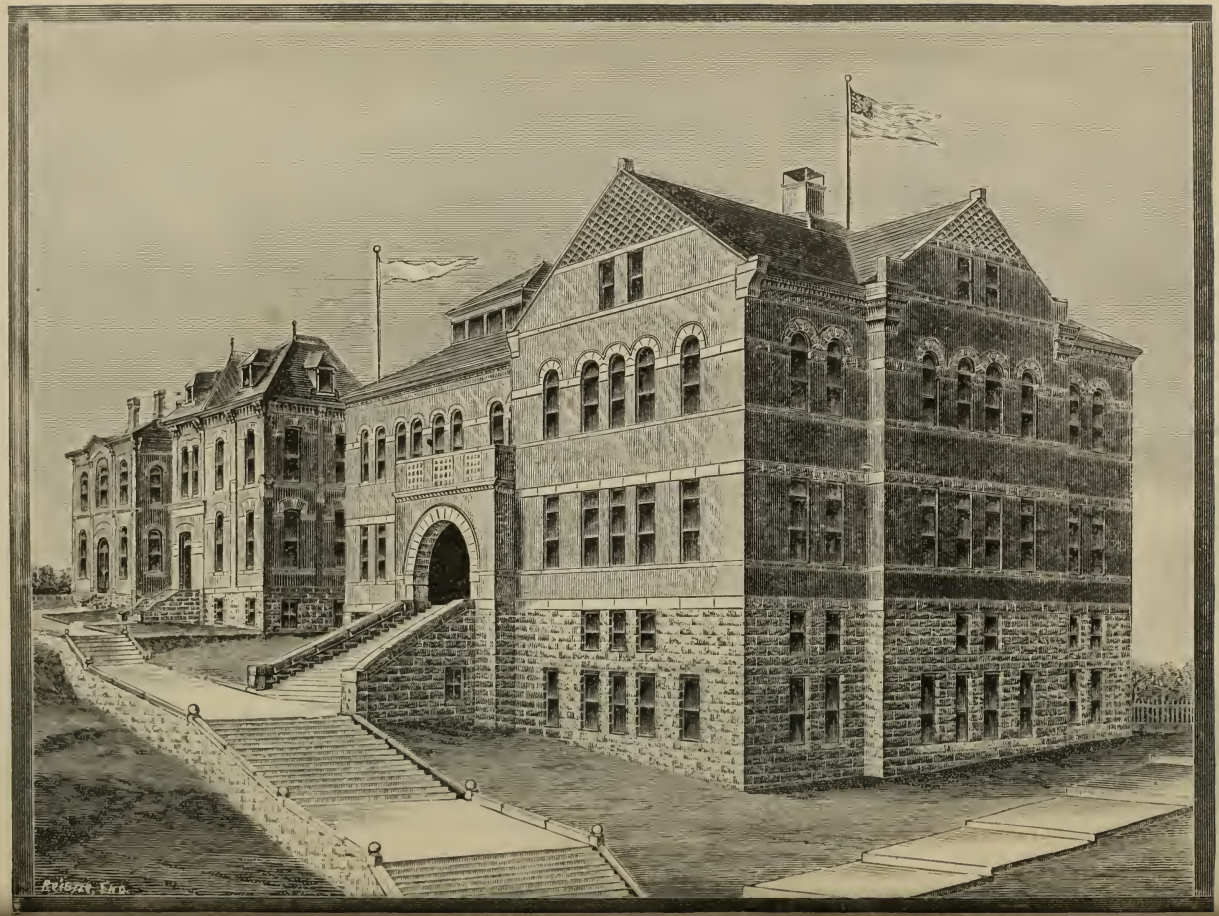
CATALOGUE

OF THE

STATE SCHOOL OF MINES

GOLDEN, COLORADO.

1890-91



CATALOGUE

OF THE

STATE SCHOOL OF MINES

GOLDEN, COLORADO.

1890-91.

DENVER, COLO:
NEWS PRINTING COMPANY.
1891.

CONTENTS.

CALENDAR.

1891-92.

EXAMINATIONS FOR ADMISSION.

June 22 and 23, 1891. Sept. 17 and 18, 1891.

Fall Term begins	Sept 21, 1891,	ends Dec. 23, 1891.
Winter Term begins	Jan. 4, 1892,	ends Mch. 25, 1892.
Spring Term begins	April 4, 1892,	ends June 16, 1892.

1892-93.

EXAMINATIONS FOR ADMISSION.

June 20 and 21, 1892. Sept. 15 and 16, 1892.

Fall Term begins	Sept 19, 1892,	ends Dec. 23, 1892.
Winter Term begins	Jan. 4, 1893,	ends Mch. 23, 1893.
Spring Term begins	April 2, 1893,	ends June 14, 1893.

BOARD OF TRUSTEES.

F. Steinhauer,	Denver,	Arapahoe County.
Jas. T. Smith,	Denver,	Arapahoe County.
A. A. Blow,	Leadville,	Lake County.
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OFFICERS OF THE BOARD.

President,	F. Steinhauer.
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JOHN B. GARVIN, B. S.,
Librarian and Registrar.

CHARLES D. SMITH,
Gymnasium Instructor.

WILLIAM H. BENNETT,
JOHN HEMBERGER,
} *Janitors.*

[redacted]

Heller, D. Ernest,	Leadville,	Colorado.
Hindry, Willis E.,	Denver,	Colorado.
Kimball, George K.,	Golden,	Colorado.
Kimball, Joseph S.,	Golden,	Colorado.
Lewis, William B.,	Denver,	Colorado.
McMahan, Charles H.,	Denver,	Colorado.
Small, Edward C.,	Salt Lake,	Utah.
Thies, Ernst Augustus	Concord,	North Carolina.

SECOND YEAR.

Ambrosius, Julius R.,	Cleveland,	Ohio.
Bowie, James,	Gallup,	New Mexico.
Budrow, William B.,	Golden,	Colorado.
Collins, Philip Montagu,	Georgetown,	Colorado.
Garvin, Charles J.,	Leadville,	Colorado.
Greenfield, Edward W.,	Durango,	Colorado.
Hawley, R. Howard,	Pueblo,	Colorado.
Hubby, Rollin G.,	Cleveland,	Ohio.
Lawton, George C.,	Canton,	Connecticut.
Milliken, William B.,	Coal Creek,	Colorado.
Muzzy, William H.,	Gilman,	Colorado.
Osborne, Arthur H.,	Golden,	Colorado.
Presnell, John H.,	Golden,	Colorado.
Shaffer, Louis W.,	Idaho Springs,	Colorado.
Stephens, Wallace A.,	Denver,	Colorado.
Turner, John K.,	Idaho Springs,	Colorado.
Wheeler, Charles E.,	Golden,	Colorado.
Wood, Samuel E,	Golden,	Colorado.

FIRST YEAR.

Arthur, Edward Pellew,	Alma,	Colorado.
Atkins, Horace H.,	Georgetown,	Colorado.
Barber, Ernest C.,	Central,	Colorado.
Bohn, A. K.,	Leadville,	Colorado.
Chandler, Robert,	Denver,	Colorado.
Dargin, Percy W.,	Golden,	Colorado.
Davey, John J.,	Denver,	Colorado.
DeFrance, Hugh H.,	Golden,	Colorado.
Doolittle, Court,	Golden,	Colorado.
Eye, Clyde M.,	Covina,	California.
Groneweg, George W.,	St. Joseph,	Missouri.
Hartzell, Lester J.,	Golden,	Colorado.
Hoffman, Frederick,	Milwaukee,	Wisconsin.
Jewell, Gilbert E.,	Sydney,	Australia.
King, Clarence S,	Atchison,	Kansas.
Lancaster, Charles H.,	Leadville,	Colorado.
McGregor, Philip,	London,	England.
Medell, William S.,	Golden,	Colorado.

FIRST YEAR.—Continued.

Merriman, Herbert E.,	Denver,	Colorado.
O'Connor, Frank H.,	San Josè,	California.
Old, John W.,	Georgetown,	Colorado.
Pike, Edward A.,	Farnham,	Colorado.
Post, George M.,	Denver,	Colorado.
Rowe, Edward E.,	Golden,	Colorado.
Sadtler, Albert,	Golden,	Colorado.
Sayers, Robert H.,	Kansas City,	Missouri.
Schneider, George W.,	Colorado Springs,	Colorado.
Shepard, Lucius P.,	Denver,	Colorado.
Smith, Irving Chester,	Idaho Springs,	Colorado.
Tonge, Thomas R.,	Denver,	Colorado.
Williams, Percy W.,	Cleveland,	Ohio.

SPECIAL STUDENTS.

Bowen, Thomas W., Ph. C., B. S. (Univ. of Mich.)	Idaho City,	Idaho.
Brown, Frank C.,	Leadville,	Colorado.
Chanute, Charles D.,	Chicago,	Illinois.
Everett, William R.,	Cleveland,	Ohio.
Heikes, Victor C.,	St. Louis,	Missouri.

STUDENTS IN PARTIAL COURSES.*

Adamson, W. H.,	Madison,	Wisconsin.
Alexander, L. W.,	Roehampton,	England.
Camp, Calvin E.,	San Francisco,	California.
Carrington, Thomas S.,	Denver,	Colorado.
Easeley, Charles H.,	Jefferson Co.,	Colorado.
Garvin, John B.,	Springfield,	Colorado.
Gray, Latimer D.,	Golden,	Colorado.
Hammond, Mark T.,	Golden,	Colorado.
Herr, Jesse,	Silverton,	Colorado.
Irish, Dana C.,	Denver,	Colorado.
†Kyte, David B.,	Indianapolis,	Indiana.
Lippett, William M.,	Longmont,	Colorado.
Mencimer, J. L.,	Golden,	Colorado.
Moffat, James L.,	Golden,	Colorado.
Morrison, William,	Sterling,	Scotland.
Nichols, John,	Golden,	Colorado.
Oden, William F.,	Butte,	Montana.
Pike, Newton J.,	Idaho Springs,	Colorado.

