be estimated. HORATIO SEYMOUR adverts to another important consideration in favor of agricultural education—that of making agricultural pursuits more attractive and honorable—by making them more scientific—and thus attracting to agricultural life a larger number of our cultivated people.

But, again, the farmers, unless educated, will never have their proper weight in the social and political scale; a due proportion of them must have the special professional education, which the modern University, with its industrial department, is designed to impart. Mere clamor and complaint will never gain consideration. It will be freely accorded to education, to intelligence, to business qualification.

Professor Perry, the eminent political economist, is reported to have said: "There are, according to the census, 41,106 lawyers and 6,000,000 of farmers, and yet I could name one hundred of those lawyers who have more political influence in moulding the State and Nation than all the farmers." This statement may be somewhat rhetorical, but it is to be feared there is some foundation for it. Again we ask, shall there be provision in the University for agriculture as a science? Does this pursuit represent in the State sufficient numbers, wealth and tax-paying power, or does it require the aids of the highest science?

PROPER SUPPORT OF THE UNIVERSITY.

There is no one thing in regard to which the prevailing notions have more miserably fallen short, and especially in our own State, than as to the endowment of colleges and universities required to make them in any degree respectable. In order to prosecute scientific researches in our day there is required a great and continued outlay for books, for museums and scientific collections of various kinds, for apparatus and the means of experimental studies and exploration, and for the support of the men of learning and ability which these resources indicate. But the very word University implies an aggregation not merely of scholars of science, but of literature and art, and of professional and practical schools—it implies also growth and development with the advancement of human knowledge. It is just as absurd to attempt to propel the machinery of a vast manufactory with a ton of coal per year, as to found and conduct a Uni-

versity worthy of the name with the mere pittance, by many supposed to be an ample or even a magnificent endowment.

CONCENTRATION OF MEANS REQUIRED TO CREATE AND SUSTAIN A UNIVERSITY.

The one great thing needed above all others is concentration—this concentration in Missuori can be most effectively had upon present foundations, and in Columbia, which has grown to be the University town of the State; small additions here will do most toward the one great object. With present means and appointments, our University can soon be made to stand with the very best of the country. Harvard, Yale, Princeton, Cornell, Columbia and Michigan stand in advance of other institutions, simply because they have larger endowments, more professors and ampler equipments. Much we do just as well as even these renowned institutions. We have professors as able as elsewhere to be found; our laboratory is not surpassed; some of our apparatus and means of illustrations is just as perfect as is found in Europe. But we are still crippled in our departments for the want of instructional forces, of books and apparatus. We are by no means to be discouraged because we have not all that these great institutions have. The history of Michigan, of Cornell, and our own as well demonstrate that "hoary age" is not necessary to success. Even our oldest institutions are of recent growth. Neither Yale nor Harvard fifty years ago had our present income, nor our number of instructors. All the world over the universities are becoming new institutions. University reform is almost as much the cry as political reform. In our country a University would die out upon what a few years since would have been an ample support.

GOVERNING PRINCIPLES OF ACTION.

The Board, as a body, have in these years had constantly before them the following, as governing principles of policy:

1. To keep the University perfectly free from complications of party politics and sectarian religion.

2. To adapt the University to the peculiar needs of Missouri, by giving it that scientific cast required by our special circumstances; also, while furnishing the highest instructions in various departments for the scholar, also to afford instruction to a large class who require shorter courses to prepare themselves for specific pursuits.

3. To give the largest practicable liberty of choice in the selection of studies, according to the most advanced ideas of the day, a

system commenced in the University of Virginia, and now in a greater or less degree, adopted in all our leading institutions.

4. To admit women students to classes as they may desire; to keep the expenses of University education at the lowest practicable point to the student, by diminishing the rate of tuition one-half, and providing the means of cheap boarding.

5. To aid and encourage our local and denominational colleges, by opening the doors of the University, *without money and without price*, to their graduates, in order that they may avail themselves of the larger educational means afforded by the State in the University. In short, it has been a settled policy to make the University an Institution for the whole of Missouri, and not for any section, party, or partizan clique.

CLOSING APPEAL.

In concluding this paper, Governor, the undersigned cannot withhold the expression of his personal feelings and convictions in regard to the nobility, nay, the absolute grandeur of the enterprise in which we are engaged. While it was his lot, some months since, to visit several of the most noted of our Institutions of learning, and freely conversing with many of our distinguished Educators, he not only took in larger and more practical views, but inspired new courage and hope, in the effort to place our own University side by side with the first in the country. His convictions became strengthened that this can be very speedily done, by adding as compared with the object, but a small degree of expenditure each year.

While making examinations and comparisons, he felt also more strongly than ever, how good and great the work we have already done; and that if he could himself bear some humble part in founding and perfecting our University, as a monument for our State and generation, he would have fulfilled his largest hopes of benefitting his fellow men.

In submitting to your Excellency the report of the year, as required by law, the Board desires, at this turning point in our history, to make its appeal to the people of the State, to the Executive, to the Legislature, and to the Constitutional Convention now in session, and which has in its hands so largely the moulding of our institutions, that the University, coeval as it is with the State, recognized in the first Constitution, and in each Constitution since adopted or proposed, and provided for (however inadequately) as a part of the commonwealth, having its origin in the seminary lands, the parting gift of the parent government when Missouri entered the sisterhood of States;

that the University of the State, with such associations clustering around it, receive the consideration and fostering care that our early Missouri statesmen evidently intended; that it be guarded and held as a sacred trust, and that its means of usefulness be enlarged according to the advancing wealth, intelligence, and refinement of the people, and that as designed, it be made the crowning glory of our system of public education.

This board, selected by your Excellency, with the advice and consent of your constitutional advisers, to represent this important interest of the State, and to be its guardians and curators, make in its behalf this earnest appeal and memorial.

In behalf of the Board of Curators,

JAMES S. ROLLINS,
President.

UNIVERSITY OF THE STATE OF MISSOURI, COLUMBIA, MAY 18, 1875.

CONSTITUTIONAL AND LEGAL REQUIREMENTS.

PROVISION OF THE CONSTITUTION.

The State of Missouri, in devising a scheme of public education, provides in the Constitution as follows:

"SEC. 1. A general diffusion of knowledge and intelligence being essential to the preservation of the rights and liberties of the people, the General Assembly shall establish and maintain free schools for the gratuitous instruction of all persons in this State between the ages of five and twenty-one years."

"SEC. 4. The General Assembly shall also establish and maintain a State University, with departments of instruction in teaching, agriculture, and in natural sciences, as soon as the public school fund will permit."

Thus it will be seen, the State has made free schools and a University part of the same system; and the object is declared in the preamble of the provision on the subject, to be a "general diffusion of knowledge and intelligence," and this as "essential to the preservation of the rights and liberties of the people." The end to be secured is the highest possible one that can be held up before a free people.

CONGRESSIONAL ACT OF 1862 FOR THE ENDOWMENT BY A LAND GRANT OF A COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

"The leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

The leading object is declared to be "*to teach such branches of learning as are related to agriculture and the mechanic arts*"—mani-

festly, not merely agriculture and the mechanic arts, but the branches of learning related thereto.

This endowment of land for a College of Agriculture and Mechanic Arts was accepted by a resolution of the Legislature passed unanimously, and approved March 17, 1863, in the following terms:

"*Resolved by the General Assembly of the State of Missouri*, That the said act of Congress of the United States is assented to and accepted by the State of Missouri, with all the conditions, restrictions and limitations therein contained; and the faith of the State of Missouri is hereby pledged for the faithful performance of the trust hereby created."

The State, by its act of acceptance, guarantees the capital of the fund, so that if, by any action or contingency, it shall be diminished or lost, the State is bound to replace it.

"No part of the fund nor the interest thereon shall be applied, directly or indirectly, under any pretence whatever, to the purchase, erection, preservation or repair of any building or buildings."

This makes it necessary that the State should provide buildings. It is most honorable to our American States, East and West, that they have liberally provided, under the requirements of the Congressional act, not only buildings but apparatus, libraries, stock for farms, and other material aids of instruction.

HISTORY AND PROGRESS.

The existence of the University is originally due to the liberal policy adopted by the Congress of the United States in regard to the new States upon their admission into the Union. Its enlargement by the addition of the College of Agriculture and Mechanic Arts, and the establishment of the School of Mines at Rolla, is due to the Congressional land grant of 1862, and the subsequent act of the State Legislature to carry the same into effect, approved February 24, 1870.

Upon the admission of Missouri as a State in 1820, the grant of two townships of land, for the support of a seminary of learning, was made by Congress, in accordance with the settled policy of the General Government, and the State Legislature became the trustee for the management of the land and the proper application of the funds arising therefrom.

The lands of the grant, known as "Seminary Lands," were mainly situated in the county of Jackson, and were among the best in the State.

By an act passed in the year 1832, the Legislature made provision to offer them for sale at a minimum price of $2 per acre. The result of this legislation was that barely $70,000, after expenses paid, was realized from these magnificent lands, worth, at the time of sale, a half million of dollars.

The sum thus originating was invested in the stock of the old Bank of the State of Missouri. When it had grown by accumulation to the sum of $100,000, the question of instituting and locating the University began to be agitated.

In the year 1839, an act was passed "to provide for the institution and support of the State University, and for the government of Colleges and Academies." This act, drafted by Henry S. Geyer, a distinguished lawyer, and afterwards United States Senator, was very elaborate, consisting of five articles, and provided for colleges and acade-

mies in different parts of the State, to be connected with the State University, and to be under the visitorial power of its Curators.

This idea of a State University, with branches and subordinate institutions scattered over the State, was a favorite one with many distinguished men in the earlier history of the country, and was placed upon the statue book of several of the States; but the plan was found cumbrous, and too unwieldy to be carried out into practice, and was abandoned wherever projected.

In the same year an act was passed making provision for selecting a site for the University. This act was drafted by the Hon. James S. Rollins, at that time the Representative of Boone county in the Legislature, and who has since so honorably distinguished himself by his efforts in behalf of the Institution.

The act provided that the site should contain at least fifty acres of land, in a compact form, within two miles of the county seat of the county of Cole, Cooper, Howard, Boone, Callaway, or Saline.

Five commissioners were appointed to select the site, viz: Peter H. Burnett, of Clay; Chancey Durkee, of Lewis; Archibald Gamble, of St. Louis; John G. Bryan, of Washington, and John S. Phelps, of Greene.

The Commissioners by the terms of the law were to meet in the City of Jefferson, on the first Monday of June, 1839, and thereafter at the county seat of each county mentioned, to receive conveyances of land and subscriptions of money as bids. After visiting all the county seats and receiving bids as required, the commissioners were to return to the seat of government and open the bids; "and the place presenting most advantages, keeping in view the amount subscribed, the locality and other advantages," was to be entitled to the location.

A bonus was offered by citizens of Boone county for its location at Columbia, the county seat, amounting to $117,500; the offer was accepted by the Commissioners, and the University accordingly located there on the 24th of June.

On the 4th day of July, 1840, one year from the location, the corner-stone of the present principal University edifice was laid, in the midst of great pomp and ceremony. The address of the ocasion, said to have been most impressive and eloquent, was delivered by the Hon. James L. Minor, of Jefferson City.

In the year 1840, the late John H. Lathrop, LL. D., then a Professor of Hamilton College, New York, was elected the first President of the University.

The first class, consisting of two members, graduated in 1843. Although the Institution was reasonably flourishing, few students

reached the attainments required for their graduation. This is, in fact, a usual condition in our Western institutions of higher education; nor is the amount of good which they accomplish to be measured by the number of those who complete the full course and attain graduation.

In the year 1850, Dr. Lathrop resigned his position as President of the University, and the Rev. James Shannon, LL. D., became his successor, and continued President six years.

Professor W. W. Hudson succeeded Dr. Shannon, and upon his death, B. B. Minor, Esq., then of Richmond, Virginia, was elected President and continued in office about two years, when, in the troubles of the civil war, the Institution was suspended, and its buildings occupied by United States troops. A portion of the Professors remained on the ground, and soon resumed their instructions, so far as they had students, and circumstances permitted. In 1863 there was one graduate, and the next year two, and in 1865, five. In this year Dr. Lathrop was again elected President, having in 1860 returned to the University, being elected Professor of English Literature.

Soon after the death of Dr. Lathrop, which occurred in the summer of 1866, the present incumbent, Daniel Read, LL. D., was unanimously elected the President.

THE GENERAL PLAN.

The general plan adopted by the Board of Curators, April, 1867, was intended to meet the actual condition and educational wants of the people of Missouri, and was as follows, viz:

"1. To retain substantially the usual college curriculum for those who desire that course.

"2. To enlarge and perfect the scientific course.

"3. To establish and maintain the College of Agriculture and Mechanic Arts, which, in addition to instruction in agriculture, horticulture, etc., with the appropriate exhibitions and experiments (including military tactics), shall embrace: *First*, a School of Engineering; *second*, a school of analytical chemistry; and *third*, a School of Mining and Metallurgy.

"4. A Normal School.

"5. A Law School.

"6. A School of Preparation for other departments. This will be necessary in the present condition of education in the State, and may form a part of the Normal School.

"7. The University to be expanded by instituting colleges of applied science, or professional departments, as its means will permit or the wants of the State demand.

"8. The constant annual accumulation of the materials of education, as books, apparatus, cabinets, models, etc.

"9. The different departments of instruction to be so adjusted to each other, and *dovetailed*, as to economize labor and material, and thus render the instruction most effective to the largest number, and save means for the enlargement of the University and the increase of its facilities.

"10. A judicious economy in all departments, that there may be improvement in all, and the accumulation, year by year, of those educational means and appointments which belong alike to all departments and increase the general prosperity."

THE UNIVERSITY ORGANIZATION.

In pursuance of this plan the University is at present organized with the following departments or colleges, established from year to year, as the means of the Institution would permit:

I. *The College Proper.*

This department has been retained, and is now organized with as full and complete a course in the classical and modern languages, in mathematics, in literature, and in the natural sciences, as is known in any of our American colleges; and the ablest instructors have been secured to carry out this course of instruction.

The studies are adjusted in four courses, viz: Those of Arts, Science, Letters and Philosophy—so as to allow as large a liberty of choice, as to studies, as may be consistent with the college idea, and at the same time award an appropriate degree, according to the course pursued.

The professional schools, now forming a part of the University, are the following, viz:

II. *The Normal, or College of Instruction in Teaching.* Opened Sept., 1868.

III. *The Agricultural and Mechanical College.* Sept., 1870.

IV. *The School of Mines and Metallurgy*, at Rolla. Nov., 1871.

V. *The College of Law.* Oct., 1872.

VI. *The Medical College.* Feb., 1873.

VII. *The Department of Analytical and Applied Chemistry.* May, 1873.

DEPARTMENTS STILL NEEDED.

In the progressive development of the Institution, there are still other departments needed, in order to make a complete and well-rounded University of liberal and practical education. Among these are:

1st. *The College of Mechanical Arts.*—It is due the mechanics of the State that they should be recognized in the University system of the State, and that instruction should be furnished them pertaining to the mechanic arts. Besides, the Congressional land grant was equally for the benefit of a college of mechanics and agriculture. Nothing has been done in this direction for the want of means, and in this we are behind.

2d. *A College of Fine Arts*, embracing Drawing, Landscape Gardening, etc., auxiliary to other departments, and also for independent students in the arts of design. All art collections would properly belong to this department.

3d. *The Department of Engineering*, for special and professional instruction.

4th. *Provision for Architecture and Construction* must also be made as a part of an industrial system, without which an important branch of practical and æsthetic culture is wanting.

GOVERNMENT OF THE UNIVERSITY.

The present organization of the University, as established by the Legislature, provides for a Board of Curators, consisting of thirteen members, three of whom shall be chosen from the county of Boone; two from the county of Phelps; four from that part of the State lying north of the Missouri river, outside of the county of Boone; and four from that part of the State lying south of said river, outside of the county of Phelps. They are appointed by the Governor and confirmed by the Senate.

"They have power to make such by-laws or ordinances, rules and regulations, as they may judge most expedient for the accomplishment of the trust reposed in them, and for the government of their officers, and to secure their accountability."

The Curators appoint the President, professors and tutors, no one of whom is permitted to preach or exercise the functions of a minister of the Gospel, or of any one of the learned professions, during his continuance in office.

The manifest object of this provision is to secure a Board of Instruction for the University, who shall be professional teachers, and devoted to their profession as such; and not men belonging to some other profession and exercising its duties.

The duty of the President of the University, as defined by the act of incorporation, is, "among other things, to superintend and direct the care and management of the Institution and its grounds, and to make and transmit to the Curators, at each annual meeting thereof, a report of the state and condition thereof, containing such particulars as the Curators shall require."

There is also provision for a Board of Visitors, five in number, three of whom shall be gentlemen distinguished in agriculture or the mechanic arts, and two of whom shall be graduates of the University.

This last Board is required to meet at least once each year, to make personal examination into the condition of the University in all its departments, and to report to the Governor, suggesting such improvements and recommendations as they consider important, which report shall be published with the annual Report of the Curators.

BOARD OF CURATORS.

JOHN S. CLARKSON, Esq.....Columbia.
LUTHER T. COLLIER, Esq.....Chillicothe.
Hon. NORMAN J. COLMAN.....St. Louis.
Hon. JERRE C. CRAVENS.....Springfield.
Hon. H. CLAY EWING.....Jefferson City.
JOHN A. FLOOD, Esq.....Fulton.
Dr. WM. E. GLENN.....Rolla.
Dr. S. H. HEADLEE.....St. James.
Judge JOHN HINTON.....Columbia.
Col. JOHN E. HUTTON.....Mexico.
Hon. JOSHUA LADUE.....Clinton.
Col. ROBERT F. LAKENAN.....Hannibal.
Hon. JAMES S. ROLLINS.....Columbia.

OFFICERS OF THE BOARD.

Hon. JAMES S. ROLLINS, *President.* Dr. Wm. E. GLENN, *Vice-President.*
R. L. TODD, *Secretary.* R. B. PRICE, *Treasurer.*
Dr. PAUL HUBBARD, *Business Agent.*

VISITORS.

(UNDER APPOINTMENT OF THE GOVERNOR.)

J. V. C. KARNES, Esq.....of Kansas City.
Hon. CYRUS S. BROWN.....of Shelby county.
Col. ALEX. F. DENNY.....of Randolph county.
CHARLES E. LEONARD, Esq.....of Cooper county.
Hon. E. W. FOX.....of St. Louis.

UNIVERSITY FACULTY AND INSTRUCTORS.

DANIEL READ, LL. D., PRESIDENT,
Professor of Mental, Moral and Political Philosophy.

JOSEPH G. NORWOOD, M. D., LL. D.,
Professor of Physics and General Chemistry, and Dean of the Medical Faculty.

JOSEPH FICKLIN, PH. D.,
Professor of Mathematics, Mechanical Philosophy and Astronomy.

ERASTUS L. RIPLEY, A. M.,
Principal of College of Normal Instruction.

GEORGE C. SWALLOW, M. D., LL. D.,
Professor of Agriculture, Geology and Botany, and Dean of the Agricultural Faculty.

CHARLES P. WILLIAMS, PH. D.,
Director and Professor of General and Analytical Chemistry and Metallurgy. (Mining School.)

COL. JAMES W. ABERT, A. M.,
Professor of Applied Mathematics and Drawing. (M. S.)

PAUL SCHWEITZER, PH. D.,
Professor of Analytical and Applied Chemistry.

EDWARD HENRY TWINING, A. M.,
Professor of Latin Language and Literature.

JOHN MOORE LEONARD, PH. D.,
Professor of Greek Language and Comparative Philology.

HON. PHILEMON BLISS,
Professor of Law and Dean of Law Faculty.

HON. BOYLE GORDON,
Professor of Law.

THOMAS ALLEN ARNOLD, M. D.,
Professor of Anatomy and Practice.

ANDREW W. McALESTER, M. D.,
Professor of Surgery, Materia Medica and Diseases of Women and Children.

GEORGE D. EMERSON, M. E.,
Professor of Civil and Mining Engineering. (*M. S.*)

SAMUEL S. HAMILL, A. M.,
Professor of English, History and Elocution.

MISS MARY BRICE READ,
Teacher of the German and French.

SCOTT HAYES, B. S., B. AG.,
Assistant Professor of Agriculture.

WM. A. CAUTHORN, A. M.,
Assistant Professor of Mathematics.

R. W. DOUTHAT, A. M.,
Professor of English Branches.

JAMES S. YANTIS,
Assistant Professor of Mathematics (*M. S.*)

CHARLES V. RILEY, A. M., STATE ENTOMOLOGIST,
Lecturer on Entomology.

HON. ARNOLD KREKEL, U. S. DISTRICT COURT,
Lecturer on the Jurisdiction of the Federal Courts.

HON. HENRY S. KELLEY,
Lecturer on Criminal Jurisprudence.

WILLIAM E. GLENN, M. D.,
Lecturer on Anatomy, Physiology and Hygiene. (*M. S.*)

JOHN H. DUNCAN, M. D.,
Instructor in Physiology and Chemistry, and Demonstrator of Anatomy.

WOODSON MOSS, M. D.,
Instructor in Anatomy and Practice of Medicine, and Demonstrator of Anatomy.

ROBERT FAGAN, B. S.,
Assistant Instructor in the Law of Real Estate and Contracts.

Miss LULIE GILLETTE, B. S.,
WILLIAM S. PRATT, A. M.,
CALEB L. BUCKMASTER,
Instructors in Normal and Preparatory Studies.

A. W. HARE,
Assistant in Preparatory Department. (*M. S.*)

Dr. J. G. NORWOOD,
Librarian.

Prof. SCOTT HAYES,
Assistant Librarian.

Prof. E. H. TWINING,
Secretary of the Faculty.

STUDENTS.

RESIDENT GRADUATES.

Badger, Baker Wood, B. A.	Columbia.
Davis, George F. B., Ph.	Columbia.
Duncan, John Harris, M. D.	Medical Department.
Moss, Woodson, M. D.	Medical Department.
Riggs, Brutus, B. S.	Sturgeon.
Sandusky, John Wesley, A. M.	Columbia.

SENIORS.

Babb, James Franklin	Columbia.
Buckmaster, Caleb Lockwood	Columbia.
Chamberlain, Arthur Wallace	St. Louis.
Early, Thomas Crede	Bolivar.
Laughlin, Napoleon Bonaparte	Columbia.
Miller, Frederick Jacob	Spickardsville.
Welborn, Edward Livingston	Aullville.
Wilson, David McConaughy	Milan.

JUNIORS.

Aldrich, Ida Dickson	Columbia.
Babb, Henry Belton	Columbia.
Babb, Jeremiah Glenn	Columbia.
Burnam, Curtis William	Columbia.
Burroughs, George Winfield	Columbia.
Castlio, Mitchell	Mechanicsville.
Dimmitt, Ella	Woodlandville.
Evans, Tyson Dines	Columbia.
Field, John Hardin	Columbia.
Halstead, Nathaniel Wickliffe	Breckenridge.
Hoffmann, Louis	Bay.
Johnston, Augustus Menefee	Chillicothe.
Letcher, Rule	Marshall.
Orr, Robert Jamison	Columbia.
Payne, Willie Elbridge	Bridgeton.
Rozzelle, Frank Finley	Breckenridge.
Russell, Julia	Columbia.

Sherman, Henry Edwin.....Columbia.
Sherman, James Silas.....Columbia.
Timmons, Winfield Scott.....Carrollton.
Wilson, John Henry.....Pleasant Hill.

Cutright

SOPHOMORES.

Austin, Frank Roselle.....Hamilton.
Boulton, Robert Perrine.....Columbia.
Brown, Frank Mullins.....Shamrock.
Catron, Adolphus Thomas.....Waverly.
Codding, Elroy Edward.....Sedalia.
Collins, James Johnson.....Columbia.
Cutright, Henry Theodoric.....Columbia.
Douglass, Alexander Edwards.....Columbia.
Hardeman, John Locke.....Gray's Summit.
Hayes, Edward Benjamin.....Columbia.
Hayes, Trew.....Columbia.
Hultz, Manlius Ezra.....Columbia.
Jones, Elijah.....DeKalb.
Jones, Wiley.....DeKalb.
Lipscomb, Thomas Wood.....Palmyra.
McChesney, Arthur Clay.....Mt. Hope.
Mudd, Lloyd Dorsey.....Millwood.
Peters, Laura Agnes.....Plattsburg.
Phillips, Emmett Everett.....Sedalia.
Robinson, William Henry.....Paris.
Steffens, George.....St. Louis.
Tindall, Cordell.....Rocheport.
Vallandigham, Luther Mathenis.....Columbia.
Whitworth, Thomas Alexander.....Aullville.
Withers, Sylvester Richard.....Pierce City.

FRESHMEN.

Agnew, William Stephen.....East Lynne.
Alexander, William Martin.....Columbia.
Beatty, John William.....Mexico.
Bell, Victor Bee.....Kansas City.
Bogy, Joseph Francis.....Ste. Genevieve.
Bond, James Alexander.....Craig.
Booth, Andrew Barbee.....Millspring.
Bradley, John Sexton.....Sturgeon.
Bruton, Philip.....Columbia.
Clay, Benjamin Franklin.....Columbia.
Cowherd, Walker.....Waverly.
Davis, Earnest.....Plattsburg.
Dollis, George Washington.....Kearney.
Duncan, John Hudson.....Columbia.
Garnett, Gordon Newton.....Columbia.
Garnett, Joseph Herndon.....Miami.

Garnett, Reuben Brodie.....Columbia.
Gill, Nathaniel Boone.....Wittenberg.
Gould, Nellie Ethelinda.....Hannibal.
Graves, Hugh Irvine.....Fairville.
Graves, Ralph Toucey.....Fairville.
Harris, Curtis Otis.....Wellington.
Hayes, Ida.....Columbia.
Hertich, Augustus.....Ste. Genevieve.
Hoffman, Gustavus Adolphus.....Sidney.
Houchens, Ella Haseltine.....Sturgeon.
Huffaker, John William.....Brookfield.
Jamison, Charles Franklin.....Columbia.
Johnson, Laura Alice.....Columbia.
LaForce, William Mosby.....Carthage.
Lapsley, Thomas Clelland.....McAfee, Ky.
Lincoln, Newton Hockaday.....Kearney.
McBaine, John Turner.....Columbia.
McPike, James Edward.....Curryville.
McQuitty, William Fielding.....Columbia.
Marshall, William Boyd.....Columbia.
Martin, Arthur.....Oronoga.
Merrill, Robert Nicholas.....Kearney.
Nickell, John Hardin.....Sue City.
Riggins, James Wyatt.....Sedalia.
Riley, John James.....Jacksonville.
Rollins, Frank Blair.....Columbia.
Rozier, Edward Amable.....Ste. Genevieve.
Scott, Adolphus Gustavus.....Columbia.
Singleton, De Pat.....Columbia.
Smith, Frederick.....St. Louis.
Swindle, John.....Corsicana.
Taylor, Edward Gibson.....Dirk.
Traylor, Lucius Marquis.....Cape Girardeau.
Turner, William Edwin.....Wellsville.
Wade, John William.....Sturgeon.
Wilkes, Lewis Bryan.....Columbia.
Williams, John Canales.....Sedalia.
Wilson, Horace Everett.....Marshall.
Yeager, Edward Rufus.....Palmyra.
*Youngs, William Edgar.....Aullville.
Wright, Daniel Webster.....Frankford.

PREPARATORY.

Ainsworth, William Levi.....Pleasant Hill.
Allison, John Alexander.....Medoc.
Austin, Asa Sylvester.....St. Charles.

* Deceased.

Banks, Hartley Hopson.....Columbia.
Banks, Jane Moore.....Columbia.
Banks, Laura Alice.....Columbia.
Banks, William Rochester.....Columbia.
Barlow, George Washington.....Bethany.
Bates, James Parker.....Columbia.
Beckmann, Frederick William.....Morrison Station.
Beckmann, Henry.....Morrison Station.
Belcher, John Newby.....Rocheport.
Bennett, Genevieve Davis.....Concord.
Berry, William Wallace.....Trenton.
Beyersdorf, Franklin.....Bœuf Creek.
Bird, Robert Emmett.....Rockport.
Blanchard, John Milton.....Columbia.
Boggs, Tyre Harris.....Rocheport.
Bonham, Vaughn Q.....New Franklin.
Boswell, Samuel W.....Hendricks' P. O., E. Va.
Bowling, Charles Brightberry.....Columbia.
Brooks, Florence.....Columbia.
Brooks, George Harston.....Middlegrove.
Broughton, Maggie A.....Columbia.
Brown, Baxter.....Fayetteville.
Burgwin, Abner Benton.....Columbia.
Burgwin, William Samuel.....Columbia.
Burney, Charles Fremont.....Peculiar.
Burney, James Travis.....Peculiar.
Burroughs, Sallie Ada.....Columbia.
Burton, Benjamin Franklin.....Sturgeon.
Burton, Oscar Emsly.....Middlegrove.
Butler, John Thomas.....Silver Creek, Miss.
Cable, Charles Chauncy.....Everett.
Callahan, David.....Waverly.
Callison, John Gillespie.....Knob Noster.
Carlisle, Ellena B.....Columbia.
Campbell, Robert Henry.....Dover.
Cason, George Isaac.....Columbia.
Cason, Minnie Belle.....Columbia.
Chinn, Eugene.....Fayette.
Clark, Eli Simpson.....Mound City.
Clark, Robert Joseph.....Columbia.
Clinkscales, Emmett Clayton.....Columbia.
Coffman, George Washington.....Haynesville.
Cohick, James Fillmore.....Bridgton.
Conrad, Sallie Nicholas.....Columbia.
Copeland, Edward Byron.....Columbia.
Courtney, James William.....Dresden.
Craycroft, Rose.....Chillicothe.
Crayne, Joseph Wells.....Providence.
Crenshaw, James Colman.....Charleston.

Crenshaw, John Vincent ..... Columbia.
Cromwell, Addie Davis ..... Columbia.
Crumbaugh, James Edward ..... Columbia.
Davis, Henry Bascom ..... Howland.
Dawes, John William ..... Marshall.
Dewitt, William Henry Webster ..... Milan.
Dorsett, Larkin Taylor ..... Everett.
Douglass, James Robert ..... Frankford.
Douglass, William Joseph ..... Louisiana.
Drummond, Joseph Hudson ..... Warrensburg.
Dusenbury, Robert Depew ..... Columbia.
Elkins, Samuel Hobbs ..... Santa Fe, N. M.
Ellington, William Marshall ..... Columbia.
Evans, Eva ..... Rocheport.
Evans, Lanius Duane ..... Columbia.
Farr, Lorenzo Dow ..... Carrollton.
Feagans, Orashia Burr ..... Lamonte.
Fenton, Martha Ann ..... Columbia.
Fenton, Virginia Letcher ..... Columbia.
Ficklin, Octavia ..... Columbia.
Field, Elizabeth McDowell ..... Columbia.
Field, Fannie Provines ..... Columbia.
Fink, Richard M ..... Lamar.
Flynn, James Thomas ..... Holden.
Freund, Jacob Adolphus ..... Kiddville.
Fristo, John D ..... Waverly.
Games, John Craig ..... Concord.
Games, William Henry ..... Concord.
Garnett, Virginius Lee ..... Columbia.
Gentry, Mary Neill ..... Columbia.
Gentry, Richard White ..... Sedalia.
George, Thomas Carroll ..... Everett.
Gillette, Zella Charlotte ..... Hannibal.
Gray, Alexander Harney ..... Dresden.
Green, William Turley ..... Medoc.
Greer, Jerome Bonaparte ..... Fayetteville.
Greer, William A ..... Fayetteville.
Haley, Walter Lenoir ..... St. Joseph.
Hall, Robert Henry ..... Columbia.
Hamill, Harry ..... Columbia.
*Hamner, Cummins Asbury ..... Columbia.
Harnett, William Attwell ..... Flint Hill.
Harris, Dieugueid Randolph ..... Wellington.
Harris, Overton ..... Columbia.
Hartman, Anne V ..... Columbia.
Haydon, Clemmie ..... Columbia.
Haydon, Mary Samuel ..... Columbia.
Hayes, Gretta ..... Columbia.

* Deceased.

Hayes, Kate.....Columbia.
Hayes, Lee.....Columbia.
Hill, Ezra Philip.....Cambridge.
Hoffman, Lloyd William.....Fayetteville.
Holmes, May.....Columbia.
Hopper, John Frank.....Marshall.
Houchens, Laura Boardman.....Sturgeon.
Houchens, Marilda Elizabeth.....Sturgeon.
Hudspeth, Joseph Lamartine.....Blue Mills.
Hughes, Horace Carter.....Denver, Col.
Hulett, Robert Franklin.....Hallsville.
Hull, Frank Wilber.....Sedalia.
Hume, Cora Lena.....Columbia.
Hume, George.....Columbia.
Hunter, Shapley Richard.....New Madrid.
Jackson, Jemima Susan.....Columbia.
Jackson, Kate.....Columbia.
Jackson, Rebecca Jane.....Columbia.
Jamison, Haskall.....Columbia.
Jennings, Archer Payne.....Columbia.
Johnson, Charles Beattie.....Shreveport, La.
Jones, Conway.....Versailles.
Jones, James Amber.....Independence.
Kitchen, Ralph.....Kansas City.
Kyle, Absalom.....Graham.
Lamb, Alfred William.....Hannibal.
Leavelle, Leonidas.....Kearney.
LeCompte, Adria Enna.....Moberly.
Leonard, John Wesley.....Moberly.
Leonard, Mollie R.....Moberly.
Littrell, Charles Franklin.....Warrensburg.
Lonsdale, Frank Stewart.....Columbia.
Lougeay, Mary V. M.....Columbia.
Lukens, Fannie H.....Columbia.
Luttrell, Samuel Lee.....Blue Springs.
McCune, Jimmie Green.....Spencersburg.
McCutchen, James Welton.....Pilot Grove.
McPike, Thomas Jefferson.....Curryville.
Mantz, Harry Prescott.....St. Louis.
Matthews, Charles.....Columbia.
Mead, Thomas Olin.....Cambridge.
Morris, John Franklin.....Versailles.
Morse, Frederick Henry.....Columbia.
Morse, George Milan.....Columbia.
Moss, Joseph Samuel.....Columbia.
Nattress, Hattie Estelle.....Columbia.
Nickell, Walker Willis.....Sue City.
O'Rear, Frank Howard.....Marshall.
Payne, Jacob James.....Index.

Phillips, Joseph Leslie.....Columbia.
Popplewell, William Compton.....Columbia.
Potts, Edward.....Columbia.
Powers, James Rhodian.....Columbia.
Prather, Philip Dollarhide.....Columbia.
Preston, James Andrew.....Perryville.
Renner, Sarah.....Graham.
Renner, Tobias.....Graham.
Ringer, William Russell.....Newark.
Ripley, Helen E.....Columbia.
*Robinson, Charles Alexander.....Millwood.
Robnett, Lou Baker.....Columbia.
Robnett, William Howard.....Columbia.
Roby, Thomas Aquilla.....Peculiar.
Rogers, Lenoir Stanton.....Columbia.
Rogers, Millard Fillmore.....Columbia.
Romero, Serapio.....Las Vegas, N. M.
Rucks, Arthur.....Greenville, Miss.
Runyan, Eugene Burr.....Columbia.
Runyan, Justin Aaron.....Columbia.
Russell, Linnie Eolia.....Columbia.
Russell, Walter Thomas.....Columbia.
Sampson, John Alfred.....St. Louis.
Scott James.....Columbia.
Sexton, George.....Columbia.
Sexton, Sallie Nettie.....Columbia.
Shannon, Lenoir Douglass.....Jeffersonville, Ga.
Shelby, Joseph.....Lexington.
Shields, Elias Dorsey.....Columbia.
Simpson, Richard Warmach.....Chain of Rocks.
Sitton, Charles Kinchen.....Chain of Rocks.
Sloan, Milton Fackler.....Platte City.
Smith, Allie Gly.....Columbia.
Smith, Daniel Jonathan.....Wittenberg.
Smith, Eva Iona.....Columbia.
Talley, Edwin Preston.....Wentzville.
Tandy, Ephraim.....Columbia.
Tapley, Joseph.....Spencersburg.
Tate, George Washington.....Lone Jack.
Taylor, DeWitt Clinton.....Pond P. O.
Tharp, William Smith.....Milan.
Thomas, Edward Jacob.....Columbia.
Thomas, Victoria Royale.....Columbia.
Tipton, William Reuben.....Columbia.
Van Horne, May Eliza.....Columbia.
Vermillion, Melvin Enoch.....Middletown.
Vernon, Charles D.....Brookfield.

* Deceased.

Whitton, Worley Lease.....Mexico.
Wilkes, Edmond.....Columbia.
Wilson, Charles Burr.....Wetz.
Winston, Rufus Ripley.....Hickman, Ky.
Wolff, Ferdinand Otto.....Utopia.
Woodson, Robert Silbern.....Chain of Rocks.
Womack, Nowlin.....Fulton.
Youngs, Marcus.....Aullville.

ELECTIVE.

Andrae, John Daniel.....St. Louis.
Burrus, Ninian Edward.....Fayette.
Farwell, Adelia Adelaide.....Columbia.
Fleming, Josie Lillian.....Columbia.
Harrison, George William.....Aullville.
Hitt, Orlando.....Mexico.
Houchens, Fielding Wilhite.....Sturgeon.
Humphrey, Theron Martin.....Weston.
Leeper, Charles.....Graham.
Maupin, Joseph Hickam.....Columbia.
Menard, Edmond Saucier.....Ste. Genevieve.
Porter, Sarah Elizabeth.....Watersbury, Conn.
Smith, William Robert.....Ashland.

SPECIAL.

Burnam, Lucie.....Columbia.
Gordon, Scott David.....Columbia.
Gordon, Webster.....Columbia.
Harbison, Mary Delmont.....Columbia.
Mercer, John Swank.....Kirksville.
Pontius, Benjamin Franklin.....Shelbyville, Ill.
Read, Bertha.....Columbia.
Sitlington, James Morrison.....Aullville.

LAW STUDENTS.

SENIOR CLASS.

Armstrong, Francis Kincannon.....Atchison.
Bolte, August Henry.....Clover Bottom.
Burris, Milton.....
Fagan, Robert, B. S.....Columbia.
Letcher, Jerrold Ransom, B. S.....Marshall.
Pendleton, Edmond.....Wright City.
Shoeneich, Henry Jaromir.....St. Charles.
Sullivan, Daniel.....Jefferson City.
Yantis, James Aull.....Sweet Spring.

JUNIOR CLASS.

Babb, William Jasper, B. S.....Columbia.
Dulin, Edgar Gilkey.....Columbia.
Edwards, John Edward Fletcher.....Ironton.
Hines, Virgil McKnight.....Knob Noster.
Irvin, William McKindree.....Fairville,
Rollins, Curtis Burnam, B. A.....Columbia.
Rookwood, Thomas Samuel.....Montgomery City.
Shelton, Nathaniel Meacon.....Danville.
Sherwood, William Eli.....New Madrid.
Switzler, Warren.....Columbia.
Sydnor, Walter.....Columbia.
Wheeler, Thomas Basil.....East Lynne.

MEDICAL STUDENTS.

NAMES.	PRECEPTORS.
Ashley, Wm. Washington	J. S. Warren, M. D.
Ball, Enoch, A. M.	Jas. M. Foreman, M. D.
Cason, George Isaac	
Daugherty, William Marion	Prof. McAlester.
Douglass, Wm. Wirt	Woodson Moss, M. D.
Evans, Edwin Franklin	James H. Evans, M. D.
Evans, Tyson Dines	
Feaster, James Fowler	
Gilman, William Dyson	
Gordon, David, Jr.	Prof. Arnold.
Hagan, James Willlam	R. T. Miller, M. D.
Harrison, George William	Prof. McAlester.
Horner, James Wallace, B. A.	Prof. Arnold.
Hulen, Calvin	F. C. Brown, M. D.
*Hyer, Philip Lawson	S. P. Cutter, M. D.
Jerard, Harold	Thomas Beattie, M. D.
Johnson, Edward Wodkins	R. J. Johnson, M. D.
Jones, William Edward	W. E. Frick, M. D.
Kerrick, Benjamin Franklin	A. M. Raines, M. D.
Lemon, Walter Thomas	
Lewis, Malcolm Duane	Prof. McAlester.
Nalley, Harvey	
Popplewell, William Compton	Prof. McAlester.
Sloan, Milton Fackler	Prof. McAlester.
†South, Rufus Easton	Drs. Sprague, Jameson.
Strock, David	Practitioner.
Tipton, William Reuben	
Varnon, Charles Thomas	
Via, Benjamin Merriwether	W. P. Via, M. D.
Waters, Richard Graham	Prof. Arnold.
Williams, Samuel Kirkwood	Prof. Arnold.
Wilson, Thompson Augustus	
Young, David Hickman	Prof. McAlester.