† Deceased.

STUDENTS IN PARTIAL COURSES.*—Continued.

Redmond, John F.,	Leadville,	Colorado.
Van Dyk, Peter,	The Hague,	Holland.
Wasson, H. H.,	Wagon Wheel Gap,	Colo.
Wellman, Harold R.,	Golden,	Colorado.
Wright, Charles H.,	Denver,	Colorado.

SUMMARY OF STUDENTS, 1890-91.

Fourth Year	2
Third Year	12
Second Year	18
First Year	31
Special Students	5
Total	68

* These names are those of students who entered the institution after the issue of the last catalogue, and left before the Fall Term of 1891. The changes and additions of the last year caused the omission of any catalogue publication until the new courses and classification could be fully set forth, circulars of information (without names of students), being substituted. The list is given in order that the regular catalogues may include the names of all the students who attended, even for a partial or special course.

GRADUATES IN ASSAY COURSE, 1889-1890.

Aller, Frank D.,	Denver,	Colorado.
*Brown, Norton H.,	Golden,	Colorado.
†DeLancey, William E. C.,	Bannack,	Montana.
Frew, Samuel E.,	Denver,	Colorado.
*Fueller, Charles M,	Gunnison,	Colorado.
*Heller, D. Ernest,	Leadville,	Colorado.
*Hindry, Willis C.,	Denver,	Colorado.
*Johnson, Edward W.,	Springfield,	Illinois.
*Kimball, George K., Jr.,	Golden,	Colorado.
*Kimball, Joseph S.,	Golden,	Colorado.
Kleinschmidt, L. Kurt.,	Helena,	Montana.
*Lewis, William B.,	Denver,	Colorado.
*McMahan, Charles H.,	Denver,	Colorado.
Piper, Harry S.,	Lima,	Peru, S. America.
*Small, Edward C.,	Salt Lake,	Utah.
*Smith, Charles D.,	Denver,	Colorado.
Songer, Otis A.,	Golden,	Colorado.
Stubbs, James W.,	Barberton,	South Africa.

* Returned to the School after taking the "Assay" Diploma, and now pursuing full courses.

† Deceased.

GRADUATES SINCE ISSUE OF LAST CATALOGUE.

William H. Craigue, E. M.,
Assistant Superintendent Iron Silver Mining Co., Leadville.

Henry L. Bellam, B. S.,
Chemist, Linnton, Oregon.

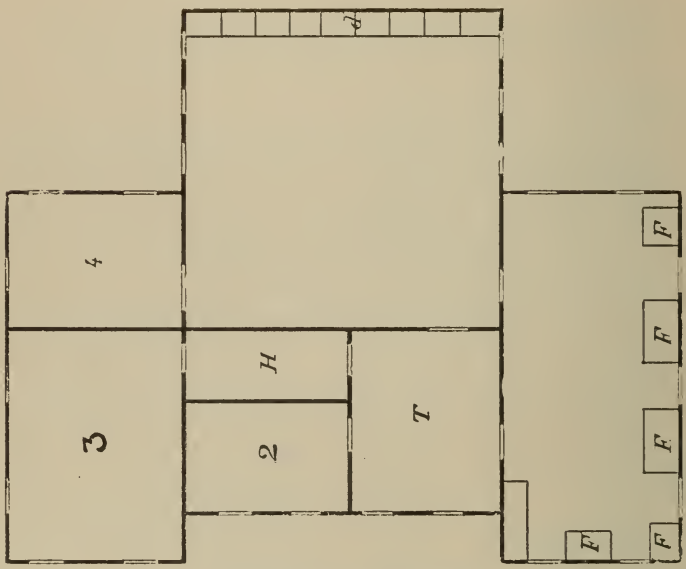
F. M. G. A. Wertheim-Salomonson, B. S.,
Mining Superintendent, Oronogo, Missouri.

Charles W. Comstock, C. E. and M. E.,
Instructor in Engineering, Cornell University, New York.

PRESENT OCCUPATIONS OF FORMER STUDENTS.*

Assayers	29	Miners	18
Business	21	Mine Owners	7
Chemists	13	Mining Superintendents	16
Electric Works	3	Railroading	8
Engineering	7	Students	4
Manufacturers	4	Surveyors, U. S. Dep.	16
Medicine	6	Teachers	4
Metallurgists	8		
		Total	164

* So far as known.



OLD BUILDING—BASEMENT.

F. F.—Assay Furnaces.
2.—Photometer Room.
3.—Galvanometer Room.
4.—Batteries.

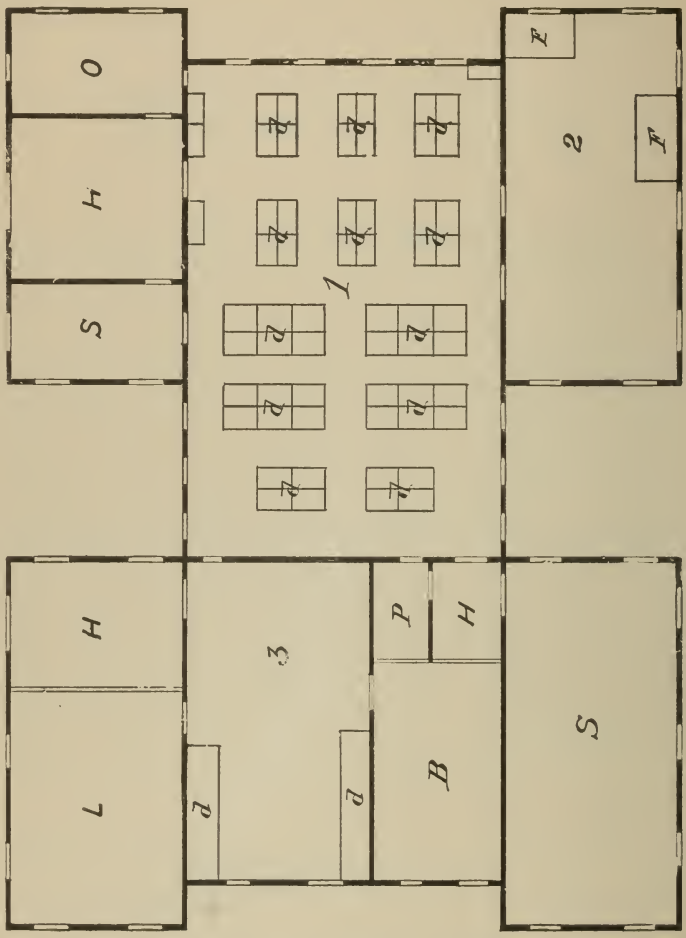
HISTORY AND ORGANIZATION.

The School of Mines of Colorado was established by Act of the Territorial Legislative Assembly, approved February 9, 1874.

Its first location was about one mile south of the city of Golden, but in 1879 the General Assembly granted an increase to its former appropriation, which enabled the Board of Trustees to erect a building on a new site, the ground for which was given by citizens of Golden, within the limits of the municipality. This building was erected in 1880, but was soon found to be too small for its purposes, and in 1882 it was doubled in size, allowing space for laboratories, and for several lecture rooms. The enlarged building served until 1889, when the growth, both in number of students and in the scope of the institution, demanded a far greater extension. This addition (first occupied in the Fall of 1890), is of greater capacity than the two former buildings combined, and is in part described later in the present catalogue.

The organization of the School of Mines of Colorado resembles that of the best technical schools of the United States. Without going into the history of its development, it is enough to say in brief, that it is now in fact what it has long been in intent, a "School of Applied Science," in which, however, more than usual weight is given to those branches having a more or less direct bearing upon Mining and Metallurgy.

The description of the various departments now in operation will be found in detail under appropriate headings. The present catalogue is the first one in the history of the



OLD BUILDING—FIRST FLOOR.

1.—Main Laboratory.
2.—Assay Furnaces.
S. S.—Special Laboratories.
O.—Balance Room.
B.—Balance Room.
L.—Apparatus Room.

institution which may fairly claim to set forth the advantages of the School of Mines of Colorado as a technical school of the first rank; for, whatever may have been the efforts of the past fourteen years, they were hampered by too small an equipment and too irregular an attendance of students to be of avail.

But, while feeling that the institution has now passed its experimental stage, its authorities are very far from asserting that nothing remains to be done, and so far as future means will permit, it is their intention that all departments shall continue to meet the ever-growing demands of Practical Science.

LOCATION.

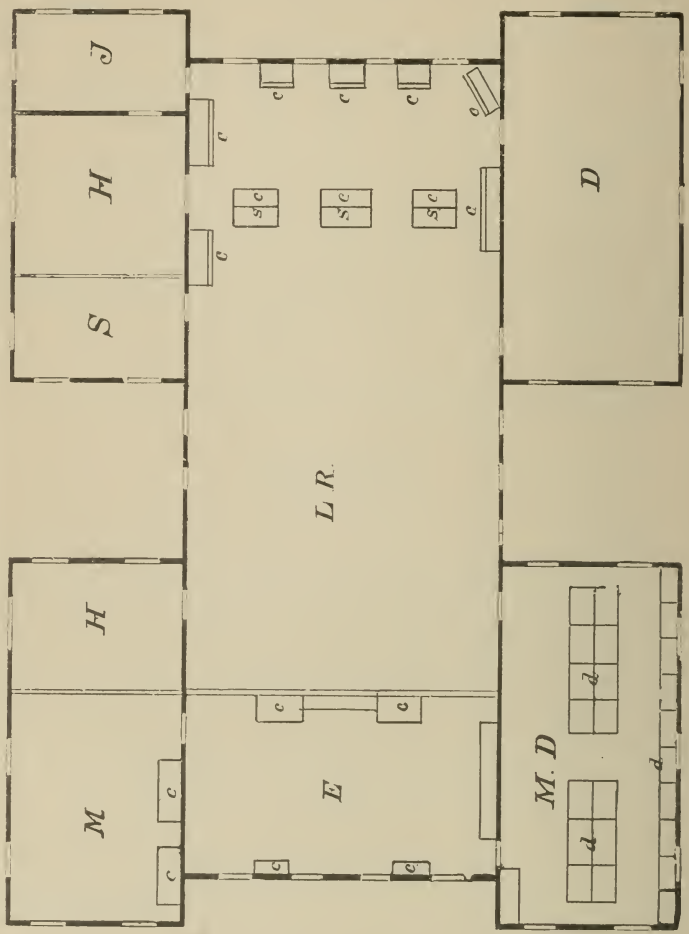
The institution is located at Golden, sixteen miles west of Denver, on the Colorado Central railroad. It is at an altitude of 5,700 feet above sea level, and very close to the first "foot-hills" of the Rocky Mountains.

No place in Colorado has a better health record than Golden. The climate is invigorating and pleasant, with open winters and a large proportion of clear days.

The surrounding region is rich in illustrations of geological formations of various ages, so that the weekly "tramps," under the direction of the Professor of Geology, afford abundant opportunities for practical instruction as well as exercise.

Denver is very accessible, and cheap commutation rates are given to students of the School of Mines who desire to reside in Denver while pursuing their course.

The completion of the Denver, Lakewood & Golden railroad (electric), will greatly increase the facilities for transit between Golden and the metropolis.



OLD BUILDING—SECOND FLOOR.

L. R.—Lecture Room.
D.—Mathematical Recitations.
M. D.—Engineering Recitations.
S.—Storage Batteries.

EXPENSES.

Tuition is free. Students are charged with material consumed or broken. Students in Assaying and Analytical Chemistry pay ten dollars ($10.00) per term for fuel, gas and ordinary chemicals Expensive chemicals are charged as used.

A deposit of ten dollars ($10.00) is required of each student in qualitative analysis, and twenty-five dollars ($25.00) of each student in quantitative analysis, at the opening of his course. These amounts being credited, the student is charged with apparatus taken out for use, and again credited with all that he returns in good condition at the close of the year or term. Balance to his credit, if any, is then returned to him in cash. An additional deposit may be required at any time, if the apparatus called for is unusual or excessive.

Five dollars ($5.00) per term is added to the bill of students in Surveying and in Electrical Engineering, for the use and wear of instruments.

Members of the students' "Athletic Association" pay a fee of one dollar a term, which is reserved for the renewal and repair of gymnasium apparatus. A small deposit is required of those students who retain keys to lockers or drawers; this is refunded upon the return of the keys.

All fees and charges are payable in advance to the Registrar, whose receipt must be shown before any working desk can be occupied.

Board and suitable accommodations can be obtained in Golden for from five to seven dollars a week.

REQUIREMENTS FOR ADMISSION.

Candidates for admission must be at least seventeen years of age. They must sustain a satisfactory examination in English Composition, Geography, Arithmetic, and in the first elements of Algebra and Geometry.

In Arithmetic they must be ready in the use of decimals and in the statement and solution of problems involving "Ratio and Proportion."

In Algebra the first five chapters of Wentworth's "Complete" Algebra, or an equivalent.

In Geometry the first book of any standard text.

In these subjects the candidate is expected to have distinct notions of the reason and meaning of all that he does, explaining them in his own language. Unless the fundamental operations of Algebra are so familiar to him that he can solve all ordinary cases with ease and rapidity, he will not be accepted.

The very slight requirement in Geometry indicates that it is not what the candidate has "gone over," but his appreciation of geometric reasoning that is regarded.

Thoroughness in the elements is a far better preparation than the imperfect knowledge of a whole text book.

Candidates for advanced standing will be examined upon all the studies of the course below the class they propose to enter, as well as upon the subjects required for admission.

June examinations for admission having now been instituted (in addition to those in September), it is recommended to all prospective candidates to attend at the earlier date. Any deficiency then discovered can almost certainly be made good before the opening of the Fall term.

COURSES AND DEGREES.

There are four full courses of study, viz: Civil Engineering, Mining Engineering, Metallurgy, and Electrical Engineering.

The Chemical course will be found partly described below, but it cannot be scheduled with the same precision as the Engineering and Metallurgical courses.

Each covers a period of four years. The studies, however, are identical during the first two years of all courses, beginning to diverge at the opening of the third year.

The course in Mathematics is taken in full by all except the students in the Metallurgical course.

The full course in Chemistry is taken by the Metallurgical students only (or "B. S." students; see below.)

Other variations are given in the detailed schedule in the following pages.

The degrees given are:

Civil Engineer (C. E.)
Engineer of Mines (E. M.)
Metallurgical Engineer (M. E.)
Electrical Engineer (E. E.)
Bachelor of Science (B. S.)

The degree "B. S." is given to any student of four years' residence, who, after having completed the course of the first two years, devotes himself for two more years to the study of analytical and theoretical Chemistry. Such students are allowed to attend lectures in the higher classes, on other topics than the specialty they have chosen, and must, during their last year, conduct some special research in analytical or technical Chemistry.

Students will not be admitted to the fourth year as applicants for the degree of "C. E." unless they have shown very marked ability in Mathematics. They must also have been connected with some survey or other active field operation in engineering lines, during one of the vacations of their course.

No special or partial students are admitted below the grade of the third year, the complete course being required of all students during the first two years.

EXAMINATIONS.

Regular examinations, which all students, whether special or regular, are required to attend, are held at the end of each term, upon the various subjects pursued during the term. Upon the completion of any branch of study, the student will be subjected to a rigid examination upon the whole subject. Special students may, at any time, be required to submit to an examination to ascertain their ability and preparation for the subjects they wish to pursue.

Any student failing in more than two subjects at the June examinations must repeat the year. A complete failure in one or two branches may subject him to the same condition. If conditioned in one or two branches, the condition must be made up prior to the opening of the ensuing Fall term.

The attempt of any student to present as his own the work of another, or to pass any examination by improper means, will render him liable to expulsion.

Absence from examination, whether from illness or any other cause, can only be excused upon presentation of satisfactory reasons to the President of the Faculty.

No student can present himself for examination in any subject who has not attended at least eighty per cent. of the lectures in that subject.

Students who are conditioned at a term examination will be re-examined in the third week of the succeeding term. If conditioned at the closing examination of the year, however, they must stand their re-examination before the opening of the next Fall term.

MEMOIRS AND THESES.

Each student is required, during the Summer vacation preceding his Senior year, to execute a Memoir on some subject assigned by the Faculty. The subject is chosen with direct reference to the practical end the student has in view in his course of study.

Careful inspection of mines, metallurgical works, etc., furnishes the student material from which to make his estimates and calculations. These memoirs and accompanying drawings must be completed and handed to the Faculty for acceptance on or before December first.

At the end of the third year the student is also assigned a subject for a graduating Thesis. Such data are given as would be met with in practical experience. The student selects what he regards as the best method of treatment, giving his reasons for the same, with estimates and drawings. When completed, the Thesis is presented to the Faculty for approval. It must be handed in on or before April first.

All Memoirs, Theses and Drawings which constitute any regular part of the school work, may be retained by the Institution, and preserved as a part of the permanent record of the student who executed them.

SCHEDULE OF STUDIES.

FIRST YEAR.

FOR ALL COURSES.

FIRST TERM.

Algebra,
Geometry,
Geology,
Free Hand Drawing,
Mechanical Drawing,
Chemistry.

SECOND TERM.

Algebra,
Geometry,
Geology,
Free Hand Drawing,
Mechanical Drawing,
Chemistry.

THIRD TERM.

Algebra,
Geometry,
Geology,
Free Hand Drawing,
Mechanical Drawing,
Chemistry,
Qualitative Analysis.

SECOND YEAR.

FOR ALL COURSES.

FIRST TERM.

Plane Trigonometry,
Descriptive Geometry,
Qualitative Analysis,
Crystallography,
Physics,
Mechanical Drawing,
Surveying.

SECOND TERM.

Spherical Trigonometry,
Descriptive Geometry,
Surveying,
Physical Laboratory,
Determinative Mineralogy,
Physics,
Quantitative Analysis,
Mechanical Drawing.

THIRD TERM.

Advanced Algebra,
Shadows and Perspective,
Field Surveying,
Physical Laboratory.
Determinative Mineralogy,
Physics,
Blow-piping,
Mechanical Drawing,
Stoichiometry.

COURSE IN MINING ENGINEERING.

THIRD YEAR.

FIRST TERM.

Analytical Geometry,
Differential Calculus,
Civil Engineering,
Mining,
Quantitative Analysis (opt)
Mechanical Drawing,
Metallurgy.

SECOND TERM.

Analytical Geometry,
Differential Calculus,
Civil Engineering,
Metallurgy,
Mining,
Quantitative Analysis (opt.)
Mechanics,
Mechanical Drawing.

THIRD TERM.

Analytical Geometry,
Integral Calculus,
Mechanics,
Theory of Strains,
Mining Engineering,
Metallurgy,
Ore Dressing,
Mechanical Drawing,
Vacation Memoir.

COURSE IN MINING ENGINEERING.

FOURTH YEAR.

FIRST TERM.

Integral Calculus,
Metallurgy,
Kinematics,
Mechanics,
Theory of Strains,
Economic Geology,
Mechanical Drawing.

SECOND TERM.

Dynamics,
Exercises in Integral Calculus,
Metallurgy,
Thermodynamics,
Plans, Constructions and Estimates,
Economic Geology,
Mechanical Drawing.