* Deceased. † Pharmacy and Toxicology.

MINING SCHOOL AT ROLLA.

THIRD YEAR.

Deegan, Francis J., (Civil Engineering Course).....Rolla, Mo.
Hare, Almon W., (Mining Engineering Course) .....Rolla, Mo.

SECOND YEAR.

Emerson, Cyrus G., (Civil Engineering Course).....Rolla.
Garvens, Oscar E., (Mining Engineering Course).....Rolla.
Greason, John D., (Mining Engineering Course).....Ironton.
Jolly, Edwin J., (Mining Engineering Course) .....Meramec Iron Works.
McGrath, John E., A. B.* (Civil Engineering Course).....St. Louis.
Minger, William C., (Mining Engineering Course).....Maries County.

FIRST YEAR.

Blanchard, Eliphalet.....Steelville.
Fetzer, Fred. W.....Rolla.
Finn, Richard H.....Arlington.
Hutcheson, John C.....Lane's Prairie.
Millsaps, Thomas H.....Steelville.
Ohmann, Dumesnil, A. A., A. B.*.....St. Louis.
Pack, James A.....Rolla.
Snelson, William H.....Meramec Iron Works.
Thiele, Louis W.....St. Louis.
Toomey, Joseph L.....Rolla.

PREPARATORY YEAR.

Brown, Wilton R.....Shelbina.
Brown, George R.....Shelbina.
Ellis, George B.....Waynesville.
Hatch, Benton.....Rolla.
Heitzeberg, Charles L. P .....St. Louis.
Johnson, John L.....Waynesville.
Love, George L.....Rolla.
Mundwiller, Gustavus J.....Hermann.
O'Brien, John.....Rolla.

* College of the Christian Brothers.

Pack, Edward J.....Rolla.
Schultee, Henry C.....West Plains.
Smith, Lorin X.....Rolla.
Story, Jacob.....St. James.
Sutherland, J. Frank.....St. Louis.
Tabor, Henry D.....Pottersville.
Wilson, F. M.....Phelps County.
Wishon, Walter.....Rolla.
Wishon, Albert.....Dillon.

SPECIAL AND PARTIAL STUDENTS.

Anderson, T. B.—English.....Vienna.
Baker, Eva—Drawing and German.....Rolla.
Beddoe, Mary—English.....Rolla.
Beddoe, Naomi—English.....Rolla.
Bishop, Tennie—English and Drawing.....Rolla.
Bishop, Julia—English and Drawing.....Rolla,
Blow, John G.—Analytical Chemistry and Metallurgy.....St. Louis.
Brucher, Geo., Jr.—English and German.....Rolla.
Buskett, Wm. C.—Analytical Chemistry and Mathematics.....St. Louis.
Coppedge, Lindsay L.—Surveying and Mathematics.....Relfe.
Crawley, S. B.—Surveying and Mathematics.....Spartanburg, S. C.
DeBauernfeind, Jas.—English and German.....Rolla.
Durment, Edward—English and German.....Rolla.
Emerson, T. Q., Jr.—English and German.....Rolla.
Falls, Emma—English and Drawing.....Rolla.
Falls, Sarah E.—English and Drawing.....Rolla.
Farnsworth, W. H.—English.....Rolla.
Gallaher, Letitia—English.....Dillon.
Guild, Frank D.—English and German.....Rolla.
Hall, Parkhurst E.—English.....Rolla.
Harrison, John P.—Surveying, German and Latin.....Arlington.
Harrison, Laura B.—English, Drawing and German.....Pulaski County.
Haskell, Wm. H.—English, Drawing and German.....Rolla.
Hill, Ada—English, Drawing and German.....Waynesville.
Hood, Matilda—English, Drawing and German.....Rolla.
Hood, Justus B.—English, Drawing and German.....Rolla.
Hoskinson, Fanny—English, Drawing and German.....Rolla.
Heryford, Covey—Assaying and Mineralogy.....Forest Green.
Hume, Mary L.—English.....Rolla.
Hutcheson, Mary—Drawing.....Rolla.
Hutcheson, Sarah—Drawing, German and Mathematics.....Rolla.
Lang, Agustus J.—English, German and Drawing.....Rolla.
Livesay, Mary J.—English and Drawing.....Rolla.
*Long, Joseph—English, German and Drawing.....Rolla.
Lumbeck, J. T. K.—Higher Mathematics.....Rolla.
Mansfield, Clifford—English.....Rolla.

*Deceased.

Moser, Henry—English and German.....Rolla.
Macguire, John—Assaying and Mineralogy.....Taylorsville, Ill.
McEntee, Jesse M.—English and Mathematics.....Rolla.
Merchant, Alameda—Drawing and Mathematics.....Phelps County.
Minium, Sarah—English and Mathematics.....Rolla.
Miller, Edward J.—English, Mathematics and German.....Rolla.
Niven, Lillie—English and Mathematics.....Rolla.
Partridge, Mary C.—English, Drawing and Mathematics.....Rolla.
Prigmore, Leah—English and Drawing.....Rolla.
Orchard, Chas. O.—English, Drawing and German.....Ozark Iron Works.
Rhoens, Chas—Mathematics and German.....Rolla.
Scott, Annie—English and Drawing.....Phelps County.
Shaw, Lois J.—English, Drawing and German.....Rolla.
Storts, Chas. B.—Mathematics and German.....Rolla.
Sprague, Wm. W.—English and German.....St. James.
Upchurch, Rufus W.—Mechanical Drawing.....Steelville.
Watkins, Jas. B.—English, German and Mathematics,..... Lake Springs.
Van Deeren, Ella—Drawing..... .....Rolla.
Webber, Ellen—English, Drawing and Mathematics.....Rolla.
Winters, Christian R.—(Third year), Anal. Chem. and Math....Rolla.
Winters, Chas. F.—English, Mathematics and German..... .....Rolla.
Whiting, Florence—(Third year), Higher Mathematics.....Rolla.
Williams, Clark M.—English and German.....Rolla.
Williams, Elmer L.—English and German.....Rolla.
Williams, Claude—English and German.....Rolla.
Wilson, Mary L.—Drawing.....Kansas City.
Whittaker, Charles—English.....Rolla.
Winkler, Felix L.—English, Mathematics and Latin.....Dent County.
Yowell, Pettes—English.....Rolla.

SUMMARY.

Third Year Students.....	2
Second Year Students.....	6
First Year Students.....	10
Preparatory Students..	18
Special and Partial Students.....	65
Total..	101

SUMMARY.

Resident Graduates		6
Under-graduates:		
Seniors	8	
Juniors	21	
Sophomores	25	
Freshmen	57	—111
Elective		13
Special		8
Preparatory		204

SCHOOL OF MINES.

Third Year	2	
Second Year	6	
First Year	10	
Special	65	
Preparatory	18	—101

LAW SCHOOL.

Seniors	9	
Juniors	12	—21

Medical Class	33
Total	497
Less, twice counted	6
	491

DEPARTMENT OF MENTAL, MORAL AND POLITICAL PHILOSOPHY.

THE PRESIDENT.

SENIOR YEAR.

First Semester.—Mental Philosophy, Haven as the Text-book, with Lectures. Hamilton's Metaphysics, and Porter's Human Intellect, as references.

International and Constitutional Law, Kent's Commentaries, with Lectures.

The student must read Eliot's History of the United States, and sustain an examination thereon.

British Constitution, Creasy as the Text. In connection with this subject, the student is required to prepare himself to sustain an examination on the Outlines of English History.

Second Semester.—Political Economy, Wayland and Walker as Text-books; Sumner's History of Currency. Compendium of the Census for 1870, on progress of Wealth and Population of the United States.

Moral Philosophy, Haven as furnishing outline of Topics—select portions of Paley, Blackstone and Kent, required to be read.

A course of twelve lectures is also delivered to the senior class on the Evidences of Christianity.

Every student must be examined on this entire course at the close of the year prior to his graduation; and no student from other Colleges will be admitted *ad eundem*, so far as to excuse him from examination on these subjects at the final examination for his degree.

The method of instruction is by examination on text-books, by class discussions, by formal lecture from the Professor, by the student himself becoming the lecturer, and in his own language presenting the topic, and by written essays and analysis.

The instruction is intended to be as little as possible dogmatic; and the method adopted is designed to make the student himself the inquirer and thinker, and to teach him the right method of using books for investigation.

The President also gives a separate course of instruction in the Law Department on Constitutional and International Law.

DEPARTMENT OF NATURAL SCIENCE.

JOSEPH G. NORWOOD, M. D., LL. D.

The course of instruction in this Department is given to the regular Sophomore and Junior Classes, and such irregular students as may desire to study Physics and Chemistry, in lieu of some branch in the regularly organized classes. Certain branches of Natural History are also taught in this Department, viz: the seniors receive instruction in Anatomy and Physiology, human and comparative, and Biology. The Anatomy, Physiology and Pathology of the Brain receive special attention in reference to mental affections.

SOPHOMORE YEAR.

The course of instruction for the Sophomore year embraces the elements of Modern Physics, and its methods of investgation. The theory, properties and laws of matter are discussed, in connection with the doctrines of motion and force, with experimental illustrations. After which the study of Molecular Physics occupies the remainder of the year. The subjects particularly attended to are Wave Motion, Heat, Light, Statical and Dynamical Electricity, Thermo-electricity, Magnetism, Electro-magnetism and Pneumatics. In connection with the study of these branches, the student will be taught the use of the Microscope, Polariscope, Spectroscope, and other apparatus of the best modern construction.

Recently large and valuable accessions have been made to the apparatus for illustration and experiment in physics, chemistry, etc., by the purchase of rare and costly pieces, so that for its extent it is

hardly surpassed in the United States. The appointments in this respect would be regarded as honorable to any scientific institution in the world.

Among recent additions are the following:

Induction coil—one of the largest made.

Holtz machine—Ritchie's patent.

Air pump—Ritchie's patent.

Magnesium Stereopticon—for projecting figures on a screen.

Several hundred exquisitely painted figures for illustrating physics, anatomy, physiology, mineralogy, etc., to be used with the stereopticon.

Browning's large model Spectroscope, made on the plan of the Gassiot instrument.

Spectrum apparatus for the microscope, by Messrs. Browning and Sorby.

Browning's large automatic electric lamp and regulator.

Browning's new spark condenser.

A complete set of apparatus for illustrating wave motion.

A large number of anatomical models of natural size, exhibiting every part of the human body, accurate in form and color, for illustrating anatomy and physiology.

In addition to the above may be mentioned more than fifty new pieces of apparatus for illustrating heat, light and electricity.

JUNIOR YEAR.

This year is devoted to the study of Chemistry. Part of the first Semester is occupied with the study of the first lines of General Chemistry, including the study of Chemical Nomenclature, Symbols, Notation, Stoichiometry, Affinity or Chemism, and Chemical Philosophy generally. In this part of the course great use is made of the blackboard, in connection with a volume of problems specially prepared for the use of classes of this Institution.

The remainder of the year is devoted to the consideration of the Metalloids and the Metals, and their compounds, together with Organic Chemistry. To such members of the class as are qualified to receive it, instruction will be given in Qualitative Analysis, by the Professor of Analytical Chemistry, upon their complying with the rules of the laboratory.

The general principles of Meteorology are discussed, and experimentally illustrated, in connection with the studies already named, during the Sophomore and Junior years.

SENIOR YEAR.

Parts of the first and second Semesters are appropriated to the study of Natural History. The branches receiving special attention are Anatomy, Human and Comparative; Biology and Functional Physiology. In addition to the facilities for demonstrating Anatomy heretofore at the command of the Department, a complete set of anatomical preparations in clastic, from the laboratory of Auzoux, of Paris, and of models in plaster, made at Leipsic, have been added to the cabinet. As heretofore, our lecture table will be supplied, as it is needed, with properly prepared anatomical material. This will enable us to demonstrate, in a satisfactory manner, every tissue and organ of the human body. With these advantages, the course of Instruction in Anatomy in the State University will not be surpassed, in point of facilities at least, by any college in this country. The models in clastic and plaster will also be used to illustrate the course of lectures on Medical Jurisprudence.

The course of Physiology is, in all respects, such as is generally given to classes devoted to medical studies alone. In addition to Human Physiology, as much attention as possible is given to Comparative Physiology. This kind of instruction is peculiarily valuable to the farmer and the stock raiser. Constant reference is also made, throughout the course to the minor Surgery of different parts, a sort of knowledge for the lack of which many valuable lives have been lost.

To such members of the class as desire it, instruction will be given in Quantitative Analysis, in accordance with the rules of the Laboratory.

Any qualified student may, by special arrangement, pursue Laboratory practice during the entire college year.

DEPARTMENT OF MATHEMATICS, MECHANICAL PHILOSOPHY AND ASTRONOMY.

JOSEPH FICKLIN, PH. D.

The studies in this department are pursued in the following order:

FRESHMAN CLASS.

First Semester.—Algebra completed.

Second Semester.—Solid Geometry and Conic Sections.

SOPHOMORE CLASS.

First Semester.—Plain and Spherical Trigonometry, Mensuration, Surveying, and Navigation.

Second Semester.—Analytical Geometry.

JUNIOR CLASS.

First Semester.—Differential and Integral Calculus.

Second Semester.—Mechanics, Hydrostatics, Sound and Light.

SENIOR CLASS.

First Semester.—Astronomy.

The adjustment and use of the Quadrant, Compass, Leveling Instrument and Theodolite, are fully explained and illustrated by practice in the field.

Students in Astronomy, after mastering the theory of the subject in the recitation room, are required to go to the Observatory and apply their theories to practice in the determination of Latitude, Longitude, Right Ascension, Time of Day, Variation of the Magnetic Needle, etc.

Special attention is given to the mental discipline of the student. The development of the intellectual powers, and the formation and cultivation of correct habits of thinking and reasoning, by a constant reference to the Logic and Philosophy of Mathematics, are made the paramount objects of every recitation.

Prominence is also given to the great practical utility of Mathematics. As far as possible, every principle demonstrated is also illustrated by some useful application of it to the arts.

The recitations are conducted with the aid of well selected textbooks, and such additional illustrations and explanations as may be necessary are given, in order to impart to the student a thorough philosophical and practical knowledge of all the subjects taught.

Original problems in the various branches are given to the student, to test his knowledge of the subject, and to make him self-reliant and independent.

During the course, lectures are delivered on the Philosophy, Utility and History of Mathematics.

Special attention is called to the requirements in the Pure Mathematics for admission to the Freshman Class. Imperfect preparation in Algebra is so common as to compel the conviction that sufficient attention is not given to this branch of Mathematics in the Preparatory Schools. Its importance cannot well be over estimated.

DEPARTMENT OF NATURAL HISTORY.

G. C. SWALLOW, M. D., LL. D.

This department comprises *Mineralogy*, *Geology*, *Botany* and *Zoölogy*.

MINERALOGY AND GEOLOGY.

Our means for teaching Mineralogy and Geology are ample. The collection of the Geological Survey of Missouri, and the private collections of Drs. Norwood and Swallow, afford ample means for a full and complete illustration of all the departments of this science, which is so taught as to give the student a practical knowledge of the whole subject, by a full and complete course, illustrated by numerous maps, sections and charts, and by visits to important localities.

BOTANY

Is taught by a combination of lectures and recitations, which are illustrated by numerous specimens of living and dried plants, paintings and drawings of rare plants, and figures showing the form and structure of their various organs.

The structure, physiology and classification of the vegetable kingdom, receive careful attention.

A part of nearly every recitation is devoted to the analysis of plants.

ZOOLOGY.

This branch of Natural History is so taught as to include an elementary course in *Comparative Anatomy* and *Physiology*.

PHYSICAL GEOGRAPHY

Is taught by a combination of recitations and lectures, illustrated by maps, minerals, plants, animals and fossils.

This study is placed at the close of the course of education, that all the sciences may lend their aid in rendering the long catalogues of scientific terms used, so hard and meaningless to the uninitiated, an illuminated history of nature.

Geology and *Palæontology* are presented in their cosmical relations.

Hydrography, in the dynamics of water and water-sheds.

Meteorology, including the philosophy of wind, rain and temperature, is considered in its relations to the structure and history of the earth.

Natural History, in its chronological changes and geographical and climatic relations.

Ethnography is taught in its relations to the origin, geographical distribution, and characteristics of the races of man.

Astronomy, as presenting the system of the Universe.

DEPARTMENT OF LATIN.

EDWARD H. TWINING, A. M.

PREPARATORY STUDIES.

Requirements for entering the Freshman Class:

Allen and Greenough's, or Harkness' Latin Grammar, including Prosody.

Leighton's Latin Lessons, or Harkness' Reader.

Sallust's Catiline and Jugurtha, or Four Books of Cæsar's Commentaries.

Four Books of Virgil's Æneid.

Cicero's Select Orations.

Harkness' Latin Composition, Parts I. and II., or equivalent.

FRESHMAN YEAR.

First Semester.—Livy (Selections)—Latin Prose Composition.

Second Semester.—Livy—Ovid or Virgil.

SOPHOMORE YEAR.

First Semester—Horace (Odes)—Latin Composition.

Second Semester.—Horace (Satires and Epistles)—Cicero.

JUNIOR YEAR.

First Semester.—Tacitus, Germania and Agricola, or Histories.

Second Semester.—Select Comedies and Satires.

The instruction is given by recitations, accompanied by lectures on the language and its literature, and on other collaterals.

Frequent written exercises are required.

BOOKS OF REFERENCE.

Andrews' or White's Lexicon.

Madvig's Latin Grammar.

Smith's or Anthon's Classical Dictionary.

Smith's Dictionary of Antiquities, or Fiske's Eschenburgh's Manual of Classical Literature.

Long's Classical Atlas.

PRONUNCIATION.—"Roman Method."

DEPARTMENT OF GREEK AND COMPARATIVE PHILOLOGY.

JOHN M. LEONARD, PH. D.

This Department aims to make *thoroughness a conditio sine qua non*, by educating the student's powers of memory, comparison, discrimination and combination; by teaching him to think, and convincing his judgment of the *practical* arising from a scientific study of the language; by developing his esthetical nature; by making him acquainted with the philosophic development of words; by tracing out the etymological home of naturalized words in the English, as related to the Indo-European family of languages, and showing their historic value; by pointing out parallels in form, meaning, and construction between the Greek and the English; by showing the Greek language to be one of the most prolific sources of the English vocabulary; by textual criticism; by essays on portions of the authors read, and analyses of the drama; by exegetical lectures; lectures on the philosophy of the language, on Greek literature, and on the public economy of Ancient Greece.

Scheme of Study and Text-Books for the Collegiate Year 1875-76.

FRESHMAN CLASS.

First Semester.—Homer (Odyssey); Greek Prose Composition; Herodotus (Selections); Goodwin's Moods and Tenses.

Second Semester.—Xenophon's Cyropædia (Selections); Greek Prose Composition; Lucian (Selections); Grecian History.

SOPHOMORE CLASS.

First Semester.—Demosthenes (Adv. Leptinem); Essays; Euripides (Iphigenia Taurica); Æschylus (Agamemnon); Comparative Syntax of the Greek and Latin Languages.

Second Semester.—Thucydides (Book II); Essays; Plato (Symposium); Sophocles (Œdipus Coloneus); Grecian History.

JUNIOR CLASS.

First Semester.—Aristophanes (Knight's); Plato (Phædo); Aristotle (Ethics); Archæology of Literature and Art; Greek Literature; Lectures.

Second Semester.—Polybius; Elegiac and Lyric Poets (Selections); Grecian History; Structure of the Greek language as viewed in the light of Comparative Philology; Lectures.

BOOKS RECOMMENDED FOR REFERENCE.

Hadley's, Goodwin's or Crosby's, Curtins', Krueger's or Kuehner's Greek Grammar.

Goodwin's Greek Moods and Tenses.

Smith's Ancient Geography.

Long's Classical Atlas.

Smith's or Anthon's Classical Lexicon.

Smith's Greek Antiquities.

Felton's Ancient and Modern Greece.

Grote's History of Greece.

Boeckh's Public Economy of the Athenians.

Ahrens de græcæ linguæ Dialectis.

Liddell and Scott's, or Passow's Greek Lexicon.

Arrangements may be made with Professor Leonard to pursue the study of the Sanscrit, Zend, Modern Greek and the Semitic languages.

He will also read to students, if desired, such of the productions of the Greek authors as are read in the Universities of Germany, but not usually studied in American Colleges.

DEPARTMENT OF ENGLISH, HISTORY AND ELOCUTION.

S. S. HAMILL, A. M.

Candidates for admission to this Department must pass a satisfactory examination in English Grammar and Analysis, Rhetoric and United States History.

This Department includes the following branches: First—The origin, growth and laws of our language; second, the history of the literature of our language; third, the art of effective expression, both by voice and pen; fourth, regular practice in writing and speaking; fifth, history, ancient, mediæval and modern.

FRESHMEN—First Semester.

English—Exercises in Grammatical and Rhetorical Criticism, once a week; Compositions, semi-monthly.

History—Ancient, three times a week; author, Thalheimer.

Elocution—Phonics, Vocal Culture, and exercises in reading and speaking, once a week. Text-book, "Science of Elocution," Hamill, (throughout the course.)

Second Semester.

English—Composition, semi-monthly.

Elocution—Exercises in Phonics, Vocal Culture, Reading and Speaking, once a week.

SOPHOMORES—First Semester.

English—Lectures on the Art of Effective Expression, and special criticism in presence of the class. Essays, semi-monthly.

History—Mediæval, three times a week; author, Thalheimer.

Elocution—Exercises, once a week, in Quality, Form, Force, Stress, Pitch and Movement; Oratorical and Dramatic Recitations.

SECOND SEMESTER.

English—Lectures on Style and Invention, with criticisms on Orations; Orations, once a month.

History—English, three times a week; author, Collier.

Elocution—Principles of Gesture, Readings and Recitations, once a week.

JUNIORS—FIRST SEMESTER.

English—History of English Literature, four times a week; author, Collier. Original Orations, once a month.

Elocution—Grouping and Illustrations of the Emotions and Passions; Recitations, Selections from the Drama, once a week.

SECOND SEMESTER.

English—Rhetoric, four times a week, for the first eight weeks; authors, Whately and Campbell. Logic, four times a week, for the remaining twelve weeks; author, Jevon. Orations, once a month.

Elocution—Readings from Milton and Shakspeare, once a week.

It is the aim of this Department to give thorough English scholarship and good power of speaking and writing. Enthusiasm is awakened by requiring efforts before large audiences and awarding prizes for excellence in composition and delivery.

All public exercises must be submitted to the Professor for his criticisms and approval.

All students, except members of the senior class, having two recitations in the Collegiate Department, are required to write essays or orations, semi-monthly, and attend weekly exercises in composition.

DEPARTMENT OF MODERN LANGUAGES.

MISS MARY BRICE READ, *Instructor.*

From the Report of the Curators on the Reorganization of the University.

"Not rejecting the culture of the ancient languages, we surely cannot pass by or neglect that of the principal European languages,

and especially the German and French. Ample provision is now made for the study of these languages, with the literature belonging to them, in most of the principal schools in the country of every kind. They are made a requirement, not only in the colleges of letters, but equally so in the scientific and technical schools. In the earlier part of the present century, the modern languages were not considered necessary for the professional man, and if any provision whatever was made for them, it was accidental and temporary, and never from the permanent fund of the Institution. But the changed relations of the world have produced the change referred to in our various institutions of learning, and Harvard, Cornell, Michigan, etc., now have each several permanent teachers of these languages.

"The requirement should be imperative upon graduates of both the scientific department and that of arts, that they should be able to read the German and French; and that in the elective courses to be provided, these languages be made optional for longer courses. The committee so recommend."

The course of study in the two languages is according to the following order. German is commenced only at the beginning of the first University Semester, and French at the beginning of the second.

FRENCH.—First Year.

First Semester.—Otto's French Grammar, with exercises in French Syntax and Composition; Fénelon's Té émaque.

Second Semester.—French Grammar and Syntax, continued, with Composition; Select Prose and Poetry; Racine (Athalie).

SECOND YEAR (*optional.*)

Grammaire française (Noël et Chapsal); French Composition, continued; Selections in Prose; Select Plays from Racine, Moliére, and Corneille; Littérature française.

GERMAN.—First Year.

First Semester.—German Grammar, Exercises, and Composition.

Second Semester.—Whitney's Reader, German Stories; Syntax and Composition, continued.

SECOND YEAR.

First Semester.—Whitney's Reader; Schiller's William Tell; Marie Stuart; Conversational Exercises, with Composition.

Second Semester.—Selections from Schiller, Goethe and Lessing; Goethe's Egmont; Lessing's Minna von Barnhelm; Composition and Conversational Exercises; Prose Selections; German Literature.

THIRD YEAR (*optional*).

Schiller's Thirty Years' War (two books); Wallenstein; Goethe, Faust (First Part); Lessing's Prose; Goethe's Lyrics; Advanced Composition.

COURSE IN ARTS.

Pupils to enter the Freshman Class must pass a strict and satisfactory examination in Reading, Writing, English Grammar, Geography, United States History, Arithmetic, Algebra to Equations of the Second Degree, and Plane Geometry; Latin Grammar, Elements of; Latin Prose Composition. First four books of Cæsar's Commentaries. The four Orations of Cicero against Catiline, Virgil, (first four books of the Æneid); Greek Grammar, Greek Prose Composition, the first three books of Xenophon's Anabasis, and the first two books of Homer's Iliad.

FRESHMAN YEAR.

First Semester.—Algebra (Ficklin's), finished; Herodotus; Homer; Greek Prose Composition; Livy; Latin Prose Composition; Ancient History.

Second Semester.—Solid Geometry; Xenophon, Isocrates; Elocution (Sargent's Standard Speaker); Botany and Drawing; Ovid and Virgil; Grecian History; Greek Prose Composition; Modern Languages.

SOPHOMORE YEAR.

First Semester.—Trigonometry, Surveying, and Navigation; Horace, Æschines, Euripides, Sophocles; Physics; Mediæval History.

Second Semester.—Analytical Geometry; Horace and Cicero's Philosophical Works; Thucydides, Æschylus, Plato, Physics; English History.

JUNIOR YEAR.

First Semester.—Analytical Geometry; Tacitus, Aristophanes, Demosthenes, Plato; Archæology of Literature and Art; Chemistry; English Literature.

Second Semester.—Mechanics; Chemistry; Tacitus and Juvenal, Polybius, Plutarch; Elegiac and Lyric Poets; Rhetoric and Logic.

SENIOR YEAR.

First Semester.—Astronomy; Mental Philosophy; International and Constitutional Law (Kent); British Constitution (Creasy); Anatomy and Physiology; Mineralogy and Palæontology; German; Applied Chemistry (*optional*).

Second Semester.—Political Economy (Wayland and Bowen); Moral Philosophy; Anatomy and Physiology; Geology and Physical Geography; Natural Theology and Evidences of Christianity (Lectures); French.

☞English Composition and Declamation through the first three years, and Original Orations in the Senior Year.

COURSE IN SCIENCE.

Candidates for admission to the Freshman Class must pass a satisfactory examination on the following studies:

Mathematics—Arithmetic, Algebra to Equations of the Second Degree, and Plane Geometry.

English Language—English Grammar and Analysis, United States History and Geography.

German—Grammar and Reader.

French—Grammar.

The examination will be upon *principles* without regard to authors.

FRESHMAN CLASS.

First Semester.—Algebra (completed), Composition, French and German, Ancient History.

Second Semester.—Solid Geometry, Conic Sections, French (*optional*); German, Botany.

SOPHOMORE CLASS.

First Semester.—Plane and Spherical Trigonometry, Mensuration, Surveying and Navigation, Physics, Mediæval History.

Second Semester.—Analytical Geometry, Physics, English History, Zoölogy.

JUNIOR CLASS.

First Semester.—Differential and integral Calculus, Chemistry, Laboratory Practice, English Literature.

Second Semester.—Mechanics, Hydrostatics, Sound and Light, Chemistry, Laboratory Practice, Rhetoric and Logic.

SENIOR CLASS.

First Semester.—Astronomy, Mental Philosophy and Metaphysics, International and Constitutional Law, British Constitution, Anatomy and Physiology, Mineralogy and Palæontology, Applied Chemistry.

Second Semester.—Political Economy, Moral Philosophy, Anatomy and Physiology, Geology and Physical Geography, Natural Theology and Evidences of Christianity.

COURSE IN LETTERS.

(*See Table of Recitations and Lectures.*)

The Preparatory Course is the same as that of Arts.

COURSE IN PHILOSOPHY.

(*See Table of Recitations and Lectures.*)

The Preparatory Course is the same as that in Arts, substituting German for Greek.

COURSE IN ENGINEERING.

(*See Table of Recitations and Lectures.*)

The Preparatory Course is the same as that in Science.

ORDER OF COURSES,

AS RECOMMENDED BY THE COMMITTEE OF ORGANIZATION.

The committee present the following courses, as allowing large freedom of choice, and at the same time indicating a specific University honor to be attained in each. The courses first indicated lead to the highest academic honors, requiring, each of them, a wide and general culture; and, it is to be presumed, will be held by students in nearly or quite equal honor. They will be pursued, in large part, in

SYNCHRONISTIC

A.—PREPARATORY.

	COURSE IN ARTS.	Hour.	COURSE IN SCIENCE.	Hour.	COURSE IN PHILOSOPHY.	Hour.	COURSE IN LETTERS.	Hour.	COURSE IN ENGINEERING.	Hour.	COURSE IN AGRICULTURE.	Hour.	NORMAL COURSE.	Hour.
FIRST YEAR.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.
	Latin—Greek*	II.	English Grammar	II.	Latin	II.	Latin—Greek*	II.	English Grammar	II.	English Grammar		English Grammar	II.
	Geography	I.	Geography	I.	Geography	I.	Geography	I	Geography	I.	Latin	II.	Geography	I.
FIRST SEMESTER.			Drawing		Drawing				Drawing		Geography	I		
	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.	Arithmetic	IV.
	Latin	II.	English Analysis	II.	Latin	II.	Latin	II.	English Analysis	II.	English Grammar		Natural Philosophy	
SECOND SEMESTER.	Greek	III.	Hygiene	I.	Hygiene	I.	Greek	III.	Hygiene	I.	Latin	II.	Rhetoric	VI.
			Drawing		Drawing				Drawing		Hygiene	I.		
	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.
SECOND YEAR	Latin	VI.	German	VI.	Latin	VI.	Latin	VI.	German		Elementary Chemistry		Elementary Chemistry	
	Greek	III.	Physical Geography	III.	German		Greek	III.	Physical Geography	III.	Physical Geography	III.	Physical Geography	III.
FIRST SEMESTER.	Rhetoric and Elocution	V.	Rhetoric and Elocution	V.	Rhetoric and Elocution	V.	Rhetoric and Elocution	V.	Rhetoric and Elocution	V.	Drawing		Drawing	I.
	Algebra and Geometry	IV.	Algebra and Geometry	IV.	Algebra and Geometry	IV.	Algebra and Geometry	IV.	German	II.	Algebra and Geometry	IV.	Algebra and Geometry	IV.
	Latin	V.	German	II.	Latin	V.	Latin	V.	French	V.	U. S. Hist'y & Elocution	VI.	U. S. Hist'y & Elocution	VI.
SECOND SEMESTER.	Greek	I.	French	V.	German	II.	Greek	I.	Algebra and Geometry	IV	Penmanship and Book-keeping		Penmanship and Book-keeping	
	U. S. Hist'y & Elocution	VI.	U. S. Hist'y & Elocution	VI.	U. S. Hist'y & Elocution	VI.	U. S. Hist'y & Elocution	VI.	U. S. Hist'y & Elocution	VI				

B.—COLLEGIATE.

FRESHMEN.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.	Algebra	IV.
	Latin	III.	German		Latin	III.	Latin	III.	French	V.	Practical Agriculture	V.	Elementary Astronomy	VI.
	Greek	I.	French	V.	German	I.	Greek	I.	German	I.	Ancient History and Elocution	II.	Hygiene	
FIRST SEMESTER.	Ancient History and Elocution	II.	Ancient History and Elocution	II.	Ancient History and Elocution	II.	Ancient History and Elocution	II.	Ancient History and Elocution	II.			History and Elocution	II.
	Geometry	IV.	Geometry & Conic Sec's.	IV.	Geometry	IV.	Geometry	IV.	Geometry and Conic Sections	IV.	Geometry	IV	Geometry & Conic Sec's	IV.
	Latin	III.	German	III.	Latin	III.	Latin	III.	French (op.)		Practical Agriculture	V.	Methods of Primary Instruction	VI.
SECOND SEMESTER.	Greek	II.	French (op.)		German		Greek	II	Botany	I.	Botany	I.	Eng. Hist'y & Eng. Lit	I.
	Botany	I.	Botany	I.	Botany	I.	Botany	I.	German	III			Botany	VI.
													German	
	Trigonometry and Surveying	I.	Trigonometry and Surveying	I.	Trigonometry and Surveying	I.	Trigonometry and Surveying	I.	Trigonometry	I	Trigonometry and Surveying	I	Trigonometry and Surveying	I.
	Physics	II.	Physics	II.	Physics	II.	Physics	II.	Physics	II.	Shades and Shadows	VI.	Physics	II.
SOPHOMORE.	Latin and Greek	IV.	Mediæval History and Elocution	III.	Latin and Greek	IV.	Latin and Greek	IV.	Mediæval History & Elocution	III.	Practical Agriculture	VI.	Theory and Practice of Teaching	VI.
FIRST SEMESTER.	Mediæval History and Elocution	III			Mediæval History & Elocution	III.	Mediæval History & Elocution	III.			German & History (op.)			
	Analytical Geometry	I.	Analytical Geometry	I.	Analytical Geometry	I.	Physics	II	Analytical Geometry	I.	Analytical Geometry	I.	Analytical Geometry	I.
	Physics	II.	Physics	II.	Physics	II.	Latin and Greek	IV.	Physics	II.	Physics	II.	Physics	II.
	Latin and Greek	IV.	English History and Elocution	III.	Latin and Greek	IV.	English History and Elocution	III.	History	III	Zoölogy	IV.	Zoölogy ½	III.
SECOND SEMESTER	English History and Elocution	III.	Zoology ½	IV.	English History and Elocution	III.	Elocution		Zoölogy	IV.	Practical Agriculture	VI.	Professional Instruction	VI.
					Zoölogy		German	IV.			French & History (op.)			
					French	V								
	Chemistry	III.	Chemistry	III.	Chemistry	III.	Chemistry	III.	Civil Engineering	I.	Chemistry	III.	English Literature and Elocution	I.
	Latin and Greek	IV.	Calculus	II.	Latin	IV.	Latin and Greek	IV.	Chemistry	III	Domestic Animals	IV.	Chemistry	III.
JUNIOR.	Calculus (op.)	II.	English Literature and Elocution	I.	Calculus (op.)	II.	English Literature and Elocution	I.	Calculus	II.	English Literature and Elocution	I.	Calculus	II.
	English Literature and Elocution	I.	Analytical Chemistry		English Literature and Elocution	I.	Zoölogy	VI.	Analytical Chemistry		Analytical Chemistry			
FIRST SEMESTER.					French	V.			English Literature and Elocution	I.				
	Mechanics	II	Mechanics	II.	Mechanics	II.	Chemistry	III.	Mechanics	II.	Mechanics	II.	Mechanics	II.
	Chemistry	III.	Descriptive Geometry	III.	Chemistry	III.	Latin and Greek	IV.	Descriptive Geometry	III.	Chemistry	III.	Chemistry	III.
	Latin and Greek	IV.	Chemistry	I.	Rhetoric and Logic	I.	Rhetoric and Logic	I	Chemistry	I.	Analytical Chemistry		Rhetoric and Logic	I
SECOND SEMESTER.	Rhetoric and Logic	I.	Rhetoric and Logic	I.	French (op.)		Analytical Chemistry (op.)		Civil Engineering	I.	Agricultural Chemistry			
			Analytical Chemistry		Analytical Chemistry (op.)		French	V.	Analytical Chemistry		Rhetoric and Logic	I.		
									Rhetoric and Logic (op.)					
	Astronomy	V.	Astronomy	V.	Astronomy	V.	Astronomy	V.	Astronomy	V.	Astronomy	V.	Astronomy	V.
	Mental Philosophy, Constitut'n'l and Int. Law	I	Mental Philosophy	I	Mental Philosophy	I	Mental Philosophy	I	Military Engineering	VI.	Mental Philosophy	I.	Mental Science	I.
	Anatomy & Physiology	IV.	Constitutional and International Law	I	Constitutional and International Law	I.	Constitutional and International Law	I	Applied Chemistry	III.	Constitutional and International Law	I.	Constitutional Law	I.
SENIOR.	Applied Chemistry (op.)	III.	Anatomy & Physiology	IV.	Anatomy & Physiology	IV.	Anatomy & Physiology	IV.	Anatomy & Physiology	IV.	Anatomy & Physiology	IV	Anatomy & Physiology	VI.
	Mineralogy and Palæontology	II.	Applied Chemistry	III.	Applied Chemistry	III.	Mineralogy and Palæontology	II.	Mineralogy and Palæontology	II.	Mineralogy and Palæontology	II.	Mineralogy and Palæontology	II.
FIRST SEMESTER.	German	VI.	Mineralogy and Palæontology	II.	Mineralogy and Palæontology	II.	German	VI.			Applied Chemistry	III.	Applied Chemistry	III.
	Moral Philosophy	I.	Moral Philosophy	I.	Moral Philosophy	I.	Moral Philosophy	I.	Military Engineering	VI.	Moral Philosophy	I.	Moral Science	I.
	Political Economy	I.	Political Economy	I.	Political Economy	I.	Political Economy	I.	Anatomy & Physiology	IV.	Political Economy	I.	Political Economy	I.
	Anatomy & Physiology	IV.	Anatomy & Physiology	IV.	Anatomy & Physiology	IV.	Geology and Physical Geography	II.	Geology and Physical Geography	II.	Practical Agriculture	III.	Geology and Physical Geography	II
SECOND SEMESTER.	Geology and Physical Geography	II.	Geology and Physical Geography	II.	Geology and Physical Geography	II.	Evidences of Christianity	I.	Evidences of Christianity	I.	Anatomy & Physiology	IV	Philosophy of Education	VI
	Evidence of Christianity	I.	Evidences of Christianity	I.	Evidences of Christianity	I.					Geology and Physical Geography	II.	Evidences of Christianity	I
	French	V									Evidences of Christianity	I.		

* Students who have studied Latin are permitted to take Greek this Semester. † Greek may be substituted for this Course.

the same classes, bearing the same designation; and where there is a divergence, the students will go to professors already provided in the University. These courses are substantially those of Cornell, and agree mainly with those of Michigan and Wisconsin. Each should embrace the same period of time for its accomplishment (four years); unless, indeed, it be thought best, as a temporary arrangement, to adjust the scientific course to three years, as at present:

I. The Course in ARTS—leading to the degree of A. B. This course embraces Latin, Greek, French and German; mathematics, natural science, political and moral philosophy, history and literature.

II. Course in SCIENCE—leading to the degree of B. S. This course embraces mathematics (including calculus), natural science, excludes Latin and Greek, substitutes therefor French and German languages; includes philosophy and literature. The same, approximately, as the A. B. course (except as to classics); extends, however, the course in mathematical or natural science.

III. Course in PHILOSOPHY—degree B. Ph. Combination of the courses in the Arts and Sciences; includes Latin, excludes Greek; includes modern languages, modifies the course in mathematics—less of mathematics, more of philosophy, history and literature.

IV. Course in LITERATURE—degree, Bachelor of Letters. This course embraces Latin, Greek, modern languages; a thorough study of English in its linguistic elements and in its literature; philosophic and historical studies, together with the elements of mathematics and natural science, but not to the same extent as required in the other courses.

The Faculty may excuse a student from any study in either of these courses, and substitute for it another of equal educational value, and better suited to the taste or objects of the student, without impairing his claim to his degree.

After the Sophomore year, an election of studies designated by the Faculty to be allowed the students.

The object is to secure the highest culture, with the greatest liberty of choice, and to award specific University honors to the deserving.

V. Elective Course—leading to diploma of Proficiency in studies successfully pursued.

Any student, instead of entering upon the preceding courses, may select his own course; and students thus selecting their own studies shall be known as students in the elective courses, or elective students.