THIRD TERM.

Mechanical Engineering,
Metallurgy,
Thesis Work, including Plans, Estimates and Drawings.

COURSE IN CIVIL ENGINEERING.

THIRD YEAR.

FIRST TERM.

Analytical Geometry,
Differential Calculus,
Quantitative Analysis, (optional.)
Excavation and Tunneling.
Civil Engineering,
Mechanical Drawing.

SECOND TERM.

Analytical Geometry,
Differential Calculus,
Quantitative Analysis, (optional.)
Civil Engineering,
Mechanics,
Mechanical Drawing.

THIRD TERM.

Analytical Geometry,
Integral Calculus,
Architecture,
Civil Engineering,
Mechanics,
Mechanical Drawing,
Vacation Memoir.

COURSE IN CIVIL ENGINEERING.

FOURTH YEAR.

FIRST TERM.

Mechanics,
Integral Calculus,
Theory of Strains,
Hydraulics,
Railroad Equipment,
Architecture,
Kinematics,
Mechanical Drawing.

SECOND TERM.

Exercises in Integral Calculus,
Dynamics,
Thermodynamics,
Hydraulic Engineering,
Mechanical Drawing,
Plans, Constructions and Estimates.

THIRD TERM.

Sanitary Engineering,
Mechanical Engineering,
Thesis Work, including Plans, Estimates and Drawings.

COURSE IN METALLURGY.

THIRD YEAR.

FIRST TERM.

Mining,
Quantitative Analysis,
Metallurgical Chemistry,
Civil Engineering,
Metallurgy,
Mechanical Drawing.

SECOND TERM.

Mechanics,
Quantitative Analysis,
Civil Engineering,
Mining,
Metallurgy,
Metallurgical Chemistry,
Mechanical Drawing.

THIRD TERM.

Mechanics,
Metallurgical Chemistry,
Ore Buying and Smelting Charges,
Metallurgy,
Ore Dressing,
Mechanical Drawing,
Vacation Memoir.

COURSE IN METALLURGY.

FOURTH YEAR.

FIRST TERM.

Kinematics,
Metallurgy,
Economic Geology,
Plans, Constructions and Estimates,
Theory of Strains,
Applied Chemistry,
Slag Calculations,
Mechanical Drawing,
Economics of Metallurgy.

SECOND TERM.

Dynamics,
Metallurgy,
Economic Geology,
Economics of Metallurgy,
Thermodynamics,
Applied Chemistry,
Plans, Constructions and Estimates,
Mechanical Drawing.

THIRD TERM.

Mechanical Engineering,
Metallurgy,
Thesis Work, including Plans, Estimates and Drawings.

COURSE IN ELECTRICAL ENGINEERING.

THIRD YEAR.

FIRST TERM.

Analytical Geometry,
Differential Calculus,
Civil Engineering,
Quantitative Analysis, (optional.)
Primary and Secondary Batteries,
Electrical Units and Measurements,
Mechanical Drawing,
Pattern Work.

SECOND TERM.

Analytical Geometry,
Differential Calculus,
Civil Engineering,
Quantitative Analysis, (optional.)
Mechanics,
Primary and Secondary Batteries,
Electrical Units and Measurements,
Mechanical Drawing,
Iron Work.

THIRD TERM.

Analytical Geometry,
Integral Calculus,
Theory of Strains,
Lathe and Pattern Work,
Electrical Units, etc,
Mechanics,
Machine Design,
Mechanical Drawing,
Vacation Memoir.

COURSE IN ELECTRICAL ENGINEERING.

FOURTH YEAR.

FIRST TERM.

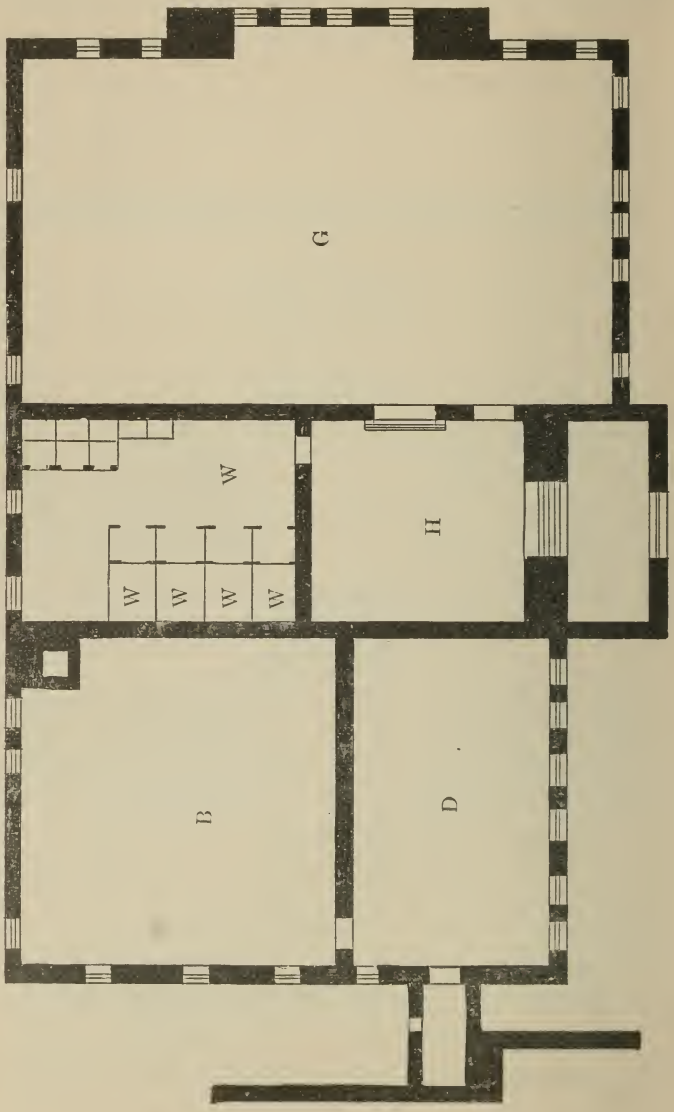
Integral Calculus,
Thermodynamics,
Mechanics,
Hydraulics,
Steam Engine,
Dynamo-Electric Machinery,
Photometry of Arc and Incandescent Lamps,
Mechanical Drawing,
Kinematics.

SECOND TERM.

Integral Calculus,
Machine Design,
Electro-Metallurgy,
Mechanical Drawing,
Dynamo-Electric Machinery,
Distribution of Electricity for Lighting,
Dynamics.

THIRD TERM.

Electricity in Mining,
Mechanics,
Long Distance Transmission of Power,
Thesis Work, Detailed Plans and Estimates of Lighting, Mining or Milling Plant.



NEW BUILDING—BASEMENT.

G.—Gymnasium.
W.—Baths, etc.
B.—Heating Apparatus and Bins.
D.—Workshop.

DEPARTMENTS OF INSTRUCTION.

CHEMISTRY.

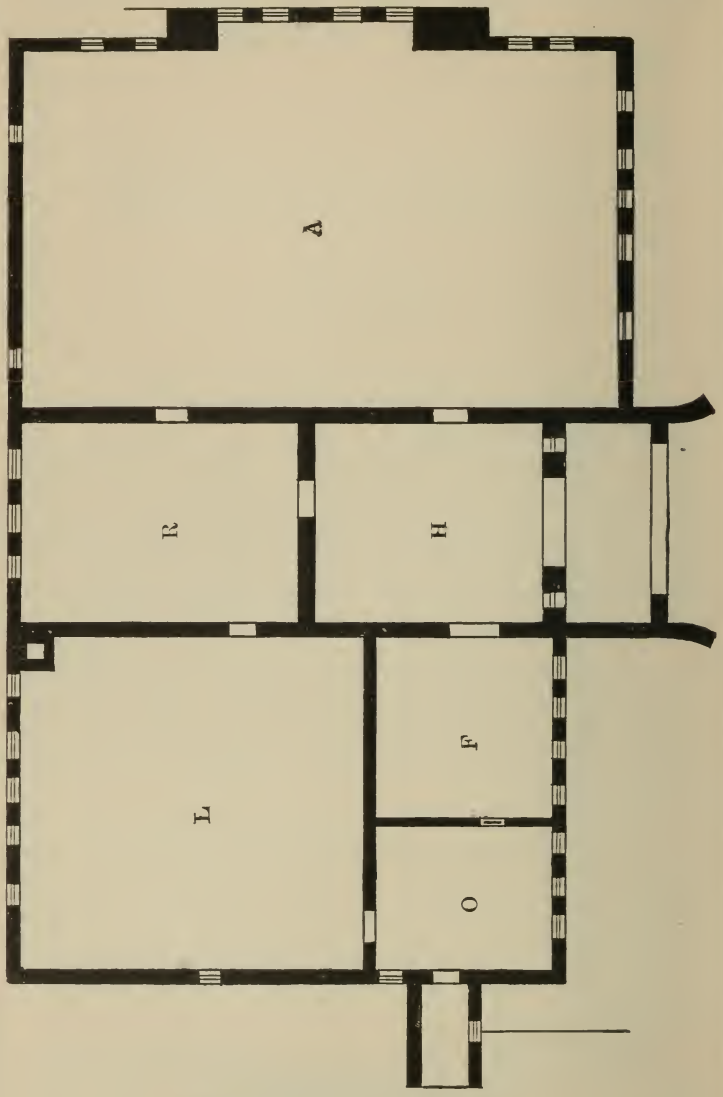
A large amount of time is devoted to Chemistry, general, analytical and applied.

Theoretical and Experimental Chemistry are taught during the whole of the first year, by lectures and recitations. The course includes what is known as "general" Chemistry, its principles and nomenclature, descriptions of the elements, the nature of chemical reactions, and the use of symbols and equations to express them.