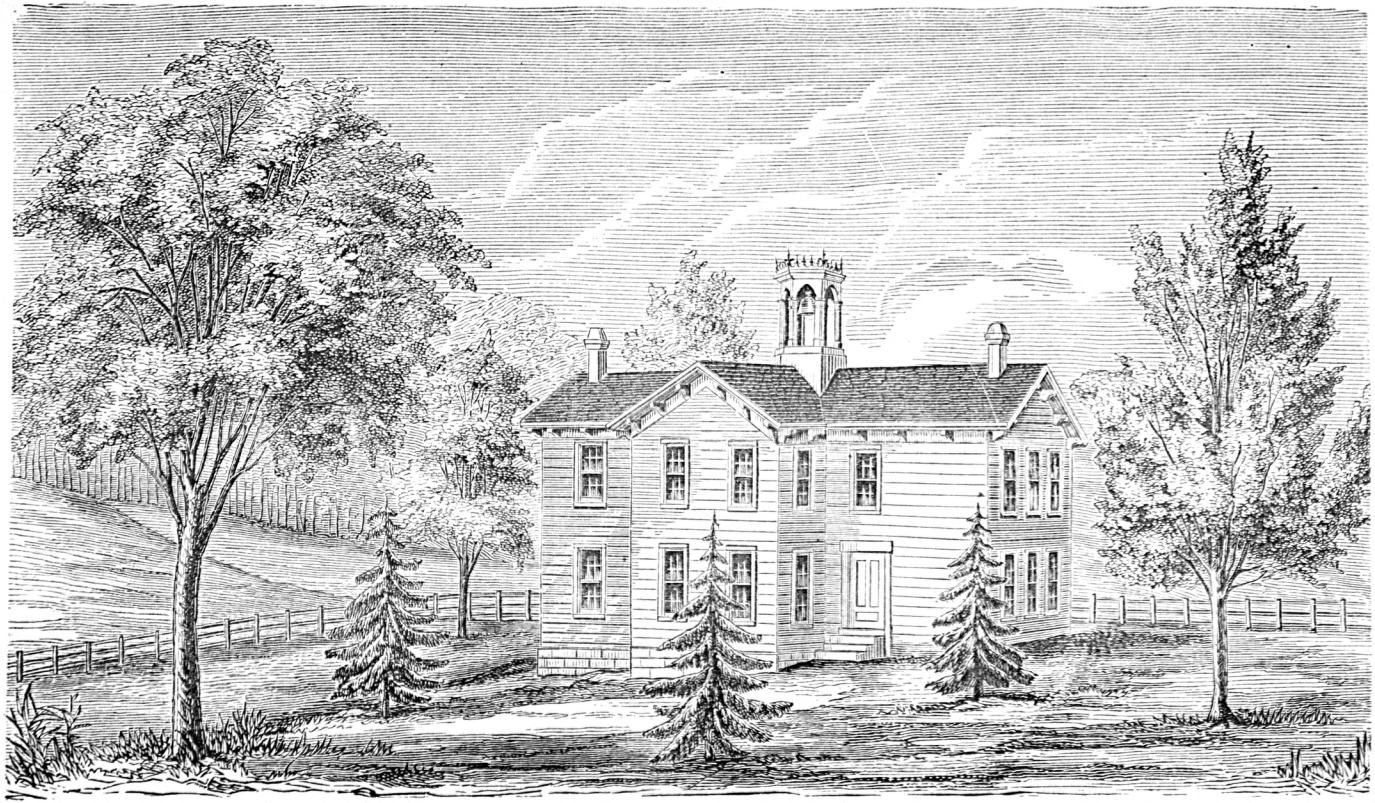
The following rules will apply to this class of students, and must be inflexibly enforced:

1. They must be qualified, by previous study and discipline, for the classes they propose to enter.

2. They cannot "*get up*" classes according to their own notions, but must choose such studies as are at the time pursued in some of the courses; nor can they have recitation or lecture hours changed to suit their convenience.

3. They must, in ordinary circumstances, and unless specially excused, have the full quota of studies.

4. While it is intended, as far as can be, to give the full freedom of the continental universities, this is by no means to be understood as permitting the student to pass from one course to another without good reason, and without the permission of the President.



NORMAL COLLEGE.

COLLEGE OF NORMAL INSTRUCTION.

The College of Instruction in Teaching was opened September 14, 1868. Seven classes, numbering in the aggregate 49, have been graduated; while not less than 400 have received instruction in the theory and practice of teaching, and a greater number in studies which have fitted them for college or for business.

The Board of Instruction is complete. In addition to the regular teachers, the assistance of all the Professors and Instructors of the University is available.

COURSES.

The courses of instruction have been adjusted and adapted to the actual condition of education in Missouri, and not to an ideal and impracticable standard of culture.

The curriculum of studies embraces, first, a full academic or college course, a course requiring the same attainments as are demanded in the non-professional departments.

Graduates in this course will be found qualified to take positions as tutors in colleges, or as principals of academies and high schools.

The curriculum embraces, secondly, a two years' course, which is intended to prepare teachers for their duties in the common schools.

Lectures on the best methods of teaching reading, spelling, writing, arithmetic, geography, grammar and history, will continue throughout the entire year.

A SPECIAL COURSE.

There is a special course of training in the College of Normal Instruction to qualify teachers for their professional duties. This course is so conducted as greatly to improve those who can remain but a portion of the year. Teachers, male and female, are especially invited to avail themselves of the advantages which are thus afforded them. The organization of this department is more perfect than heretofore, and the means of instruction more complete.

MODEL SCHOOL.

The Model School embraces two departments, a Primary School and a High School.

Every pupil in the professional department will have an opportunity of teaching in one of these schools, and of receiving such criticisms and suggestions as the inexperienced most require. Especial attention will be given to Free-hand Drawing and Mapping.

Instruction will also be given to the more advanced pupils in Perspective Drawing, in Painting and in Taxidermy. The latter art is of great value to all those who are interested in Object Lessons.

Classes in Natural Philosophy and also in Chemistry will be formed for the special benefit of teachers. In a word, the connection of the Normal School with the various departments of the University affords an opportunity to the ambitious student to perfect his preparation for the work of the school room.

FACULTY.

DANIEL READ, LL. D.,
President of the University.

ERASTUS L. RIPLEY, A. M.,
Principal.

JOSEPH G. NORWOOD, LL. D.,
Professor of Natural Science and Natural Philosophy.

JOSEPH FICKLIN, A. M.,
Professor of Mathematics, Mechanical Philosophy and Astronomy.

GEORGE C. SWALLOW, LL. D.,
Professor of Botany.

PAUL SCHWEITZER, PH. D.,
Professor of Chemistry.

SAMUEL S. HAMILL, A. M.,
Professor of English and History.

EDWARD HENRY TWINING, A. M.,
Professor of Latin Language and Literature.

MARY B. READ,
Instructor in German and French.

WILLIAM A. CAUTHORN, A. M.,
Assistant Professor of Mathematics.

WILLIAM S. PRATT, A. M.,
Instructor in Latin.

SCOTT HAYS, B. S.,
Instructor in Geography.

LOUISA GILLETT, N. G.,
Instructor in Arithmetic and Grammar.

CALEB BUCKMASTER,
Instructor in Natural Philosophy.

GRADUATING CLASSES.

NORMAL COLLEGE COURSE.

James F. Babb.....Columbia.
Caleb C. Buckmaster.....Freedom.
Thomas C. Early.....Bolivar.
Frederick J. Miller.....Spickardsville.

NORMAL COURSE.

Frank Austin.....Hamilton.
George W. Barlow.....Bethany.
John W. Beatty.....Mexico.
John S. Bradley.....Sturgeon.
Philip Bruton.....Columbia.
Nellie E. Gould.....Hannibal.
Ella Houchens.....Sturgeon.
Theron M. Humphrey.....Weston.
John W. Huffaker.....Brookfield.
Newton H. Lincoln.....Kearney.
Robert Merrill.....Kearney.
Lloyd D. Mudd.....Millwood.
William F. McQuitty.....Columbia.
Arthur Martin.....Oronogo.
James J. Riley.....Jacksonville.
William E. Turner.....Wellsville.
Luther M. Vanlandingham.....Columbia.
John W. Wade.....Sturgeon.

NORMAL GRADUATES.

GRADUATES OF 1869.

NAMES.	PROFESSION.	RESIDENCE.
Anderson, J. G.	Law	Keokuk, Iowa.
Conway, James M.	Medicine	Stockton, Missouri.
Crowe, George W. J.	Miner	Utah Territory.
Penter, Eli	Law	Ashland, Missouri.

GRADUATES OF 1870.

Lowry, T. J.	Coast Survey	College Mound, Missouri
Robinson, J. F.	Teacher	Columbia, Missouri.
Gillette, Lulie	Teacher (State Univ.)	Hannibal, Missouri.

GRADUATES OF 1871.

Craycroft, Clark	Teacher	Howard Co., Missouri.
Gentry, Eliza	Teacher	Kansas City, Missouri.
Huffaker, J. R.	Medicine	Brookfield, Missouri.
Shidy, Leland P.	Teacher	St. Louis, Missouri.

GRADUATES OF 1872.

Callison, Miss Sue	Teacher	Jamesport.
Harrison, A. T.	Teacher	Richmond, Virginia.
Packer, Miss Helen A.	Teacher	Illinois.
Seward, Miss Gertie C.	Teacher	Laclede.
Swinford, Samuel T.	Teacher	Independence.
Trantham, William H. B.	Teacher	Springfield.

GRADUATES OF 1873.

Barton, Abraham Poole	Teacher	Centralia.
Dryden, James Henderson	Law	Carthage.
Fagan, Robert	Law	Milwaukee, Wisconsin.
Rogers, Stephen Cawood	Teacher	Lathrop.

GRADUATES OF 1874.

Babb, William J.	Teacher	Columbia.
Marlow, George H.	Teacher	Norbonne.
Ridgway, Joseph T.	Teacher	Columbia.
Ripley, Julia F.	Teacher	Columbia.
Wilson, Thomas C.	Civil Engineer	Auburn.

SPECIAL COURSE.

Allison, George W.	Teacher	Sturgeon.
Barkley, John G.	Teacher	Beardstown.
Cole, John B.	Teacher	Edna.
Deatherage, George M.	Teacher	Waverly.
Farwell, Adelia A.	Teacher	Columbia.
Livingston, Nathan F.	Teacher	Higbee.
Young, Sarah M.	Teacher	Fayetteville.

COURSE OF STUDY.

(1.) NORMAL COLLEGE COURSE.

Freshman Class.

First Semester.—Algebra (completed), German, Livy, Drawing.

Second Semester.—Geometry and Conic Sections, Botany, Methods of Primary Instruction, Elocution.

Sophomore Class.

First Semester.—Trigonometry, Physics, Theory and Practice of Teaching.

Second Semester.—Analytical Geometry, Chemistry, History, Professional Instruction.

Junior Class.

First Semester.—Rhetoric, Logic, Chemistry, Natural History, Calculus.

Second Semester.—Mechanics, Chemistry, English Literature.

Senior Class.

First Semester.—Astronomy, Mental Science, Constitutional Law, Mineralogy, Philosophy of Education.

Second Semester.—Moral Science, Political Economy, Geology, Evidences of Christianity, Philosophy of Education.

(2.) NORMAL COURSE.

Candidates for admission must pass an examination in Arithmetic as far as Fractions, in the elements of English Grammar, and in the elements of Geography. Candidates for graduation must pass an examination in Reading, Orthography, Penmanship, Arithmetic, Algebra (one-half), five books of Geometry, and in the elements of Botany, of Natural Philosophy, of Hygiene, of Astronomy and of Chemistry; in English Grammar, Rhetoric, History of the United States, and in the History of England.

They must also attend the following

COURSE OF PROFESSIONAL TRAINING. (Five periods, of eight weeks):

First Period.—Methods of teaching Mental and Written Arithmetic, Free-hand Drawing.

Second Period.—Methods of teaching Reading, Composition, English Grammar, Map Drawing.

Third Period.—Methods of teaching Geography and History, Penmanship and Spelling.

Fourth Period.—Methods of teaching Primary Science, Object Lessons, Book-keeping.

Fifth Period.—Lectures on the Development of the Intellectual Faculties, on Physical Training, Moral Culture, Order of Studies, School Organization and School Government.

AGRICULTURAL AND MECHANICAL COLLEGE.

FACULTY.

DANIEL READ, LL. D., PRESIDENT,
Professor of Political Economy and Agricultural Statistics.

GEORGE C. SWALLOW, LL. D.,
Dean of the Faculty, and Professor of Agriculture, Geology, and Botany.

JOSEPH G. NORWOOD, M. D., LL. D.,
Professor of Physics, Chemistry, Anatomy and Physiology.

JOSEPH FICKLIN, A. M., PH. D.,
Professor of Mathematics, Mechanical Philosophy and Astronomy.

E. L. RIPLEY, A. M.,
Professor of Drawing and Book-keeping.

PAUL SCHWEITZER, PH. D.,
Professor of Agricultural Chemistry.

SAMUEL S. HAMILL, A. M.,
Professor of English Language, Elocution, and Rhetoric.

CHARLES V. RILEY, A. M., PH. D.,
Lecturer on Entomology.

SCOTT HAYES, AG. B.,
Assistant Teacher in Agriculture.

NORMAN J. COLMAN,
Farm Committee.

MR. THOMAS MADDEN,
Farm Superintendent.

COURSE OF STUDY.

The following Course of Study was adopted by the Curators, and will be carried out as far as the means and material of instruction can be provided.

PREPARATORY.

The Preparatory Course is nearly the same as in Science, the German and French excepted. (See Synchronistic Table).

FRESHMAN OR FIRST YEAR.

First Semester.

Horticultural Botany.

Pruning—Scientific principles; objects to be gained and how accomplished; pruning implements.

Practical applications in pruning fruit, ornamental, and forest trees.

Transplanting—Best time and mode.

Propagation—Botanical and chemical principles involved; modes of, with seeds, buds, bulbs and tubers.

Experiments in producing new varieties, and in cultivating native fruits.

Meteorology and Climatology.

Temperature and Rainfall—How distributed.

Adaptations of climate to various crops and fruits; how to protect the more tender from its severities and changes.

Prognostics of weather, or how we may best know its changes.

Algebra.

Essays—

On Pruning, Transplanting and Propagating.

Second Semester.

Soils.

Classification—By natural productions, by mineral ingredients, by chemical composition, and by physical properties.

Properties—Physical and chemical, how changed and improved.

Tillage—The best modes and implements of.

Sub-soiling—When beneficial, and how best performed in various soils.

Draining—Its advantages, and the best modes and implements.

Manures—Various kinds and their properties.

KITCHEN GARDENS—

Their design, use, location and arrangement; kind of soil; culture and implements.

Garden Fixtures—Walls, hot beds, cold frames and propagating houses.

Experiments with garden crops.

BOTANY—

In its scientific relations.

Physiology and structure of plants.

Analysis and determination of plants.

GEOMETRY.

ELOCUTION.

SOPHOMORE OR SECOND YEAR.

First Semester.

ECONOMICAL BOTANY.

Useful Plants—Botanically, economically, historically, and geographically considered.

Man's Vegetable Food—How and where produced; properties and value of each article; what can be produced best at home, and what best be purchased.

Experimental Culture of fruits and crops grown in other countries and other climates.

DOMESTIC ANIMALS.

Anatomy and Physiology of the horse, ox, sheep, hog and other domestic animals. Their natural history, including the peculiarities and uses of each; what they eat, and the crops cultivated for their food.

WEEKLY ESSAYS ON SUBJECTS TAUGHT.

TRIGONOMETRY AND PHYSICS.

Second Semester.

ENTOMOLOGY.

Classification of Insects—Their history and habits; how to extirpate and prevent the depredations of the injurious, and foster and multiply the beneficial.

Pests of the farm and garden, both animal and vegetable.

Meadows and forage plants.

Pastures and herbage plants.

FRUIT CULTURE.

Orchards—Location, preparation and management.

Vineyards—Best grapes for table, and those best for wine.

Nurseries—Their culture and management.

Essays—On Fruits, Fruit Culture, including grapes and small fruits.

ZOÖLOGY.

ANALYTICAL GEOMETRY AND PHYSICS.

SURVEYING.

THIRD OR JUNIOR YEAR.

First Semester.

DOMESTIC ANIMALS.

Breeds—Characteristics and adaptations of each to farm economy.

Breeding—Principles and modes of producing desirable and peculiar properties.

Management of Animals—In feeding, working and selling them.

Veterinary Surgery and Medicine—In all their varied applications to the domestic animals.

Essays on domestic animals and forestry, and farm buildings.

Second Semester.

AGRICULTURAL CHEMISTRY.

Vegetable—Structure of cells; office of chlorophylle; production of organic matter by plants; nitrogenous and non-nitrogenous constituents; osmose and endosmose.

Soils—Chemical and physical properties; production from various geological strata; their improvement by mechanical means and by fertilizers.

Fertilizers—Their relative value; their employment for extensive and intensive cultivation, and as a paying investment in a new country.

SENIOR OR FOURTH YEAR.

First Semester.

ECONOMICAL BOTANY.

Forestry—Influence of trees on climate and soils; their protection to man, domestic animals, gardens, orchards, vineyards, nurseries and field crops; their wood for fuel and timber; their bark, leaves and fruit.

Experimental culture of forest trees.

ARCHITECTURE.

Farm Buildings—Houses and barns; pig, poultry, tool, wood and ice houses.

POLITICAL ECONOMY.

MINERALOGY AND PALÆONTOLOGY.

Second Semester.

LANDSCAPE GARDENING.

Æsthetics of Nature—Laying out farms, gardens and lawns; location and arrangement of building.

Ornamentation by ponds, streams, fountains, plants, walks, drives, fences and bridges.

BOTANIC GARDEN.

Structures—Green-houses, Hot-houses, Pits and Propagating houses; their structure and uses, care and management.

Propagation and culture of ornamental plants.

AGRICULTURAL STATISTICS.

FARM MACHINERY.

Essays on Landscape Gardening and Botanic Gardens and Machinery.

GEOLOGY.

Lithological—Structure and relations of rocks.
Chronological—Fossils and their teachings.
Economical—Uses of rocks and their mineral contents.

ASTRONOMY,

And its relations to the seasons, weather, animals and plants.

OPTIONAL STUDIES.

While all the studies of the University are open to the students of Agriculture, the following are those deemed most desirable outside of those prescribed in the course:

Latin, as the language of the sciences on which Agriculture is based.

German and *French* are useful as repositories of Agricultural Science.

Calculus.

Evidences of Christianity.

Natural Theology.

RESIDENT GRADUATE COURSE, OR FIFTH YEAR.

First Semester.

PHYSICAL GEOGRAPHY.

Geology and *Palæontology* in their cosmical relations.

Hydrography, or the dynamics of water and water-sheds.

Meteorology, or the philosophy of storms, prognostics and atmospheric dynamics.

Natural History, in its geographical and historical relations.

Ethnography, in its relations to the origin and geographical relations of the races of men.

Astronomy, as exhibiting the earth's relations to the grand system of the Universe.

VETERINARY SURGERY.

Diseases of animals and their causes, and the best remedies and proper treatment, with practical applications.

MORAL PHILOSOPHY.

EVIDENCES OF CHRISTIANITY.

RURAL ECONOMY.

The Balance Sheet of Farming; what it yields in money, food and pleasure.

The Supervision of farm work.

Farm Accounts and farm reports.

Managing Working Parties and reporting the results.

Essays on farm management.

Second Semester.

FARM MECHANICS.

Structure of farm buildings and farm machinery and implements.

Plans and *Specifications* of farm buildings.

ECONOMICAL GEOLOGY.

Discovering and working of coal and metallic deposits.

Discovering and *Testing* building materials—rocks, cements, clays and paints.

SURVEYING.

Plotting farms and ornamental grounds.

Drawing Machinery, animals, plants and landscapes.

History of farming, horticulture, and industrial education in Europe and America.

ORGANIC CHEMISTRY.

Analysis, Qualitative and Quantitative.

NATURAL THEOLOGY.

CONSTITUTIONAL LAW.

The students in this course will be exempt from all fees, and will be expected to assist in conducting the labors and instruction of the under-graduates, as a part of the practical course.

COURSE IN HORTICULTURE OF ONE YEAR.

First Semester.

HORTICULTURAL BOTANY.

Propagation—Botanical and chemical principles involved; modes of, with seeds, buds, layers, slips, tubers and bulbs.

Pruning—Principles involved and objects to be gained; pruning implements; practical applications in pruning.

Transplanting—Best time and modes.

Floriculture—In all its practical relations in houses, gardens and green-houses.

Soils.

Classification and improvements of soil for horticultural purposes.

Chemistry, Meteorology, and Climatology.

Second Semester.

Landscape Gardening.

Æsthetics of Nature—Laying out of grounds; location and arrangement of buildings, lawns, gardens, orchards, vineyards, forests, meadows, fields and pastures.

Ornamentation—Arrangement and construction of lakes, fountains, streams, bridges, walks and fences; location and selection of trees, shrubs and flowers.

Gardening.

Botanic Garden—Its arrangements and plants; hot and green-houses, their structure and uses.

Kitchen Garden—Including hot-beds, pits, cold frames, and propagating houses.

Flower Garden—With all its necessary appliances.

Fruit Culture.

Culture and management of orchard, vineyard, nurseries and small fruits.

Manufacture of wine, cider, perry, domestic wines and beers.

Botany.

Botany is taught in its principal relations to the varied operations of horticulture.

History of Horticulture.

PRIZES.

There are two permanent prizes connected with this college:

The *Harris Medal* to the Senior Class, "For the *Best Essay on Dairy Stock*," or "*Indian Corn.*"

The *Swallow Prize* to the Freshman Class, "For the *Best Examination on Pruning.*"

DEGREES GIVEN IN THE AGRICULTURAL COLLEGE.

Students who have finished the *four years' course* shall be entitled to the degree of Bachelor of Agriculture (B. Ag.); and those who have completed the Resident Graduate Course shall be entitled to the degree of Master of Agriculture (M. Ag.)

Those who complete the course in Horticulture shall be entitled to a Diploma.

DESIGN OF THIS INDUSTRIAL COLLEGE.

It is the design of this school to give an education that will fit the pupil for intellectual and manual labor—to make him a man in body and mind, that he may enjoy the *mens sana in corpore sano.* Our graduates must be the peers of scholars in mental culture, and the equals of laborers in manual skill and physical development, that they may be prepared to honor labor and utilize and dignify learning.

To do this, one must have a thorough knowledge of his profession, and be able to do his work with skill and care.

The first and highest employment of man is to cultivate the soil, to feed and clothe the world. To do this well has been the ambition of the great and good of every land. The increase of populations, and the multiplied demands for the products of the soil, must render this department of human industry more and more prominent, lucrative and honorable.

It is, therefore, eminently appropriate for this College, located in the midst of the best agricultural region of the continent, in which the populations of the earth are concentrating with unprecedented rapidity, to invite our youths to such a collegiate course of study and labor as will best fit them to develop the agricultural and mechanical

resources of the State, and meet the coming demand upon their capacities. For such an education, the people must learn two things:

1. What to do, and how it should be done.
2. He must acquire the manual skill to do it, and do it well.

To know what and how, is the *Science.*

To have the manual skill, is the *Art.*

To get the *Science,* he must study.

To get the *Art,* he must work.

Our industrial College, then, must be a school of *labor* as well as *study.* But how much study and how much labor, are questions not definitely settled, but in general terms it may be stated—

The pupil must study until he knows what should be done, why it should, and how. When this is done, the Intellectual division of an Industrial Education is finished.

The pupil must labor until he can do all farm work with skill; and when this is accomplished, the Manual division of an Industrial Education is finished.

Whatever is more than this, has no more place in an Industrial School than in any other. It is not the idea of our school to furnish a place for pupils to work,* but a place where they may learn to work as well as think.

But what shall the pupil do? Everything that is done on the farm, in the garden, orchard and nursery.

Who shall direct the labors of the pupils? He who says what is to be done, why it should be done and how, is the one to see that it is done and well done. Then the teaching and practice will agree, science and art go hand in hand. This will prevent the introduction of many useless and impracticable theories. When one teaches merely, he can advance many beautiful theories for others to practice; but when he is expected to carry out his own suggestions, he will be more cautious, take more care that his instructions will bear the test of actual experiment.

HORTICULTURAL DEPARTMENT.

As the ladies of Missouri have done so much to create a taste for the culture of fruits and flowers and ornamental grounds, it is but

* We furnish work, so far as possible, for those who desire it as a means of support; but this is no part of the plan of instruction.

just the Commonwealth should provide a school where their daughters, as well as sons, may perfect themselves in these delightful pursuits. All necessary fixtures will be provided to make this department of the Industrial College most useful and instructive.

The ladies are, therefore, invited to partake of the benefits of this Horticultural course, where everything will be so managed as to awaken and cultivate the most refined and exalted tastes, and lead woman back to the pursuits she so much enjoyed in Eden.

The first class in this department was formed during the past year. It consisted of *nineteen* young ladies and *five* young gentlemen, besides a large number of the Agricultural students. *Twenty-four* completed the course and received diplomas.

AGRICULTURAL LECTURES.

Lectures will be given each day on the practical applications of science to agricultural pursuits.

The students of this College are by law admitted to the lectures and other exercises of all the departments of the University.

PROGRESS OF THE AGRICULTURAL COLLEGE.

College opened in 1871 with a class of *six* pupils. The number gradually increased to *twenty-nine* during that year. In 1872 the Junior Class numbered *twelve*, and the Freshman Class *forty-five*. In 1873 the Senior Class numbered *seven*, the Junior Class *nineteen*, the Freshman Class *eighty-seven*, and the Horticultural Class *twenty-four*. In all, we had that year one hundred and thirty-eight students in the classes of practical Agriculture. These pupils were young *men and women*, mostly from the farms and workshops of our own State, who came here to learn; and they maintained an unflagging interest in the studies and practical labors of the Agricultural College.

The wide-spread prejudices against a collegiate education for farmers, are rapidly disappearing before the manifest beneficial results already developed; and this has been accomplished with but few of the fixtures and appliances enjoyed by similar schools in the neighboring States. When we have secured the same advantages, our College may be made far more attractive and useful.

A college, like a city, must be the growth of many years.

The farm needs houses, stables, fences, roads, bridges, and a supply of domestic animals.

Hot and propagating houses, cold frames, pits, and other fixtures of horticulture, are also needed.

Mechanic and machine shops are a prime necessity.

We also need apparatus for the lecture-room, as scarcely any has yet been supplied.

Our instruction must of necessity be defective until these fixtures and apparatus are furnished.

G. C. SWALLOW,
Dean of the Agricultural College.

UNIVERSITY OF MISSOURI.

SCHOOL OF

MINES AND METALLURGY,

ROLLA, PHELPS COUNTY, MISSOURI.

ANNOUNCEMENT AND REGISTER FOR YEAR ENDING JUNE 17TH, 1875.

SCHOOL OF MINES AND METALLURGY.

FACULTY AND OFFICERS.

DANIEL READ, LL. D.,
President.

CHARLES P. WILLIAMS, PH. D.,
Director and Professor of Analytical Chemistry and Metallurgy.

COL. JAMES W. ABERT, A. M.,
Professor of Applied Mathematics and Graphics.

GEORGE D. EMERSON, M. E.,
Professor of Civil and Mine Engineering.

Professor of Geology, and ex officio State Geologist.

R. W. DOUTHAT, A. M.,
Professor of English Branches.

JAMES A. YANTIS,
Adjunct Professor of Pure Mathematics.

PETER E. BLOW,
Assistant in Analytical Laboratory.

A. W. HARE,
Assistant in Preparatory Department.

R. W. DOUTHAT,
Secretary of Faculty.

JAMES A. YANTIS,
Librarian.

COURSE OF STUDY.

PREPARATORY.

First Semester.

Algebra—to Quadratic Equations (Ficklin); Metrical System.
Rhetoric and Composition (Hart); Word Analysis (Swinton).
Physical Geography (Guyot); Physics (Ganot).
Drawing—Free-hand and Ornamental.

Second Semester.

Algebra (Ficklin) finished.
English Literature (Hart); Logic (Coppee).
Chemistry (Elliott & Storer's Manual).
Botany—Structural and Systematic (Gray).
Drawing—Free-hand and Ornamental.
During the entire year—bi-weekly Exercises in Declamation and Themes.

FIRST YEAR.

First Semester.

Geometry—(Davies' Legendre).
Chemical Philosophy (Cooke); General Chemistry (Lectures).
Analytical Chemistry—Blow-pipe Analysis (Elderhorst).
Mineralogy—Descriptive (Dana).
Physics (Lectures); Drawing—Mechanical.
During the semester—Exercises in Declamation and Themes.

Second Semester.

Trigonometry (Olney); Mensuration (Vogdes).
Land Surveying (Gillespie), with Field Practice.
General and Industrial Chemistry—Lectures.
Mineralogy—Determinative (Laboratory).
Physics (Lectures); Drawing—Mechanical.

SECOND YEAR.

First Semester.

I.—(For all Courses.)

Analytical Geometry (Olney); Descriptive Geometry (Davies).
Higher Surveying (Gillespie), with Field Practice.
Geology—Dynamical and Historical—(Lectures and Dana's Manual.)
Drawing—Mechanical.

II.—(For Civil Engineering Course.)

Roads and Railroads (Gillespie).
Analytical Chemistry—Qualitative (Fresenius)—optional.

III.—(For Mine Engineering Course.)

Mine Engineering—Systems of Attack, etc. (Lectures).
Metallurgy—Iron, Zinc, Copper (Lectures).
Analytical Chemistry—Qualitative (Fresenius).

IV.—(For Course in Philosophy.)

Course of No. I. and III., omitting Lectures on Mine Engineering.

Second Semester.

I—(For all Courses.)

Calculus (Olney); Shades, Shadows and Perspective (Davies).
Geology—Dynamical and Historical (Lectures and Dana's Manual).
Drawing—Mechanical.

II.—(For Civil Engineering Course.)

Civil Engineering (Mahan) and Lectures.
Analytical Chemistry—Quantitative (optional).

III.—(For Mine Engineering Course.)

Mine Engineering—(Lectures).
Metallurgy—Lead, Silver and Mercury (Lectures).
Analytical Chemistry—Quantitative (Fresenius).

IV.—(Course in Philosophy.)

No. I. and No. III., omitting Lectures on Mine Engineering.

THIRD YEAR.

First Semester.

I.—(For all Courses.)

Analytical Mechanics; Stone Cutting (Mahan).
Elements of Mechanism (Goodeve).
Drawing—Mechanical.

II.—(For Civil Engineering Course.)

Civil Engineering (Mahan and Lectures).

III.—(For Mine Engineering.)

Mine Engineering (Lectures).
Metallurgy—Gold, Tin, Bismuth and Antimony (Lectures).
Applied Geology—Veins and Vein Phenomena.
Analytical Chemistry—Quantitative (Fresenius) and Assaying (Mitchell's).

IV.—(For Course in Philosophy.)

Nos. I. and III., omitting Lectures on Mine Engineering and Applied Geology.

Second Semester.

I.—(For all Courses.)

Applied Mechanics; Machinery and Motors.
Graduation Theses.

II.—(For Civil Engineering Course.)

Civil Engineering (Mahan and Lectures).

III.—(For Mine Engineering Course.)

Mine Engineering—(Lectures).
Analytical Chemistry—Quantitative and Assaying (Mitchell's).

IV.—(For Course in Philosophy.)

Nos. I. and III., omitting Lectures on Mine Engineering.

French, German and Spanish are optional studies during all the years. Latin is made an optional study in the preparatory year.

A course of lectures on Anatomy, Physiology and Hygiene, is delivered during the winter semester, and is open to all students. It is well illustrated by preparations, diagrams and the oxy-hydrogen lantern. Arrangements will also be perfected for a winter's course of lectures on subjects of general interest or on special departments of Science.

SYNOPSIS OF DEPARTMENTS OF INSTRUCTION.

MATHEMATICS—PURE AND APPLIED.

PROFESSORS ABERT AND YANTIS.

PREPARATORY YEAR—Algebra (Ficklin.)

FIRST YEAR—Geometry (Davies' Legendre); Trigonometry, (Olney); *Mensuration** (Vogdes).

SECOND YEAR—Analytical Geometry (Olney); Calculus (Olney); *Descriptive Geometry* (Davies); *Shades, Shadows and Perspective* (Davies).

THIRD YEAR—Mechanics (Peck); *Stereotomy and Stone Cutting* (Mahan).

ANALYTICAL CHEMISTRY.

CHARLES P. WILLIAMS, PH. D., Professor.

FIRST YEAR—Blow-pipe Analysis (Elderhorst Manual); Qualitative Analysis (Fresenius).

SECOND YEAR—Qualitative Analysis (Fresenius); Quantitative Analysis (Fresenius).

THIRD YEAR—Quantitative Analysis (Fresenius); Assaying, (Mitchell.)

The Quantitative Course includes analyses, either partial or complete, of the following series, each estimation being, at least, duplicated :†

*Recitations of this department printed in italics are under charge of Prof. Abert; those in Roman type are conducted by Prof. Yantis.

† Those in italics are *partial* analyses.

(1) *Zinc Sulphate;* (2) *Barium Chloride;* (3) *Alum;* (4) *Chrome Alum;* (5) *Sulphate of Iron and Ammonia;* (6) *Blue Vitriol;* (7) Calcite; (8) Calamine; (9) Galena; (10) Chalcopyrite; (11) Orthoclase; (12) Kaolin; (13) Hematite; (14) Pyrolusite, and Chlorine valuation; (15) Soda Ash, valuation; (16) Bleaching Powder, valuation; (17) Cerusite; (18) Smithsonite; (19) Blende; (20) Coal, proximate; (21) Coal, ultimate and heating power; (22) Stibnite; (23) Realgar; (24) Blast furnace slag; (25) Lead furnace slag; (26) Pig Iron; (27) Fahlerz; (28) Commercial Lead; (29) Spelter; (30) Native Bismuth; (31) Kupfer-Nickel; (32) Beryl; (33) Zircon; (34) Illmenite; (35) Chromite; (36) Saltpetre Soil; (37) Mineral Water.

Besides this course, there is the usual practice in the fire assay of the ores of Lead and Silver, of argentiferous and auriferous native compounds and artificial products, and in the docimastic valuation of the ores of the most prominent metals.

METALLURGY.

PROFESSOR WILLIAMS.

The instruction in this department is given by lectures, supplemented by laboratory practice, (omitting Nos. 14, 15, 16, 32, 33, 36 and 37 of the list given under Analytical Chemistry), and is illustrated by diagrams, models, and specimens. The course is introduced by Iron, and is followed by Zinc, Lead, Silver, Nickel, Mercury, Copper, Gold, and Antimony. The principles of furnace construction, of slag formation, and of general metallurgical operations, are discussed throughout the course, and special illustrations are given of all the methods described. The students are required to solve problems involving the discussion of the desirable method of treatment of ores of stated composition under given economical conditions, and to accompany the solutions with plans and estimates for works to carry out the method. In the lectures and other exercises of this department, full cognizance is taken of the peculiar economic conditions surrounding metallurgical industry in this country, and especial reference is had to the staple metallic products of Missouri—Iron, Lead and Zinc. Studies are made of the local Iron establishments, and excursions are made to other Iron works, as well as to those at which Lead and Zinc ores are practically treated.

PHYSICS.

————————, Professor.

[At present this department is but partially organized, the instruction in it being given by the Director and Professors Yantis and Emerson. Excellent and complete apparatus for demonstration has already been purchased, and more definite shape will be given to the department at the earliest practicable date.]

GEOLOGY AND MINERALOGY.

In the preparatory year, the students have recitations and lectures in Physical Geography; in the first year, recitations and lectures in Descriptive Mineralogy, and Laboratory exercises in the determination of a series of fifty-five well selected mineral species, with special reference to the ores of the metals and their associated gangues. These exercises are followed, in the second year, by lectures and recitations (based on Dana's Manual) on Dynamical and Historical Geology. The lectures on Lithology, and on Mineral Veins, and Ore Deposits, together with an account of the chief Geological features of and modes of occurrence in the principal Mining Districts, complete the course.

By an act of the General Assembly, the school of Mines and Metallurgy became charged with the duty of operating the Geological Survey of the State, an annual appropriation of $5,000 having been made for its expenses. This act became a law March 18, 1875. By it the Curators of the State University are directed to elect a professor of Geology for the School of Mines, who shall be *ex officio* State Geologist. In pursuance of this provision, the called meeting of the Board (held at Columbia, ————,) directed the Executive Committee of the School of Mines to arrange for the presentation, at the annual meeting in June, of the names of candidates for the chair. The department will therefore be completely organized and fully arranged by the opening of the next collegiate year.

This measure, it is evident, is one of great importance to the school, and must prove of benefit to the State at large. Its passage was largely due to the following from the very favorable report of the

House Committee on Mines and Mining, which officially visited and carefully examined the School of Mines and Metallurgy in January last:

Your Committee is also of the opinion that the interests of the school would be enhanced by an additional professorship—that of Geology. This would require but a small addition to the library, as the science is already taught to a considerable extent, and a cabinet would soon be collected that would prove of immense practical value—the situation of the school offering superior advantages for the prosecution of this study.

As the adjunct sciences are taught here, and a laboratory exists where practical analysis could be conducted under the immediate supervision of the professors, the students could be put to work on practical as well as theoretical study, and the day may not be distant when practical Geological reports will emanate from this Institution worthy of distribution throughout the State.

CIVIL ENGINEERING.

PROF. EMERSON.

Besides the recitations and lectures, the practical work in the field forms a prominent feature of the method of instruction in this department. The use of instruments in the field by all the students of Civil Engineering begins with the second semester of the first year and is continued throughout the course. Friday and Saturday of each week are devoted to this exercise, and, where necessary, longer time is taken for excursions to the mines, furnaces, bridges, railroad constructions, etc., of the country. The field practice consists of Land Surveying by all the methods in use, or described in the books. Railway curves are calculated and set out upon the ground; earth-work is measured and estimated from the embankments and excavations of the railroad; contours of the adjacent country are made and platted, and the student is made practically familiar with the manipulation of all instruments in common use. A general system of triangulation of the country about Rolla is begun from a base line carefully laid by the students, and will be extended from time to time for their instruction.

The course is parallel with those of the Pure and Applied Mathematics, and is supplemented by that of

GRAPHICS.

COL. J. W. ABERT, PROFESSOR.

During the preparatory year the students are instructed in the elements of Drawing with pencil and pen, according to the principles contained in Chapman's Drawing-Book. They are also practiced in Free-hand Drawing. These exercises develop the special tendencies of the pupil and enable the Professor to judge in what direction his greatest strength lies, and where his weak points most need to be reinforced.

During the first year the practice is in Topographical Drawing with pen and India ink, representing the lines of contour of the earth's surface, showing the bounding curves which would limit the surface in case of a gradual rise of water taken at every 5, 10 or x feet. The hatching lines of declivity are drawn; also the various conventional representations of surface. The students are exercised in a carefully organized method of drill in printing, in order to acquire a rapid system of lettering, of essential importance in finishing maps, problems, title pages, and mechanical drawings. There is also a careful study of the true standards of the three colors, with their secondary and ternary combinations, simultaneous contrasts, harmonies, unisons, aërial perspective, and the important practical application of laying on flat tints. This is followed by applications to colored topography, etc.

The second years' exercises are in construction of problems in Descriptive Geometry, and in Shades, Shadows and Perspective. The problems are drawn with pen and India ink on "demi" drawing paper, and are all constructed on mathematical principles, displaying all the difficult problems of the intersection of curved surfaces, and the representations of warped surfaces having two or three directrices.

In the third year the subject of Stereotomy is taken up in its application to the various problems of stone-cutting, and the construction of terre-pleins, ramparts, ramps, and embrasures of permanent fortifications. There are also required Drawings of bridges, furnaces, machines, their shadows and perspective, as they would appear to the eye at a finite distance from the perspective plane, mathematically constructed and properly colored.

Those who possess the requisite taste for such subjects may be exercised in pen, India ink and color Drawings of landscapes, figures, etc., and be led to apply their acquirements to Natural History.

MINE ENGINEERING.

PROF. EMERSON.

This is taught entirely by lectures. The subjects of systems of attack of mineral deposits; of shafts; adits, and levels; timbering, subterranean transportation; hoisting, pumping; surface transportation, and mechanical concentration, are properly considered. The course is fully supplemented by extended field practice, the important parts of the civil engineering course, the field and office work of the geological department, and by extended instruction in assaying and analytical chemistry, and in drawing plans and sections of mines and the results of the practical work.

GERMAN.

R. W. DOUTHAT, PROFESSOR.

FIRST YEAR.

First Semester.—Woodbury's "New Method with the German"—through Exercises and Reading.

Second Semester.—Schiller's William Tell, or Comfort's German Reader, and the Etymology of Woodbury's New Method.

SECOND YEAR.

First Semester.—Goethe's Wahlverwandtschaften, or his Lyrics, or Conversation, and the Syntax of Woodbury's "New Method." In those cases in which the Reader is taken, in the Second Semester of first year, Schiller's William Tell, or *any* of the classic German plays, and the Syntax of Woodbury's New Method; for the Second Semester of second year, the course will be what is prescribed for *First* Semester of second year, excepting the study of Syntax.

(PREPARATORY) DEPARTMENT OF ENGLISH.

PROFESSOR DOUTHATin, charge.

First Semester.—The students have daily recitations in (Swinton's) Word Analysis until the book is finished and has been reviewed.

The subject of Rhetoric (with Hart's Manual as the text-book) is then taken up, completed, and reviewed. Arithmetic, with special reference to the metrical system, is also reviewed.

Exercises in Composition and Declamation are given a prominent place in this as well as in the Second Semester of the year. The exercises take place every Saturday morning, and are superintended by Professor Douthat, with other of the Professors as critics.

The studies of the First Semester are continued through the Second Semester, for the benefit of those found unprepared on examination, to enter upon the studies of the second term proper. This arrangement also accommodates those who have been unable to present themselves for admission at the beginning of the collegiate year, affording opportunity for review of useful English studies before entering upon the duties of the school proper.

The English studies of the Second Semester of the preparatory year comprehend English Literature and Logic; more time being given during this term to preparatory work in Chemistry and in Natural History. During the entire year there is a (optional) course in Latin elements, including, in the First Semester, recitations from Harkness, Arnold's First Book, or Harkness' Grammar and Cæsar; in the Second Semester, Harkness' Latin Reader, Cæsar or Virgil. No attempt is made to supply the wants of those who desire further advance in the Classics, nor can the time be properly spent from the regular studies of the school.

FEES, EXPENSES, ETC.

The fees for instruction, etc., at the School of Mines and Metallurgy, are the same as at the other departments of the University, viz.: An annual entrance fee of $10, besides an assessment of $5 per Semester for incidentals and for the use of the library. Special and partial students are subject to the same charges; an exception, however, being made against those devoting their entire time to Analytical Chemistry or Assaying. Such pay a small additional fee for chemicals consumed. All laboratory students furnish their own blow-pipes, platinum-crucibles and-apparatus, silver and gold solutions, alcohol for heating purposes, and pay for apparatus damaged or broken while in their service.

The exercises of the Drawing-room require also a small expenditure, annually, for materials. Text-books and all requisite materials

for students can be procured in Rolla, either from dealers, or, in the case of chemical apparatus, from the school, at the usual rates.

A fee of $5 must be paid, before graduation, for the diploma, and a fee of $1 for the certificate of proficiency.

The courses of study will be rigidly enforced on all students candidates for the degrees of the Institution. The professional degrees awarded are Civil Engineer (C.E.), Mine Engineer (M.E), or Bachelor of Philosophy (Ph.B.) Students not candidates for degrees, or special students, are admitted at any time, and are allowed the fullest liberty in the selection of their studies; provided, always, that such shall have the equivalent of at least sixteen recitations, weekly. To these classes of students certificates of proficiency are granted on satisfactory examination being passed. These certificates, or the diplomas, are issued only at the public commencements.

ADMISSION.

For the Preparatory Department applicants must be at least sixteen years of age, and must stand an examination in the ordinary branches of an English Education. For admission to First Year studies, students must be at least seventeen years of age, and must pass satisfactory examination in all the regular studies of the Preparatory Year.

Special students, in any department, are admitted without previous examination.

Before matriculation and entrance upon the duties of the school, the Treasurer's receipt for entrance fee, and for the incidentals of the Semester, must be shown to the Director, and a card, properly endorsed, be procured from him. The Secretary of the Faculty will then place the student's name upon the roll, and furnish him with all necessary information.

An examination for admission will be held on Tuesday and Wednesday, the 14th and 15th days of September. The collegiate year begins Thursday, September 16th. There is no suspension of exercises—other than for examination—between the two Semesters of the year.

Excellent boarding, at places approved by the Faculty, can be obtained at from $3.50 to $4 per week. A list of such places can be seen on application to the Secretary. The expenses for board may be reduced somewhat by a judicious system of clubbing in rented rooms. The school has no dormitories under its control.

HISTORICAL, ETC.

The school of Mines and Metallurgy—a department of the University of the State of Missouri—is located at Rolla, Phelps county, on the line of the Atlantic and Pacific Railroad, one hundred and thirteen miles southwesterly from St. Louis. The locality is pre-eminently healthy, is in the midst of an extensive and rapidly developing iron section, with districts abounding in lead and zinc deposits within easy access, and thus affords excellent opportunities for the field study of some of the modes of occurrence of the ores of these metals, as well as for the practical investigation of their methods of treatment. Excursions for such purposes will constitute a prominent feature in the instruction of the advanced classes.

The Institution was created by the legislative act of February, 1870, disposing of the Congressional grant of land for agricultural and mechanical colleges. It was formally opened November 23, 1871, the first class, of three members, graduated in June of 1874, having completed the full course. At the public commencement, held at that time, the address was delivered by the Hon. Albert Todd, of St. Louis, and the charge to graduates was given with the diplomas by the director of the school. The fourth year of the Institution closes with the issue of this Announcement and Catalogue.

The design of the School of Mines and Metallurgy, in connection with the Agricultural College, is to carry out to its amplest extent the intention of the act of Congress, providing for education in the Industrial Arts. This has been kept prominently in view in arranging the curriculum of the school, in the selection of its apparatus, in providing its equipment and in the organization of its Faculty. It is a School of Technology, with Civil and Mining Engineering, and Metallurgy as specialties.

The school is well furnished with apparatus instruments, and other appliances for practical instruction and demonstration. It has a full supply of excellent surveying and engineering instruments, physical apparatus, embodying the newest forms for illustration and research, together with diagrams and models for the illustration of metallurgy, and for engineering, topographical and ornamental drawing. The geological, mineralogical and technical collections are all rapidly increasing, and are already rich in specimens and products illustrative of the mineral industries of Missouri. The laboratories for analysis and assaying have been increased in working capacity, and are

amply furnished with apparatus and reagents necessary for practical instruction, and for any line of chemical or metallurgical research. The library has been selected with special reference to supplementing the labors of the class and lecture rooms, and consists, therefore, largely of standard reference works on the physical sciences, mathematics and technology. A good selection of technical periodicals is supplied to the reading room, and strong efforts will be made to keep the collection of these and of the books up to the progress of the several departments. The same may be safely promised for the apparatus, collections, models and other adjuncts to the proper working of a school of this character.

The class and other rooms of the building are comfortably furnished, well lighted and well ventilated, and are heated by hot-air flues from furnaces in the basement. The first floor is occupied by the analytical laboratory, the chemical lecture room, and the room of the professor of geology. On the second floor are the public hall, the office, library, reading and the mathematical rooms; and in the third story are the engineering room—those of the Professors of Applied Mathematics and English, and a large drawing room with ample accommodations for upwards of —— students. The basement contains the assay furnaces and other appliances for metallurgical work.

With regard to the equipment, organization and effective character of the work of the school, the following from the official Report of the visit and examination of the Committee of Mines and Mining, of the XXVIIIth General Assembly, may be cited, with the additional remark that the recommendation for an appropriation made by this committee was passed, the school thereby becoming the recipient of ten thousand dollars for the years 1875 and 1876:

"We do not intend to eulogize this Institution with high-sounding phrases, nor do we mean to underrate the difficulties that each undertaking meets with, during its incipient stage, but with pride we acknowledge the unanimous opinion of your Committee that this school is highly worthy of the people of the great State of Missouri, and in full coincidence of the intent which led to its creation. We may look forward with well founded hopes that by the practical workings of this school our dormant mineral wealth will meet the attention of the entire civilized world.

"The force of professors employed to teach the various branches of learning has been selected with more than usual care, and their ability and devotedness justify the highest expectations.

"Analytical Chemistry, Mineralogy, Geology, Metallurgy, Mathematics, pure and applied; Drawing, artistic and mechanical; Civil

and Mining Engineering, Military Tactics, etc., form the main branches of study in this Institution.

The apparatus, mathematical and philosophical instruments, are all of the latest and most approved kind, and their selection shows excellent tact; the laboratory is in good working order, and the library, consisting mainly of technical works, contains a number of rare volumes.

The morals of the students are vigilantly looked after, and the remarkable progress made by them is not only noteworthy, but also a source of gratification to your Committee.

The maps of surveys and mines, the drawings of furnaces and reduction works prepared by the more advanced students, display art and mastery on the subject of their study and labor.

A remarkable feature of the school consists in combining theory with practice."

GRADUATES OF THE SCHOOL OF MINES AND METALLURGY—1874.

Duncan, Gustavus H., C. E.....Brulder, Col.
Gill, John Holt, C. E.....Assistant in U. S. Engineering Dpt., Washington City.
Peck, John W., M. E.....Metallurgist at Boyd's Smelting Works, Brulder, Col.

CALENDAR.

1875.

September 20, Monday.....Winter Semester begins.
December 22, Wednesday, P. M.....Closes for Christmas Holidays.

1876.

January 3, Monday A. M.....Exercises resumed.
February 7, Monday.....Half-yearly examination begins.
February 12, Saturday.....Half-yearly examination closes.
February 14, Monday.....Summer Semester begins.
June 19, Monday.....Yearly examination begins.
June 27, Tuesday.....Yearly examination closes.
June 29, Thursday.....Annual Commencement.

DEPARTMENT OF LAW.

Law Faculty.

DANIEL READ, LL.D.,

President of the University, and Professor of International and Constitutional Law.

Hon. PHILEMON BLISS,

Resident Professor of Law and Instructor in the Law of Real Property, of Bills and Notes, in Equity, and in Practice and Pleading, and Dean of the Law Faculty.

Hon. BOYLE GORDON,

Resident Professor of Law, and Instructor in Elementary Law, in Evidence, and the Law of Contracts and Torts.

JOSEPH G. NORWOOD, M.D., LL. D.,

Professor of Medical Jurisprudence.

Hon. ARNOLD KREKEL, U. S. District Judge,

Lecturer upon Federal Jurisprudence, including Bankruptcy and Maritime Law.

Hon. HENRY S. KELLEY, Judge of the Eleventh Circuit,

Lecturer upon Criminal Law, and Pleadings and Practice.

TERMS OF ADMISSION.

For admission to the Junior Class no special preparation is required; but the student, if not a graduate of some college, must be nineteen years of age, and, if unknown to the Professors, must bring testimonials of good moral character. Young practitioners, and such others as pass examination in the studies of the junior year, will be admitted to the Senior Class.

COURSE OF INSTRUCTION.

The Law term commences on the first Monday of October, and ends the last week in March. The full course is two years, and embraces the various branches of the common law, and of Equity, Commercial, International, and American and English Constitutional Law, Criminal and Federal Jurisprudence.

The mode of instruction is by daily examinations upon the text-books, by daily lectures upon Special Titles, and by the exercises of a Moot Court.

The text-books upon Constitutional Law, for both Junior and Senior years, are Creasy's English Constitution, and Kent's Constitution of the United States (Com. Vol. I), with constant reference to Hallam and May, and other authors upon that of England, and to Story and other writers, upon that of the United States. The text-book upon International Law, which the student is required to study, is Kent's Com., vol. I, but constant reference is had to Wheaton, Hallock, etc., and to questions that have recently arisen in our diplomatic relations. Upon these subjects instruction is given, both by examinations and lectures.

The text-books upon Municipal Law, used in class examinations, are Blackstone's Commentaries, Kent's Commentaries, Smith on Contracts, Parsons on Contracts, Addison on Torts, Greenleaf's Evidence, Vols. 1 and 2, Stephen on Pleading, Bispham's Equity, and Parsons on Bills and Notes.

Immediately after the Senior Class has concluded Stephen on Pleading, Judge Bliss delivers a course of lectures upon Code pleading, following somewhat the method of Stephen, and showing the changes that have been made in the different States adopting the new system. He also lectures upon Legal Ethics, upon Extraordinary Remedies, and other subjects.

Dr. Norwood's lectures embrace more fully than is usual in such a course, the subjects of Anatomy and Physiology, and like all the

other lectures, are given to both the classes, so that each student, so far as lectures are concerned, attends substantially the same course each year. The necessary models and preparations are provided and the course is unusually thorough.

Law students are permitted to enter classes in other departments, if it does not interfere with the Law Course, and will be expected to attend the weekly lectures in the chapel upon History and other subjects.

THE MOOT COURT.

Great attention is given to the exercises of this court, and they are our chief reliance for teaching practice. It is held every Saturday, is made to represent some actual court, with its clerk and sheriff, and every matter discussed arises in some supposed cause. Regular pleadings are in all cases required—most of them drawn according to the common law and equity system—and when the cause is supposed to be in the Supreme Court, in addition to the pleadings, every paper is prepared, necessary in actual practice; as the writ of error, assignment of errors, bill of exceptions, embodying the instructions to the jury, rulings upon the admission or exclusion of evidence, motions for new trial or in arrest, etc. Briefs of points and authorities must also be filed, and no one will be permitted to argue a cause if in default in any particular. One or more students are called to sit as special judge or judges in each cause, who, the next week, give their opinions in writing, subject to appeal to the Faculty. Essays upon legal topics are also read each week.

LIBRARY.

A well selected law library—consisting of the best treatises and digests of the various titles of the common law, of the Reports of the Supreme Court of the United States, and of a few of the leading States, of treatises upon the civil law, ancient and modern, with some choice works of law literature—is open at all hours for consultation and study. Besides this, the general library of the University and the reading room are open to the students of the law, as well as of other departments. The necessary text-books for class exercises must, however, be furnished by the student.

DEGREES.

Those of the Senior Class who, at the close of their term, sustain an examination, will be entitled to the degree of Bachelor of Laws. The examination will be in writing, and the answers will be submit-

ted to a committee of lawyers, who report to the Law Faculty, and the degree will be given or withheld according to the proportionate number of failures. All who receive the degree are by law admitted, without further examination, to practice in the Missouri courts.

EXPENSES.

Tuition for each term is $40, payable in advance. Boarding is had in clubs at from $1.75 to $2.25 per week, and in families from $3.50 to $5.00. No fee for incidentals.

GENERAL REMARKS.

The success of the College of Law has been such, that with continued diligence in following up and perfecting the system adopted, no fears are entertained of its future. The Law Faculty are more and more satisfied that the highest results cannot be reached by lectures alone, however clear and thorough they may be, but that the student should, as far as possible, be required to study the text-books and be subjected to a daily examination upon their contents, accompanied by oral explanations by the teacher. It is the only way the subject can be fastened in his memory, and the only way to secure the formation of proper habits of study. The lecture system has been combined with the other, and, as to subjects, that for want of time and proper books cannot be otherwise taught, is chiefly relied upon. Thus we have, in addition to the daily examinations upon text-books, at least one daily lecture, but usually two.

The Faculty are sometimes asked for advice as to the necessity of preliminary study of law. If instruction were given by lectures alone, they would say to the student that he should by all means master a few elementary works, like Blackstone and Kent, before attempting to listen to them. The lectures would either fail to be understood or to be remembered, even by an attentive student, without some previous knowledge of the subject. Under our system there is less necessity for such preparation, and yet the advantage it gives the student is very great. He can better understand and remember his daily work, not only because of some previous knowledge of the subject, but from the habit of study he has acquired. It is for the latter reason, other things being equal, that those who have had the advantage of the discipline of Academical study so generally show themselves in the class-room superior to others.

MEDICAL DEPARTMENT.

This department was established by the Board of Curators as one of the Colleges of the University in December, 1872, and was formally opened for instruction February 17, 1873.

FACULTY.

DANIEL READ, LL. D.,
President.

THOMAS ALLEN ARNOLD, M. D.,
Professor of Anatomy, and the Practice of Medicine.

ANDREW W. McALESTER, M. D.,
Professor of Surgery, Obstetrics and Diseases of Women and Children.

GEORGE C. SWALLOW, M. D.,
Professor of Botany, Comparative Anatomy, and Physiology, and Materia Medica.

PAUL SCHWEITZER, PH. D.,
Professor of Pharmacy, Materia Medica, and Toxicology.

JOSEPH G. NORWOOD, M. D.,
Professor of Chemistry, Institutes of Medicine, and Medical Jurisprudence, and Dean of the Faculty.

JOHN H. DUNCAN, M. D.,
Instructor in Physiology and Chemistry, and Demonstrator of Anatomy.

WOODSON MOSS, M. D.,
Instructor in Anatomy and Practice of Medicine, and Demonstrator of Anatomy.

(For names of students, see general catalogue of students of the University.)

DESIGN.

This College is designed to be a primary and theoretical school of a high order, in which the student will be thoroughly indoctrinated in the principles of medicine and surgery. The course will be as full and complete as is given in any school in this country, with the exception of clinical or bedside instruction, which, of course, can be best taught in the hospitals of our large cities. To these fountains of practical knowledge our students will be urged to resort as soon as they are deemed competent to comprehend and appreciate such instruction. While all intelligent members of our profession will fully admit the value of clinical instruction, they will, at the same time, as freely concede the fact that it is a very unprofitable use of time for a "first course" student to devote attention to it.

Opportunities for studying diseases and witnessing treatment will be afforded to students qualified for it, at the County Hospital and Insane Asylum, to which the Faculty have access. This institution contains constantly from fifty to sixty patients. In addition to this, the Professors of Surgery and the Practice of Medicine, hold clinics twice a week at the College, where patients are prescribed for and treated free of charge.

GENERAL PLAN OF INSTRUCTION.

The plan of instruction is designed to be the same as that pursued in the University of Virginia. The length of the sessions, *nine months*, renders it practicable to distribute the branches taught among a limited number of teachers, and enables them at the same time to present the various subjects in their natural order and succession. For example, the elementary branches, Anatomy, Physiology, Materia Medica and General Therapeutics, are taught for the first half session; after which, if the student is found prepared for it, he is allowed to pass to other and higher branches, which are taught during the last half-term. Chemistry is taught throughout the College year. The student is thoroughly drilled each day by examinations upon the lectures of the previous day, and by recitations from the text-books.

By this method of teaching it is claimed that we avoid the process of cramming, a deleterious practice too prevalent in the general system of medical education. We believe that the proposed method of teaching will do more to elevate the standard of medical education, and exalt the dignity of our profession, than any other measure

that could be adopted. The high standing throughout the country of the graduates of the medical department of Virginia University is sufficient evidence of the value of this method of teaching.

Besides the ordinary instruction in Chemistry, a special course will be given to advanced students in Pharmacy and Toxicology, the material and appliances for teaching which are not excelled by those of any institution in the United States.

The student will also be taught the use of the microscope, especially in relation to pathological studies.

Another feature, to which we invite attention, is the course of instruction in Botany; and the attention given to comparative Anatomy and Comparative Physiology, branches of knowledge essential to every accomplished physician.

Among the advantages offered by this school, is the privilege granted to all students who enter the medical department, of pursuing such studies as they may desire in the academic course. Or, they may be academic students, and take one or two branches in the medical course, preparatory to entering on the full medical course after graduating in Arts or Science. Some students are pursuing this plan at present.

A full course of lectures will be given on Medical Jurisprudence to the classes in Law and Medicine. When necessary for the more complete understanding of the subject, the lectures will be illustrated by the use of accurate anatomical models.

This department is now splendidly equipped with models in clastic and papier maché, plaster casts, drawings and other appliances for the illustration of the lectures on anatomy, surgery and physiology.

Among the many valuable preparations for demonstrating anatomy and surgery, received since the last report was made, is Dr. Auzoux' *Clastic Man*, a complete and accurate model of the male human body. The figure is five feet ten inches in height, and is composed of ninety-two separate parts, which may be detached from one another. It exhibits over two thousand details of the viscera, muscles, nerves, blood-vessels, etc.; in short, all that is usually embraced in a complete treatise on anatomy.

Also, Auzoux' female pelvis, with the external and internal organs of generation, the lumbar vertebræ, diaphragm, muscles, aponeuroses of the perineum, vessels and nerves.

Also, his collection illustrating *Ovology*. These models are on an enlarged scale, and exhibit the modifications of the ovum, envelopes and vitelline vesicle, from the first to the thirtieth day, viz.: from the appearance of the ovum in the ovary to the formation of the embryo.

In addition to the above, are eight *uteri*, in elastic, containing the products of conception at the first, second, third, fourth, eighth and ninth month, with examples of tubular and ovarian pregnancy.

Another model, to which we deem it proper to call especial attention, is Dr. Auzoux' synthetic preparation of the *Brain*, which exhibits the texture of that organ upon an immensely magnified scale. Designed in conformity with the new anatomical indications furnished by Dr. Luys, this model presents a resumé of all the researches of ancient and modern anatomists. *It enables the student to follow the nerve fibres throughout the nerve mass*, and thus to comprehend the mechanism by which external impressions arrive at any given point in the brain, and also by which volition transmits its influence to the various parts of the body. This entirely new method of studying the brain opens an immense field for the researches of physicians and philosophers.

The models of the *Eye* and *Ear* are greatly enlarged, and very accurate, showing the complete structures of these organs as described by modern anatomists.

The preparation of the *Head* is most admirably executed. The bones are disarticulated, and mounted according to the method of Beanchini.

Besides these invaluable models and preparations, we have a complete set of the German anatomical models, in plastic, made at Leipsic.

Every facility will be afforded the student for the study of practical anatomy. Adequate provision has been made for a supply of subjects sufficient for any number of students. The dissecting rooms will be open during the whole winter season, where, under the guidance of the Demonstrator, the student may by dissection acquire a practical knowledge of the structure of the human body in all its parts.

The degree of Doctor of Medicine will be conferred upon such students as prove their fitness to receive it, by rigid and searching examinations, conducted by a committee of three physicians, to be appointed for that purpose by the District Medical Society, and independent of the Faculty of the school.

Candidates for graduation must have a standing of 85 per cent. in Anatomy and Physiology; of 60 in Botany, Chemistry, Toxicology and Pharmacy, and of 75 per cent. in all other studies.

It will be the policy of this department to make its honors testimonials of merit, and not mere certificates of an attendance on a pre-

scribed course of instruction. In accordance with this policy, the degree of Doctor of Medicine may be conferred whenever the student is found worthy to receive it.

The next session will begin on the 1st of October, 1875, and terminate on the 29th of June, 1876. The fee for tuition, for the term of nine months, will be forty dollars; for Demonstrator's ticket, ten dollars.

LIST OF STUDIES AND HOURS OF RECITATION.

9—10 h. Therapeutics and Obstetrics; Botany.
10—11 h. Anatomy; Zoology and Comp. Anatomy; Toxicology and Pharmacy.*
11—12 h. Chemistry.
12— 1 h. Physiology; Practice of Medicine.
2— 3 h. Surgery and Obstetrics.
12— 1 h. Medical Jurisprudence—3 times a week.

It is considered proper to state that the salaries of the professors are paid out of the endowment fund of the University, and are entirely independent of tuition fees. For any further information in relation to the school, address—

J. G. NORWOOD, M. D.,
Dean of the Faculty.

* Students are required to take a course in Analysis in the Laboratory.

REPORT

OF THE

COMMITTEE OF EXAMINERS FROM THE DISTRICT MEDICAL SOCIETIES, APPOINTED TO EXAMINE INTO THE QUALIFICATIONS OF STUDENTS APPLYING FOR THE DEGREE OF M. D., IN JUNE, 1874.

COLUMBIA, MO., June 24, 1874.

To J. G. NORWOOD, M. D., *Dean of the Faculty of the Medical Department of the State University:*

The undersigned, having been requested to act as an examining committee of the medical class, beg leave to report:

That we have carefully read the written examinations that were submitted to our inspection, and after testing the class by a rigid and thorough oral examination, we take great pleasure in saying that, in our judgment, they gave evidence of more than ordinary proficiency in the class, as well as skill and fidelity on the part of the teachers. Five of the class are candidates for graduation, viz.: J. H. Duncan, W. V. Smith, Woodson Moss, W. L. Ragan and A. M. Conway, and we recommend that the degree of Doctor of Medicine be conferred on each of them.

We take this occasion to express our gratification at the success of the first regular session of this department. We feel fully satisfied in predicting a growing prosperity for the school, if the same diligence and energy be continued that have been exhibited the past session.

The success of this department, in our opinion, will also depend very much upon the fostering care and encouragement that may be given to it by the Board of Curators and other friends of the University. Certainly no object could be more laudable.

Respectfully submitted.

THOMAS J. MONTGOMERY, M. D.,
President of Pettis County Medical Society.

H. H. MIDDELKAMP, M. D.,
President of Linton District Medical Society.

GEO. W. BROOME, M. D,

J. W. PRYOR, M. D.,
President Monroe City District Medical Society.

DEPARTMENT OF ANALYTICAL AND APPLIED CHEMISTRY.

P. SCHWEITZER, PH. D.

The Laboratory, provided for the use of the students, is situated on the lower floor of the Scientific Building; it is furnished in the most approved style with working tables, reagents and apparatus generally, affording to the student all the means which science commands, for acquiring a thorough knowledge of Analytical Chemistry, both qualitative and quantitative, and offering facilities for pursuing investigations in Chemistry which are not equaled anywhere else in this State. Ample provision is made for ventilation, a very important item in the construction of a Laboratory; between the windows and the working tables of the students, evaporating niches are constructed, through which offensive gases and vapors are carried off, facilitating thereby greatly the purification of the air. The working tables are furnished each with sink and water and closet-room sufficient to pack away all apparatus used during the day.

Qualitative Analysis is taught by lectures and black-board exercises, and the student is required to repeat at his table in the Laboratory all the experiments performed by the professor; after becoming familiar in this way with acids and bases, simple substances (of the composition of which he is ignorant) are given to him for identification; thus he proceeds from simple to more complex cases, until he is able to determine the composition of the most complicated and difficult mixtures. Use is made of the spectroscope in these investigations as often as it is needed.

When the student, upon written and experimental examination, proves to be sufficiently familiar with Qualitative Analysis he passes to the study of Quantitative Analysis. Lectures and black-board exercises go here also side by side with laboratory work. The student executes a number of analyses, determining in the substances handed to him, each constituent by weight; when he has attained the requisite amount of skill to insure accurate results, he is required to execute analyses of a more complex nature, as of coals, limestones, slags, ores of iron, lead, cobalt, zinc, copper, nickel, pig iron, technical products, etc.

There is a room fitted up in the basement for the execution of analyses by the dry method. The general principles of Assaying and special processes are explained in the lecture-room, after which the student is provided with suitable apparatus, and, having access to crucible and muffle furnaces, executes a number of assays to determine the percentage of lead, silver, and gold, in any ore or product.

If after pursuing this course the student desires to engage in any special investigation, either scientific or practical, every facility of the University and the special attention of the professor will be given him.

The instruction in Applied Chemistry consists of lectures, illustrated by experiments, diagrams, and specimens.

The subjects discussed are:

1. *Food and Drink*—Cereals, starch, bread, meat, sugar, preservation of food, water, milk, tea, coffee, fermentation of wine, beer, spirits, vinegar, tobacco, etc.
2. *Clothing*—Textile fabrics, bleaching, calico printing, dyeing, tanning, paper, glue.
3. *Illumination*—Candles, oils and lamps, petroleum, gas and its products.
4. *Fuel* and its application, including steam and steam engine.
5. *Disinfectants and Antiseptics*—Preservation of wood, etc.
6. *Limes, Mortars, Cements*, etc.
7. *Glass, Porcelain, Pottery*, etc.
8. *Oils, Fats, Soaps, Glycerine.*
9. *Pigments*—Paints, resins, varnishes, inks, essential oils.
10. *Fertilizers*—Guano, superphosphates, poudrette.
11. *Chemical Manufactures.*

The collection of specimens to illustrate these lectures is already large and constantly increasing; in addition to it, a complete set of Knapp's Technological Diagrams has been procured, facilitating greatly the instruction in this Department.

The lectures on Agricultural Chemistry, delivered to the Junior Class in Agriculture, comprise a scientific exposition of the production of organic matter within the plant, beginning with a description of the physiological structure of the cell, proving the office of Chlorophyll to be an apparatus for doing chemical work, depending upon light and heat, analyzing the rays capable of doing this work, and tracing finally the conversion of the organic matter produced into the various carbohydrates. The nitrogenous constitutents of the plant are treated in reference to its organs, to the nitrogenous fertilizers

and to the nitrogen of the air, leading to the consideration of the mineral matter or ash to the growth of plants and to the soil. Osmose and Endosmose of gases and fluids are illustrated by experiment, and the influence of climatic conditions explained by reference to statistics.

The chemical and physical properties of the soil are fully treated of, by tracing its productions from the various geological formations through natural agencies, and by improvements through mechanical means and fertilizers of various composition and origin, to its present condition.

The different fertilizers in use, their relative value and their employment for extensive and intensive cultivation as a paying investment, are discussed next.

If a special student in Chemistry passes a satisfactory examination in Physics, General Chemistry, Applied Chemistry and Mineralogy, in addition to the work required of him in the Laboratory, he shall be entitled to a Certificate of Proficiency; such a course would extend over three Semesters.

It is probable that the Board of Curators will make provision for the extension of this course, by establishing a professional school, to be called the School of Chemistry, in which students may graduate with the degree of Bachelor of Chemistry.

EXAMINATIONS.

The examinations are both oral and written.

No student will be admitted to a standing or receive credit in a department unless he shall sustain his proper examination.

The following is a collection of examination papers, presented as specimens from different departments:

EXAMINATION PAPERS.

CONSTITUTIONAL LAW—President Read.

1. Articles of confederation—by what body proposed, by whom and when finally adopted, causes of their inefficiency and failure.

2. The Constitution—by what authority was the convention organized which formed it, where and when did it sit, how many States represented, principal points of disagreement and the compromise, how was the constitution proposed and adopted.

3. What powers does the general government possess, and where does that not delegated remain?

4. What is the *rationale* of two separate houses in a Legislature?

5. In what respect may not the constitution be amended, otherwise how amended?

6. Whence is derived trial by impeachment, and wherein does it differ in the United States and Great Britain—has the King of Great Britain the right to pardon after conviction—has he that power before conviction?

7. What is meant by a bill of attainder?

8. Under what authority of the constitution has territory been acquired?

9. If a State constitution shall forbid a judicial officer from accepting any other office during the time for which he shall have been elected a judge, and he shall during the time be elected a U. S. Senator, will he be permitted to hold his seat as such?

10. What is meant by an indictment, and what by a presentment of a grand jury?

11. Give the outlines of the Feudal System, and name some of the principal incidents thereof.

12. When, and for what object, did the House of Commons come into existence?

13. Who is the presiding officer in the House of Lords, and who in the House of Commons?

14. Of these two bodies, which in our day is the more potential body in Great Britain?

15. What is the object of a dissolution of Parliament, and who dissolves it?

16. What was the object of the Reform Bill of 1832?

17. May the British Constitution be amended, and how?

INTERNATIONAL LAW—President Read.

1. What nations recognize the obligation of international law?
2. What does Vattel mean by the necessary law of nations?
3. Does a change in the form of the government of a nation change the rights or duties of a nation? Illustrate the principle and give historical instances.
4. What territorial jurisdiction have nations on the high seas?
5. What extent of jurisdiction may a nation exercise over adjoining seas?
6. What was the complaint of the American government in the Alabama case, and what principle of duty on the part of neutrals was recognized in that case?
7. Under what circumstances may belligerent rights be accorded to a people in a state of rebellion; and what do these rights imply? When is a people entitled to recognition as an independent nation?
8. Are there any lawful *commercia belli* between belligerents; if so, what?
9. Does the same department of government declare war and make peace? Is a formal declaration necessary to a *bellum justum;* and what circumstances have produced the change in this respect?
10. What different rule obtains as between belligerents as to captured property on land and on sea?
11. Name the several classess of public ministers, and which of these does the United States not appoint, and why?
12. What are the offences against international law which municipal law recognizes and punishes?

CHREMATISTICS AND POLITICAL ECONOMY—President Read.

1. Give an account of the origin of the right of property.
2. What is meant by eminent domain?
3. What is capital? Name the different kinds?
4. What are the expedients by which labor is economized?
5. Is machinery a benefit to the laborers?
6. Explain the different circumstances which will control the price of labor.
7. State the conditions under which population will increase, or remain stationary.
8. What is consumption, and state kinds and objects of?
9. What is the principal rule to be observed in the consumption of labor?

ETHICS—President Read.

1. Give the methodology of the subject.
2. What is casuistry?
3. What is the foundation of right?
4. Give the theory of Socrates, of Hobbes, of Paley.
5. Give the duties to self.
6. Show that duty to self really requires the performance of duties to God and to our fellow men.
7. In what sense are all duties, duties to God?

DEPARTMENT OF NATURAL SCIENCE.

PHYSICS.—Dr. Norwood.

1. A piece of gold, the sp. gr. of which is 19.36, weighs 140 grs. in a liquid, and 159.7 grs. in the air, what is the sp. gr. of the liquid?

2. If the specific gravities of gold and silver are 19.35 and 10.51 respectively, find the specific gravity of a mixture consisting of seven parts by weight of gold, and six of silver.

3. A piece of copper, the sp. gr. of which is 8.85 weighs 446.3 grs. in a liquid, and 490 grs. in the air; required the sp. gr. of the liquid.

4. A mixed mass of gold and quartz (the sp. gr. of the quartz being 2.6) weighs 20 lbs. Its sp. gr. is 8.5. How much gold does it contain?

5. What will be the weight of a block of limestone containing 12 cubic feet; one cubic foot of water weighing 62.5 pounds, and the sp. gr. of the stone being 2.64?

6. How is temperature measured?

7. Name the instruments in common use, and describe their differences.

8. Convert 60 degrees of Fahrenheit's scale into degrees of the Centigrade scale.

9. What is the mechanical equivalent of heat? Explain what is meant by *work?*

10. What is meant by kinetic, and what by potential energy? Give illustrations.

11. How is light propagated?—What is the theory of Huygens?

12. What do you mean by a voltaic current? State the conditions necessary for its production. What is the difference between a simple and compound voltaic current? Which possesses the higher intensity?

13. What is meant by polarization as applied to the electric current? State some of the inconveniences arising from this effect, and how they have, sometimes, been remedied.

14. Arrange the elements named below in their electro-chemical order. Select two of them; describe how you would proceed to establish a voltaic current by their agency, and point out what would be the direction of the current. *Hydrogen, phosphorus, gold, copper, carbon, iron, zinc, potassium, sulphur.*

15. Describe the construction of Grove's battery and the action which takes place in it. Explain how it comes to pass that the intensity as well as constancy of the current is increased by this arrangement.

16. State what you know regarding the chemical effects of the voltaic current.

17. Give some illustration of the resemblance in their nature between electricity from the frictional machine and from a voltaic battery; and state to what you ascribe the great difference between the general effects obtained with electricity from the two sources.

GENERAL CHEMISTRY.—Dr. Norwood.

1. What are chemical symbols? Give examples of the manner in which they are employed.

2. What is meant by the term salt?

3. What is the difference between a mechanical mixture and a chemical compound? Give an illustration.

4. What are the laws of combination?

5. Write out the formulæ of the following salts:

Potassic nitrate.
Ferric sulphate.
Sodic Carbonate.
Hydric sodic sulphate.
Cupric sulphate.
Hydric potassic carbonate.
Zincic sulphate.
Ferrous sulphate.
Ferric phosphate.
Cupric nitrate.
Plumbic nitrate.
Argentic oxalate.

6. Write the names of the following compounds, and give a complete analysis of each formula:

$CaSO_4$.	$AsCl_3$.	$SrCO_3$.	$KClO_3$.	Na_3BO_3.
NH_4NO_3.	$CaHAsO_3$.	Na_2HAsO_4.	$BaSo_3$.	Fe_2Cl_6.
$Pb(NO_3)_2$.	Fe_2SiO_4.	NH_4HS.	K_2CrO_4.	$BiCl_3$.

7. What weight of oxygen is contained in one kilogramme of potassic chlorate?

8. 30 litres of oxygen were measured off at 15° C. What would be the volume of the gas at 0° C, the pressure remaining unchanged?

9. What is the volume of 12 grammes of hydrogen at 15° C?

10. One hundred cubic centimeters of air are mixed with fifty cubic centimeters of hydrogen, and exploded by the electric spark. What is the volume of the residual mixture after explosion, supposing all the steam to be condensed?

11. A block of Wenham-lake ice weighs 280 kilogrammes. What is its volume?

12. What weight of hydric nitrate, HNO_3, ought to be obtained from one kilogramme of sodic nitrate, $NaNO_3$, supposing none of the product to be decomposed?

13. What weight of pure "manganese" is needed for the evolution of 100 grammes of chlorine?

14. What weight of potassic hydrate is needed for the neutralization of 10 grammes of hydrochloric acid gas?

15. What weight of sal-ammoniac must be taken to obtain one kilogramme of ammonia?

16. What volume of nitrogen is obtained by the combustion of 10 cubic centimeters of ammonia?

17. What volume of carbonic oxide will be obtained by passing a litre of oxygen over an excess of white hot charcoal?

APPLIED CHEMISTRY—Frof. Schweitzer.

1. What are the proximate chemical constituents of cereals?
2. Arrange the cereals according to their per centage of Gluten.
3. What is Gluten; how is it obtained, and into which three nitrogenous principles can it be separated?
4. Why is the percentage determination of the Nitrogen in any grain or flour an expression of its nutritive value?
5. What are respiratory and what are plastic foods?
6. What is the physiological office of Starch in seeds and other parts of the plant?
7. Describe and define fermentation.
8. Give the constitution of a fat.
9. Mention a solid, a fluid and a gaseous Hydrocarbon?
10. What is the difference between a Hydrocarbon and a Carbohydride?
11. What is understood by the term illuminating power, and how is it measured?
12. Give the general principles of making Illuminating Gas.
13. What is understood by the flashing and the burning point of an oil; what is the temperature of these two points as fixed by law in some of the States?
14. How is Aniline produced from Coal-Tar?
15. What is a disinfectant and what an antiseptic?

MATHEMATICS.—Prof. Ficklin.

Arithmetic.

1. Find the greatest common divisor and the least common multiple of 153 and 187.
2. Multiply 108 billionths by 2,000, and extract the cube root of the product.
3. What is the sum of $\frac{\frac{3}{4}}{5\frac{1}{2}}$ and $\frac{6\frac{7}{8}-2\frac{2}{3}}{9\frac{1}{8}}$?
4. A cellar is 30 feet long and 20 feet wide, and contains 50 cubic yards; how deep is it?
5. Find the amount of $500 at 10 per cent. for 1 y. 3 m., the interest being compounded quarterly.
6. A man receives $20 for six days' work of 8 hours each; what should he receive for 10 days' work of 10 hours each?
7. How deep must a cistern be whose diameter is 10 feet, in order that it may hold 100,000 gallons of water?
8. The extremes of an arithmetical progression are 2 and 50, and the number of terms is 10; what is the sum of all the terms?

Algebra.

1. Solve $ax^2+bx=0$.
2. Solve $\frac{1}{ax^{-1}}+bx^{-1}=\frac{1}{c^{-1}}$.
3. Solve $2(x^{\frac{1}{n}}+x^{-\frac{1}{n}})=5$.

4. Solve $\left\{\begin{matrix} x^2+y^2=65 \\ xy=28 \end{matrix}\right\}$.

5. If $x^2<y^3$, and $x=2$, when $y=3$, what is the value of y in terms of x?

6. Find the sum of the coefficients in the expansion of $(x+a)^n$.

7. Separate $\frac{x+2}{x^3-x}$ into partial fractions.

8. Find the generating fraction of the series $1+3x+4x^2+7x^3+11x^4+ \ldots$.

9. $1-2\sqrt{-1}$ is a root of the equation $x^3-x^2+3x+5=0$; what are the other roots?

10. All the roots of the equation $x^5-3x^4-5x^3+15x^2+4x-12=0$ are real; how many of them are positive?

Plane Geometry.

1. The sum of the angles of a plane triangle is equal to two right angles.

2. Find the value of any interior angle of a regular hexagon.

3. An angle inscribed in a circle is measured by half the intercepted arc.

4. Inscribe a regular hexagon in a given circle.

5. Find a mean proportional between two given lines.

6. The area of a regular dodecagon inscribed in a circle is equal to three times the square of the radius.

Solid Geometry.

1. The intersection of two planes is a straight line.

2. The sum of the angles formed by the edges of a solid angle is less than four right angles.

3. A line which is perpendicular to two lines of a plane at their point of intersection is perpendicular to the plane.

4. Similar cones are to each other as the cubes of their altitudes.

5. Two spherical triangles on the same sphere, or on equal spheres, are equal in surface, if the sum of the angles in one is equal to the sum of the angles in the other.

6. Find the volume of the greatest sphere which can be cut out of a cylinder, the diameter of whose base is 12 feet, and whose altitude is 20 feet. What will be the volume of that part of the cylinder which remains?

Trigonometry.

1. Show that $\sin 2a=\frac{2\tan a}{1+\tan^2 a}$.

2. The area of an equilateral triangle is a; find the length of one side.

3. The parallel chords, whose lengths are 96 feet and 60 feet, are 26 feet apart; find the radius of the circle.

4. Find a formula for the difference between true and apparent level.

5. State and prove the theorem for parallel sailing.

6. If $\sin x=\frac{1}{2}$, what is the value of $\tan x$?

7. Find the value of x in the equation $2\sin x \cos=1$.

8. Show that, in every right-angled spherical triangle, an oblique angle and its opposite side are of the same species.

9. State the rule of Napier.

10. State the rule for finding the area of a spherical triangle.

Analytical Geometry.