Lectures in Applied Chemistry are given in the fourth year of the course in Metallurgy, in which course are also given lectures upon chemical theory of a more advanced character than those in the course in "general" Chemistry above described.

Instruction in Analytical Chemistry begins with the third term of the first year. In this, and in the first term of the second year, qualitative analysis is pursued, the course including the reactions of the bases and acids, separation and identification of all the ordinary elements, and analysis of simple and complex compounds, ores, industrial products, slags and mattes.

The work in the laboratory is supplemented by two lectures a week, in which the student is taught the theory of chemical equations, details of manipulation, simple and useful field tests. The laboratory is open every afternoon in the week except Saturday.



NEW BUILDING—FIRST FLOOR.

A.—Physical Laboratory and Lecture Room.
R.—Student's Reading Room. L.—Library.
O. F.—Offices. H.—Hall.

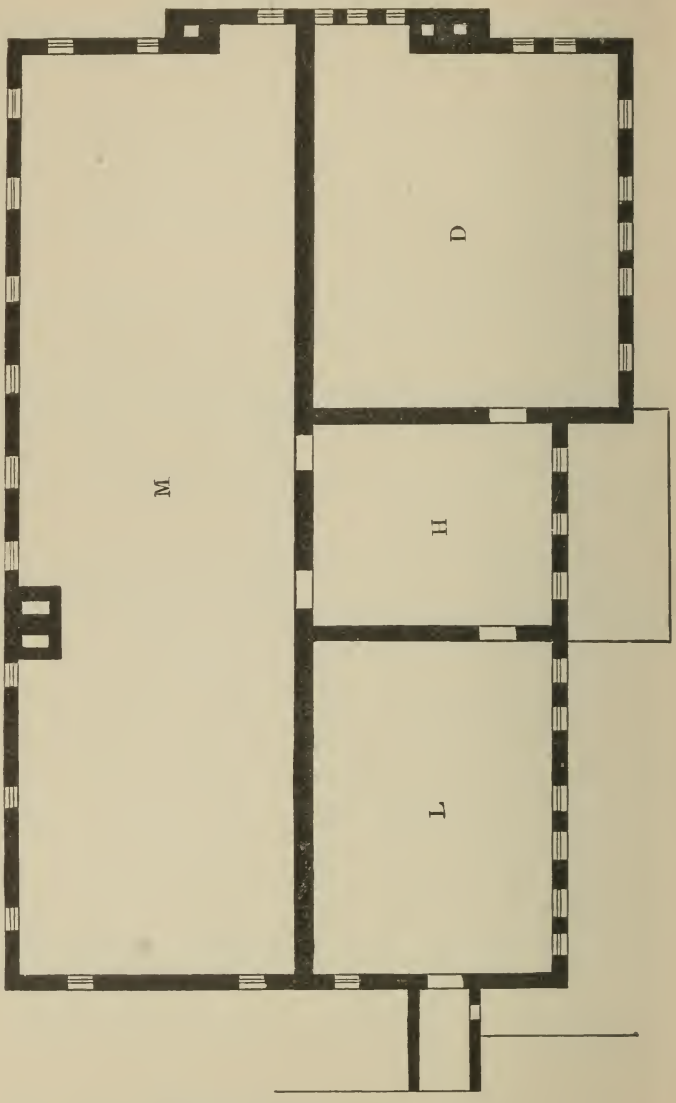
Instruction in Quantitative Analysis is given during the second term of the second year; also during the first and second terms of the third year. The course includes the analysis of a number of salts of definite chemical composition; the gravimetric and volumetric determinations of iron, copper, zinc, lead and other metals from their ores; the complete analysis of limestones, clays, slags, building stones, and of various types of ores.

Fire Assaying is a part of this course, coming usually in its last term. Those students who continue their course in Analysis beyond the second term of the third year, or who have made more than the usual progress in the schedule work, are put upon special cases, such as the examination of drinking water for sanitary investigations, analysis of pig iron and steel, and other work demanding delicate manipulation.

Accurate methods are taught in quantitative analysis, but a due amount of time is given to instruction in the rapid volumetric methods, which find so much favor in Western metallurgical works, for ore and matte valuation.

In the fire-assay course, large numbers of samples are given for examination. It is believed, indeed, that no technic school in the country exacts such an amount of actual practice from its students as is here insisted upon before the student is pronounced fit for a practical assayer. Not less than one hundred assays for copper, and several hundred for silver and gold, with very numerous cases for other metals, are required of every student. The best proof of the success of the institution in this direction is the fact that no term passes without application being made to it for assayers or chemists. Nor has a case yet arisen in which the person sent in answer to such application has failed to give perfect satisfaction.

From smelting works and other establishments in the State, the School has secured very great numbers of well-checked samples, and may claim to be far more than usually



NEW BUILDING—SECOND FLOOR.

D.—Mechanical Drawing Room. M.—Museum.
L.—Metallurgy and Mineralogy. H.—Hall.

well supplied with material for assay and analysis. Students are required to "check" with the results obtained by experienced workers, and that, too, with certainty and rapidity, before they can pass out of this department.

Each student receives individual instruction in the laboratory. If his progress exceeds that of his classmates, he may be promoted to a higher class of work, provided the same does not interfere with the regular schedule of laboratory terms.

The "B. S." course coincides with the regular course for two years. After this, the student is under the direction of his Professor, so far as the nature of his work is concerned, though he is now (in his third year), expected to conduct the details of his analyses without so much attention from instructors as in the earlier parts of his course. During the first term of the third year the course will not greatly differ from that of the Metallurgical students, afterwards diverging into various specialties. Soil and gas analysis, use of the microscope, detection of alkaloidal poisons, and other lines, as may be suggested by the Professor in charge, and in the last year a special investigation, either in organic or inorganic work, analytical or synthetical, according to the direction his previous preparation has taken.

There are three laboratories for general chemical work, and two for fire-assaying. The whole of the first floor of the old building is now devoted to practical chemistry, and much of the basement and second floor. There are two balance rooms, private laboratory and still room. The general laboratories are fitted with working desks, each student having the exclusive use of one, in which he keeps (under lock) the apparatus he has drawn from the school. The laboratory is furnished with gas (manufactured on the premises), and with sinks, hoods and all other necessary adjuncts. Apparatus is issued as called for, by the Registrar. (See "Expenses.")

No fee for chemicals less than that for a whole term can be accepted. Students are strictly prohibited from taking analyses or assays on their own account, whether for a fee or gratuitously. All work, of whatever description, performed by laboratory students must be at the suggestion and under the direction of the Professors of Chemistry.

Attendance in the laboratory on all days scheduled is as obligatory as that upon lectures or other exercises.

STOICHIOMETRY.

This subject is taught by lectures and recitations, with numerous exercises in calculation. It is not wholly confined to chemical calculations, but includes physical and metallurgical features.

The lectures begin with the second term of the first year, and end with the year. An advanced course, having reference mainly to slag calculations, and introductory to third year work in Metallurgy, is taken in the third term of the second year.

The entire course includes the metric system, specific gravity determinations, density and tension of gases, calculation of formulæ and analyses, slag calculations, and generally, all applications of elementary mathematics to chemical and metallurgical problems.

METALLURGY.

Metallurgy is taught by class-room lectures and conferences, also by frequent visits to smelting works under the guidance of the Professor.

The School is very fortunately situated for the practical study of this subject. The smelters at Argo and Denver are convenient of access, and by the courtesy of their managements the students are given the fullest opportunity for study of all practical details. These works are visited weekly when the topic under consideration demands it. The smelters, refineries and iron and steel works in other parts of the State are visited by a yearly excursion, as outlined elsewhere.

The various milling and concentration works of Gilpin, Clear Creek and Boulder Counties are visited by short and convenient excursions. The large manufacturing establishments of Golden, which produce very superior fire-brick and other refractory materials from the fire-clay and quartz found in the immediate vicinity, enable the students to investigate the treatment of such clays, and the nature of their products.

The course in Metallurgy begins with the study of fuels and refractory materials, then follows the discussion of furnaces, engines and of various other constructions and appliances of metallurgical establishments. When the student is familiar with these the treatment of the ores of the different metals is taken up in detail, all the well known and important processes being thoroughly studied, and their relation and application to the reduction of the ores of the Western States and Territories considered, special attention being paid to slag formation, calculation of charges, furnace working, and other points of Metallurgical practice.

It is the aim, as far as possible, to familiarize the students with all details of the smelting business as practiced in this country, and prepare them to fill practical positions acceptably from the start.

Through the courtesy of several smelters, the school has been able to gather a very good collection of smelter and refinery products and by-products. A collection of models illustrating the principal types of modern ore-treating plants has recently been obtained.

Students in civil engineering attend the lectures on fuels, refractory materials, furnace constructions, etc., devoting one term to the work. Those in mining engineering pursue a more complete course, becoming familiar with the usual processes employed in the reduction of the principal ores; while those in the Metallurgical course devote six terms to an exhaustive study of the whole subject, and after they have acquired a comprehensive knowledge of Metallurgy, and have had considerable experience in chemical work, one term is spent in the examination of the different furnace products, and in making quantitative analyses of the same.

MINERALOGY AND BLOWPIPING.

These subjects are studied throughout the second year, in all courses.

The first term is devoted mainly to the topic of Crystallography, taught by lectures and by the study of models illustrating all the forms in which the more important minerals crystallize. These models, nearly two hundred in number, are at all times accessible to the students.

After a sufficient familiarity with this subject is acquired, the student is put to work at determining the minerals in a working collection, which, while embracing all the principal classes of minerals, is especially rich in illustrations of economic value, and in the ores of the metals as they are usually seen in practice. During the time (second and third terms of the second year) occupied by this work, the properties and practical uses of the minerals examined are taught both by lecture and conversation.

The extensive general and local collections of the institution (minerals and ores), are also freely used in illustration of this course.