1. Where do the lines whose equations are $y^2=mx$ and $x^2+y^2=R^2$ intersect?

2. What is the equation of the straight line which passes through the centers of the circles whose equations are $(x-2)^2+(y-3)^2=25$ and $(x-5)^2+(y-6)^2=49$?

3. Where does the line whose equation is $y=10$ cross the axis of ordinates?

4. Where does the line whose equation is $y=\sin x$ cross the axis of abscissas?

5. Construct an ellipse whose axes are 8 and 6.

6. Show how to find the axis and focus of a parabola when the curve is given.

7. Show how to find the axes and foci of an ellipse when the curve is given.

8. Find the locus of the intersection of a perpendicular drawn from the focus of an ellipse to the tangent.

9. Find the equation of a tangent line to the ellipse.

10. Find the co-ordinates of the center and the radius of the circle whose equation is $x^2-4x+y^2-6y-12=0$.

Calculus.

1. Differentiate $u=x \log x$.

2. Differentiate $u=\cos x$.

3. Differentiate $u=\sin x \cos x$.

4. Find the equation of the tangent to the curve whose equation is $y^2=\frac{x^3}{4-x}$ at the point whose abscissa is 2.

5. Find the value of $\left\{\frac{e^{nx}-e^{na}}{(x-a)^s}\right\}$ $x=a$.

6. Integrate $\frac{dx}{\sqrt{a^2-x^2}}$.

7. Integrate $\frac{xdx}{\sqrt{a^2+x^2}}$.

8. Integrate $\left(\frac{1-\sin x}{x+\cos x}\right)dx$.

9. Integrate $\frac{adx}{x^2+bx}$.

10. Integrate $\frac{m+nx}{a^2+x^2}dx$.

Mechanics.

1. Show that the path of a projectile in a vacuum is a parabola.

2. Find the equation of the path of a projectile in a vacuum.

3. A sphere is placed upon a smooth inclined plane and left to the action of gravity; will it slide or roll down the plane? Why?

4. Find the center of gravity of five equal, heavy particles placed at five of the angular points of a regular hexagon.

5. Find the center of gravity of a semi-circumference.

6. Find the center of gravity of a semi-circle.

7. Two bodies, A and B, are on the circumference of a given circle; A remains at rest while B moves in the circumference; find the path described by the center of gravity of A and B.

8. A hemisphere has its base fixed in a horizontal position, and a body, under the influence of gravity, moves down the convex side of it from the highest point. How far from the base will the body be when it leaves the surface of the hemisphere?

9. If three uniform rods be rigidly united so as to form half of the perimeter of a regular hexagon, prove that if suspended from one of the angles, one of the rods will be horizontal.

10. A cone, whose specific gravity is $\frac{1}{8}$, floats on water with its vertex downward; how much of its axis is immersed?

ASTRONOMY.

1. Show how to find the R. A. and Dec. of a heavenly body. State what instruments you would use.

2. Show how to find the parallax of the moon.

3. Show how to find the time of day by the sun's altitude, the latitude of the observer, and the sun's declination being given.

4. State Kepler's laws, and prove the first one.

5. Explain the method of finding the height of lunar mountains.

6. Find the semi-angle of the earth's shadow.

7. Show how to find the distance of an inferior planet from the sun.

8. How much must the mass of the earth be increased in order that the moon may revolve about it in the same time as it now does, when removed to three times its present distance?

9. The sidereal period of Mercury is 88 days; find its synodical period.

10. What is the longitude of a place where the local time is 1 h. 30 m. slower than Greenwich time?

GERMAN. (Close of first year.)—MISS MARY B. READ.

Translate into German:—

1. We lived in the country; the weather was fine and warm.

2. This man has become very rich; he has always been industrious.

3. There are large forests, high mountains, lovely valleys and beautiful rivers in Germany.

4. Gold is more precious than silver, and the diamond more precious than gold.

5. William the Fourth was the son of George the Third.

6. I have bought this house and that garden from my neighbor.

7. Whose book have you found?

8. They came at half-past five o'clock, two hours too late.

9. He was standing under a tree.

10. By whom has the house been built in which you live?

11. How many exercises have you copied?

12. We got up very early and copied all the exercises before you came in.

13. Have you taken a walk to-day?

14. We were just going to take a ride, when it began to rain.
15. I feel cold, but I do not feel sleepy.

Grammatical Questions.

1. Write the genitive singular (with the respective definite article) and the nominative plural of the following nouns: Baum, Meſſer, Fiſch, Uhr, Vetter, Ohr, Tochter, Wald, Freiheit, Hund, Soldat, Student.
2. Translate and decline in both numbers: the round table—a good book—the beautiful lady—the stranger.
3. Decline der, die, das, in its function of relative pronoun.
4. Conjugate reden in the indicative mood.
5. Write the first person of the imperfect and the past participle of: ſprechen, kommen, halten, heißen, ſteigen, thun.
6. Conjugate the present of the verb ſich freuen.
7. Write the comparative and superlative of the adverbs: gern, wohl, bald.
8. When does the verb precede its subject in German?
9. When is the verb placed at the end of the clause?
10. What is the difference in the use of: als, wenn, wann?

Translate into English:—

"Dass alle Jahreszeiten sind gut." "Ja, dass sie alle reich an Freuden, reich an mannigfaltigen Gaben sind, und dass der liebe, grosse Gott viel besser, als wir armen Menschen sich auf das Weltregieren verstehen muss. Hätt' es vorigen Winter von dir abgehangen, so würden wir keinen Frühling, keinen Sommer, keinen Herbst gehabt haben. Du hättest die Erde mit ewigem Schnee bedeckt, um nur Schlitten fahren and Schneemänner machen zu können. Und wie viele andere Freuden hätten wir dann entbehren müssen! Wohl uns, dass es nicht auf uns ankommt, wie es in der Welt sein soll; wie bald würden wir sie verschlimmern, wenn wir könnten!"

Es stand in alten Zeiten ein Schloss, so hoch und hehr,
Weit glänzt' es über die Lande bis an das blaue Meer,
Und rings von duft'gen Gärten ein blüthenreicher Kranz,
Drin sprangen frische Brunnen im Regenbogen Glanz

Einst zog nach diesem Schlosse ein edles Sängerpaar,
Der Ein' in goldnen Locken, der Andere grau von Haar;
Der Alte mit der Harfe, er sass auf schmuckem Ross,
Es schritt ihm frisch zur Seite der blühende Genoss.

"Weh euch, ihr stolzen Hallen! nie töne süsser Klang
Durch eure Räume wieder, nie Saite noch Gesang;
Nein! Seufzer nur, und Stöhnen, und scheuer Sklavenschritt,
Bis euch zu Schutt und Moder der Rachegeist zertritt!"

FRENCH.—Miss Read.

Translate into French:—

1. My father, mother and sisters are in the country.
2. I should build a large house, if I were rich.
3. I should give you some money, if you were more industrious.
4. Do not give him my book, I want it myself.
5. Your rooms are more spacious than ours, but ours are higher.
6. The man of whom you are speaking is dead.
7. The horse to which you have given some water is mine.
8. A cousin of ours came yesterday to see us.
9. Brave and trusty men are generally humane and merciful.
10. He who gets riches, knows not for whom he gets them.
11. Of all the nations of the earth, there is none but has an idea of God.
12. How long is it since you lost your father?
13. Get up early to-morrow morning, that we may start in good time.
14. May God protect you.
15. I do not deny that it may be so.
16. O thou! said I to the young man, son of a father that I loved so much, how dost thou come here?
17. True happiness is not on earth; but what one can at least avoid, is to be unhappy by one's own fault.
18. I could at length satisfy one of my dearest wishes by making a journey to Switzerland.
19. Having often traveled in France, and having resided there several years, I am perhaps able to give you a just idea of that country and its inhabitants.
20. I cannot accompany you into the country, having some business that requires my presence here.

Grammatical Questions.

1. Give the plurals of: château, palais, cheval, ciel, noix, grand-père, arc-en-ciel,
2. Compare: joli, bon, grand.
3. Give a synopsis (1st person singular) of all the simple tenses of: être, donner, vendre.
4. Conjugate the present indicative of: se réjouir—and state with what auxiliary its compound tenses are conjugated.
5. Give the principal parts of: venir, mettre, rire, naître, plaire.
6. Conjugate the present indicative of: prendre, aller, faire, dire, courir.

Translate into English:—

Je fus hier aux Invalides: j'aimerais autant avoir fait cet établissement, si j'étais prince, que d'avoir gagné trois batailles. On y trouve partout la main d'un grand monarque. Je crois que c'est le lieu le plus respectable de la terre.

Quel spectacle de voir assemblées dans un même lieu toutes ces victimes de la patrie, qui ne respirent que pour la défendre, et qui, se sentant le même cœur et non pas la même force, ne se plaignent que de l'impuissance où elles sont de se sacrifier encore pour elle.

Parlez, écrivez, agissez, comme si vous aviez mille témoins; comptez que tôt ou tard tout est su: il est très dangereux d'écrire. Ne confiez à personne rien qui puisse vous nuire, s'il est redit. Comptez que les secrets les mieux gardés, ne le sont que pour un temps; et qu'il n'est point de pays où il y ait plus d'indiscrétion que celui-ci (la cour) où tout se fait avec mystère.

RACINE—*Athalie.*

Prêtez moi l'un et l'autre une oreille attentive.
Je ne veux point ici rappeler le passé,
Ni vous rendre raison du sang que j'ai versé ;
Ce qui j'ai fait, Abner, j'ai cru le devoir faire.
Je ne prends point pour juge un peuple téméraire ;
Quoi que son insolence ait osé publier,
Le ciel même a pris soin de me justifier.
Sur d'éclatants succès ma puissance établie
A fait jusqu'aux deux mers respecter Athalie.
Par moi Jérusalem goûte un calm profond ;
Le Jourdain ne voit plus l'Arabe vagabond,
Ni l'altier Philistin, par d'éternels ravages,
Comme au temps de vos rois, désoler ses rivages,
Le Syrien me traite et de reine et de cœur.

EXAMINATION OF THE LAW CLASS.

The questions submitted to the Graduating Law Class, were chiefly by the Examining Committee, Hon. E. A. Lewis, of St. Louis, and Hon. John H. Overall, of Columbia. Besides oral examinations upon some titles, the following questions were answered simultaneously in writing :

EQUITY JURISPRUDENCE—JUDGE LEWIS.

1. What, if any, is the difference between equity, in its generally received sense, and equity as treated of in the works of Story, Adams, Fonblanque and others?

2. May, or may not, a right which the common law denies, be enforced in Equity?

3. Suppose a well defined legal right to become the subject of chancery adjudication. What familiar maxim will control the ruling upon such a right?

4. Assuming that some legal rule of right may be found applicable to every human transaction, what need exists for chancery jurisdiction while courts of law are accessible?

5. Give one or more illustrations of the advantages sometimes possessed by equitable over legal remedies, for the violation of rights recognized in both systems.

6. A single matter of controversy having found its way into a court of equity, and also into a court of common law, either court having a proper jurisdiction thereof, may, or may not, both courts proceed to final adjudication? If not, which court will have the right of precedence?

7. What, if any, is the difference between the common law and equity treatment of a penal bond, when forfeited?

8. What, if any, is the difference between the legal and equitable doctrines touching release from the obligation of a specialty?

9. What is a trust, and how many classes of trusts are there?

10. If a court of equity be called upon, to enforce the performance of trusts created by a will whose validity is contested, what is the proper course of procedure?

11. What is a vendor's lien, and under what circumstances in a sale is it considered as waived by the vendor?

12. What is meant by equitable conversion?

13. How do you discriminate between a mortgage and a conditional sale?

14. What are the purposes of a bill of discovery, and when will it lie?

15. What are the chief general requisites of a case for an injunction?

16. Under what circumstances, if any, may equity relieve a party against the effect of his own deed?

17. Can equity supply a failure to execute a power—or can it aid an imperfect or defective execution? Can it do both, or neither? If either, which?

18. Will willful misrepresentation, constituting an inducement to a contract, avoid such contract for fraud, in every possible case?

19. Is inadequacy of price, in any case, a ground for equitable relief against a bargain? If yes, when?

20. By what leading considerations must the joinder or non-joinder of parties to a suit in equity be determined?

21. By what process did courts of equity originally enforce their decrees—and how have their powers in this regard been modified by statute?

REAL ESTATE—JUDGE LEWIS.

1. What is a fundamental theory of the English law, as to the source of all title to land?

2. Has this theory, in any shape, obtained a footing in the United States? If so, in what form?

3. What is real estate?

4. What is a hereditament?

5. Mention some incorporeal hereditaments.

6. What is a right of way, and when may it arise without an express grant?

7. What are franchises? Name some.

8. What is a fee simple, as now understsood in this country?

9. At common law, what word is necessary to be used in a deed creating a fee simple? Is it or not, equally essential for the same purpose in a will?

10. What, in the English law, is a common recovery—to what class of estates is it specially applicable, and for what purpose?

11. What is a tenancy by the courtesy, and what are some of its essential points?

12. Is, or is not, the husband of a mortgagee entitled to courtesy in the mortgaged estate?

13. What is dower, and what, at common law, were its essential conditions and duration?

14. Does, or does not, a right of dower attach to lands held in joint tenancy?

15. What will be the effect of a jointure upon the right of dower?

16. When must a jointure take effect, and for what must it be in full satisfaction?

17. If the owner of a tract of land exchange it for another, will his widow be entitled to dower in both?

18. If a tenant for life die while his crops are growing, who will be entitled to the profits of the crops when matured, and by what name will they be known?

19. Which, in the estimation of the common law, is the higher and greater, an estate for life, or an estate for a thousand years?

20. May a lease for years commence *in futuro?* How, if at all, does it differ in this respect from a freehold?

21. Does, or does not, a lease for years, determinable at a fixed period without any contingency, entitle the tenant to emblements?

22. What, if any, is the difference between a tenancy at will and a tenancy at sufferance?

23. What is a conditional limitation, and how does it differ, at all, from an estate upon condition?

24. If a mortgagor dies, has any one, after him, an absolute right to redeem the mortgaged land; and if so, who?

25. What is a remainder, and what is held necessary to support one?

26. When does the interest in a remainder pass from the grantor?

27. By what form of action are questions of title in real estate usually determined?

28. In what particulars, if any, does the common law course of procedure in this action, differ from that used in Missouri?

29. Would a second suit in ejectment be a bar for the same land and between the same parties, after final judgment in the first.*

PLEADING—JUDGE BLISS.

1. What were the names of the personal actions at common law, and for what causes did each of them lie?

2. What change in this respect is made by the code?

3. What was the general issue at common law in actions of assumpsit? What is debt?

4. What new matters of defense could be given in evidence under the general issue?

5. What change in this respect is made by the code?

6. What change is made by the code in regard to parties, plaintiff in actions at law upon contract?

7. What change is made in regard to venue?

8. In the statement of a cause of action, what things may the petition omit?

9. What is the remedy if matters are stated in a pleading, which are irrelevant, or not proper to be stated?

10. If a material allegation is omitted, what is the remedy?

11. If two or more causes of action are contained in a petition which cannot be united, what is the remedy?

12. If they can be united, but are improperly intermingled in one statement, what is the remedy?

13. Is it necessary to plead the statute of frauds as new matter, or may one avail himself of it under a denial? If so, why? If not, why?

14. In counting upon a contract, when should the pleading show consideration, and when not?

15. In counting upon a lease, when must the pleading show title and when not?

16. What errors, which will render a pleading demurrable, are not waived by pleading over?

17. What is matter of inducement? Is it material to the cause of action, and may it be stated in a different manner from other matter; and if so, how?

18. What is a counter claim? Under what circumstances can a counter claim be made?

19. Should evidence be set forth in a pleading? and what does the statute mean, when it says the "substantive facts" should be stated?

20. What facts, if any, should be stated, not necessary to be proved?

BILLS AND NOTES—Judge Bliss.

1. A draws a bill at 90 days upon B in favor of C. It is accepted, and afterward indorsed by C and D. E is the holder at maturity, and the bill is protested and due notice given. To whom may E look for payment, and who is liable to all the other parties? Who, if accepted for accommodation?

2. What steps are required to charge all the parties? Give them in detail.

3. If a promissory note be indorsed in blank by third persons, before being delivered to the payee, what relation do the indorsers hold to the note?

4. If made payable to one of several accommodation indorsers, and indorsed by him and the others before delivery, what relation do the indorsers hold to the payee and holder, and what to each other?

5. If a note or bill be due one month from date, when is it payable without grace? When if dated January 29? When with grace?

6. Suppose a note or bill, negotiable and indorsed, be lost or stolen, and put into circulation before maturity, can its payment be enforced? If so, by whom?

7. Suppose it is payable to order and not indorsed? Suppose an indorsement is forged? Suppose it has been duly indorsed, but the amount is changed by the finder or thief?

8. What is an acceptance of a bill for honor?

9. Describe a foreign and domestic bill?

10. When must sight bills be presented? When if presented by the payee, and when if there have been several transfers and indorsements before it is presented?

11. What is a guaranty, and how does it differ from an indorsement?

EXAMINATIONS OF THE MEDICAL CLASS.

ANATOMY—Dr. Arnold.

1. What is human anatomy?
2. Describe in brief the structure and physical properties of bone.
3. What is the chemical composition of bone and its modes of development?
4. Give the names and define the different eminences and depressions found upon the surfaces of bones.
5. Define the difference between an apophysis and an epiphysis.
6. Demonstrate the inferior maxillae and temporal bone.
7. Give a brief description of the Ulna and radius, together with the part they perform in the formation of the elbow and wrist joints.
8. How many varieties of muscular tissue are found in the body?
9. What are the distinctive features in regard to their structure?
10. Give the origin, insertion and action of the bicepe muscle, together with its relation to the brachial artery.
11. Give the muscular boundaries of Scarpa's triangle and the papliteal space.
12. Give the origin and insertion and relation of the tendons of the flexor sublimis and flexor profundus digitorum.
13. Describe minutely the anatomy of the heart.
14. How does the structure of an artery differ from that of a vein?
15. Give the branches of the aortic arch.
16. What arteries enter into the formation of the circle of Willis, and where is it situated?
17. Of what is the nervous system composed?
18. Give a brief description of the brain and spinal cord.
19. Give the number, character and distribution of the cranial nerves.
20. Give the different regions of the abdominal cavity, and state the contents of each.

PRACTICE OF MEDICINE—Dr. Arnold.

1. What do you understand by the term medicine in its most comprehensive sense?
2. Give its subdivisions and define their scope.
3. What is pathology?
4. What is the difference between general and special pathology?
5. What is meant by Histology?
6. Can you give a definition of disease?
7. Define the term lesion, and give the varieties.
8. What is the difference between hypertrophy and hyperplasia?
9. Give the distinction between exudation and transudation.
10. Define the term Plethora Anaemia and Leucocythemia.
11. Give the distinction between a thrombus and an embolus.
12. Define Contagion and Infection.

13. Give the diagnosis clinical history pathology of Pneumonitis.
14. What is meant by the term fever?
15. What is the distinction between an essential and a symptomatic fever?

PHYSIOLOGY—Dr. John H. Duncan.

1. What is a "system?" an "apparatus?" a "tissue?" and give examples of each.
2. What is the object of digestion? How many digestive fluids are there? By what glands are each of these fluids secreted? Give the reaction of each, and also the organic principle in each.
3. Where is lean meat digested? Where fats? and where sugars? What effect has gastric juice on hydrated starch? What effect has it on unhydrated starch?
4. How many absorbent vessels are there, and which is the most important? Give the anatomy of a villus and show how substances absorbed by the villi reach the right side of the heart.
5. What are the objects and causes of the circulation of the blood? Of what does the circulatory apparatus consist, and state the object of each?
6. Give the circulation of the blood through the heart, commencing with the right auricle; state through what apertures it goes and the valves guarding those openings?
7. Give the different sounds of the heart; their causes, duration, and where best heard.
8. How many murmurs can be heard with the first sound of the heart; how many with the second? give their names and where best heard.
9. What is the object of the nervous system? How many kinds of irritability are there? and define irritability.
10. What is the anatomical element of a nerve trunk and what of a ganglion? What is the function of the gray matter and what of the white matter?
11. What is the effect of division of the anterior or lateral white columns of the cord in the dorsal region on the right side? also of the posterior white columns of the cord on the right side? also, of an injury to the right side of the brain? if paralysis on which side and why?
12. Give the properties of the following nerves and the effects of division of them, viz.: Hypoglossal; large root of the Trifacial; Facial; Patheticus; Pneumogastric and Spinal Accessory.
13. From what nerves does the Pneumogastric get its motor filaments?
14. Give the formation of the Amnion: What becomes of the umbilical vesicle and give the changes in the chorion.

OBSTETRICS.

A. W. McALESTER.

1. Give the diagnostic signs of pregnancy.
2. In natural labor give the expelling powers.

3. Give the mechanism of labor in a breech presentation.
4. What is a lithopædion?
5. How would you induce premature labor?
6. Give the differential diagnosis of puerperal pyæmia.
7. What is the cause of post-partum hemorrhage, and how treated?
8. What is the pathology of eclampsia?
9. Define puerperal fever.
10. Give the diagnostic points between endo-metritis and endo-cervicidis?

SURGERY.

A. W. McALESTER.

1. How may an inflammation terminate?
2. What is a cicatrix?
3. Into what two classes are tumors divided? State which of the following tumors are benign and which malignant, and give your reasons, viz.: Adenoma; epithelioma; euchondroma; lipoma; ranula, and where situated; eucephaloid; colloid.
4. Does a phagadenic chancre give rise to constitutional symptoms, and state your reasons.
5. Give the fractures of the neck of the femur; how diagnosed? What is a callous?
6. Give the guides to the ligation of the following arteries, viz.: external carotid; brachial at its middle third; brachial at the elbow; ulnar at its lower third; femoral, and where, and popliteal.
7. Can there be a dislocation of the ankle joint without fracture?
8. What are the objective symptoms of dislocations at the hip joint?
9. What is a cataract? Give the varieties and class of patients in which they are found?
10. What is the difference between trichiasis and distichiasis? What is ptosis and its cause?

MATERIA MEDICA.

PROF. SCHWEITZER.

1. What is the difference, if any, between ether, sulphuric ether and Hoffman's Anodyne?
2. Describe chloral hydrate, and state to which property its action upon the system is referable? What is its dose as an hypnotic, and in what cases is it advantageously employed?
3. Rp: Hydr. Chlor. 2ℨ.
   Water, 2ℨ.
   Why is this form of prescription objectionable?
4. How, in what dose and with what precaution should ether be administered to produce anæsthesia?

5. State the difference in composition between chlorine, chlorine hydrate, chloral hydrate and chloroform?

6. Mention the names of all anæsthetic compounds you know.

7. Describe the effects of valerian, and state in what diseases it may be administered?

8. What is tartar emetic? How is it prepared and what are its doses?

9. How is the golden sulphuret of antimony prepared, and what objections are there to its use?

10. Calomel, how is it prepared? What are its impurities, and how are they detected? What are its uses and doses, and what its physiological effects?

TOXICOLOGY.

PROF. SCHWEITZER.

1. Describe the symptoms of acute poisoning by arsenic.

2. What are the preparations used in medicine that contain arsenic? What is considered a fatal dose, what the antidotes, and what the general course of treatment to be adopted?

3. If arsenic is an irritant poison, how is its action on the lining membranes of the stomach explained, when introduced externally?

4. Describe in a post-mortem examination the appearance of the organs when affected by arsenic, their preparation for analysis, and the tests for it.

5. How do the symptoms of chronic poisoning by lead differ from those of mercury? What is the treatment in either case?

6. Compare the symptoms produced by prussic acid with those produced by opium; in what respect do they differ from each other, and how can the presence of either opium or prussic acid be established without chemical analysis?

7. Describe the general course of analysis pursued for the detection of phosphorus and prussic acid.

8. Give the antidotes to as many poisons as you know, and explain their action.

9. What effect has strychnia on the organism, and how is it recognized chemically?

10. Which organs present abnormal conditions in cases of poisoning by chloroform, ether and laughing gas? What is their appearance after death?

THE UNIVERSITY.

PROVISION FOR YOUNG WOMEN.

Young women are received into the Normal, the Preparatory, or into any of the University classes for which they may be found qualified, and have the special care and supervision of the professors or teachers whom they attend.

Several young ladies now recite in advanced classes in University courses.

There is yet no building specially designed for the Women's College. This is a great and pressing need.

Board is had in the best private families, and under the best supervision, at but three to four dollars per week. The whole charges are at so reasonable a rate, that young women may have the full advantages of the University at a cost much less than at schools affording fewer advantages.

ADDITIONAL PROVISION FOR YOUNG WOMEN.

The Board of Curators, at their meeting in June, 1874, resolved to set aside the Hudson Mansion for the accommodation of the young women who resort to the University.

This is a large and elegant mansion, retired in situation, and has been fitted up as a special College Home for young ladies.

A matron is employed as superintendent and manager, and the price of boarding is put at actual cost. This will enable many young women to enjoy the advantages of the State University who otherwise could not do so.

The Board has also fitted up a waiting room in the University building for the use and comfort of the lady students.

Young ladies expecting to occupy apartments in the Hudson

Mansion, should, as far as possible, bring bedding, towels, etc., from home, and thus reduce expenses.

Specific information will be immediately furnished by writing to Prof. Scott Hayes, Columbia, Mo. Those wishing to avail themselves of this great opportunity, should make early application.

The Curators, recognizing the perfect equality of the young women of the State to all the advantages of the University, have opened to them the doors of every department of instruction, and invite them to come in upon the same favorable terms as the young men.

The remarkable success which has thus far attended the opening of the University to women, has encouraged the Board to enlarge the means and facilities for their accommodation.

THE ROLLINS AID FUND.

This fund, now amounting to over $30,000, is the result of a bequest of the late Dr. Anthony W. Rollins, father of the Hon. James S. Rollins, President of the Board of Curators. The fund is under the care of the county court of Boone county. By the terms of the will, the principal is to be increased each year by the addition thereto of one-fourth of the interest; the remaining portion is to be expended in aiding the education of young persons from the county of Boone, possessing good talents and good moral characters, and needing such aid. Young men having in view the ministry of the Gospel are to be preferred. The selection is to be made by the President of the University, after examination as to the qualification of candidates.

The whole interest of the fund is, the preesent year, over $1,600, so that $1,200 will be available in aiding the pupils to be selected. No less than forty students have received aid from this fund during the past year.

In order to aid as large a number as possible, it is ordered by the court that not more than the sum of $100 per annum shall be appropriated to any one pupil; even a less amount has, in many cases, been awarded, and sometimes the entrance and contingent fee only. As students are near home, many expenses will be saved, and, with proper frugality and self-help, they will be able, with only small aid, to sustain themselves.

1. The benefit of this fund will be extended to female as well as to male students.

2. The applicant must not be under sixteen years old.

3. Those studying with a view to the Gospel ministry will be preferred.

4. Applicants, in order to receive aid from this fund, must have made proof of their ability, and hence those who have been for a period in the University, and shown unmistakable capacity will be preferred, and especially those who, by their own exertions, have made the means to come into the Institution.

5. Aid from this fund will, in all cases, be withdrawn from students who incur College discipline, or who fail to maintain a reputation for exemplary conduct and good scholarship. The incurring of twenty-five marks of demerit will be considered such discipline, and falling below the required standard of scholarship in any study such failure in scholarship.

ADMISSION.

In order to admission to the University, each student is required, by ordinance of the Curators, to present to the President a certificate from the Treasurer of the Board that his bill for entrance and contingencies has been paid. This bill cannot exceed $15 for the session, and when paid for the first term or semester, will be but $5 for the second.

When an applicant for admission into the University has been connected with any other institution, he should present satisfactory evidence to the Faculty of an honorable standing in the institution from which he comes.

It is highly important that students should be present at the opening of the session, since the loss of a few days at the beginning breaks the connection of their studies and occasions serious embarrassments. The applicant must be fourteen years old.

POST GRADUATES FREE.

In order to extend the advantages and usefulness of the State University still further to the youth of the State:

It is hereby resolved by the Board of Curators:

That hereafter all regular graduates in any department of the University, and every regular graduate of the Normal Schools established by law within this State; also all regular graduates of "Christian Female College," and "Stephens' Female College," located in Columbia, and the graduates of all other regularly chartered Literary and Scientific colleges in this State, with regular college classes established therein, and that are authorized by law to confer degrees and to grant diplomas to their students, shall be entitled to enter all the departments of the State University, including the Mining Department at Rolla, as *Post Graduates*—free of the payment of tuition fees, and to receive instruction in the same manner as other students, in the Practical, Lite-

rary and Scientific Departments or classes (and all students taught in the University,) and which they may choose to enter, (provided, however, that neither Law nor Medical students are included in this resolution); and also that they may have full access to the Library of the University, with all other students, on such terms, and under such rules as may be prescribed by the Executive Committee.

N. B.—Each person desiring to enter the University or School of Mines as Post Graduate will be required to exhibit his or her Diploma to President Read or Director Williams.

LITERARY SOCIETIES.

There are two societies connected with the University, viz.: "The Athenæan," and "The Union Literary." These Societies have spacious and well furnished halls in the University edifice, and hold weekly meetings for improvement in debate, oratory, and composition. There has also been formed a third society for the less advanced class of students, called "The Society of Tyros."

These Societies are in a flourishing condition, and form a most important means of culture, especially in extempore speaking and debate.

An address is delivered before the two united, during Commencement Week, and Diplomas are given to such members as belong to the graduating class.

The society orator of the present year is Col. A. W. Slayback, of St. Louis.

UNIVERSITY PERIODICAL.

The two Literary Societies, by a joint committee of editors, have, during the past year, published a monthly periodical, designed not merely as a record of University affairs, but also to contain literary, educational, and philosophical matters of interest. This paper has been creditably conducted, and will, with the experience of the past year, no doubt, be greatly improved during the coming year.

SOCIETY OF THE ALUMNI.

The Society of Alumni is composed entirely of graduates of the University. It holds an annual meeting on the evening of the day before Commencement, and is addressed in the college chapel by an orator previously selected from its own body.

The objects of this society are the promotion of education, especially in the halls of Alma Mater, the reunion of early friends and co-laborers in literary pursuits, and the revival of those pleasing associations which entwine themselves about academic life.

The Alumni Orator of the present year is —— ———, of —— ———. There will also be a reunion on the evening of Commencement Day, with supper, speeches, toasts, etc., held in the new Library Hall and adjoining rooms.

PUBLIC EXHIBITIONS.

The exhibition of the Junior Class is held in the college chapel, on the last Friday in April.

The Literary Societies give public exhibitions on the last Friday in March and the first Friday in April—the societies alternating in precedence.

Prize Declamation occurs on the Tuesday evening preceding Commencement.

During Commencement Week orations are delivered before the Literary Societies and the Society of Alumni, and on Graduation Day orations are delivered by members of the graduating class.

APPARATUS AND CABINET.

The outfit of instruments and other facilities for illustrating the principles of Natural Philosophy, Chemistry and the other cognate branches, has been increased from year to year, and is now better than in most institutions, east or west.

The Cabinet has been greatly augmented from time to time by exchanges, and particularly by additions made by order of the General Assembly through the State Geologist.

Yearly additions to the Cabinet of Minerals will continue to be made during the progress of the General Survey. Its size and value at present are increased by many valuable specimens belonging to Professors Swallow and Norwood.

The number of specimens in the Cabinet is about 500,000.

The appropriation the present year for apparatus amounts to several thousand dollars.

We must have ample apparatus for the means of illustration and experiment. We cannot do without it. The time was, in the elementary state of scientific investigation, when great results were obtained by a few broken bottles and glass retorts; and doubtless, also, the simplest and least expensive apparatus, in the hands of the ingenious professor, will be more useful than the most expensive and elaborate in the hands of the inexpert and bungling; yet the scientific man in our day requires the constant aid of the best means, both in his instructions and original investigations. He must have it, just as the farmer must have improved implements and machinery.

OBSERVATORY.

The Observatory stands west of the University edifice. It is forty-four feet long, fourteen feet wide, fourteen feet high in the Equatorial room, and ten feet high in the Transit room.

The roof of the Equatorial room is a cone, which revolves on eight lignum vitæ balls, and is confined to the building only by its gravity. The roofs of both rooms are intersected by shutters for the convenience of observation. The instruments stand on stone slabs, which rest on pillars that descend about six feet into the ground, and have no connection with the floors.

The Equatorial room contains an Equatorial Telescope, by Fitz, of New York. The Transit room contains a Sidereal Clock, a Transit Circle, an Altitude and Azimuth Instrument, and a Transit Theodolite. Besides the foregoing instruments, the outfit includes a Sextant, Mercurial Horizon, Barometers and Thermometers.

By means of these instruments, the student is enabled to gain an insight into the important *practical* work of Modern Astronomy.

LIBRARY AND LIBRARY HALL.

There has been recently fitted up a very elegant hall as a reading and library room. The University Library consists of some five thousand volumes. It is in a constant state of increase by gift or purchase.

The annual appropriation by the Board of Curators for the increase of the library is $1,200. Besides, the two literary societies have each some fifteen hundred volumes.

The library is open every day three hours, from 3 o'clock P. M., for consultation.

A large purchase of books is to be made, both for the general library and for special departments, before the beginning of the next session.

READING ROOM.

A University reading room has been established, and means taken to procure newspapers, and the home and foreign periodicals.

The Reading Room Association occupies Library Hall, which is open each day at 3 P. M., as a reading room for the students and professors.

UNIVERSITY LECTURES.

In addition to the lectures pertaining to the departments respectively, there will be delivered on each Saturday, during term time, a lecture on some literary or philosophic subject, by the professors, in such order as shall be agreed on among themselves, or by some one who may be called on to perform this service.

The students are expected to attend this lecture as any other college duty, and citizens and strangers are invited to attend.

DISCIPLINE.

The Discipline of the University is intended to be mild and suasive, as far as circumstances permit. If, however, students manifest such moral obliquities, or such idleness, as render them unworthy members of the body collegiate, they are returned to their friends without exposure, when it is practicable so to do; and it is only in cardinal offenses that the Faculty resort to PUBLIC and EXEMPLARY punishment.

When a student enters the University, the discipline of the Institution allows him a credit of one hundred merit marks; and he is charged on the record with such demerit marks as arise from misdemeanors and neglect of college duties. When it is ascertained that his demerits reach fifty, a letter of notification is sent to his parent or guardian; and when the number reaches one hundred, he is excluded from the Institution by the operation of law, which is rendered effective by an announcement of the fact by the President.

If a student shall have incurred twenty-five demerit marks, he will not be permitted to appear and take part in any public exhibition in the University.

LEAVE OF ABSENCE.

When a student wishes to leave the University, either temporarily or permanently, he should confer with the President, in order that charges for absence may not accumulate against him on the record of demerit. It is hoped that absences from the Institution for the purpose of visiting friends, etc., will be discouraged by parents and guardians, because such absences interrupt a student's progress, and greatly diminish the pleasure and profit of his literary pursuits.

In cases of withdrawal, written authority from the parent or guardian will be required even to obtain a leave of absence. Parents and guardians are again urged not to encourage withdrawals, nor to permit them save from controlling reasons.

The Faculty would add emphasis to this statement by the declaration that they consider the evil of withdrawing before examination, and prior to the close of the session to be so injurious, both to the individual student and the order of the University, that they cannot advise students having such intentions to enter the University at all. It should be understood that the student, by withdrawal, not only loses the benefit of the closing exercises of his studies—the most important of them all in fixing them in his mind—but escapes the responsibility of final examinations, and avoids the incentives which the contests and ambitions of a public institution present.

RULES.

These are few, and designed to promote the good order and welfare of the University community, and the best interests of the individual students.

IT IS REQUIRED OF STUDENTS

1. Immediately on arrival to pay entrance and contingent fee, and bring receipt of Treasurer to President, in order to be enrolled as matriculates, and examined for admission to proper classes. In case of continued delinquency to enroll, and loitering about the town, the person so delinquent will not be received as a member of the University. No one can be enrolled until he shall have presented the receipt of the Treasurer, as above specified. No student can enter a class with any Professor, until he shall have been admitted to the University, and enrolled by the President.

2. To have three recitations, unless for good reasons excused; and to take such part as may be assigned in all general exercises of the University.

3. To be present at daily prayers in the University chapel, at all recitations and other exercises as may be assigned, and to make due preparation therefor. Absolute promptness and punctuality are required.

4. Faithfully to observe "*study*" hours, and not to be found loitering in the streets, in shops, or at places of amusement during these hours, or after dark, or at late hours.

5. It is expected and enjoined that students, on Sunday, attend the church of their choice, or that of their parents, and to observe the day as good and orderly citizens of a Christian community.

6. In general terms, it is required of students to be quiet, orderly, and industrious; to observe the rules of the recitation room by abstaining from whispering or other communication; from spitting on the floor; from all unseemly postures; and at all times to observe the conduct and deportment of well-bred gentlemen.

7. It must be distinctly understood that the University is for the good and virtuous young men of the State, and not for the idle and disorderly, the vile or vicious.

THINGS FORBIDDEN TO STUDENTS.

1. To enter a billiard or drinking saloon upon any pretext whatever; to carry concealed weapons, or to use profane or indecent language, or to indulge in intoxicating drinks of any kind.

2. Noisy and disorderly conduct about the University buildings, assembling about the doors, whistling, sitting in the windows, shouting or calling aloud from the windows, or assembling in halls before or after recitation or other exercise.

3. To smoke in the buildings or on the campus.

4. In any way to injure or mar the University buildings or furniture by whittling, cutting, marking, or in any way defacing the same.

All University property is to be guarded and preserved as a sacred trust, and to be used without abuse; and in every case of a student injuring or defacing benches, tables, or other furniture, he shall be required to pay the full cost of the articles injured or defaced, and in other cases to pay for all the damage done.

5. To leave town, or to change a recitation which has been assigned, without the permission of the President. Leave must be obtained beforehand.

6. No student will receive an honorable dismission who is under a charge, or who has failed to pay all University dues, or who has not returned all library books.

7. All those things are forbidden which tend to deteriorate moral character, to prevent intellectual and moral advancement—in short, all those wicked and immoral practices and habits which would be forbidden in good and cultivated families, and which tend to prevent preparation and training for good citizenship.

☞ *The attention of students is especially called to the foregoing rules, and they will not be permitted to plead ignorance of them when called to account for delinquency.*

SESSIONS, VACATIONS AND TERMS.

The annual session begins on the third Monday of September, and continues forty weeks.

Commencement occurs the last Thursday in June (1876, June 29th).

The annual vacation is from commencement till the third Monday of September—the 20th of September in 1875.

A recess of two weeks is taken during the holidays.

The annual session is divided into two terms or semesters, the first ending on the 13th of February, the second continuing until the Commencement Day.

COUNTY COURT APPOINTMENTS ABOLISHED.

The County Court system, by which the Courts were entitled to appoint students equal to the number of representatives from the county, to be free from tuition fees, was abolished by the last Legislature.

FEES AND EXPENSES.

Annual entrance fee, $10. Library and incidental fee per term, $5—that is, the student who enters the first term pays $15, and for the second semester only $5, having paid his entrance fee for the year upon admission. If he enters the second term, he pays both his entrance and incidental fees. These charges are so low as properly to be considered merely nominal.

This rule applies to all students residents of the State. Non-resident students are charged per term $20.

Law and Medical students are charged for the session $40, to be paid upon entrance. This includes the incidental fee.

There will be a charge to the professional student of Analytical Chemistry, which has not yet been established by the Board of Curators; but it may be assumed that it will be less than in any similar institution affording equal advantages.

Board in private families, with lodging, washing and fuel, may be obtained from three to five dollars a week.

By entering clubs, this amount may be reduced to one dollar and fifty cents, or two dollars.

The allowance for clothing, books, and pocket money, will vary with the character of the student. It is hoped that parents will bear in mind that too liberal an allowance of money exposes a youth to temptation, interferes with his habits of study, and adds nothing to his happiness or respectability.

Young men working on the College Farm, or in the gardens, will be allowed from ten to fifteen cents per hour, according to their skill, fidelity and industry, to be determined by the Garden or Farm Superintendent.

BOARDING OF STUDENTS.

The University does not provide boarding for students, or oblige them to adopt any particular plan. But to insure cheap boarding and prevent any sudden or excessive rise in the price of boarding in private families, the University has erected two groups of cottages or club buildings with dining halls, about a third of a mile apart, sufficient to accommodate two clubs of fifty each. There is also another club consisting of about twelve domiciled in a University building, situated at some distance from the other two, and managed upon the same plan.