In the last term of the second year the student takes a course in Blowpiping, with especial reference to practical field work, for determining as nearly as possible the value of ores and minerals without elaborate apparatus.

MATHEMATICS.

Euclidian Geometry, Algebra, Plane and Spherical Trigonometry, are the subjects in pure Mathematics pursued during the first and second years.

In Geometry many problems not in the text are given, especially toward the close of the course. Much stress is laid upon clear comprehension of geometric reasoning, and upon ability to apply it to original solutions; comparatively little upon strict adherence to the text matter in recitation.

The student is made sufficiently familiar with determinants and special algebraic methods to make extensive use of them in following the courses in Analytical Geometry and Calculus, which begin in the third year and occupy five hours weekly during the whole school year.

The problem of maxima and minima of analytical functions is treated in its widest sense, and, as far as the present theory of quantics allows, not only the necessary, but also the sufficient conditions, are rigorously established in determinant form.

The course in the fourth year is subject to variation, and is largely adapted to the needs of individual students. It consists mainly of exercises and lectures in selected parts

of advanced mathematics. In this way lectures on the following subjects have been delivered to students specially interested in pure mathematics:

Solution of the most general system of Algebraic Equations.
Introduction to Weirstrass' Theory of Analytic Functions.
Method of Least Squares.
Elliptic Functions.
Integration on Riemann's Surfaces.
Analytical Mechanics.

All courses except the Metallurgical and Advanced Chemical ("B. S.") take the regular Mathematical course in full.

No student can omit any of the course in Mathematics during the first two years of his course.

GEOLOGY.

The advantage of a thorough knowledge of Geology, both in mining matters and as an element of scientific education, can hardly be overestimated.

Instances are without number in Colorado where thousands of dollars have been wasted in unscientific exploration and development, which the most elementary knowledge of Geology would have prevented; in fact, it is doubtful whether more money has not been wasted in this way than has actually been taken out of the mines.

Few regions present greater advantages for the study of this science than the Rocky Mountains. The appreciation of this fact is sufficiently shown by the many expeditions

sent hither by the United States Government, and by Eastern colleges to study its Geology. These mountains have been the principal theatre of geological explorations in this country, and have yielded vast assistance to the progress of this science throughout the world.

The State School of Mines is singularly well situated for this particular study, better, in fact, than any similar institution in the land, being at the foot of these mountains and in close proximity to its mines. The particular locality about Golden and its vicinity is exceptionally favorable for geological research. Nearly the whole geologic series of the Rocky Mountains is represented. The cañons cut deep sections, revealing the rock structure. Fossil leaves are abundant in the foot hills, while the locality has gained a wide spread reputation in the scientific world by the discovery of the largest fossil animals known to have existed—the gigantic lizards, or *Dinosaurs*. The Table Mountains, capped with basaltic lava, are equally remarkable for the variety and fineness of their Zeolite crystals, while beneath the volcanic cap, the sandstones have yielded a vast amount and variety of fossil leaves, of the lignite formation, which have been selected as typical forms in the leading works on Paleobotany. Economic Geology is well represented in the coal mines, stone and fire-clay quarries close to the town.

The course pursued at the School of Mines comprehends the theory of Geology, illustrated by hand specimens from the museum, by maps, geological sections, etc.

Weekly excursions in fine weather are conducted throughout the year by the Professor of Geology, both to the mines and to other interesting localities, within reach by wagon or railroad, and have proved an unfailing source of healthful and instructive recreation, after the in-door confinement of the week. The most important points along the foot hills, and in the adjacent mountains and

mines, over a distance of fifty miles, are thus studied annually by the students. The Geology of Colorado receives especial attention, and the lectures are illustrated mainly by reference to its particular formations.

General Geology belongs to the first year. Economic Geology is taught during the first two terms of the fourth year.

The cabinets are described in part under "Buildings and Appliances."

PHYSICS.

The course in Physics is given by lectures and recitations, accompanied by practical work in the laboratory. The course embraces molecular physics, gravitation, mechanics of liquids and gases, elementary machines, acoustics, the theory of heat and of the steam engine, and the general principles of light. The third term is devoted chiefly to an elementary course in electricity and magnetism.

Four hours a week are devoted to work in the laboratory. The principal features of the laboratory course are, the determination of the laws of falling bodies, the determination of the value of gravity by the inclined plane, and by both the simple and Kater's pendulums. Experiments are made to determine the efficiency of water motors, the specific gravity of various substances by the different methods, their heat and conductivity. The velocities of sound and light are obtained, thermometers are calibrated, and the principle laws of light are verified. In electricity the student performs the principal experiments in magnetism, static electricity, and the simpler ones of current electricity, more extended work in this branch belonging to the course in electrical engineering.

ELECTRICAL ENGINEERING.

The course in Electrical Engineering is intended to cover both the theoretical and practical parts of the subject. It is adapted somewhat to the peculiar needs of the state, by the devotion of much time to the study of the applications of electricity to mining and metallurgy. The opportunities offered for the study of electrical transmission of power in Colorado are unequalled in their diversity. Excursions are made each year to the mining camps of the State, where mines are worked by electrical machinery, and quite frequently to the large lighting and street-car plants. Owing to the great courtesy of the managers of these installations, the school is especially fortunate in having plans, estimates, details, and actual costs of some of the best electric light and power plants in the State.

The electrical laboratory is the most complete west of the Mississippi, and constant additions are being made to its already large equipment. The shop is run by motors, and the electric current is "on tap" in all the rooms with voltage of 220 or 110 and a current of forty amperes. Wires from the storage battery run to each room. The galvanometer room is fitted up with solid piers to prevent errors due to vibration, and contains a better class of measuring instruments. The photometer room is designed for testing both arc and incandescent lamps, and contains volt metres, am metres and all the necessary instruments for doing accurate work. The large laboratory is devoted to the rougher measurements. A private room contains the Deci-Ampere balance and Thompson galvanometer, and is fitted up for standardizing instruments, and for the higher class of instrumental work.

The first two years of this course are identical with those of all other courses, but after the second year, the student takes up the technical part of the subject. In

both the third and fourth years much time is devoted to mechanical engineering in connection with the other work.

The course in electrical units and measurements consists of lectures on the theory and value of the units of the science and the modern methods of measurement, determination of faults, etc. Four hours per week are devoted to practical work in the laboratory.

The course in distribution of electricity embraces distribution for lighting by the various "straight current" systems, by the alternating system, and the long distance transmission of power. Facilities are offered in Denver for the study of different installations, and it is hoped that one of the finest examples of long distance transmission will soon be in operation in Golden.

Now that every week sees a new accumulator on the market, the course in primary and sec ndary batteries will be given more prominence than is usually accorded it. The school is indebted to the Carpenter Electric Storage Company for the present of a number of cells, with the promise of additional ones in the near future. A long and varied series of experiments with both primary and secondary batteries is projected.

Dynamo-Electric machinery, during the whole of the fourth year, will occupy the student five hours of every week. The theory of generators and motors of both the alternating and straight current systems will occupy most of the time in the class room, for the first two terms. The third term will be devoted to designing and constructing motors or dynamos, and to thesis work. The work in the laboratory will consist in the determination of the curves of magnitization of various samples of iron, of the characteristics of machines, determination of the electrical and commercial efficiency of the different types of motors and dynamos. It is proposed to construct a number of small plants at the School, to illustrate the working of the different systems under conditions closely approximating

those existing in practice. One, illustrating the transmission of power over a circuit of twenty miles, is already installed. Much attention will be devoted to the application of electricity to mining and the utilization of water power in the generation of electricity to supply both power and light.

MECHANICS.

This subject embraces the theoretical consideration of the mode of representing forces, their composition and resolution by graphic methods, general equations of motion, laws of transmission of force, laws of impact, laws of friction and of oscillation.

Several lectures upon the mechanical theory of heat, and upon the duty and efficiency of engines conclude the course. These analytical considerations, with their application to elementary machines, occupy the second and third terms of the third year.

The theory and construction of machines are considered under the following heads: Kinematics, Dynamics and Mechanical Engineering. The student is made familiar with the general theory of motion, the relative motions of different parts of the machines, and the graphic representations of the same.

The theory of fly-wheels, valve-gearing, link motion, cams, spur-wheels, brakes, governors, and the proportions of their parts, is followed by an examination of the various forms of water wheels, construction of boilers, and a general description of the characteristic features of typical machines for pumping, hoisting and ventilation. This is succeeded by a discussion of the generation and properties of steam, hot, cold and compressed air; the fundamental laws of Thermodynamics, combustion of fuel, animal power, and

the transmission of power by chains and wire-rope. The whole is concluded with a consideration of the management of machinery, its erection, wear and tear, testing and accidents.

During the course visits are made to the D. & R. G. R. R. shops and draughting departments, and the large manufacturing establishments of Denver. These serve to illustrate the practical application of the principles obtained from the text books and lectures, and render the graduate capable of meeting the common emergencies which arise in mining camps where ability to repair machinery is so frequently demanded.

Appliances for practical mechanics have recently been added to the Engineering department. There are in process of construction appliances for testing the strength of materials of construction, as stone, cement, iron and wood. One machine will have a capacity of sixty thousand pounds. The additional appliances are for determining the elastic limit, transverse deflection, and for testing lubricants and oils. These will be placed in the Engineering labratory for the use of students in the third and fourth years, under the supervision of the Professor of the department.

CIVIL ENGINEERING.

Civil Engineering treats of the nature, elasticity and test of materials, foundations, retaining walls, arches, trestles, truss bridges, caissons, roads, pavements, railroads and their construction, tunnels and tunneling, locomotives, and grade in relation to gauge; stationary engines, gravity roads; water supply, sewage systems for houses and towns;

means of purifying water; ventilation, steam heating; street cleaning, etc.

One term is given to the determination of the proof strength of timbers, and dimensions of parts of roofs, trusses, bridges, etc., according to the stresses to which they are subjected. The thickness of tubbing for shafts, and of pipes for pumping waters, riveting, reservoir dams, locks, trunnions, flooring, dimensions of balance beams, and solids of equal resistance, are among the special subjects examined.

Each student during the third term of the third year calculates the strains and dimensions of parts of trusses and frames; and during the fourth year other constructions of a complex nature, as machines, bridges and cranes. Bills of materials and the necessary working drawings are also made out.

It is intended to give the candidate for the degree "C. E." some knowledge of the laws of railroad construction and maintenance. Hence, a series of lectures contemporaneous with text-book instruction will embrace material for construction and cost of railroads, selection and location of routes, gradients, location of way stations, tunnels *versus* long routes, rolling stock, cost, wear and tear of the same, economics of transportation, and such other matters as may be pertinent to the successful operation of a railroad.

SURVEYING.

The instruction is both theoretical and practical, so combined as to enable students to solve all problems of computation, laying out work and construction. Every student has abundant opportunity to become familiar with the use of instruments, with which the school is well supplied, as will be seen from the list under "Building and Appliances."

The classes, after acquiring information from the text-book, are drilled in measuring lines, angles and areas by the chain; in the use of the transit to measure angles for triangulation, of heights and distances; in the construction of railroad curves; in plane surveying, and all necessary requirements for a U. S. Deputy Mineral Surveyor. In mine surveying, the student has under consideration special problems which have occurred in practice, and have been collected for use. He also makes surveys of the coal and fire-clay mines in the immediate vicinity of the school. Maps and plans of them are afterwards made. The students are further taught topographical and geological surveying, the use of the plane table being explained.

Students in Geodesy are instructed in the outlines of that subject, the different kinds of triangulation, description of the U. S. Coast Survey base apparatus, establishment of stations and signals, and triangulation of the various peaks and geological outcrops which are subsequently plotted. The whole work, when completed, will furnish a map of the region which will be an excellent reference for the various parties who are frequently investigating the different formations along the foot hills.

The instruction in railroad surveying is most thorough, embracing practice in running levels, curves of different kinds and measurement of earthworks. Saturdays are devoted to all the field work necessary to a projected railroad line, reconnoissances, preliminary and location surveys, topography, cross-sectioning, staking out of culverts, and all the plotting and calculations thereon. Designs for culverts, arches, bridges and trestles are examined and made. The student learns to anticipate the various problems which he is likely to encounter in subsequent experience, and is carefully prepared by the selection of such as will be of special importance in his work as Mining or Civil Engineer.

MINING.

Mining is taught by lectures, illustrated by drawings, photographs and models. The students are required to take such notes as will enable them not only to prepare for recitations and examinations, but will also be a valuable source of reference in subsequent practical work. During the two years more than one hundred lectures are delivered, which cover the subjects named below, and furnish a complete course upon mining operations. Not only are successful mines considered, but also many in which failures have resulted, and, so far as is possible, the causes of such failures. The following is a condensed statement of the topics considered:

Mining as a branch of study.

Occurrence of mineral in veins and deposits, and irregularities of the same.

Faults and modes of finding the continuation of faulted veins.

Day's pay, *versus* tribute and contract systems.

Classes of ground, and progress and cost in the same.

Miner's tools. Drilling operations.

Air compressors and coal cutting machines.

Explosives and blasting operations.

Tunneling and drifting.

Timbering, masonry work and iron linings.

Sinking and timbering of shafts.

Typical modes of exploitation, according to variations in width and dip.

Surface building and "plant;" water and electric power.

Extraction of water and pumping machinery.

Subterranean transportation.

Removal of material, hoisting machinery, etc.

Surface transportation; wire-rope transmission of power.

Ventilation, illumination, accidents.

Crushing machinery, rolls, stamp-mills, etc.

Sizing apparatus, jigging, theory of ore dressing, hydraulic separators. Treatment of slimes in vanners, troughs, etc.

Wet processes of milling.

Descriptions and plans of works.

MINING AND METALLURGICAL EXCURSIONS.

An important part of the work of the Institution consists in visiting mines, smelters, power plants and other works, where the processes lectured upon may be seen in actual operation. While short trips of this description are frequent, and constitute the most valued advantage which the location of the school affords, a brief outline of one of the longer yearly trips may serve to illustrate in part the exceptional opportunities given by this school for practical study and observation. That of the spring of 1891 is the one described.

The smelters and other works in Denver, having from their nearness been frequently visited, were not included in this trip, Pueblo being the first objective point. At this place the works of the Colorado Coal and Iron Company were first visited, and the students given every opportunity to observe in full detail the mechanical arrangement of the plant as well as the various stages of iron working, converting ingot steel, rolling steel rails, casting iron pipe, making

angle iron, nails and other products of this industry. At the Pueblo Smelting and Refining Co.'s works the smelting of gold and silver bearing lead and copper ores was seen, including roasting and matting operations, the refining of silver, manufacture of type-metal and various other branches of metallurgical interest.

At the Colorado and Philadelphia works, many of the same processes were inspected, each works, however, furnishing a somewhat different type of operations.

The party next proceeded to Florence, where the methods of drilling and pumping oil wells and refining the product were amply illustrated.

Coal Creek was the next point reached, and here were examined the coal mines. The two methods of mining in coal veins of medium thickness were well illustrated. Measurements of air were taken in the mine and the various mechanical and economic features discussed.

The special car was then attached to the train, and a daylight trip to Leadville offered opportunities for "geology and scenery." At the carbonate camp the large sulphide bodies of the Moyer, Col. Sellers, Minnie and A. Y., and the Maid of Erin; the carbonate wealth of the White Cap; the incline and slope of the Silver Cord; the Iron Silver, Wolf Tone, and other concentration mills; and the big stope of the Antioch were examined, as were also the pumping and hoisting machinery, the methods of timbering, and of mining flat bodies of soft ore. The courtesies of the smelters were accepted and numerous sketches made by the students.

Glenwood and Red Cliff gave additional opportunities for geological study. Aspen was the last objective point, and here unusual facilities were offered for exemplifying the side and end line controversies. The Cowenhowen tunnel presented interesting features of timbering and tunneling in running ground. At the Juniata, a fine condensing and sinking pump system; at the Deep Drainage

Co.'s shaft, the finest hoisting plant in this State; at the Aspen mine, very elaborate cribbing and square set timbering; at the Aspen M. and S. Co.'s property, diamond drill and system of recording reserves and prospects; at the last two mentioned, large bodies of mineral economically mined and handled; besides these, several aerial wire-rope tramways and other mechanical devices and improvements were examined and sketched with the courteous assistance of those in charge.

At Pueblo, by the kindness of the manager of the electric railway, a car and measuring instruments were placed at the disposal of the students, and run over all the company's lines. The observations of voltage and current made every two minutes over the whole trip, afforded data for future work.

Glenwood furnished the first example of the application of water power to the generation of electricity. Under a head of nearly five hundred feet, the water is delivered to the Pelton wheels, driving the dynamos which light that beautiful town. Here were seen some examples of alternating machines of the most modern type, and the only ones in the State with stationary armatures.

Aspen, for the amount and diversity of its electric mining machinery and the size of its hydraulic plant, leads the State. At the large plant the water is under the enormous head of eight hundred and seventy-six feet, and here again the wonderful Pelton wheel is used. Power is furnished to many mines and the thriving town is lighted by this plant. One of the best planned and equipped plants seen on this trip is the private one of the Aspen Mining and Smelting Co. They use water under a head of eighty-five feet, and employ two T. & H. generators, of five hundred volts. The current is carried about seven thousand feet to their mine, and all the hauling and hoisting is done by electricity. Data and plans have been furnished or promised to the school of most of the work visited.

The more than willingness with which the various plants and mines were thrown open to the party, and every facility offered to make the trip both profitable and enjoyable, was not its least remarkable feature.

Specimens, plans, estimates and cost of installation were given everywhere.

Thus this trip, though costing but thirty-five dollars per capita, included illustrations of smelting, manufacturing, mining and electrical engineering, whose values in the various courses can hardly be estimated.

The courtesies and concessions from smelting, mining and railroad companies on this trip are gratefully acknowledged—they were too numerous to be enumerated in a publication like the present one.

MECHANICAL DRAWING.

Work in the department of Mechanical Drawing begins with the first year, and continues to the end of the course. The use of instruments and the projections, plans, elevations and sections of objects are taught by the aid of Warren's Mechanical Drawing. The principles of lettering and coloring are then shown the student, and these, with the tracing and reproduction of the "blue-print" process, are employed in the elements of machine drawing and copying. In the second year exercises in Descriptive Geometry and Shades, Shadows and Perspective are held by class room recitations. These prepare the student for proper graphic representations of models and machines, as well as of structures. In the third year the order is as follows :

1. Drawing from copies of machines, and from architectural designs.
2. Selections from Warren's Elements of Machine Drawing.
3. Pumping engines and valve gearing.
4. Working drawings of constructions, mechanisms, furnaces, etc.
5. Making of working drawings, and finishing plans from direct measurements of engineering works or of machines, a great variety of which may be found at convenient distances from the institution.

The drawing of the fourth year is mainly devoted to the making of plans and designs for furnaces, engines, mills, etc., which are executed upon paper in the most careful and detailed manner in connection with Thesis work assigned for graduation.

The whole course, as designed and carried out, will qualify the student for the execution of the most difficult problems. At first the student is held closely to the text book, but as he advances, he gradually dispenses with its aid, so that during the last year of the course he comes into direct contact with the various works in construction. The drawings are required to be presented upon paper 19x27 inches, to be preserved in the institution for subsequent reference and inspection.