The students who board themselves in the cottages, form themselves into clubs, appoint their own commissaries and other officers, establish and keep up their own police, punish members by fine or expulsion, and on each Saturday meet to hear reports, and consider the welfare of the clubs and generally to attend to their business affairs. The weekly expense of board, including a small admission fee to keep up the furniture, also rent payable to the University, does not exceed $1.75 per week.

Each student furnishes his own room, which may be done at cheap rates. If convenient, he may bring his furniture, at least in part, from home. All may bring bed-clothing, and had better do so.

The present is the sixth year of experience upon this plan. The clubs, by their proper officials, hire their own cooks, regulate the bill of fare, buy provisions, and maintain the order of the establishment.

The plan has been a complete success, is popular among the students, and has attracted much attention throughout the State. It is a full solution of the question—how may boarding be secured at the lowest rate, and in a manner most satisfactory to the student?

Very young students, or those incapable of taking care of themselves, ought not to enter the boarding club. While the President and Professors frequently visit the rooms of the club, the police duty devolves mainly upon the young men themselves, and is more effectively carried out than it could be by the Faculty. Their rules are strict, and students of known shiftless ways or noisy habits are not admitted; or, if admitted, are soon cut off. Good behavior and quiet habits are indispensable, and none other than those possessing these characteristics can enter or continue members of the club.

It ought to be remarked that the health of the members of the club has been above the average of the students of the University, while their order and good conduct has been equal to that of those boarding in families.

Students find boarding and rooms in private families at rates such as shall be agreed on, generally as above stated, at from $3 to $5 per week.

In many cases, it is best that boarding should be obtained in good private families.

RENTING ROOMS.

Students, in order to rent rooms at the cottages, or the Hudson House, or any other building belonging to the University, must apply to the Business Agent, and receive them upon the following conditions, viz.:

1st. To keep the rooms in a proper and cleanly manner; in no way to injure or deface them, and to open them to the proper officer for inspection.

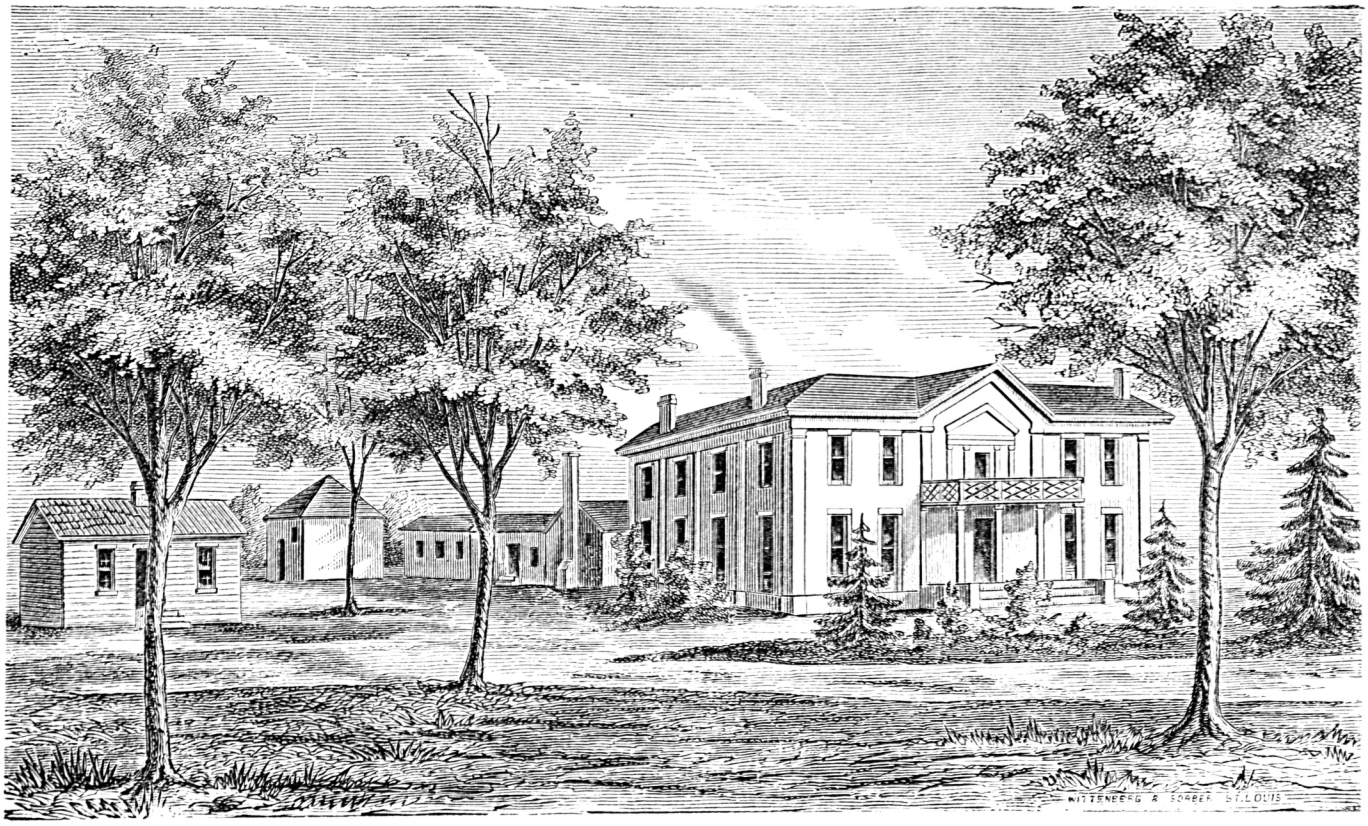
2d. To avoid boisterous and improper conduct.

3d. To observe the rules of the house or club, and to be subject to be removed for non-payment of assessments, fines, or charges.

4th. No student occupying a University room can exchange it with another student, or under-rent it, except by the permission of the Business Agent.

5th. Rent is to be paid in advance, and before entering the room.

The business agent shall in all cases be the judge of the violation of these rules, and have full power to remove a student therefor; and in case of such removal, there shall be no repayment of rent.



HUDSON MANSION.

EXAMINATIONS, HONORS, AND DEGREES.

There are four examinations in the University.

1. An examination of the new students is held at the beginning of the session, for the purpose of ascertaining their scholarship, and assigning them to the classes for which they may be qualified.

On the occasion of these examinations, the Faculty generally recommend the full course of study to students whose age and means render such a course advisable.

2. An intermediate examination of all the classes, partly oral and partly in writing, is held about the middle of February.

3. An examination of the senior class is held a short time before commencement, in order to determine what members are qualified for graduation.

4. A general examination of all the other classes is held during the week preceding commencement, for the purpose of ascertaining the progress of the students, and deciding what students shall be promoted to higher classes.

Each candidate for graduation is required to prepare a thesis—oration or essay—which may be delivered or not, at the discretion of the Faculty. The usual College honors, appropriate to each of the first academic degrees, are awarded by the Faculty among the graduates.

The regular academic degrees are—Bachelor of Arts, Bachelor of Philosophy, Bachelor of Letters, and Bachelor of Science, according to the particular course of study which the student pursues. Each of these courses occupies four years, and is intended to be of equal honor.

The degree of Master is also conferred, three years or more after graduation, upon such Bachelors as pursue a professional or literary career.

The Curators can, of course, in addition to these, confer any of the usual honorary degrees and titles.

REPORT OF COMMITTEE ON UNIVERSITY DEGREES.

The following is the report of the Committee of Re-organization, the recommendations of which were adopted by the Board of Curators, and to which the action of the University will be conformed in the awarding of its degrees and certificates of proficiency in the various branches of learning, as specified in the appointed courses. The report says:

"The question of what shall be the degree is one worthy of consideration.

"1st. Shall there be any honorary degrees? They have been abused until they are almost worthless as honors. When General Jackson received a doctorate from Harvard, it conferred no great honor either upon the recipient or the giver. Or, when the Duke of Wellington was made Chancellor of Oxford—an honorary office—and pronounced his Latin oration in very bad quantity (even after drilling), it cannot be said that the university either gave or received any extraordinary honor. But learning has in all ages, from the days of Augustus, paid its court to power. It has sometimes done itself honor by paying honor to the worthy. The object of these degrees is to honor merit, to incite to nobler effort, and to give academic recognition to great literary, scientific, or civic excellence.

Your committee are not prepared to recommend the total discontinuance of honorary degrees by a rule, as is the case in the Virginia University; but certainly that our University should be exceedingly sparing in conferring them.

"The regular academic degrees in course should be as follows: Bachelor of Arts, Bachelor of Philosophy, Bachelor of Science, and also Bachelor of Letters (*in literis humanioribus*), for great excellence in classical and literary studies.

"These degrees to be conferred after the proper trials and examinations.

"Certificates of proficiency for those proficients, who have completed the course in any branch, and sustained their examinations. Such certificates to be formally and publicly awarded.

"Students who have pursued elective courses equivalent, in the judgment of the Faculty, to one of the specified courses, may receive the degree judged most appropriate.

"The degree of Master of Arts, Master of Science, Master of Phi-

losophy, and Master of Letters, will be conferred, on the recommendation of the Faculty, after the expiration of three ye ars from the time of graduation, upon those deemed worthy.

"SPECIAL OR PROFESSIONAL DEGREES.

"These will be, Bachelor of Law, Bachelor of Agriculture (B. Ag.), Bachelor of Engineering, of Mining, etc.

"There will also be the degree of Normal Graduate, and a certificate of proficiency in the Art of Teaching, and also a degree of a higher grade to teachers.

"These degrees to be conferred by the Board of Curators, after recommendation of the candidates by the Professional Faculty to the General Faculty of the University, and thus presented to the Board.

"POST-GRADUATE COURSE AND DEGREES.

There is great difficulty in providing a system which shall meet the wants of all students of every grade. This must be done as far as possible, and, in fact, herein is the idea of the true University. As the means and appliances of the University shall be enlarged in all directions, and the Professors become numerous, it will become the residence of students who wish to continue their studies after graduation. Even now there are some such, and the number will increase from year to year.

"The course which students of this class will pursue, will be for the most part according to their own individual wishes. The Faculty when fully organized, should provide aid, by lectures, recitations and courses of reading, to assist such students in the pursuit of their studies and investigations.

"Your committee recommend that the following degrees be conferred upon students who become resident graduates, and students upon post graduate courses, under the direction of the Faculty:

"Students who remain one year after graduation in Arts, Philosophy, Science, or Letters, shall, on recommendation of the Faculty, be entitled to the degree of Master.

"Students who remain a still longer period, as shall be appointed by ordinance, may be admitted to the degree of Doctor.

"All degrees in course must be conferred upon recommendation of the University Faculty.

"Bad character, or University delinquency of any kind, shall be good reason for exclusion from a degree.

PRIZES.

The Stephens Prize, founded by J. L. Stephens, Esq., of Columbia, is given each year, in the form of a Gold Medal of the value of $50, to the member of the graduating class adjudged to be the finest Orator on Graduation day.

SOCIETY PRIZES—

Established by the two Literary Societies—To the six best speakers from sixteen competitors selected from the body of the students below the Senior Class, who shall appear at a public exhibition on the evening preceding Commencement; but no student can be selected who has received twenty-five demerit marks.

PRESIDENT'S DEPARTMENT.

The Department Prize, to the student who shall sustain the best examination on "British and United States Constitutional Law and on International Law and the Philosophy of Government." The examination to be both written and oral.

PRIZES IN THE AGRICULTURAL COLLEGE.

There are three permanent prizes connected with this department.

The *Harris Medal* to the Senior Class for the "*Best Essay on Dairy Stock*," or "*Indian Corn.*"

The *Swallow Prize* for the "*Best Oral Examination on Pruning*," to the Freshman Class.

The *Barr Prize* for the "*Best Essay on the Horse.*"

PRIZES IN NATURAL PHILOSOPHY.

Mr. Charles Dachsel, of Cedar City, Missouri, offers to the Sophomore Class, a prize of TEN DOLLARS, to be awarded to the student who sustains the best examination on PHYSICS, and presents, at the same time, the best *Original Essay on the Steam*

Engine, the award to be made by a select committee during Commencement Week.

PRIZE IN ANATOMY AND PYSIOLOGY.

Dr. J. G. Norwood offers to the Graduating Class of 1875, a prize of TEN DOLLARS, to be given to the student who presents the best THESIS on some physiological subject, to be designated by the Professor of those branches. The award to be made by a select committee of graduates in medicine. Those who contest for the prize must hand their Theses to the Professor at least one week prior to Commencement Day.

SENIOR PRIZE.

Prizes (first and second) of Senior, Sophomore and Freshman Classes to Juniors, for excellency in oratory at the Junior Exhibition —matter and style of composition, as well as delivery, being taken into consideration.

THE LANE CLASSICAL PRIZE.

A prize of FIFTEEN DOLLARS is offered by C. E. Lane, A. M., of St. Louis, to the student in the Sophomore Class who shall pass the best examination in Latin, including Latin Prose Composition.

UNIVERSITY HONORS.

GRADUATING CLASSES—1874.

CLASS GRADUATING IN ONE OF THE COLLEGE COURSES.

B. S.....Marlow, George Hedges.....Norbonne.
A. B.....Ridgway, Joseph Thomas.....Columbia.
B. S.....Riggs, Brutus.....Sturgeon.
A. B.....Ripley, Julia Fisk.....Columbia.
A. B.....Rollins, Curtis Burnham.....Columbia.
B. S.....Royse, Frank.....Carrollton.
A. B.....* Watkins, Charles Allen.....Richmond.
B. S.....Wilson, Thomas Cranmer.....Auburn.
A. B.....Shannon, Richard D. (Class 1862).....Jefferson City.

SCHOOL OF MINES, AT ROLLA—1874.

Duncan, Gustavus A., C. E.....Boulder, Col.
Gill, John Holt, C. E., Assistant in U. S. Engineering Department..Washington, D. C.
Pack, John W., M. E., Metallurgist at Boyd's Smelting Works.....Boulder, Col.

LAW.

Bayley, William Bell.....Brookfield.
Dyer, Simpson Cash.....Towash, Texas.
Eby, David Henry.....Hannibal.
Frisbie, William H.....Cedarville.
Fristoe, John Davis.....Waverly.
Gentry, Thomas B.....Columbia.
Gordon, Carey Hawkins.....Columbia.
Gordon, Irving.....Columbia.
Hilbun, George Washington.....Arcadia, La.
Keithly, Ora Alexander.....Wellsburg.
Silsby, James Wilkes.....Vernon, Ill.
Spencer, Thomas F.....Chillicothe.
Thompson, Lysander Aurelius.....Macon.

* Deceased.

NORMAL.

Normal College Course.

William J. Babb, Joseph T. Ridgway,
Julia F. Ripley, Thomas C. Wilson.

MEDICAL.

Conway, Andrew M., B. S.....Columbia.
Duncan, John Harris, A. B.....Columbia.
Moss, Woodson.....Columbia.
Ragan, Wilson Lafayette.....Lebanon.
Smith, W. V.....Warrensburg.

CLASS HONORS—1874.

COLLEGE GRADUATES.

Valedictory—Miss Julia Fisk Ripley.
Latin Salutatory—Joseph Thomas Ridgway.
Scientific—Brutus Riggs.
Mathematical—Thomas C. Wilson.

LAW GRADUATES.

Appointed to represent the Class on Commencement.

William B. Bayley, Irving Gordon, Ora A. Keithly.

MEDICAL GRADUATES.

Chosen to represent the Class on Commencement.

John A. Duncan.

CANDIDATES FOR COLLEGE GRADUATION—1875.

Babb, James Franklin.....Columbia.
Buckmaster, Caleb Lockwood.....Freedom.
Chamberlain, Arthur Wallace.....St. Louis.
Early, Thomas Crede.....Bolivar.
Laughlin, Napoleon Bonaparte.....Columbia.
Miller, Frederick Jacob.....Spickardsville.
Welborn, Edward Livingston.....Aullville.
Wilson, David McConaughy.....Milan.
Riggs, Brutus.....Sturgeon.
Davis, George F.....

LAW GRADUATES—1875.

Francis K. Armstrong.....Atchison, Kans.
August H. Bolte.....Clover Bottom.
Milton Burris.....Columbia.
Robert Fagan, B. S.....Columbia.
Jerrold R. Letcher, B. S.....Marshall.
Edmund Pendleton.....Wright City.
Henry J. Schoeneich.....St. Charles.
Daniel Sullivan.....Jefferson City.
James A. Yantis.....Brownsville.

DEGREES IN COURSE.

A. M.

Joseph M. McKim..... Newark.
Richard D. Shannon.....Jefferson City.

M. S.

Allen Glenn.....Harrisonville.
John E. Johnson.....Holden.
Jacob L. Ladd.....Mexico.

HONORARY DEGREES.

A. M.

Rev. William C. Dawson.....New York, N. Y.
J. K. Pemberton.....New Brookfield.
Prof. James M. Greenwood.....Warrensburg.
Prof. Nelson W. Allen.....Mining School, Rolla.

D. D.

Rev. William R. Rothwell..... William Jewell College, Liberty.

LL. D.

Rev. Baxter Craven.....Trinity College, N. C.
Hon. B. Gratz Brown.....St. Louis.
Hon. Carl Schurz.....St. Louis.

PRIZES AWARDED.

1874.

STEPHENS' PRIZE, (GOLD MEDAL—$50), AND PRIZE BY A. S. BARNES & CO.

Best Orator in Graduating Class.

Curtis B. Rollins.....Columbia.

PRESIDENT'S DEPARTMENT.

Best Examination in United States and English Constitutional Law.

PRIZE BY A. S. BARNES & CO.....Julia F. Ripley.....Columbia.
DEPARTMENT PRIZE.....Frank Royse.....Carrollton.

DEPARTMENT OF PHYSICS.

"*Best Essay on the Steam Engine.*"

PRIZE BY CHARLES DACHSEL.....Thomas C. Early.....Bolivar.

DEPARTMENT OF MATHEMATICS.

"*To the Student Standing Highest in the Department.*"

PRIZE BY A. S. BARNES & CO.....Thomas C. Wilson.....Auburn.

DEPARTMENT OF AGRICULTURE.

"*Best Essay on Dairy Stock.*"

HARRIS MEDAL (value $50).....John T. Beale.....Eureka.
DEPARTMENT PRIZE.....Judson R. Moore.....Manchester.

"*Best Oral Examination on Pruning.*"

SWALLOW PRIZE.....Henry S. Claggett.....Gray's Summit.
1ST DEPARTMENT PRIZE.....Laura A. Johnson.....Columbia.
2D DEPARTMENT PRIZE.....Edward D. Phillips.....Kansas City.

To Class in Botany—"*Best Recorded Analysis of Plants.*"

DORSEY PRIZE.....Cordell Tindall.....Rocheport.
DEPARTMENT PRIZE.....Elijah Jones.....DeKalb.

DEPARTMENT OF LATIN.

"Best Examination in Latin Prose of Sophomore Year."

LANE PRIZE ($15).....George W. Burroughs...Columbia.

NORMAL DEPARTMENT.

"To the Student Graduating Highest in the Department."

PRIZE BY A. S. BARNES & CO. (Teacher's Library)...Miss Julia F. Ripley...Columbia.

ELOCUTION—JUNE 24.

SOCIETY PRIZE—*To the best four speakers from sixteen competitors selected from Students, except Senior Class. Prize established by the two Literary Societies, June, 1872.*

1ST.....Napoleon B. Laughlin...Columbia.
2D.....Luther B. Terrill.....Moberly.
3D.....Ed. C. Ballew.....Princeton.
4TH.....Dulaney R. Kemble.....Benbow.
1ST HONOR.....Joseph Shelby.....Lexington.
2D HONOR.....Ddward D. Phillips.....Kansas City.

MEDICAL DEPARTMENT.

Award of Prizes in the Medical Department—Commencement, 1874.

1ST.—An Amputating Case, worth Fifty Dollars; offered by Professor A. W. McAlester, for the best examination in Surgery.—Awarded to W. V. SMITH, of Warrensburg, Missouri.

2D.—An Office Case of Instruments, of the value of Fifty Dollars; offered by Professor McAlester, for the best examination in Obsterics.—Awarded to WOODSON MOSS, of Columbia, Missouri.

3D.—An Office Case of Instruments, worth Twenty-five Dollars; offered by Professor Thomas A. Arnold, for the best examination on the Principles and Practice of Medicine.—Awarded to WILSON R. RAGAN, of Lebanon, Missouri.

The same prizes are offered for competition to the Graduating Class of 1875.

PROGRAMME

OF THE

THIRTY-THIRD ANNUAL COMMENCEMENT,

1875.

Examinations, daily, from Monday, June 14th, to Friday, June 18th.

FRIDAY, JUNE 18.

Graduation exercises of the Normal College.

SUNDAY, JUNE 20.

4:00 P. M. Baccalaureate Discourse by Rev. W. H. Hopson, D.D., of St. Louis.

MONDAY, JUNE 21.

8:00 P. M. Address before the Athenæan and Union Literary Society, by Col. A. W. Slayback, of St. Louis.

TUESDAY, JUNE 22.

9:00 A. M. Meeting of the Board of Curators and Board of Visitors.

7:30 P. M. Prize Declamations.

WEDNESDAY, JUNE 23.

Meeting of the Alumni, and adress by James H. Wright, Esq., of Carrollton.

THURSDAY, JUNE 24.

9:00 A. M. Commencement Exercises, Conferring of Degrees, and Public Award of Prizes.

CALENDAR.

1875-76.

1875.

September, 20, Monday.....Academic Session opens.
October 4, Monday.....Medical Session opens.
October 4, Monday.....Law Session opens.
December 23, Thursday.....Closes for Holiday Recess.

1876.

January 4, Tuesday.....Reopens.
January 10, Monday.....Subjects for Junior Exhibition, and Commencement presented.
February 7, Monday to February 11, Friday.....Semi-annual examinations.
February 14, Monday.....Second Semester begins.
March 13, Monday.....Orations for Junior Exhibition presented.
March 17, Friday.....Annual Exhibition of Union Literary Society.
March 31, Friday.....Law Session closes.
April 7, Friday.....Annual Exhibition of Athenæan Society.
April 17, Monday.....Graduation Orations presented.
April 21, Friday.....Junior Exhibition.
May 1, Monday.....Honors announced.
May 5, Friday.....Prize Declaimers appointed.
June 19, Monday to June 23, Friday.....Annual Examination.
June 25, Sunday.....Baccalaureate Discourse.
June 26, Monday.....Address before Societies.
June 27, Tuesday, A. M.....Meeting Board of Curators.
June 27, Tuesday, P. M.....Prize Declamations.
June 28, Wednesday.....Alumni Meeting.
June 29, Thursday.....Commencement.

THE UNIVERSITY TOWN.

The University is situated near the centre of the State, at Columbia, in a beautiful and picturesque limestone region, on the elevated rolling table land lying back from the north side of the Missouri river; and were the selection of the site to be made anew, perhaps no spot in the State could be found combining more desirable elements as the seat of the State University. The town contains three thousand inhabitants; and in its healthfulness and scenery, and especially those social, moral and religious influences which tend to preserve the character of young men, and promote among them gentlemanly conduct, good order and studious habits, can hardly anywhere be surpassed.

There are located here two highly popular colleges of female education—Christian College, and Stephens College—so that Columbia is peculiarly an educational centre.

DIRECTIONS FOR NEW STUDENTS.

1. Reach Columbia, if possible, on the Friday preceding the opening of the session.

2. If assistance is desired in obtaining board, report to the President or other member of the Faculty, at the University building.

3. Before entering the University, entrance and incidental fee must be paid to Mr. R. L. Price, Treasurer, at the Boone County National Bank, and his certificate obtained.

4. The Treasurer's certificate should be at once presented to the President, at the University, when the name of the student will be entered upon the roll, and assignment made for study.

5. Young men coming to Columbia, intending to enter the University, are cautioned against delaying their entrance without good reason, as such delay not only injures the work of the entire session, but leads to unfavorable inferences concerning the character and intentions of the student.

APPENDIX.

[A.]

CONTRIBUTIONS

FROM THE

LABORATORY OF THE STATE UNIVERSITY.

By P. SCHWEITZER, Ph. D.,

Professor of Analytical and Applied Chemistry.

ON THE TRUE COMPOSITION OF COAL, AND ON THE METHODS OF ARRIVING AT IT; WITH DEDUCTIONS AND REMARKS ON COAL IN GENERAL; ILLUSTRATED ON A SAMPLE OF COAL FROM THE LOWER COAL SERIES OF MISSOURI.

A. THE COAL.

The following investigations were originally undertaken for the purpose of determining the origin of the mineral matter of the spring-waters, issuing from the ground in various parts of Boone county, and extended afterwards, so as to serve as a first contribution to our knowledge of the Coals of Missouri, and if time and health permits, of the Coals of the three great western Coal Fields. Though at the beginning only of this work, I feel satisfied, that from a number of investigations, similar to the one I present here of Boone county Coal, clearer views regarding the origin, relative age, and manner of formation of Coal can be obtained, than from isolated phenomena or experiments of necessarily short duration. It is true, inductions should only

be drawn from a number of facts, and I would for this reason enlist in the work of solving one of the great scientific questions of the day all chemists, who consider it sufficient reward, to work patiently and unselfishly for the advancement of human knowledge. A determination of the true composition of Coals belonging to the same Coal-basin would be a first step in this direction.

Neither elementary nor proximate analysis alone furnish the desired information; but when taken together with additional determinations of the constituents of the Ash of Sulphur and of Sulphuric Acid, are quite sufficient for the accurate calculation of the true composition of Coal.

The Coal, which I selected for analysis, came from the mine of ....., a few miles from Columbia, and was remarkable for the large percentage of Sulphuret of Iron, which it contained. It was burned in the furnaces of the Scientific Building of the University during the winter of 1873 to '74, during which time I selected specimens of the Coal, as it was delivered at the Building, until I had about ten pounds of it, representing, I think, well the average quality of the Coal of that particular seam, which is one of the three lowest ones in the Lower Coal Series of the State. The pieces selected remained in a closet during the summer, and were apparently not altered, when they were pulverized in the fall for examination. Some change, however, had probably taken place, though the oxidation of the Sulphuret is no doubt going on in the bed itself, resulting in the waters, percolating them, becoming charged with mineral salts, and appearing often in the form of mineral springs at a greater or lesser distance from the Coal-bed.

The pulverized Coal, while under examination, was kept in a cool room and in a well stoppered bottle, so as to prevent, if possible, any further oxidation. In stating the results of my analysis I shall not attempt to give all figures, but simply the amount of substance taken, the percentage obtained and the method followed. Gr. stands throughout for gramme.

1. Elementary Analysis.

For the determination of Carbon and Hydrogen 0.5 gr. of Coal were taken each time; the combustions were conducted in a charcoal-furnace with pure and perfectly dry Lead Chromate, with a spiral of Metallic Copper of about two inches in length placed in front. Four combustions were made, in the last of which the Carbon determination miscarried by the breaking of the absorption-apparatus.

The Nitrogen was determined in 2 gr. and 2.5 gr. of Coal respect-

ively; the Soda-Lime employed for this purpose was prepared by myself, and was entirely free from nitrogenous matter. The escaping Ammonia was collected in dilute Hydrochloric acid, the Platinum salt prepared and the latter ignited. From the weight of Metallic Platinum the amount of Nitrogen was calculated. The following percentages were obtained:

Carbon	=	50.76 p. c.	
		50.56 p. c.	
		50.90 p. c.	
		152.22 p. c.	Mean = 50.7400 p. c.
Hydrogen	=	4.5422 p. c.	
		4.5089 p. c.	
		4.4600 p. c.	
		4.5222 p. c.	
		18.0333	Mean = 4.5083 p. c.
Nitrogen	=	0.9000 p. c.	
		0.8720 p. c.	
		1.7720	Mean = 0.8860 p. c.

2. Proximate Analysis.

Water and volatile matter were determined in 2 gr. of coal; the former by heating 15 minutes at a temperature of 112° C. and weighing then from 5 to 5 minutes, until the weight commenced to increase; and the latter by heating the platinum crucible over a Berzelius-Lamp, with a chimney placed over it; no blast was employed, and the temperature to the end a bright cherry-red. The Carbon could not be burned off in this way (Methylic-Alcohol was the source of heat) and the ash had to be determined in separate samples. A large quantity of ash was desirable, and 10 gr. of Coal were taken for this purpose, placed in an open Platinum-Capsule, and the latter heated in the muffle of a muffle furnace, until the weight remained constant. The percentages were as follows:

Water	=	5.844 p. c.	
		5.025 p. c.	
		5.451 p. c.	
		16.420	Mean = 5.4733 p. c.
Volatile matter	=	28.194 p. c.	
		28.457 p. c.	
		28.554 p. c.	
		85.205	Mean = 28.4017 p. c.

Ash = 17.803 p. c.
17.729 p. c.
17.332 p. c.

52.864 Mean = 17.6213 p. c.

The color of the ash was pink, with numerous white specks in it; these latter, I think, were derived from the destruction of the organic matter of the Coal, and were originally part of the plants that formed it; they were mixed with the finely-pulverized brown oxide of the roasted Sulphuret, and with larger grains of a yellowish color, which I am inclined to consider Clay. No remains of microscopic animal life were detected by me in the ash.

Upon placing 10 gr. of this Coal over pure, distilled Sulphuric Acid, it lost the following percentages of water—each subsequent-mentioned percentage including all previous ones:

In 4 days, 1.923 p. c.
In 9 days, 1.977 p. c.
In 16 days, 1.985 p. c.
In 24 days, 1.989 p. c.

The same sample, placed now in a drying apparatus, through which a current of heated air of 60° F. was passed, lost—

In 2 hours, 2.427 p. c.
In 6 hours, 3.072 p. c.
In 8 hours, 3.232 p. c.

3. Determination of Sulphur.

The total amount of Sulphur existing in the Coal was determined by deflagrating in a large Platinum crucible a mixture of 2 gr. of Coal with 12 gr. of Sodium Carbonate and 12 gr. of Potassium Nitrate. After freeing the Hydrochloric Acid solution, which was free from any undissolved particles, from Silica and Nitric Acid, the Sulphuric Acid was precipitated by Barium Chloride. The thoroughly washed precipitate was dissolved in a large Platinum dish in concentrated Sulphuric acid, re-precipitated by water, filtered, washed and weighed. In addition to this determination, the Sulphuric Acid, existing as such in the Coal, was estimated in 4 gr. of the Coal (*a*) by boiling with Hydrochloric Acid, precipitating and proceeding as before, and (*b*) by boiling with Sodium Carbonate, acidulating with Hydrochloric acid and finishing in the same manner. Here are the results:

Total Sulphur = 11.8563 p. c.
11.7530 p. c.

23.6083 Mean = 11.8046 p. c.

Sulphur existing as Sulphuric Acid:

a = 2.4660 p. c.
b = 2.4740 p. c.

4.9400 Mean = 2.4700 p. c.

Equal to 6.1750 p. c. of Sulphuric Acid.

The solution, obtained by Sodium Carbonate, evolved a small amount of Sulphuretted Hydrogen Gas upon the addition of acid; this was owing to the presence of Sulphuret of Sodium formed by the action of the Carbonate upon free Sulphur, which I had reason to suspect and afterwards proved to be present in the Coal. The decomposing Sulphuret of Iron is converted into Sulphate with separation of Sulphur, and the latter can readily be extracted by Carbon Disulphide, and obtained by evaporating the solution; a fact which explains, without constraint, the excess of Sulphur over the Iron, which is found to exist in nearly all of the Western Coals. T. G. Wormley* and Rush Emery† furnish a number of analyses illustrative of this point; their Coals were altered and contained Sulphuric Acid, and this, I think, will be found to be the case with all Coals in which such excess of Sulphur is detected, unless, indeed, it has been washed away by percolating waters.

Future investigations may throw more light upon this point, and enable us to calculate, perhaps, the amount of oxidation to which a Coal has been subjected; for if it be found true, as I suspect it will be, that decomposing Pyrite, under the conditions under which we find it in Coal, yields by oxidation a definite amount of Sulphur, this latter would, of course, be a measure of the oxidation that has taken place, and a measure at the same time of the quantity of Sulphuric Acid which must have been formed, and been either retained by the mineral constituents of the Coal or washed away by telluric waters. The excess of Iron over the Sulphur, which Rush Emery reports in two cases, may be easily explained by the presence within the Coal of insoluble Iron compounds, such as Silicates, which, no doubt, exist in some and perhaps in all Coals containing much ash.

The elementary composition of this Coal then would be:

Carbon	=	50.740 p. c.
Hydrogen	=	4.508 p. c.
Oxygen	=	14.440 p. c.
Nitrogen	=	0.886 p. c.
Sulphur	=	11.805 p. c.
Ash	=	17.621 p. c.
		100.000

* Geological Survey of Ohio; Report of Progress in 1870.

† Sill. Am. Jour., January, 1872.

In which the Oxygen would be the only doubtful figure, from the fact that Sulphur and ash together might not represent the mineral matter in the Coal.

The proximate composition would be:

Water	=	5.473 p. c.
Volatile matter	=	28.402 p. c.
Fixed Carbon	=	48.504 p. c.
Ash	=	17.621 p. c.
		100.000

In which every figure, except that of water, is uncertain; the ash, as it does not represent the quantity of mineral matter in the Coal; the Fixed Carbon, as it includes Sulphur, Oxygen, Hydrogen and Nitrogen; and the Volatile Matter in so far as it is meant to represent Bitumen or Volatile Hydrocarbons.

Two further experiments were made for the purpose of ascertaining how two other methods, proposed for the determination of total Sulphur in Coals, compared in accuracy with the one followed by me. In the one (*a*) a mixture of 2 gr. of Coal with 1 gr. of pure, precipitated Calcium Carbonate, was moistened with Ammonia, dried and ignited in a muffle furnace; the ash, which was rather lighter in color than the pure ash, was boiled with Hydrochloric Acid, and Sulphuric Acid determined in the usual way. In the other (*b*) 2 gr. of Coal were treated for nearly a day with Hydrochloric Acid and Bromine Water; this treatment was repeated after filtering off the solution, and Sulphuric Acid determined separately in each fluid. The results, expressed in per cent. of Sulphur, are—

a	=	5.8200 p. c.
b	=	7.3320 p. c.
		0.8120 p. c.
		8.1440 p. c.

Both determinations show so marked a deficiency in the amount of Sulphur found, that the methods, to say the least, prove impracticable. I will add that in the first experiment, all Carbonic Acid of the Lime had disappeared, there being no effervescence observed by the addition of acid, and that a portion of the Lime existed in the caustic state, though some of it had united with Silica to a Silicate, which was easily decomposed with separation of gelatinous Silicic Acid.

I am aware that the method, as actually carried out, is somewhat different from mine but consider it, in any case, doubtful to be able to take sufficient Lime, even in the caustic state, to fulfill the three conditions requisite for obtaining accurate results, namely: to envelope completely all particles of Sulphuret of Iron; to allow the air to have access to it, and to retain all Sulphurous Acid formed by air and heat. The other method, though answering perfectly well in the case of Copper Pyrites, must be rejected for Coal.

4. Analysis of Ash.

The first of the three determinations of ash yielded 1.7803 gr. and served for the estimation and independent analysis of the portions,

which were soluble and insoluble in Hydrochloric Acid. The insoluble portion was freed from Silica by Ammonium Fluoride and Sulphuric Acid, and the bases determined in the resulting solution. I chose this process on the supposition that the whole of it consisted of Silica.

The second determination yielded 1.7729 gr. of ash, which were fused with Sodium Carbonate, and analyzed in the usual way.

The third determination left 1.7332 gr. of ash, which were examined for alcalies with a perfectly negative result.

In these Analyses Ferric oxide, Alumina and Phosphoric Acid were precipitated by Ammonia; the weighed precipitate was dissolved in fusing Potassium Disulphate, and the Iron, after adding Tartaric Acid and Ammonia, precipitated by Ammonium Sulphide; the washed precipitate was dissolved, oxidized, reprecipitated and weighed. Alumina and Phosphoric Acid were then obtained by subtraction. In the Analysis of ash number two, the filtrate containing these two substances was evaporated with the addition of Sodium Carbonate and the dry mass fused with Potassium Nitrate. After dissolving the fused mass in water, Nitric Acid was added to acid reaction and Phosphoric Acid precipitated by Molbydic Acid solution.

Sulphuric Acid was precipitated after the removal of Magnesia; and as the Barium Sulphate might have contained some Oxalate, the washed precipitate was rinsed back into a beaker and heated with a little Bromine water before collecting it definitely for determination.

I. 1.7803 Gr. of Ash.

83.7275	p. c. portion soluble in acid.
16.2725	p. c. portion insoluble in acid.
100.0000	

Calculated for the mean percentage of Ash (17.6213).

83.724	p. c. =	14.753	p. c. (of Coal.)
16.276	p. c. =	2.863	p. c. (of Coal.)
100.000		17.621	

A. Solution in Hydrochloric Acid:

Ferric Oxide	=	75.7853 p. c.
Manganic Oxide	=	1.1801 p. c.
Alumina	=	5.0609 p. c.
Lime	=	0.3673 p. c.
Magnesia	=	0.1313 p. c.
Phosphoric Acid	=	0.1404 p. c.
Sulphuric Acid	=	0.7635 p. c.
		83.4286

B. Insoluble residue:

Ferric Oxide	=	0.1476 p. c. =	0.0260 p. c. (of Coal.)
Alumina	=	2.1918 p. c. =	0.3862 p. c. (of Coal.)
Magnesia	=	0.3223 p. c. =	0.0568 p. c. (of Coal.)
		2.6617	

II. 1.7729 Gr. of Ash.

Silica	=	14.3438 p. c.
Ferric Oxide	=	75.8596 p. c.
Manganic Oxide	=	0.8001 p. c.
Alumina	=	7.6630 p. c.
Lime	=	0.4287 p. c.
Magnesia	=	0.3224 p. c.
Phosphoric Acid	=	0.1404 p. c.
Sulphuric Acid	=	0.6618 p. c.
		100.2198

III. 1.7332 Gr. of Ash.

No Potassa and no Soda present.

The mean composition of the ash, as obtained from analyses one and two, is, therefore:

Silica	=	14.3438 p. c. =	2.5204 p. c. (of Coal.)
Ferric Oxide	=	75.8962 p. c. =	13.5739 p. c. (of Coal.)
Manganic Oxide	=	0.9901 p. c. =	0.1745 p. c. (of Coal.)
Alumina	=	7.4578 p. c. =	1.3141 p. c. (of Coal.)
Lime	=	0.3980 p. c. =	0.0701 p. c. (of Coal.)
Magnesia	=	0.3881 p. c. =	0.0684 p. c. (of Coal.)
Phosphoric Acid	=	0.1404 p. c. =	0.0248 p. c. (of Coal.)
Sulphuric Acid	=	0.7126 p. c. =	0.1256 p. c. (of Coal.)
		100.3270	17.8718

The ash is remarkable for the total absence of Alcalies and Chlorine, for the small amount of Phosphoric Acid, and for the comparatively large amount of Manganese which it contains. The insoluble Residue, consisting of Silica, Alumina, some Magnesia and a little Iron existed, I think, as such in the Coal, perhaps in the form of an insoluble Silicate, f. e. clay, and was precipitated from the muddy waters of the Lagoons at the same time with the vegetable matter, which produced the Coal. Nearly the whole of the Alumina, insoluble and soluble, of this and other Coals is derived from such a source. It is itself no constituent of the ash of recent plants and no more likely to have been one of the ash of plants of the Carboniferous period. In fact its very properties and its constitution seem to be unfavorable to its passing through membranes or capillary openings. That portion of Alumina, which is soluble in Acid, becomes thereby sugges-

tive of the decomposition of a part of the Silicate by means of Sulphuric Acid, appearing in numerous springs of aluminous and vitriolic waters, which may form beds of Gypsum and Ochre during their course, and is attributable to the reverse of the process, which during submergence produced the Sulphuret of Iron in the Coals by the action of decaying vegetable matter upon Salts of Iron.

5. Analysis of the aqueous Solution of Coal.

204. 1 gr of Coal were packed into a tall Glass-Funnel with Glass-stopcock, and washed with small portions of water (about 100 cc at a time), which were allowed to remain in contact with the Coal for 24 hours. By opening the stopcock, the fluid was run every morning into a large bottle, and fresh water poured upon the funnel. When 2140 cc had been collected, every trace of soluble matter was deemed to have been removed, and the solution, the first portions of which were yellow, while the rest was colorless, was subjected to Analysis. A large number of determinations were made, originally for a different purpose, as before stated, and which I shall have occasion to describe more particularly in another paper. I will mention here only the composition, as obtained by Analysis of 1048.5 cc of the liquid, representing 100 gr. of Coal, and expressing therefore direct weight in gr. as well as percentages.

Silica, Iron, Alumina, Lime and Magnesia were determined in one portion; Sulphuric Acid in another; Ferrous Oxide in a third; and in a fourth, fifth and sixth search was made for Alcalies, Chlorine and Phosphoric Acid, with perfectly negative result, no trace of either of them proving to be present. The following is the composition of the liquid:

Silica	=	0.0076 p. c.
Ferric Oxide	=	0.9892 p. c.
Alumina	=	0.1569 p. c.
Ferrous Oxide	=	3.0479 p. c.
Lime	=	0 3403 p. c.
Magnesia	=	0.0150 p. c.
Sulphuric Acid	=	5.8075 p. c.
		10.3584

Upon evaporating and igniting this solution, there would plainly be volatilized all Sulphuric Acid, except 0.5163 p. c. united with Lime and Magnesia, while the Ferrous Oxide would take up Oxygen and become converted into Ferric Oxide. The quantity of ash therefore, which would be left by this operation, could be found by subtracting

from the total weight of the residue all Sulphuric Acid minus 0.5163 gr. and 0.3387 gr. of O, requisite for the oxidation of FeO., this would leave 5.4059 p. c. of ash.

One of the results of the examination becomes apparent, namely, that the ash does not express the quantity of mineral matter in Coal, and that therefore by assuming this to be the case, grave errors may be committed in the calculation of the Oxygen of the Organic Matter, a knowledge of which I hold to be essential in tracing the change, which Cellulose has undergone in becoming Coal.

Oxygen is reduced from 44.6 p. c. in Cellulose to about 3 p. c. in Anthracite; Hydrogen from 6.3 p. c. to about 2 p. c. The range in the former case is through 41.6 degrees, that in the latter through 4.3 degrees. We can easily understand, that a method, which arranges Coals with all their various shades of Composition within a compass of 41.6 degrees must be freer from error than one in which the compass is only 4.3 degrees. If the amount of Oxygen in the Organic Matter of Coal could be determined accurately and directly, we would have no need of the somewhat round-about way, followed by me; but until such method is discovered, indirect means must be employed to reach this important result. It is true, though, that in Coals, which are free from Sulphur and Iron, the ash is a measure of the mineral matter in them, but when Iron is contained in the ash, even in the absence of Sulphur, this becomes already doubtful; and I think that only in cases, where it can be proved to exist in some unsoluble form (unsoluble in Acid) the ash may be supposed to represent the amount of Mineral Matter in the Coal; whenever the Iron is in the soluble form, the degree of oxidation, in which it exists in Coal, should be ascertained and correction be made for it by adding the difference between the two states of oxidization to the Oxygen. Without such correction the error will increase with the amount of Sulphuret and the degree of weathering, without however becoming so small, that it could in safety be overlooked.

6. Composition of the Mineral Matter in this Coal.

The portion soluble in Hydrochloric Acid is obtained by subtracting from the constituents of the ash all that is soluble in water and insoluble in Acid, and also the remainder of that part of Iron, Manganese and Sulphur, which is given as Sulphuret.

In calculating the amount of Sulphuret present 6.5420 p. c. of Iron and Manganese would require 7.4791 p. c. of Sulphur to form Disulphuret, while 9.3376 p. c. are available. This excess of 1.8555 p. c. of Sulphur is contained in the Coal in the free state, and not in combi-

nation with the Iron in a higher state of Sulphurization, as Rush Emory (*) supposes, nor also united with Organic Matter, as suggested by E. B. Andrews (†). I base my reasons for declining to accept their views upon the existence of free Sulphur in the Coal, and upon an Analysis (see Litt. D.) of a solution, obtained by boiling a portion of the washed Coal (obtained under No. 5) in Hydrochloric Acid.

Silica	=	0.0076 p. c.	
Ferric Oxide	=	0.9892 p. c.	
Alumina	=	0.1509 p. c.	
Ferrous Oxide	=	3.0479 p. c.	
Lime	=	0.3403 p. c.	
Magnesia	=	0.0150 p. c.	
Sulphuric Acid	=	5.8075 p. c.	
		10.3584	Soluble in water.
Alumina	=	0.7770 p. c.	
Lime	=	0.0577 p. c.	
Phosphoric Acid	=	0.0248 p. c.	
Sulphuric Acid	=	0.3675 p. c.	
		1.2270	Soluble in acid.
Silica	=	2.5204 p. c.	
Ferric Oxide	=	0.0260 p. c.	
Alumina	=	0.3862 p. c.	
Magnesia	=	0.0568 p. c.	
		2.9894	Insoluble in acid (Clay.)
Iron Disulphuret	=	13.7582 p. c.	
Manganese "	=	0.2629 p. c.	
Sulphur	=	1.8555 p. c.	
		15.8766	Sulphuret and Sulphur.

Or, to condense it:

5.4104 p. c.	soluble portion (except Sulphuric Acid).
2.9894 p. c.	insoluble portion (Silicate).
14.0211 p. c.	Sulphuret.
6.1750 p. c.	Sulphuric Acid.
1.8555 p. c.	Sulphur.
30.4514.	

By subtracting from the above amount all Sulphuric Acid, less the quantity actually found in ash, and also all the Sulphur, and adding to the product sufficient Oxygen to oxidize Iron and Manganese,

* Sill. Amer. Journal, January, 1872.

† Geological Survey of Ohio, 1870, pp. 224, 412.

we obtain 18.2106 p. c., which agrees closely enough with the percentage of ash found, to prove the correctness of the calculation.

T. G. Wormley in his excellent report (*) mentions a Coal (of New Straitsville, 3d seam), having an excess of Sulphur over the Iron, which if I understand him correctly, he suggests to be in combination with organic matter; his suggestion would seem to be strengthened by the fact that Coke, obtained from the same Coal, still retained 0.26 p. c. of Sulphur, while 0.027 p. c. were only found in the ash, which added to 0.088 p. c. united with all the Iron present as Disulphuret, would still leave an excess of 0.147 p. c. of Sulphur unaccounted for, which were to exist then in Coke in combination with organic matter. I think the fact of such a combination would be difficult to realize, as no organic substance free from ash, can be heated to redness without losing its Sulphur. (†) The Coal contained no doubt Sulphuret, Sulphuric Acid and Sulphur, and I am inclined to ascribe the excess of Sulphur in the Coke, a little more than 0.147 p. c., to errors incidental to the analytical determination of Sulphuric Acid, especially as the weight of Barium Sulphate, which would correspond to 0.147 p. c. of Sulphur in 5 grains of substance analyzed, would amount to only 0.0035 gr. At the same place ten analyses of Coal ashes are given, in each of which Sulphur is reported present, besides Sulphuric Acid. Supposing the Reagents to have been pure, and the ash properly prepared, that Sulphur must have existed as Barium or Strontium Sulphate.

7. Composition of the Coal.

The composition of the Coal, then, is represented as follows:

Carbon	=	50.7400 p. c.
Hydrogen	=	3.9001 p. c.
Nitrogen	=	0.8860 p. c.
Oxygen	=	8.5492 p. c.
Water	=	5.4733 p. c.
Mineral matter	=	30.5414 p. c.
		100.0000

The organic matter in it by:

Carbon	=	79.19 p. c.
Hydrogen	=	6.09 p. c.
Nitrogen	=	1.38 p. c.
Oxygen	=	13.34 p. c.
		100.00

Or, without the Nitrogen, by:

Carbon	=	80.30 p. c.
Hydrogen	=	6.18 p. c.
Oxygen	=	13.52 p. c.
		100.00

(*) Geological Survey of Ohio, 1870, pages 412, 418, 428.

† Gemlin—Handbook of Chemistry, Vol. XII., page 78—speaking of the effect of heat on organic compounds, says: "If the compounds contain (Cl, Br, I or) Sulphur, these elements, if they do not separate in the free state, or enter into volatile organic compounds, are given off in combination with Hydrogen in the form of (HCl, HBr, HI or) Hydrosulphuric Acid. Part of the Sulphur (and Cl) may also be evolved in the form of Sulphide of Carbon (or Chloride of Carbon).

In comparing the two amounts of Oxygen, obtained here and under No. 2, we find a much smaller difference than might have been anticipated; and though this difference is probably not a constant figure, I suppose one-ninth might be subtracted from the Oxygen of all Coals containing Sulphur and Iron, in which Oxygen is determined in the ordinary way by subtraction, in order to arrive at a figure which would be a close approximation to truth, and offer a basis for comparison. The number of ultimate analyses of western Coals is small, and I have at present no access to their records; but those few that I have been able to compare, show within the same basin those Coals of a lower geological horizon to contain more Oxygen and Hydrogen, and less Carbon, than those placed above them, a difference, which is equally noticeable in the lower and upper portions of Coal of the same seam. Any marked exception to this rule will be owing to geological disturbances of the beds, during and after the formation of the Coal, in consequence of which it may have become dry and exposed to the action of atmospheric Oxygen.

B. THE COKE.

The amount of Coke obtained from the Coal is 66.125 p. c. (See A 2). Its consistency and hardness is greater than might be anticipated, and only a small portion remains loose or in powder in the coking vessel. The Coal therefore belongs to the class of dry or sinter Coals with long flame, which when free from Pyrite are so excellent a furnace fuel. I trust that at no distant day means will be discovered by which our Coals can be freed from deleterious admixture, so that Missouri ores can be smelted by Missouri Coals. The analyses and individual determinations in Coke were made in the same manner, as those in Coal; I refer therefore to them for the methods.

1. Elementary Analysis.

Carbon	=	58.140 p. c.	
		58.580 p. c.	
		116.720	Mean = 58.3600 p. c.
Hydrogen	=	1.4511 p. c.	
		1.5155 p. c.	
		2.9666	Mean = 1.4833 p. c.
Nitrogen	=	0.5333 p. c.	
		(In 4 gr. of Coke.	

2. Determination of Sulphur.

Sulphur = 13.1200 p. c.

The coke contained no Sulphuric Acid, (boiling Hydrochloric Acid extracted none, but caused an evolution of Hydrosulphuric Acid, proving the presence of a lower Sul-

phuret,) which had partly been reduced and partly been volatilized, with the free Sulphur and a portion of the Sulphur of the Pyrite. 13.12 p. c. of Sulphur in the Coke are equivalent to 8.6756 p. c. of it in the Coal, demonstrating a loss of only 3.129 p. c. by coking. Calculating the Sulphates of Iron, Lime and Magnesia to become reduced to Mono-sulphurets, there would be volatilized—

1.8555 p. c. of free Sulphur.
0.4804 p. c. Sulphur from rest of Sulphuric Acid.
0.7931 p. c. Sulphur from Pyrite.

3.1290

I confess that a loss of 0.7931 p. c. of Sulphur, or only one tenth of the Sulphur of the Pyrite is rather smaller than might have been expected.

3. Composition of Coke.

The mineral matter of the Coke consisted no doubt of the mineral matter in the Coal, less all Sulphuric Acid, all Sulphur and all Oxygen of the soluble bases, plus the Sulphur actually found, calculated in p. c. of the Coal. The product increased in the proportion of 66.125 : 100 would indicate percentages.

6.1750 p. c. of Sulphuric Acid (of Coal.)
9.3346 p. c. of Sulphur (of Coal.)
1.0773 p. c. of Oxygen (of Coal.)

16.5869

30.4514 p. c. of mineral matter (of Coal.)
16.5869 p. c. volatilized.

13.8645
8.6756 p. c. of Sulphur in Coke (of Coal.)

22.5401 p. c. of mineral matter.

This amounts to 34.0871 p. c. in the Coke.

The composition of the Coke then is:

Carbon	=	58.3600 p. c.
Hydrogen	=	1.4833 p. c.
Oxygen	=	5.5363 p. c.
Nitrogen	=	0.5333 p. c.
Mineral matter	=	34.0871 p. c.
		100.0000

The relative composition of the organic matter of Coal, Coke and volatile matter, in percentages, is appended here:

COAL:

Carbon	=	50.7400	=	79.19	= 80.30
Hydrogen	=	3.9001	=	6.09	= 6.18
Oxygen	=	8.5492	=	13.34	= 13.52
Nitrogen	=	0.8860	=	1.38	100.00
		64.0753		100.00	

COKE:

Carbon	= 38.5971	= 88.52	= 89.30
Hydrogen	= 0.9808	= 2.25	= 2.27
Oxygen	= 3.6709	= 8.35	= 8.43
Nitrogen	= 0.3526	= 0.88	100.00
	43.6014	100.00	

VOLATILE MATTER:

Carbon	= 12.1429	= 59.31	= 60.89
Hydrogen	= 2.9193	= 14.26	= 14.60
Oxygen	= 4.8783	= 23.83	= 24.51
Nitrogen	= 0.5334	= 2.60	100.00
	20.4739	100.00	

I will point out that in calculating Nitrogen and Oxygen in volatile matter, as Ammonia and Water, the remaining Carbon and Hydrogen exist in equal atomic proportions.

Some further experiments were made to test the accuracy of the analytical results, given in the previous part of this paper, first with the Coal, washed with water and subsequently dried, (obtained sub. A. 5,) and then with this Coal, after treatment with Hydrochloric Acid. The results are recorded sub C and D.

C. COAL AFTER WASHING WITH WATER.

Water removed from the original Coal, as stated sub A. 5, 10.3584 p. c. of solid matter with 5.4059 p. c. of Ash, leaving in the washed Coal 12.2151 p. c. The quantity of Sulphur found was 11.8046 p. c., of which 2.3230 p. c. were removed by water, leaving 9.4816 p. c. behind.

The insoluble Residue amounted to 2.9394 p. c. 100 gr. of Coal would be reduced by washing and drying to 84.1683 gr., so that a correction must be made, if we desire to compare the calculated figures with those obtained by actual experiment. By this, we should expect to find in the washed Coal—

14.513 p. c. of Ash.
11.265 p. c. of Sulphur.
3.552 p. c. of insoluble matter (Clay.)

1. Proximate Analysis of Washed Coal.

Water	= 1.841 p. c.		
	1.224 p. c.		
	3.965	Mean	= 1.532 p. c.
Volatile matter	= 32.421 p. c.		
	32.303 p. c.		
	64.724	Mean	= 32.362 p. c.
Ash	= 12.850 p. c.		
	12.934 p. c.		
	25.784	Mean	= 12,892 p. c.

The composition is therefore:

Water	= 1.532 p. c. for dry coal.	
Volatile matter	= 32.362 "	= 32.866 p. c.
Fixed Carbon	= 53.214 "	= 54.041 "
Ash	= 12.892 "	= 13.093 "
	100.000	100.000

The ash treated with Hydrochloric Acid left a residue of 3.446 per cent., equal to 3.499 per cent. of the dried coal.

The washed coal was dried at a comparatively low temperature, a process which required several days; the remaining moisture was then determined as described before, and the coal exposed over concentrated Sulphuric Acid, and subsequently to a dry and hot current of air. It lost—

0.469 p. c. in 4 days.
0.510 " in 9 "
9.459 " in 16 "
0.348 " in 24 "
0.800 " after heating 2 hours.
0.815 " after heating 6 hours.

It will be seen that the difference between the loss in water and the absorption of Oxygen, which takes place under these conditions, neutralize each other after a while, so that reliable results cannot be obtained in this way.

2. Determination of Sulphur.

Total Sulphur = 9.9882 p. c. of coal.
= 10.1436 " of dry coal.

In comparing the percentages calculated with those actually found, we are struck by a significant difference between the two sets of figures:

	Calculated.	Found.	Difference.
Ash	= 14.513	13.093	1.420
Sulphur	= 11.265	10.144	1.121
Clay	= 3 552	3.499	0.053

I was unable for a long while to account for this apparent discrepancy, amounting in the case of the Ash to 10.84 per cent., and in that of the Sulphur to 11.05 per cent. of the coal, but am inclined at present to ascribe it to an oxidation and consequent increase of the coal by drying. It has long been known that coal increases in weight by weathering, which increase will sometimes amount—especially if the temperature be elevated—to about 20 per cent. of the weight of the coal;* at the same time the heating power diminishes, caused by a loss of the Carbon and Hydrogen, which are only partially given off as Carbonic Acid† and water, while by far the larger amount is retained, and can be determined easily by the air pump.‡ In following out the comparison still further, at least as far as the fixed Carbon is concerned, which I think is obtained by proximate analysis under exactly parallel conditions in both coals, we would expect to find in the washed and dried coal 57.63 per cent. (48.504 per cent. in the proportion of 84.1683: 100), we obtain actually 54.04 per cent., a loss also of 2.59 per cent., equivalent to 6.46 per cent. of the coal.

Ash and Sulphur furnish a basis for calculating the increase of weight in coal, freer from error, than Carbon; adopting then 11 per cent. as the mean increase, we may calculate the actual loss of fixed Carbon at 4.41 per cent., of which 2.59 per cent. is lost by dissipation and 1.82 per cent. by combination; that is to say, 1.82 per cent. of Oxygen and perhaps Nitrogen have entered into a combination with the organic matter of coal, which cannot be destroyed by simple heat. E. Richters, in the paper already cited, determines in one case the loss of Carbon under the action of atmospheric air and heat to be 2.61 per cent.

D. COAL C AFTER WASHING WITH HYDROCHLORIC ACID.

100 gr. of the previous coal were boiled with Hydrochloric Acid, the solution filtered off and completely removed by washing. It had the following composition:

0.6421	p. c. Ferrous Oxide.¿
1.4460	p. c. Sulphuric Acid.
0.0256	p. c. Silica.
Trace	p. c. Magnesia.
2.1137	p. c.

*E. Richters. Dingler's Journ., vol. 190, vol. 193, vol. 195.

†F. Varrentrapp. Dingler's Journ., vol. 175, vol. 178.

‡E. von. Meyer, Journ. f. pract. Chemie, 1872, vol. v., Ueber die in Steinkohlen eingeschlossenen Gase.

¿Not all the iron was Protoxide.

The mineral constituents of the Coal had previously been washed away by the water. Weathering, that is moisture and heat, decomposed a fresh portion of the Sulphuret, and its composition is represented by the Sulphur and Iron found in the solution:

0.6421 FeO = 0.4994 Fe=0.01783 Atoms=1.00
1.4460 SO_3 = 0.5784 S=0.03615 Atoms=2.03

The Sulphuret was evidently Fe S_2, which supports my former statement (A. 6) in reference to the excess of Sulphur found in Coal. In calculating the amount of Ash, Sulphur and insoluble residue in the dry Coal, after the treatment with Hydrochloric acid, we obtain with the correction (96.3543: 100).

12.60 p. c. Ash.
9.76 p. c. Sulphur.
2.58 p. c. Insoluble Matter.

1. Proximate Analysis of this Coal.

Water = 0.299 p. c.
0.133 p. c.
0.432 mean = 0.216 p. c.

Volat. Matter = 32 612 p. c.
32.477 p. c.
65.089 mean = 32.543 p. c.

Ash = 12.347 p. c.
12 788 p. c.
26.135 mean = 12.567 p. c.

The composition is therefore:

Water	=	0.216 p. c.	for Dry Coal.
Volat. Matter	=	32.543 p. c.	32.613 p. c.
Fixed Carbon	=	54.674 p. c.	54.793 p. c.
Ash	=	12.567 p. c.	12.594 p. c.
		100.000	100.000

The ash, treated with Hydrochloric Acid, left 3.584 p. c. of Residue, or 3.592 p. c. for Dry Coal.

Over Sulphuric Acid this Coal lost:

—0.025 in 4 days.
+0.005 in 9 days, (gain.)
—0.060 in 16 days.
—0.192 in 24 days.
—0.055 after 2 hours drying.
—0.060 after 6 hours drying.

The quantity of Sulphur found was 9.9437 p. c., or for Dry Coal = 9.8646 p. c. The calculated figures in this case agree almost exactly with the figures found.

	Ash.	Sulphur.	Residue.
Calculated	= 12.600	9.76	3.58
Found	= 12.594	9.86	3.59

This would exclude an increase in the weight of the Coal by drying after washing with Hydrochloric Acid and Water. I am, at present, not prepared to tell whether this be found true, and whether it is caused by a change of condition, or by a shorter exposure to a somewhat more elevated temperature in drying. I close with the hope of finding other chemists join me in this particular kind of inquiry, namely: of determining the composition of the Organic Matter of Coals.

[B.]

THE WATER-SUPPLY OF COLUMBIA, BOONE COUNTY, MISSOURI; BEING AN EXPOSITION OF THE ORIGIN OF THE SPRINGS AND SUBTERRANEAN WATER-COURSES OF THE TOWN AND NEIGHBORHOOD, WITH SOME ANALYSES OF CISTERN WATER.

The town of Columbia is situated in a belt of country, the mean annual rainfall of which is 32 inches, a remarkable small amount of atmospheric precipitation, compared with that of the southern portion of the State; this rain constitutes the larger source of the water-supply of the town, as the springs hardly ever furnish a water of sufficient purity to serve for culinary purposes; the reason of this is found in the absence of hills of sufficient height and extent, to collect the waters of an extended area, and in the prevalence of dense surface deposits, such as Bluff (red clay) overlying either Limestones, beds of more or less impure Coal or both. The atmospheric precipitates, which never descend here in profusion at any time, are partly absorbed or sucked up by these formations, and find their way to lower levels by slow degrees, becoming saturated with the products of solution or decomposition of the strata, through which they pass. They appear again in the valley below, either diluted by waters that flow through fissures and cavities in the rock at a more rapid rate, or modified by the last formation, through which they force their way up to light.

While there is therefore danger in using the harder water of the springs, from their liability of producing bowel complaints of an aggravated character, there is hardly less danger from using rain water, from its liability of becoming impure. Summer and fall are usually dry; the water gets low in the cisterns and the atmospheric conditions become favorable to the decomposition of Organic Matter, swept into the cisterns from the shingle-roofs of the houses in the shape of dust, leaves, berries and insects. Animal life, microscopic and otherwise is developed, and the mainstay of our health, comfort and civilization, naturally pure water, is put in question. Care and judgment in the selection of spring waters, and supervision of the cistern will however remove all difficulties.

In tracing the origin of most of our springs to certain chemical processes, which take place in some of the geological strata, it be-

comes necessary to know exactly their composition. I shall give these first; then describe an experiment to determine the combination in which Iron exists in certain mineral waters, and finally state experiments and analytical results of artificial and natural waters in support of my proposition.

A. COMPOSITION OF THE BLUFF, LIMESTONE AND COAL.

1. Bluff (Red Clay.)

This formation is so well described in the 1 and 2 Report of the Geological Survey of Missouri by G. C. Swallow, that I concluded to copy the description. The Report: The geological position of this formation in the series of Missouri rocks is easily determined. That it is newer than the drift, is satisfactorily proved by the fact, that it rests upon the latter formation, when both are present and undisturbed. It caps nearly all the bluffs of the Missouri and Mississippi within our State, forming the very highest deposits skirting their valleys. Thus, while the Bottom Prairie occupies a higher geological horizon, the Bluff is usually several hundred feet above it in the topographical.

This formation, when well developed, usually presents a fine, pulvurent, obsoletely stratified mass of light grayish-buff, silicious and slightly indurated marl. Its color is usually variegated with deeper brown stains of oxide of Iron. When but sparingly developed, it generally becomes more argillaceous and assumes a deeper brown or red color, as on the railroad, south of Palmyra, where it is a dark brick-red, tinged with purple. In some places the ferruginous and calcareous matter increases, and we find concretions of marl and iron-stone, either disseminated through the mass, or arranged in horizontal belts. At other places it has more arenaceous matter, and is much more decidedly stratified, as at a point one mile above Wellington and in the Bluff at St. Joseph.

The Bluff formation is often penetrated by numerous tubes or cylinders, about the size or thickness of pipe stems, some larger and others smaller. They are composed of clay, carbonate of lime and oxide of Iron, being argillo-calcareous oxide of Iron or calcareous clay-ironstone. But it is not so easy to say how they are formed. Several facts may aid us in determining this matter. These tubes penetrate the formation in all directions, and are most abundant near the surface; though some extend to the depth of twenty feet. The space of some half inch around each tube, more or less, according to its size, is of a much lighter color, as if the coloring matter (oxide or Iron) had been extracted.

The same appearances were observed around the green and dry roots of the white oak, which had penetrated the same formation. Qualitative Analysis proved these same roots to contain a large portion of oxide of Iron. And besides, oak-wood always contains a large portion of that metal and manganese. An analysis of its ashes by Saussure, gave 2.25 per cent. of the oxides of these metals; while the analysis of oak-wood-mould, or the decayed wood, by the same Chemist, gave 14 per cent. of the same oxides.

It is thus made manifest, that oak-wood contains Iron, which must have been absorbed through the roots from the earth. This fact readily explains the loss of the Iron from the marl around the roots, and around the tubes, provided they were once oak-roots. But the question naturally arises, how these roots become tubular. But they were seen in the various stages of decay, and the woody fibres of some had disappeared, and left the bark in the form of a tube, still retaining its organic structure, though strongly impregnated with the oxide of Iron and aluminium and carbonate of lime.

These phenomena have been thus minutely investigated, not merely as interesting scientific facts, but also as one of the most useful agricultural features of this preèminently valuable formation; for upon it, and sustained by its absolutely inexhaustible fertilizing resources, rest, the very best farms of the Mississippi and Missouri valleys. These tubes and holes, also, constitute the most thorough system of drainage imaginable. So far as my own observations extend, this formation caps all the Bluffs of the Missouri, from Council Bluffs to its mouth, and those of the Mississippi from the mouth of the Des Moines to that of the Ohio, and forms the upper stratum beneath the soil of all the high-lands, both timber and prairie, of all the counties north of the Osage and Missouri, and also St. Louis and the other Missippi counties on the south.

Its greatest development in this State is in the counties on the Missouri, from the Iowa line to Boonville; but thence to St. Louis it is not so thick. In some places it is two hundred feet thick; at St. Joseph it is one hundred and forty; at Boonville one hundred, and at St. Louis, in St. George's quarry, and the Big Mound, it is about fifty feet thick, while its greatest thickness observed in Marion county was only thirty." (So far the Report.)

The specimen which I selected for Analysis came from a shaft, sunk for the purpose of building a cistern, and was taken from a depth of about 12 feet. A large quantity of it was pulverized and air-dried. It had a specific gravity of 2.510 and absorbed weight for weight 0.513

parts of water, so that a cubic foot of it, weighing about 160 pounds, is able to absorb and retain against the law of gravitation 82 pounds of water. This is a significant and important fact to Agriculturists, which I shall discuss more specially at a future time.

The Mechanical Analysis or separation of the particles into various degrees of fineness, executed by a Shöne-Apparatus with a fall of water of two feet, gave the following result:

44.372	p. c. coarser particles.
16.155	p. c. finer particles.
16.105	p. c. still finer particles.
16.182	p. c. finest particles.
5.736	p. c. water.
100.000	

The coarsest particles were about as fine as fine sand, and probably about six times as fine as ordinary sea sand. No coarser material was found at all.

Chemical analysis established the following composition:

77.7061	Silica.
3.0772	Ferric Oxide.
0.2314	Manganic Oxide.
10.2391	Alumina.
0.3788	Lime.
0.2722	Magnesia.
1.5250	Soda.
0.5750	Potassa.
0 0214	Phosphoric Acid.
0.6426	Carbonic Acid.
5.7363	Water.
100.4051	

Another portion was treated with boiling Hydrochloric Acid, and the filtrate analyzed, which, by subtraction from the original analysis, furnished the composition of the insoluble portion.

Soluble portion.		Insoluble portion.	
0.1244		77.5817	Silica.
2.5471		0.5301	Ferric Oxide.
0.2314		none	Manganic Oxide.
3.9251		6.3140	Alumina.
0.2067		0.1721	Lime.
0.2549		0.0173	Magnesia.
7.2896		84.6152	
0.0214	Phosphoric Acid.	2.1000	Alcalies.
7.3110		86.7152	

Two specimens of the same substance, one from the neighborhood of Hannibal, and the other from the Big Mound, St. Louis, were collected and analyzed about twenty years ago by Dr. Litton, and show a marked similarity with my sample. They differ, however, from mine in containing more Carbonates of Lime and Magnesia, amounting to about 7.5 p. c. in the former and 6 p. c. in the latter. This may be owing to his specimens having come from nearer the surface, where surface waters might have deposited these salts.

I will call attention to the Loess, a similar formation to the Bluff, on the Rhine, in Germany, which has a composition almost exactly like that of the Bluff, except in being richer in Carbonate of Lime and Magnesia.

2. Limestone.

I quote again from the above Report: This (the Encrinital Limestone) is at once the most extensive and best characterized of the divisions of the Carboniferous Limestone. It is made up of brown, buff, gray and white, coarse-crystalline, heavy-bedded Limestones. The darker-colored, impure varieties prevail near the base, while the lighter and more purely calcareous strata abound in the upper part. It everywhere contains globular, ovoid and lenticular masses of chert disseminated or arranged in beds parallel to the lines of stratification. These masses of chert are more abundant in the upper divisions.

The beds of this formation are frequently intersected by joints resembling the sutures of the cranium, which I have ventured to call suture-joints. The remains of Crabs and Mollusks are very abundant; some of the strata are made up almost entirely of their exuviæ, especially of the joints and plates of the Crinoideans. The lower beds are more impure, darker-colored and contain fewer fossils than other portions.

Many caves have been observed in these Limestones; several in Boone county were explored—one for the distance of some two miles. They abound in beautiful Stalactites and Stalagmites. Some have streams running along their beds, and constitute a natural system of drainage for a considerable extent of country. "Sink-holes," funnel-shaped depressions, are common in all places where this formation is well developed, and form the natural channels by which much of the surface water reaches the caverns below. Small streams sometimes enter them and again appear at the mouth of the cavern. These "sink-holes" frequently become ponds by the closing up of the passages to the caverns below, with clays impervious to water. There are several such in the western part of Boone county. The thickness

of this formation is quite variable; on the Osage it is about 200 feet; on the Mississippi, above Hannibal, 175 feet; and on the Hinkston, in Boone county, about 400 or 500 feet.

There are eight divisions of this Limestone in Missouri, each quite well marked by its fossils.

The middle portions of the Encrinital Limestone are made up of thick-bedded, gray and buff and brown, crystalline, crinoidal, cherty Limestones, marked with many suture-joints. This part of the formation is conspicuous in the bluffs of the Missouri, both above and below Rocheport, in Boone and Howard counties; also, on Salt river, in Monroe, where it furnishes an abundance of good building material. The foundations and columns of the State University are from these beds, as are also those of the beautiful court house in Boone county. (So far the Report.)

The composition of this Limestone is:

55.3006	p. c. Lime.
0.4000	p. c. Magnesia.
0.1013	p. c. Ferric Oxide.
0.0946	p. c. Alumina.
0.0019	p. c. Sodium.
43.4505	p. c. Carbonic Acid.
0.3149	p. c. Silica.
0.0021	p. c. Phosphoric Acid.
0.0037	p. c. Chlorine.
99.6696	

Bases and Acids are united in this way:

98.7467	p. c. Calcium Carbonate.
0.8390	p. c. Magnesium Carbonate.
0.0046	p. c. Calcium Orthophosphate.
0.1013	p. c. Ferric Oxide.
0.0946	p. c. Alumina.
0.0056	p. c. Sodium Chloride.
0.3149	p. c. Silica.
100.1067	

The specific gravity of the Limestone is 2.682 and it absorbs by weight 0.379 parts of water; a cubic foot of it, weighing about 170 pounds, absorbs 65 pounds of water.

As the waters of several springs were supposed to derive their mineral matter almost exclusively from Limestone beds, a large quantity in coarse powder was washed repeatedly with distilled water, and the solution analyzed; the Carbonic Acid was not determined directly, but was supposed to be present by absorption from air.

GRAINS IN A GALLON.

0.3939	Silica.
2.9427	Calcium Carbonate.
0.8399	Magnesium Carbonate.
0.0234	Ferrous Carbonate.
1.4553	Sodium Chloride.
5.6552	

Carbonate of Magnesia and Chloride of Sodium, it will be seen, are easily washed out of the Limestone, and this is no doubt the source of these two salts in many springs and cistern waters. For completeness sake I will give here also the analysis of Chert, accompanying this Limestone. The fresh mineral has a dark, semi transparent appearance, which, however, changes by exposure to air to an opaque porcelain like color, breaking up at the same time into numerous pieces. This change is probably caused by the removal of Alcali and the absorption of water. The unaltered chert contained 0.571 p. c. of water, while the opaque, weathered specimens contained 0.815 p. c.

CHERT.

0.5710	p. c. Water.
95.2910	p. c. Silica.
1.0134	p. c. Alumina.
0.0206	p. c. Ferric Oxide.
0.4350	p. c. Lime.
0.3090	p. c. Magnesia.
97.6400	
2.3600	p. c. Alcalies (?).
100.0000	

3. Coal.

For the complete composition of the Coal of this formation, I refer to the previous paper, and confine myself here exclusively to the consideration of the solution obtained by washing this Coal with water. The composition of the solution has been given before, and as it is customary in the United States to calculate the mineral matter of waters in grains per U. S. gallon of 241 cubic inches. I have done it in this case, with the following result:

GRAINS IN U. S. GALLON.

0.4258	grains Silica.
55.0412	grains Ferric Oxide.
8.3996	grains Alumina.
169.5829	grains Ferrous Oxide.
18.7974	grains Lime.
0.8374	grains Magnesia.
322.9250	grains Sulphuric Acid.
576.0093	

Bases and Acids were supposed to be united in the following manner:

0.4258 grains Silica.
137.6030 grains Ferric Tersulphate.
27.9714 grains Aluminum Tersulphate.
358.0083 grains Ferrous Sulphate.
45.6508 grains Calcium Sulphate.
2.5222 grains Magnesium Sulphate.
3.8378 grains Sulphuric Acid.

576.0093

It will be seen, that there is an excess of Sulphuric Acid in the water, as there is likely to be, whenever the products of the decomposition of pyritiferous formations do not find sufficient Iron, Lime or Magnesia to unite with. It is in fact artificial concentrated Mine or Pit Water, such as would naturally form in a Coal bed, when water and atmospheric air have access to it. I will place side by side with this three other waters, having the same origin, two of them being waters collecting in Coal mines; and the third, the water of a spring, issuing not far from a Coal field in Nova Scotia. They present, it might be supposed, different degrees of concentration of one and the same solution. The results are in grains per U. S. gallon.

	1.	2.	3.	4.
Silica	0.4258	2.6851	1.4651	0.52
Ferric Tersulphate	137.6030	33.4004	21.8603	none.
Aluminum Tersulphate	27.9714	9.6897	6.1699	none.
Ferrous Sulphate	358.0083	1.2083	none.	4.58
Calcium Sulphate	45.6508	36 2957	38.9924	25.69
Magnesium "	2.5222	20.7512	23.5881	9.45
Sulphuric Acid	3.8378	8.8667	none.	0.43
Other Salts	.....	10.0290	14.0160	7.72
	576.0093	122.9254	106.0909	48.39

The solution, containing the products of decomposition of pyritiferous Coal, gave a precipitate by boiling; this was filtered off and analyzed, proving to be entirely Ferric Oxide in the form of a basic salt; its quantity amounted to—

39.6016 Ferric Oxide, leaving in solution the rest of the Iron with all the Alumina.
15 4396 Ferric Oxide in solution.
8.3996 Alumina.
169.5829 Ferrous Oxide.

2. Th. Poleck and Brettschneider.—Jahresbericht 1869, p. 1284.
3. E. Willigk —Dingler's Journ., vol. 195, p. 212.
4. How.—Journ. Chem. Society [2], 8, p. 155.

Nearly all the figures given are means from duplicate and often triplicate determination, especially with regard to the FeO. I shall now proceed to describe experiments with regard to obtaining a basis upon which to calculate FeO in solutions, containing both Sulphates and Carbonates.

B. ON THE STATE OF COMBINATION IN WHICH IRON EXISTS IN CHALYBEATE WATERS.

In calculating the results of an analysis of a Chalybeate water considerable difficulties are met with in the grouping of the bases and acids; this is especially the case when Sulphates and Chlorides of the Alcaline Earths are present, for then the question naturally comes up whether or no a part of the Iron does not exist as Sulphate or Chloride. In all analyses that have come under my notice, Sulphate of Lime was found to be a never failing constituent, and my experiments, I believe, fully prove its incompatibility with Carbonate of Iron; a partial decomposition takes place, by which Sulphate of Iron and Carbonate of Lime are produced, the latter of which is precipitated, unless excess of Carbonic Acid and high pressure prevent it. No matter whether Carbonate of Iron in solution be brought in contact with Sulphate of Lime, or Carbonate of Lime in solution in contact with Sulphate of Iron, the result is always the same; the Iron is divided between the Carbonic and Sulphuric Acids, one-fourth of it uniting with the former and three-fourths with the latter. If chemists generally have calculated the Iron as Carbonate, whenever boiling or removal of Carbonic Acid by an air-pump produced a precipitate, they have lost sight of the fact that only a portion of the Iron is thus precipitated, while the larger part remains in solution; and this conversion or selection of acids, of which I have spoken, takes place not in consequence of elevated temperature, but at the moment of mixture.

A solution of 10 grammes of green vitriol was placed in a bottle of 3 litres capacity, and Lime-water added until turmeric paper turned slightly brown, and a filtered part of the solution gave no precipitate with Ammonia. The bottle was by this time nearly filled with liquid, which held a greenish, quickly-subsiding precipitate of Hydrated Protoxide of Iron in suspension; the whole was shaken up and Carbonic Acid was passed through for an hour, when most of the precipitated Iron had redissolved. The clear limpid and colorless solution was then filtered off from the slight remaining precipitate and analyzed. It contained:

GRAMMES IN THE LITRE.

3.7948 gr. Sulphuric and
2.7942 gr. Ferrous Oxide
1.0252 gr. Lime.

7.6142

In precipitating Sulphate of Iron with Lime-water Gypsum is formed, which remains for some time dissolved in the liquid in larger quantity than is found to be the case, by experimenting upon the solid substance with distilled water; Carbonic Acid does not affect the solubility, as proved by J. Davy, so that we may take all Sulphuric Acid found to have existed originally in combination with Lime as Sulphate of Lime or Gypsum. This would require 2.6564 gr. of Lime, while there are present only 1.0252 gr.; the difference, equal to 1.6312 gr. of Lime must have been precipitated, and can only have been precipitated as Carbonate of Lime. To precipitate however 1.6312 gr. of Lime from its solution as Sulphate would require 2.0972 gr. of Protoxide of Iron in the state of Carbonate, and as all the Iron present must have been originally Carbonate, the difference, equal to 0.6970 gr. of FeO must still exist as such in the solution. There might perhaps be an objection raised to Carbonate of Lime being precipitated in the presence of Carbonic Acid, while Carbonate of Iron is held in solution; but the former yields up its Carbonic Acid much more readily than the latter, as I found by placing both of them side by side under a bell jar, with caustic Potash and Potash and Pyrogallic Acid. Carbonate of Lime separated completely in a few days; Carbonate of Iron had formed only a slight precipitate after a month, and yielded by boiling a copious separation of Oxide.

The composition of the solution then was:

2.0972 FeO as Sulphate of Iron.
0.6970 FeO as Carbonate of Iron.
1.0252 CaO as Sulphate of Lime.

3.8194

The proportion between the Iron as Sulphate to that as Carbonate is exactly as 3:1; we might therefore expect that under the same or similar conditions one-fourth of the Iron present would be precipitated by boiling. The experiment was made at the time with a portion of the same liquid, which was boiled three successive times, the precipitate being filtered off each time, dissolved in acid and reprecipitated and weighed. The second and third precipitate contained, or were altogether, basic salt, as Sulphuric Acid was found in them in

larger proportion than was required for the Lime that was mixed with them.

0.7058 FeO	= 25.26 p. c.	1 precipitate.
0.1613 FeO	= 5.77 p. c.	2 precipitate.
0.0797 FeO	= 2.85 p. c.	3 precipitate.
1.8474 FeO	= 67.12 p. c.	remained in solution.
2.7942	100.00	

Another experiment was made by placing aside a part of the solution and filtering off the precipitate which had formed after the lapse of a month, and boiling then the filtrate:

0.7438 FeO	= 26.62 p. c.	precipitated by standing.
0.1795 FeO	= 6.42 p. c.	precipitated by boiling.
1.8709 FeO	= 66.96 p. c.	remained in solution.
2.7942	100.00	

The results of these experiments, it seems to me, prove satisfactorily my proposition, namely, that Carbonate of Iron is decomposed by Sulphate of Lime; the reverse, however, is equally true and equally supported by figures. Carbonic Acid Gas was passed through Lime-water, which was kept cool by placing the bottle in snow, until much of the precipitate, which had formed at first, was redissolved. The fluid was then filtered, and with proper precaution—that is, exclusion of air—mixed with a small quantity of Sulphate of Protoxide of Iron. The solution remained clear and colorless. It contained, by analysis, 1.4816 gr. of FeO to the litre. A portion of it was boiled, whereby a precipitate formed, which was filtered off and analyzed; it was perfectly free from Sulphuric Acid, proving the absence of all basic salt, and amounted to—

0.3397 gr. FeO	= 23.93 p. c.	precipitated.
1.1419 gr. FeO	= 76 07 p. c.	in solution.
1.4816	100.00	

It seems to me then, that in calculating the results of an analysis of a Chalybeate water, containing much Gypsum, one-fourth of the Iron present should only be counted as Carbonate, and the rest as Sulphate.

C. ON THE CHANGE IN THE COMPOSITION OF MINE WATER, BY PASSING THROUGH BEDS OF CLAY, LIMESTONE, OR BOTH.

One of the most important questions in Agricultural Chemistry has been, and still is, the determination of the absorptive power of soils for certain substances in solution. A vast amount of labor and patience has been spent upon solving this point, and a vast amount of material has been collected in the shape of experimental demonstration and analytical data. It has been found that the seat of this absorptive power is to be found in the Hydrous Silicates in the soil; that it is a chemical and not a mechanical power; that it is in fact no mere absorption, but an interchange of certain acids and bases in the Silicate, with certain others in the solution. Of the hosts of chemists whose labors have shed light upon this point, I shall only mention the name of one, Way,* who was the first to clearly point out this fact and prove it by analytical demonstration. I mention all this solely for the purpose of suggesting the possibility to calculate beforehand, the result of treating the aqueous solution of Coal with Clay.

1. TREATMENT WITH CLAY.

The experiment was performed in a glass-stoppered bottle, shaking the solution occasionally with an excess of Clay for two days, and filtering through a moistened filter. Measured portions of the liquid were then analyzed, and the results calculated in grains to the gallon:

9.9459	Silica.
0.4375	Ferric Oxide.
15.2409	Alumina.
114.6422	Ferrous Oxide.
44.1522	Lime.
13.8826	Magnesia.
269.8486	Sulphuric Acid.
468.1499	

Bases and acids were united in this way:

9.9459	Silica.
1.0937	Ferric Tersulphate.
50.7537	Aluminium Tersulphate.
242.0224	Ferrous Sulphate.
107.2268	Calcium Sulphate.
41.6478	Magnesium Sulphate.
15.4595	Sulphuric Acid.
468,1499	

* Jour. of the Roy. Ag. Soc. 1850, Vol. XI., page 313, and Vol. XV., page 491. Bronner proved the fact before.

The difference between this and the original solution by direct comparison is as follows:

+ 9.5201 Silica.
+ 6.8413 Alumina.
+25.3548 Lime.
+13.0452 Magnesia.
—54.6037 Ferric Oxide = 99.25 per cent.
—54.9407 Ferrous Oxide = 32.39 per cent.
—53.0764 Sulphuric Acid = 16.44 per cent.

In comparing the amounts of Protoxides, we find that for the Iron retained, an exactly equivalent quantity of Lime and Magnesia was exchanged. The Sesquioxides are partially exchanged for each other and the rest of the Iron retained no doubt as a basic salt. The large amount of Silica in solution points to the Silicate as the seat of this action. By boiling this solution, there was precipitated only a little Ferric Oxide, and no Alumina or Ferrous Oxide whatsoever:

0.4375 Ferric Oxide precipitated.
15.2409 Alumina in solution.
114.6422 Ferrous Oxide in solution.

2. Treatment with Limestone.

In digesting the solution of Coal with Limestone the process will be a more simple one, resulting in the neutralization of the Acid, the removal of Sesquioxides and the solution of some Lime. The experiment was performed like the previous one, taking care to retain as much as possible the Carbonic Acid generated. Results in grains per gallon:

1.8372	Silica.
7.5249	Alumina.
127.0401	Ferrous Oxide.
78.7202	Lime.
1.4292	Magnesia.
240.1490	Sulphuric Acid.
456.7006	
37.2492	Carbonic Acid.
439.9558	

Bases and acids were united as follows:

1.8372	Silica.
25.0587	Aluminium Tersulphate.
203.8689	Ferrous Sulphate.
67.7258	Ferrous Bicarbonate.
191.1776	Calcium Sulphate.
4.2876	Magnesium Sulphate.
439.9558	

The amount FeO in the form of Bicarbonate is 31.4766 grains, while it should be, according to the experiment (described under B), 31.7651 grains. I am inclined to ascribe this difference to to an error in the determination of either Iron or Sulphuric Acid.

The difference between this and the original solution, is as follows:

+ 1.4114	Silica.	
+ 59.9228	Lime.	
+ 0.5918	Magnesia.	
— 55.0412	Ferric Oxide	= 100.00 p. c.
— 0.8747	Alumina	= 10.41 p. c.
— 42.5368	Ferrous Oxide	= 25.14 p. c.
— 82.7760	Sulphuric Acid	= 25.63 p. c.

It will be seen that Ferric Oxide is easily precipitated in this way, while Alumina, though no doubt precipitated in time, remains much longer in solution. Ferrous Oxide is partially removed, and would be removed completely and quickly if the Carbonic Acid were allowed to escape and atmospheric air be admitted. In connection with this, I refer again to the previously cited paper by E. Willigk.* By boiling there were precipitated from this solution:

23.9401 Ferrous Oxide.
22.4741 Lime.

While there remained in solution:

103.1064 Ferrous Oxide.
7.5249 Alumina.

This presents two points of interest—the one, that not quite the calculated quantity of Carbonate of Iron is precipitated; and the other, that the Alumina is not easily removed from waters by simply passing through calcareous strata—the former is explained, I think, by simultaneous precipitation of Carbonate and Sulphate of Lime, which rendered some Sulphuric Acid available for the Iron. In a more dilute solution, I have no doubt, this would not take place.

No direct experiments were made, to treat the waters filtered off from the clay, with Limestone or the reverse. The changes in composition will no doubt be similar to those already pointed out, and could easily be foretold and even be estimated.

3. Natural Waters.

I proceed now to give the analyses of a number of natural waters, which I believe are to be traced to such sources as I have marked out

* E. Willigk, *ibid.* Mine-water lost its acid reaction by standing for three days over granular Limestone; Chalk effected the same in thirty minutes; broken up Witherite decomposed quickly and completely all Sulphates in solution.

in the previous part of this paper. They are waters originating, I think, in decomposing Pyritiferous Coal beds, and are changed by the quantity and quality of the Geological formation through which they pass before issuing above ground. They are arranged according to the degree of change which they have suffered during this passage, and prove, I think, fully my proposition.

a. Bratton Spring.

This spring is situated about seven miles north of Columbia, and a mile east of Stephen's station, N. M. R. R. It was analyzed in the fall of 1874, containing then 204.1200 grains of mineral matter to the gallon, while in the spring of the same year it contained only 158.4897 grains. The interval had been remarkably dry, and hence no doubt this increase. The results are as follows:

2.5316	grains Silica.
15.7499	grains Alumina.
18.5847	grains Ferrous Oxide.
38.7852	grains Lime.
5.2438	grains Magnesia.
0.5139	grains Sodium.
0.7932	grains Chlorine.
121.9277	grains Sulphuric Acid.
13.3996	grains Carbonic Acid.
217.5296	
13.3996	
204.1200	

Bases and acids were united in the following manner:

2.5316	grains Silica.
52.4489	grains Aluminium tersulphate.
36.7340	grains Ferrous Sulphate.
2.6320	grains Ferrous Bicarbonate.
64.1926	grains Calcium Sulphate.
15.7314	grains Magnesium Sulphate.
1.3071	grains Sodium Chloride.
11.9520	grains Carbonic Acid.
217.5296	

b. Columbia Chalybeate Spring.

The analysis of this spring was published in last year's Catalogue. I copy it here for completeness' sake. The spring, situated in the University campus, has been known to the citizens and physicians of Columbia for years, who have used it with entire satisfaction. I analyzed it during the months of June and July (1873), its water being uniformly of the temperature of 61° F., while the thermometer in the

surrounding air indicated often 90° F., proving thereby that it came from a sufficient depth not to be affected by atmospheric changes of temperature. There were contained in one U. S. gallon of 231 cubic inches the following substances:

1.4582	grains Silica.
0.7872	grains Alumina.
2.4773	grains Ferrous Oxide.
45.0871	grains Lime.
10.4473	grains Magnesia.
7.8036	grains Soda.
86.3743	grains Sulphuric Acid.
27.4220	grains Carbonic Acid.
0.0730	grains Organic matter.
181.2100	

After determining the amount of Carbonic Acid in the water, bases and acids, in the proportion in which they combine, were calculated, the results representing the true composition of the water in one U. S. gallon:

1.458	grains Silica.
*0.787	grains Alumina.
*5.505	grains Ferrous Bicarbonate.
95.777	grains Calcium Sulphate.
31.342	grains Magnesium Sulphate.
16.224	grains Sodium Sulphate.
14.527	grains Calcium Bicarbonate.
15.517	grains Carbonic Acid.
0.073	grains Organic Matter.
181.210	

c. Second Bratton Spring.

The spring issues not far from the other spring of Mr. Bratton, but if originating in the same Coal bed, takes a different course before appearing above ground. Only a partial examination of it was made, and the large quantity of Carbonic Acid not determined at all.

61.0394	Alumina.
40.1685	Lime.
2.2166	Magnesia.
166.1310	Sulphuric Acid.
269.5555	

There was no Iron present, and the Magnesia and part of the Lime must have existed as Carbonates. This spring probably took its course

* These were the results as calculated two years ago.

through fissures or cavities in the Limestone, by which all Iron become oxidized and precipitated.

d. Well Water.

Two waters come in here, one from a well in the University grounds, back of the University building, and the other from a well in the yard of the students' cottages. They are at a distance from each other of about 50 feet, and separated by a street running between them. They are fed by a stream running, I think from west to east.

WELL IN STUDENTS' YARD.

1.4057 grains Silica.
0.0058 grains Alumina.
16.8641 grains Lime.
4.5908 grains Magnesia.
1.1189 grains Sodium.
1.6748 grains Chlorine.
20.0724 grains Sulphuric Acid
6.1552 grains Carbonic Acid.

51.8877

Bases and acids united as follows:

1.4057 grains Silica.
0.0058 grains Alumina.
34.1231 grains Calcium Sulphate.
5.0240 grains Calcium Bicarbonate,
4.6906 grains Magnesium Bicarbonate.
2.7937 grains Sodium Chloride.
3.2102 grains Carbonic Acid.

61.2531
9.3654 grains Carbonic Acid.

51.8877

WELL IN UNIVERSITY YARD.

2.0064 grains Silica.
0.0116 grains Alumina.
18.5452 grains Lime.
4.4772 grains Magnesia.
1.0249 grains Sodium.
1.5339 grains Chlorine.
19.7576 grains Sulphuric Acid.
8.6295 grains Carbonic Acid.

55.9863

Bases and acids united as follows:

2.0064 grains Silica.
0.0116 grains Alumina.
33.5879 grains Calcium Sulphate.
12.1241 grains Calcium Bicarbonate.
14.3270 grains Magnesium Bicarbonate.
2.5585 grains Sodium Chloride.
2.9731 grains Carbonic Acid.

67.6026
11.6026 grains Carbonic Acid.

55.9863

There was no organic matter found in either of these two waters.

e. Spring in Nova Scotia.

This spring was analyzed by How,* and is situated about 3 kilometres west of Stellarton, mentioned before as the place in or near which beds of pyritiferous Coal are worked, giving rise to waters like the one I obtained by washing Coal. This spring passes through dark colored Slates and Sandstones, which are without doubt calciferous and the cause of the change in the composition, which is as follows:

0.63 Silica.
11.55 Calcium Carbonate.
3.67 Magnesium Carbonate.
1.14 Potassium Sulphate.
4.17 Sodium Sulphate.
0.84 Sodium Chloride.
3.55 Sodium Carbonate.

25.55

I might close this paper here with the hope of having proved satisfactorily the connection of springs, containing larger quantities of Iron, Alumina or Sulphuric Acid, with beds of decomposing, pyritiferous Coal; but I will add, as an appendix, a few analyses of spring and cistern waters, which have no connection with Coal beds, and contain only the salts carried into solution by contact with Limestone and Clay.

D. APPENDIX.

The first of these is a spring situated on the farm of Mr. John W. Harris, furnishing an excellent though, perhaps, hard water. It contains, to the gallon:

* How. Jour. Chem. Society, p. 176.

1.8374 grains Silica.
1.8258 grains Alumina.
20.9987 grains Calcium Bicarbonate.
3.7331 grains Magnesium Bicarbonate.
7.1162 grains Sodium Chloride.
3.7135 grains Carbonic Acid.

39.2247

The second is the water from a cistern* built of Limestone, and not cemented, having, it is said, a connection with a spring. (Cistern situated near the house in which I live.) It contains, to the gallon:

0.525 grains Silica.
1.301 grains Alumina.
7.277 grains Calcium Sulphate.
3.689 grains Calcium Chloride.
0.971 grains Magnesium Chloride.
2.329 grains Calcium Bicarbonate.
0.023 grains Ferrous Bicarbonate.
2.967 grains Sodium Chloride.
3.450 grains Carbonic Acid.

22.532

The third is a water from a cistern* built of Limestone, and not cemented, and about three months in use. The mineral matter of this water has, no doubt, been dissolved from the Limestone. It contains, to the gallon:

0.718 grains Silica.
0.150 grains Alumina.
1.364 grains Magnesium Sulphate.
7.753 grains Calcium Bicarbonate.
0.279 grains Ferrous Bicarbonate.
2.104 grains Sodium Chloride.
1.103 grains Carbonic Acid.

13.471

The fourth is a water from a cistern, well cemented, and in use about two years. All soluble matter of the cement has, in the interval, been washed out, so that the total inorganic matter per gallon is only—

1.8204 grains.

This has not been further tested. I have omitted to mention, in any of these waters, organic matter, though series of tests were made

*Analyzed and published last year.

with many of them. I shall at present only give the relative averages of a few, reserving the details for some future time. A solution of Permanganate of Potassa was used for the purpose, which contained, in one cubic centimetre, 0.000064 grammes of available oxygen. 250 C. C. of water were experimented upon each time.

2.20 C. C. Permanganate for distilled water.
1.00 C. C. Permanganate for well water, obtained from the wells in University and students' yard.
9.50 C. C. Permanganate for cistern water (a spring opening into cistern.)
15.50 C. C. Permanganate for cistern water (containing only 1.8204 grains of mineral matter.

Even this amount of organic matter is not larger than is found in Croton water, one of the purest waters supplied to a city. There may, however, be danger in using it, as I have indicated before, especially when, after a dry summer, the organic matter in the cisterns is concentrated. These should, therefore, be carefully cleaned out every fall, and will then furnish about as good potable water as can be obtained anywhere in the Mississippi Valley.

[C.]

CONTRIBUTIONS

FROM THE

LABORATORY OF THE SCHOOL OF MINES.

By. Chas. P. WILLIAMS, Ph. D.,

Director and Professor of Analytical Chemistry and Metallurgy.

In accordance with the custom of this Institution, and in compliance with that provision of the Agricultural College land grant act, calling for the publication of the statistical matter collected or experimental results reached in the various institutions established under it, the following contributions from the laboratory of the School of Mines are offered. In giving them publicity, selection has been made, from among a considerable number of analyses, of those results of more immediate technical interest and importance. Most of those now given have been obtained by students working under my supervision and instruction, the line of investigation and the methods of analysis pursued being suggested by myself. Beyond this, excepting in very rare instances, the press of duties has prevented me from going; though it should be stated that in every case where results have been used in this report, ample verification has been secured by repeated analyses, and by a careful personal examination of the accumulated data.

COMMERCIAL LEADS OF MISSOURI.

Of primary importance, viewing the condition of the lead market throughout the country, is the question of the degree of purity and the composition of the various brands of metallic lead produced in

this State. For the purpose of White Lead corrosion, some of the brands of European leads have secured a prominence, and are preferred, notwithstanding their relatively high prices. How far this preference is justified by the inherent qualities of the lead, evidenced in the results of corrosion obtained, or how far it may be the result of a prejudice, perhaps, created and fostered by trade manipulations, are questions difficult of settlement. The imported and prized leads are generally the products of refining processes to which the Missouri metal cannot be economically submitted because unwarranted by a sufficient amount of silver. On the other hand, the established purity of the ores of the lead districts of Missouri should permit of the production of a metal which by a simple process of so-called refining and improving or rather softening, ought to approximate at least to the purity of the much prized imported brands. The circulation, therefore, of correct knowledge of the composition of the pig leads produced from the ores of the great lead area of the Mississippi Valley regions must be of value if they should be able to show that much of the prejudice against the domestic and in favor of the foreign Lead, is ill-founded or is based only (as may be the case with white lead manufactures) on traditional results of corrosions obtained. On this point a recent writer on the metallurgy of lead* gives the following: "The best white lead, i. e., the whitest, was supposed by many to be made from what is known in the market as 'W. B. selected and refined pig lead,' (the initials being those of Walter Blackett, the producer, and now applying equally to the name of his successor, Wentworth Beaumont.) This pig lead is the produce of certain mines on the Greenwich Hospital estate, in the north of England, which are leased to Mr. Beaumont. It fetched a higher price to the amount of from 5 p. c. to 7½ p. c. than any other pig lead. So great was the prepossession in favor of this pig lead for the manufacture of white lead, that attempts to persuade London manufacturers to make a trial of the best and purest soft lead from other sources were fruitless, notwithstanding it was offered at about 30 s. per ton, i. e., 7½ p. c. less than W. B. lead. Commercial competition, however, seems at length to be uprooting prejudices which, as in the case in question, have probably no better foundation than traditional credulity. It is to be hoped that now-a-days the world is growing wiser, and will judge an article of manufacture by its quality and not by its pedigree. Many illusions connected with articles of manufacture have been dispelled, in recent years, with much gain to the public, and possibly it will be

* *Percy's Metallurgy*, p. 508.

found that plenty of lead is produced in Great Britain and elsewhere, quite as suitable for conversion into white lead as that bearing the mark 'W. B. selected and refined.'"

For the following analyses the samples operated upon, were procured in open market by reliable persons, interested in the settlement of this question of the purity of our domestic Lead because consumers of it. The method of analysis consisted in dissolving the weighed amount of lead (in no case less than one hundred grammes) in nitric acid; precipitating with sulphuric acid; boiling off the nitric acid; adding tartaric acid; diluting and filtering. The fifth and sixth groups (less most of the lead) were then precipitated by sulphydric acid and separated by sulphide of sodium, the separation of the individual members of the two groups thus obtained being carried out by the usual methods. The fourth group was precipitated by super-saturating with ammonia and passing sulphydric acid through the liquid; the members of the group were separated as usual. Unless otherwise noted, the silver was determined by cupellation. The analyses and assays were carried on by Mr. C. R. Winters, a former student and now an assistant in the laboratory.

No. I. Pig Lead from Scotch-American Hearth; Granby Mining & Smelting Company, Newton county, Missouri.

100 grammes gave: Arseniate-Ammonia-Magnesia, .0005: Antimoniate of Teroxide of Antimony, .0025; Cupric Oxide, .0060. 101.6303 grammes gave: Ferric Oxide, .003148; Zincic Oxide, .00177; Oxide Nickel, .0006. 100 grammes gave (by cupellation) .00045 grammes Silver.

From the above data, the following percentage composition is derived:

Arsenic	.00019 per cent.
Antimony	.00198 per cent.
Silver	.00045 per cent.
Copper	.00479 per cent.
Iron	.00220 per cent.
Zinc	.00142 per cent.
Nickel	.00047 per cent.
Sulphur	trace.
Lead by difference	99.98850
	100.00000

No. II. Lead from St. Louis Smelting & Refining Company's works, Cheltenham, St. Louis. Prepared from work-lead from territorial ores, (?) and refined by zinc process. Specific gravity, at O°C, 11.3585,

100.0098 grammes gave: Arseniate-Animonio-Magnesia, .00169; Antimoniate of Teroxide of Antimony, 00679; Oxide Bismuth, .03969; Cupric Oxide, .03079; Ferric Oxide, .01169; Oxide Nickel, .0006; Chloride Silver, .00279; Oxide Zinc, .00589.

The percentage composition, calculated from the above, is as follows:

Arsenic	.00066 per cent.
Antimony	.00538 per cent.
Bismuth	.03559 per cent.
Copper	.02457 per cent
Iron	.00819 per cent.
Nickel	.03036 per cent.
Silver	.00045 per cent.
Zinc	.00493 per cent.
Lead (by difference)	99.91813
	100.00000

No. III. Moffet & Sergeant, Joplin, Jasper county, Missouri; reverberatory process; 100.0070 grammes gave: Arseniate-Ammonio-Magnesia, .0007; Ferric Oxide, .01109; Oxide Zinc, .02581; Cupric Oxide, .00579; Oxide Nickel, .00039; Antimoniate of the Teroxide of Antimony, .00339. 100 grammes gave, by cupellation, Silver, .00025 gramme.

These figures give the annexed composition, centesimally expressed:

Arsenic	.00027 per cent.
Iron	.00777 per cent.
Zinc	.02071 per cent.
Copper	.00463 per cent.
Nickel	.00031 per cent.
Antimony	.00266 per cent.
Silver	.00025 per cent.
Lead (by difference)	99.96340
	100.00000

No. IV. Lone Elm Lead, manufactured at Joplin, Jasper county, Missouri, by "Lone Elm Mining and Smelting Company."

Analyzed by myself. 105.1883 grammes gave: Arseniate-Ammonia-Magnesia, .0205 grm.; Antimoniate of Teroxide of Antimony, .0907; Cupric Oxide, .0054; Ferric Oxide, .05489; Sulphide Zinc, .2497; 3 assay tons gave Silver (by cupellation), 2.8 oz. per ton. The percentage composition is as follows:

Arsenic	.01189 per cent.
Antimony	.08168 per cent.
Copper	.00409 per cent.
Iron	.03650 per cent.
Zinc	.15910 per cent.
Silver	.00994 per cent.
Sulphur	trace.
Nickel	trace.
Lead by difference	99.69680 per cent.
	100.00000

No. V. Frumet Lead, from ores from Frumet Mines, Jefferson county, Missouri.*

100.0067 grammes gave: Ferric Oxide, .00359; Arseniate-Ammonia-Magnesia, .00009; Cupric Oxide, .05509; Oxide Zinc, .00299; Oxide Nickel, .000799.

100.0025 grammes gave: Antimoniate of the Teroxide Antimony, a .0001. Silver (by cupellation,) .00179 gramme. From these data the annexed composition is obtained:

Arsenic	.00004 per cent.
Iron	.00282 per cent.
Copper	.04399 per cent.
Zinc	.00240 per cent.
Nickel	.00063 per cent.
Antimony	.00007 per cent.
Silver	.00179 per cent.
Lead by difference	99.94826 per cent.
	100.00000

No. VI. Residual "Blue Lead," from white lead corrosion of Granby Pig Lead.

100 grammes gave: Antimoniate of the Teroxide of Antimony, .0020; Arseniate-Ammonia-Magnesia, .0055; Ferric Oxide, .0045; Cupric Oxide, .0173; Oxide Zinc, .0096; Oxide Nickel, .0007. 100 grammes, by cupellation, gave .0005 gramme, Silver.

From the above data is obtained the following percentage composition:

*The following analysis of Frumet Lead by Messrs. Chauvenet & Blair, chemists, St. Louis, is published (*Mines, Metals and Arts*, Vol. III, No. 5, April 8, 1875.) Amount taken, 100 grammes:

Lead	99.957 p. c.
Copper	0.041 p. c.
Iron	0.002 p. c.
Antimony	trace.
Nickel and Zinc	none.

Arsenic	.00217 per cent.
Antimony	.00158 per cent.
Iron	.00315 per cent.
Zinc	.00770 per cent.
Copper	.01381 per cent.
Silver	.00050 per cent.
Nickel	.00055 per cent.
Lead by difference	99.97054 per cent.
	100.00000

None of the specimens analyzed contained any trace of cobalt—the separated nickel being examined for that metal by nitrite of potassa.

The annexed table will show at a glance the foregoing results; to them has been added some analyses of foreign samples, for purposes of comparison. The analyses from I to VI (inclusive) are those given in the preceding pages; the succeeding six results were obtained at the Clausthal Laboratory, Lautenthal (1) having been desilverized by Pattisonizing and Lautenthal (2) and Altenau (3) by the Zinc process. The remaining analyses are on the authority of the names given; the last contained traces of both cobalt and manganese:

COMPOSITION OF SOME MISSOURI COMMERCIAL LEADS, WITH ANALYSES OF SOME WELL KNOWN FOREIGN BRANDS.

Name.	Analyst.	Lead.	Antimony	Arsenic.	Bismuth.	Copper.	Silver.	Iron.	Zinc.	Nickel.	Sulphur.
I	This Report.	99.98850	0.00198	0.00019	none.	0.00479	.00045	0.00220	0.00142	0.00047	Trace.....
II	This Report.	99.91813	0.00538	0.00066	0.03559	0.02457	0 00210	0.00819	0.00493	0.00045	.....
III	This Report.	99.96340	0.00266	0.00027	none.	0.00463	.00025	0.00777	0.02071	0.00031	.....
IV	This Report.	99.69680	0.08168	0.01189	none.	0.00409	0.00994	0.03650	0.15910	trace.	Trace.
V	This Report.	99.94826	.00007	.00004	none.	0.04399	.00179	0.00283	0.00240	0.00063	....
VI	This Report.	99.97054	0.00158	0.00217	none.	0.01381	.00050	0.00315	.00770	0.00055	.....
Lautenthal (1)	Laboratory at Clausthal.	99.95627	0.00160	....	....	0.03740	0.00193	0 00440	.....	.....	.....
Lautenthal (2)	Laboratory at Clausthal.	99.98790	0.00340	.....	....	0.00510	0 00110	0.00130	0.00120	.....	.....
Altenau (3)	Laboratory at Clausthal.	99.98430	0.00490	.....	.....	0.00700	0.00100	0.00200	0.00080	.....	....
Pontifex and Wood—selected	Laboratory at Clausthal.	99.91360	0.00320	.....	.....	0.07580	0.00200	0 00220	0.00320	.....	.....
W. Blackett—best selected	Laboratory at Clausthal.	99.95200	0.00590	.....	.....	0.03180	0.00500	0.00170	0.00370	.....	.....
Stolberg, near Aix-la-Chapelle	Laboratory at Clausthal.	99.95000	0.00500	.....	.....	0.03830	0.00250	0.00240	0.00180	.....	.....
Tarnowitz	Löwig	99.21000	.....	.....	.....	.....	.....	0.02000	0.03000	.....	.....
	Ziurek	99.88300	.....	.....	.....	.....	.....	0.01800	.....	.....	.....
Eschweiler Company, near Stolberg	Fresenius.	99.94060	0.00210	.....	0.00200	0.05010	0.00440	0.00080	.....	.....	.....
Pirath & Jungcommern	Fresenius.	99.98329	0.00921	trace.	.....	0.00268	0.00275	0.00121	.....	.....	.....
Real Compania Asturania	Fresenius.	99.98597	0.00133	trace.	0.01041	0.00057	0.00040	0.00124	0.00008	trace.	.....

It would appear, from these results, in connection with the comparative analyses, that the difference in price between the leads is not warranted by difference in purity. That the small percentage of impurities can materially affect the degree of corrosion such leads will undergo in the white-lead stacks can hardly be anticipated in theory, nor has this view been really established by practice. There are so many disturbing and in the present state of the knowledge of the phenomena, so many uncontrollable elements, in the manufacture of white lead, that much that approximates to failure in the business has been assessed on the raw material used, rather than on where it properly belongs—the conditions of corrosion. The history of any well conducted establishment, doubtless shows as wide ranges in the percentages of actually corroded blue lead in stacks of the same metal as between those in which different brands have been set. Too little is in reality known of the actual thermal and other internal conditions of the stacks during their ripening to enable any dogmatic assertion to be made in reference to the influence of limited variations in the purity of the lead upon the corrosions, and, too often the encouraging figures claimed for a certain brand are the result of a sincere, though none the less injurious self-deception.

With regard to the quality of the white lead in relation to the lead from which it has been produced, there are also difficulties in the way of reaching exact analytical evidence, which the expert must appreciate. The large quantity of material to be operated upon to reach attainable amounts of impurities makes variations in analytical results exceedingly probable, and slight variations render all hypotheses exceedingly uncertain, if not dangerous. Nevertheless it would seem somewhat unreasonable to ascribe to small fractional percentages of foreign substances in an original lead, an almost unlimited power of working injury in a white lead corroded from it. The formation of a yellowish tinge in white lead was long supposed to be due to foreign substances, but Grueneberg has shown that there is decidedly more probability in its being owing to an excessive amount of hydrated lead oxide beyond that necessary to the generally received chemical formula of white lead; the rose tint formerly attributed to the presence in the white lead of copper, iron, and by Baker, of silver, has been shown by Barrow and Kraemer,* to be due to the presence of lead suboxide caused by an insufficient access of air in a badly conducted corrosion.

**Berg-und huettemmaennische Zeitung*, 1872, page 125; quoted by Hampe, a translation (by Prime,) of whose excellent article "On the Adaptability of Lead containing Bismuth for the manufacture of White Lead," can be found in the *American Chemist* Vol. V. No. 7, page 241 *et seq.*—January, 1875.

That the product obtained by corroding Missouri lead will compare favorably as regards these foreign matters, (whatever may be their potency) with others manufactured from some of the most prized brands of foreign production, may be seen from the following analysis of a sample of unwashed white lead produced by corroding No. 1 of the analyses before given. The material was carefully separated from the blue or malleable lead and 98.3048 grammes were used for the analysis, which was carried on by Mr. Winters. In connection with it we give the results obtained by Dr. Hampe, of Clausthal,* of the products of some well known European leads—regard having been had only to the foreign metals in all cases:

	I.	II.	III.	IV.	V.
	per cent.	per cent.	per cent.	per cent.	per cent.
Bismuth.....	none.	.004841	.006276	trace	.000197
Copper..	.00926	.001708	.000431	.000566	.000408
Antimony.....	.00076	.001236	.000903	.000444	.002218
Silver.....	.00034	.000500	.000500	.000130	.000300
Iron.....	.00085	.002100	.000728	.000903	.000937
Zinc.....	.00025	.000305	.000128	.000257	.000237
Nickel.....	.00007	trace	trace	.....	.....
Cadmium	none	.....	trace	.000360	.000408

No I. Unwashed White Lead from Granby pig lead; No. II. Ordinary Hartz White Lead (Hampe); No. III. From Lautenthal lead, (*ib*); IV. From Silesian lead, (*ib.*); V. From Mechernich lead, (*ib.*)

All the leads thus far examined smelted from the Missouri ores are free from Bismuth, but Antimony, Zinc and Nickel are invariably present. With regard to Antimony, its association with the ores of southwestern Missouri is shown by the analyses of the Granby, Joplin and Lone Elm leads; further, in the analysis of the fume from the stack of the reverberatory at Granby, published in the report of last year, I found 0.903 per cent. of the oxide of Antimony. Its existence to the amount of 0.239 per cent of the oxide is shown in the analysis of the cinder from the Granby Scotch Hearth, made by myself and W. C. Minger, and given below. On the other hand, in the selected pure galenas from the southwestern lead district Chauvenet† finds no trace of Antimony though operating on twenty grammes, and Winters finds in a specimen of carefully sorted galena from the Holman diggings, at Granby, only a trace of Antimony, using the same amount for analysis. In view of these facts the supposition is not unreasonable that the blendes associated with the lead ores are somewhat antimonial, and that presence of Antimony in the metal, the fume and the

* Loc. cit.

† Chemist's Report, 1 Broadhead's Geol. Survey of Missouri, 1874, page 709.

scoriae results chiefly from the treatment of blende-bearing charges.

In this connection the result of detailed, though not exhaustive analysis of the so-called slag from the Scotch Hearth (above alluded to) is somewhat interesting as showing the presence and amounts of the foreign metals associated with the ores smelted by that method at Granby. The slag contained shots and pieces of metallic lead—819 grammes giving, by mechanical separation, 105.9 grammes of shot lead, equivalent to 13.49 per cent. The slag, freed from the metallic lead gave 3.360 per cent. of sulphate of lead (existing as such and separated by the use of sodium hyposulphite), 24.661; oxide of lead; 25.866 Zinc oxide; 0.239 Antimony oxide; 0.674 arsenic acid; 0.362 oxide Nickel; 2.642 cupric oxide, besides Silica, lime, oxide of Iron and a little Sulphur. A little of the oxide of Zinc was combined with sulphuric acid into a soluble sulphate—amounting to 0.032 per cent. of the slag freed from metallic lead.

Analysis VI—Residual Blue Lead or kernel from white lead corrosion—is given as of interest in regard to the matter of the real or imputed enrichment of the foreign metals in such residues. The question is one difficult of satisfactory answer, because the differences in amounts of such foreign matters in the original Lead, and those in the kernels are, as Hampe says, "so small that it is impossible to say whether they are essential, or whether they are due to the uncertainty caused by taking the samples for analysis from the residues." The specimens analyzed were from pots in which the corroison did not exceed fifty per cent. of the lead introduced.

It is the intention to continue these analyses of the commercial leads of Missouri, till sufficient data have been accumulated for further and more complete comparisons with the foreign leads now in demand for the manufacture of white lead, especially.

It may be noted here that the amounts of Nickel found in several of the samples analyzed, are relatively quite large.

ZINC OXIDE OR WHITE, MANUFACTURED IN MISSOURI.

At Hopewell, in Washington county, Zinc White is manufactured directly from the ore by the use of the Wetherill furnace—the common method employed in this country. The process offers no especially new features, excepting in the use of charcoal, both as fuel and for reduction. The ores used are from various localities in the State, among them being the newly opened deposits of Dade county, southwest. The Oxide produced is of good color and body. A sample of it has been analyzed by Mr. P. E. Blow, under my instruction, operat-

ing on upwards of thirty-three grammes, and estimating the Oxide of Zinc by difference. The analysis shows the following centesimal composition of the Zinc White:

Calcic Sulphate	0.1114	Soluble in water.
Zinc Sulphate	0.3001	
Zinc Chloride	0.0948	
Cadmium Chloride	0.9446	
Lead Sulphate	0.0195	
Lead Oxide	0.4995	
Ferric Oxide	0.0322	
Zinc Oxide, by difference	97.9979	
	100.0000	

With the amount operated upon, no traces of Arsenic or Antimony could be detected.

Another sample from the same establishment, but somewhat "off-color," having a decided buff-tint, and marked impure, was also analyzed by Mr. Blow; twenty-two grammes being used in this case. The result is not widely different from the preceding, in so far as the amount of impurities is concerned, but varies chiefly in the large amount of lead oxide it contains. To the increase of this its somewhat impaired color may, probably, be due. The result of the analysis is as follows:

Zinc Sulphate	0.4998 per cent.
Cadmium Sulphate	0.2024 per cent.
Lime Sulphate	0.1400 per cent.
Chlorides	traces. per cent.
Lead Sulphate	0.0042 per cent.
Lead Oxide	1.1488 per cent.
Ferric Oxide	0.0976 per cent.
Zinc Oxide, by difference	97.9062 per cent.
	100.0000

Arsenic and Antimony both absent.

These "oxides" are evidently both prepared by the treatment of ores containing some galena and perhaps blende; this view being supported by the presence of the lead and the other sulphates. The presence of cadmium is interesting, and if, as I am informed, the samples analyzed were from the products "burned" from Dade county ores, the presence of notable amounts of that metal in the zinc minerals of the recently opened mines is established. A specimen of mixed ores—Calamine, Carbonate and Blende—reported from Dade county, and

said to be representative of those used in the charges from which the above named "oxides" were prepared, gave Mr. Blow 0.842 per cent. of cadmium oxide. Chauvenet* finds in two samples of Blende from the Jasper county districts 0.623 and 0.509, respectively, of cadmium, and states that other samples from the same region failed to give even a trace of that metal.

CHEMICAL STUDY OF THE OZARK BLAST FURNACE.

In the report for last year the statistics of the new furnace at Ozark Station (Atlantic & Pacific R. R.), Phelps county, were given. A chemical study of its raw materials, products, and its action, have since been made by Mr. A. W. Hare, of the graduating class, and forms the subject of his thesis. The ore used is a mixture (of one-third each) of the ores from the Beaver, the Hancock and the St. James' Banks, and are used raw. According to Mr. Hare, they have the following composition:

		I.	II.	III.
Water	per cent	.....	.....	Not est.
Silica	"	3.853	6.491	11.941
Ferric Oxide	"	91.612	73.604	79.437
Alumina	"	3.800	2.608	5.228
Oxide Manganese,	"	.....	.....	0.081
Lime	"	0.384	12.402	0.174
Magnesia	"	0.221	4.803	0.290
Phosphoric Acid,	"	0.156	0.230	0.074
Sulphur	"	0.151	0.214	0.073
		100 352	100.177	97.298
Metallic Iron	"	64.128	51.523	55.606
Phosphorus	"	.0671	0.1004	0.0323

No. I.—Ore from Beaver Bank, Sec. 4, T. 36, R. 8 W. (Phelps county); mean of two analyses; Sulphur and Phosphoric Acid estimated by self. No. II.—Hancock Bank ore, Sec. 14, T. 38, R. 12 W. (Miller county); mean of two analyses; Sulphur and Phosphoric Acid estimated by self. No. III.—Ore from St. James' Bank, Sec. 29, T. 38, R. 6 W. (Phelps county); mean of two results. Samples all dried at 102° C. before analysis.

*Geological Survey Missouri, 1873-1874, p. 712.

The flux is from one of the Magnesian Limestone series, and shows the following composition on analysis:

	A.	B.	Mean.
Calcic Carbonate	53.479	53.604	53.541
Magnesic Carbonate	41.107	41.229	41.168
Alumina and Ferric Oxide	0.804	0.665	0.734
Insoluble matters	3.657	3.934	3.795
Bisulphide Iron	.091	Not est.	.091
Phosphoric Acid	.004	"	.004
Organic matters	Trace.	Trace.	Trace.
			99.333

Sulphur	0.0485
Phosphorus	0.0017

Samples dried before analysis.

The charcoal is chiefly from oak. It contains 4.301 per cent. moisture, and 2.240 per cent. ash constituents. In every twenty-four hours there are used: Of ore (mixed, as before stated, in equal parts), 49.12 tons; of Limestone, 4.91 tons; charcoal, 22.76 tons, producing 23 tons of No. 1 gray Iron, with the annexed composition, as determined by Mr. Hare—the Sulphur and Phosphorus estimations being made by myself:

Carbon	2.6588 per cent.
(Graphite ——)	
(Combined ——)	
Silicon	0.4199 per cent.
Manganese	0.5713 per cent.
Phosphorus	0.0066 per cent.
Sulphur	0.0440 per cent.
Iron (by difference)	96.2994 per cent.
	100.0000

The slag contains:

	A.	B.	Mean.
Silicic Acid	48.939	48.919	48.928
Alumina	16.875	16.360	16.617
Ferrous Oxide	2.356	2.810	2.573
Lime	27.895	Not est.	27.895
Magnesia	.917	.794	.855
Potash (with little Soda)	——	2.202	2.202
Calcium Sulphide	——	.456	.456
Phosphoric Acid	——	.078	.078
			99.625

Sulphur	0.2005
Phosphorus	0.0340

From the daily make of pig and the consumption of the raw materials before given, it will be seen that for each one ton of pig iron there are consumed on an aver-

age, ore, 1.854 tons; limestone, 0.175 tons, and charcoal, 0.805 tons. The constituents of these materials may be regarded as distributed somewhat as under:

	Ore.	Tons.		Iron.	Slag.	Gas.
81.55	per cent. Ferric Oxide	1.502		.934 tons.	——	——
			Ferrous Oxide	——	0.117	——
			Oxygen	——	——	0.417
7.43	per cent. Silica	.138	Silicon	.00044	——	——
			Oxygen	——	——	.021
10.276	per cent. gases	.191		——	0.191	——
	Flux.					
49.59	Magnesia and Lime	.087			.087	——
45.12	Carbonic Acid	.079			——	.079
3.79	Silica	.008			.008	——
0.73	Alumina	.001			.001	——
	Charcoal.					
64.76	per cent. Carbon	.521		.026	——	.495
2.24	per cent. Ash	.018		——	.018	——
33.	Water and volatile matters	.2226		——	——	.226
				.96044	.528	1.238

[The amounts of Sulphur, Phosphorus and Manganese are ignored in the summing up of the Iron, hence the shortage in the ore ton.]

The further calculations concerning the heat, etc., of this furnace, though interesting and valuable from an industrial standpoint, are too technical for publication in this report.

ROLLA, *May 22, 1875.*

GENERAL INDEX.

APPENDIX.

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Local identifier	Catalogue1875

Source information

Format	Book
Content type	Text with images
Source ID	010-014609131
Notes	page numbers missing from pgs 11,12 Campus map is a foldout, the page after page 58 is a foldout; pg134 corner cut off (because of page)

Capture information

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