FREE HAND DRAWING AND WATER COLOR PAINTING.

The aim of the instruction in Free Hand Drawing and Water Color Painting is to develop that skill of hand and eye which will enable the student to sketch and color

any objects met with in the mining field. These are usually the outlines of mountains, showing the course of veins and topography; the interiors of mines; the mining "plant" and its surroundings; contour and section of the hill, showing the vein and development under ground; the rough outlines of parts of machinery, furnaces and Metallurgical establishments.

The following is an outline of the course in Free Hand Drawing:

Elementary principles of perspective, practically applied by sketching from objects, such as wooden blocks, models, interiors of rooms and exteriors of buildings.

Sketches of statues and other curvilinear models or objects are excuted in charcoal and chalk.

Sketches of landscape from copies and nature—principally the mountains and scenery in the vicinity—with pen and pencil.

PAINTING IN WATER COLORS.

1. Laying on colors and blending them.
2. Painting in one color only, from copies and nature; afterwards in two or more colors—such sketches as can be made quickly in the field.
3. Coloring portions of machinery from copies and models.

FIELD WORK AND PUBLICATIONS.

Since 1885 the School has undertaken the work of a Geological Survey and Mining Bureau. Reports were published in 1885, 1886, 1887 and 1889. Various mining camps have been visited, and the results of the examinations

largely published. The examples of minerals and ores collected are retained in the collection of the Institution. The contributions hitherto published, in the reports above mentioned, have been as follows:

AUTHOR.	DATE.	SUBJECT.
A. A. Blow, C. E.	1887.	Ore Chutes and Recent Developments on Iron Hill, Leadville.
P. H. Van Diest, E. M.	1886.	Mineral Resources of Boulder County.
Prof. Regis Chauvenet.	1885.	Preliminary Notes on the Iron Resources of Colorado.
" " "	1886.	Notes on Iron Deposits of Northern Colorado.
" " "	1887.	Iron Resources of Gunnison Co.
Prof. Arthur Lakes.	1885.	Reports on Trinidad and Crested Butte Coal.
" " "	1886.	Geology of the Aspen Mining District.
" " "	1887.	Geology of Colorado Ore Deposits.
" " "	1889.	Geology of Colorado Coal Deposits.
Prof. Magnus C. Ihlseng.	1885.	The San Juan Region.
" " "	1885.	Oil Fields of Fremont Co.
" " "	1886.	The Present Mining Law Chaos.
" " "	1887.	Notes on Leadville.
Prof. George C. Tilden.	1886.	Mining Notes from Eagle Co.
" " "	1887.	Western Assay Methods.
Prof. Benjamin Sadtler.	1889.	Colorado Cokes.

The Field Work now outlined for future publications is as follows:

Prof. Chauvenet.	Manufacture of Pig-iron in Colorado. Iron Resources of Pitkin Co.
Prof. Lakes.	Manual of Economic Geology.
Prof. Ihlseng.	Red Cliff District, Eagle Co.
Prof. Sadtler.	Matting of Low-grade Copper Ores.
Profs. Ihlseng and Sadtler.	Treatment of Zinciferous Ores.
Prof. Tilden.	Sanitary Examination of Drinking Waters of Denver.
Prof. L. C. Hill.	Applications of Electricity to Mining.

These publications are issued as the means of the Institution will permit, no special appropriation for either Field-work or printing having ever been made by the state.

BUILDINGS.

The old building has the main dimensions of 100x70 feet, two stories, and basement under a portion of the space.

The Chemical laboratories and assay rooms are on the first floor and part of the basement, occupying a total space of 6,000 square feet. The second story contains one large and two smaller lecture rooms, devoted respectively to Chemistry (general), Mathematics and Engineering. The room for storage batteries is also on this floor. In the basement are (besides assay furnaces and still-room), the rooms for photometry and for galvanometers, the latter being fitted with two piers, to insure perfect steadiness in using instruments of precision.

The new building, (first occupied in the Fall term of 1890), is connected with the old one by passages upon each floor. Its main dimensions are nearly the same as those of

the old building, but its total available space is much greater. Mr. R. S. Roeschlaub, of Denver, was the architect, Messrs. Kimball and Quick, of Golden, the builders.

The stone basement is mainly devoted to the gymnasium, (which occupies a space of 65x40 feet), lavatory, with shower baths, work-shop, and steam heating apparatus.

The first floor accommodates the large Physical laboratory, 65x40, the Library, Student's reading room, and the offices.

The third floor is divided into three rooms only, viz: the Museum (100x27), Mechanical drawing room (40x40), and Metallurgical lecture room (32x35).

This building stands upon ground overlooking the town, and presents a handsome appearance. The basement is in solid red sandstone, the upper stories in brick laid in red mortar, and trimmed with the same red stone. It is heated by steam and electro-lighted.

The total floor space now in use in the combined buildings is slightly over thirty thousand square feet.

LIBRARY.

The Library contains 2,000 volumes, mostly standard scientific and technical works, though history, travels and literature are not neglected. Its cost per volume, as must be the case with scentific works, has been large. Additions are constantly being made. Students have free access to the library, which can be used as a reading-room during a portion of each day, the students having also a separate reading-room (22x25), on the same floor.

MUSEUM.

During the past year the School has acquired by purchase the cabinet of J. Alden Smith, of Boulder, (late State Geologist). This collection consisting chiefly of minerals, but rich also in fossils of all ages, is the most important accession to the equipment of this department ever made in a single year by the Institution. With this and its previous possessions, this department may now claim the best collection illustrative of the minerals and fossils of Colorado to be found in the State.

The collection is at all times open to inspection both by students and visitors, and is largely used for class instruction in Mineralogy and Geology.

APPARATUS.

The Scientific Apparatus in the various departments can hardly be described in detail or even named in a School catalogue. It may be said, however, that in Chemistry the apparatus in stock is ample for the supply of every student in the laboratory, and includes fine balances, volumetric instruments, and every approved appliance for analytical and experimental Chemistry. The laboratory fittings have been mentioned under "Chemistry."

The Surveying instruments are of the best makes, and at least two of each kind are provided, so that several parties can be in the field at the same time. Among the makers are Gurley & Sons, Young & Sons, Negretti & Zambra and Troughton & Simms.

The Electrical equipment, although the most recent addition is very complete, the instruments being without exception of the very best construction—Motors, Volt-Meters, Galvanometers, complete testing and resistance set, thirty cell storage battery, Siemens' Electro-Dynamometer, Cradle Dynamometer, Deci-Ampere balance, and a variety of other instruments, the whole constituting by far the best collection west of the Mississippi. Golden being lighted by electricity, the whole current from the works can be sent to the School at any time, special wires having been erected for that purpose.

The collection of models in the department of Metallurgy is already a fair one, but will be more than doubled before the opening of the Fall term of 1891, shipment having been ordered from the makers.

The estimate for the year (1891) on value of strictly scientific apparatus on hand, is $15,000, and on library, $5,000, though additions are being made so rapidly that these figures will soon be "out of date." They are *exclusive* of all furniture, fittings, cases and ordinary school appliances.

GYMNASIUM.

The Gymnasium is the most spacious and the best equipped of any college or school gymnasium in the State, and is considered a valuable adjunct to the school equipment. It is in the basement of the new building, its floor (65x40 feet) admitting drill exercise with ample space for

apparatus, while its height of twenty feet, with double set of windows, allows the use of swinging appliances and perfect ventilation. Around the walls are pulling weights of every description, while among the other instruments may be named swinging rings, parallel bars, horse buck, quarter circle, "cage" with eight pieces of apparatus for development of every set of muscles, ladders, spring-board, complete sets of clubs and dumb-bells for class exercise, and many others.

The Gymnasium, besides being open every school afternoon, is also open both for systematic class work and "free exercises" three evenings of each week. Regular instruction is given in gymnastic exercises on those evenings. Lavatory and shower baths (hot and cold) adjoin the gymnasium. Each student pays a fee of one dollar a term for the use of gymnasium, and deposits one dollar for his locker key, the latter being returnable. The gymnasium fee is not included in school receipts proper, but is used exclusively for repairs and renewals of gymnastic apparatus.

The Gymnasium is managed by the "School of Mines Athletic Association," composed entirely of officers and students of the institution. The Board of Directors of this Association is responsible to the School for the maintenance of good order and the preservation of the apparatus.

The Directors for the School year 1890–91 are given below.

Edw. W. Johnson, ('91) Prest.	Chas. D. Smith, ('91).
Chas. H. McMahan, ('92) Sec.	Wm. B. Lewis, ('92).
L. W. Shaffer, ('93).	Wm. H. Muzzy, ('93).
Geo. W. Schneider, ('94).	Fred. Hoffman, ('94).

The Registrar of the School is "Ex-Officio" Treasurer of the Association.

TEXT BOOKS.

Roscoe's Elementary Chemistry.
Fresenius' Qualitative Analysis.
Cairns' Manual of Quantitative Analysis.
Brown's Assaying.
Fenton's Notes on Qualitative Analysis.
Peters' Copper Smelting.
Dana's Manual of Mineralogy and Lithology.
Brush's Manual of Determinative Mineralogy.
Sadtler's Determinative Mineralogy.
LeConte's Geology.
Warren's Elementary Mechanical Drawing.
Church's Descriptive Geometry and Shades and Shadows.
Atkinson's Ganot's Principles of Physics.
Thompson's Dynamo-Electric Machinery.
Thompson's Electricity and Magnetism.
Wentworth's Complete Algebra.
Chauvenet's Geometry, Byerly's Edition.
Chauvenet's Trigonometry.
Wentworth's Analytical Geometry.
Bowser's Calculus.
Peck's Elementary Mechanics.
Dubois' Weisbach's Kinematics.
Mahan's Civil Engineering.
Ihlseng's Manual of Mining.
Klein's Elements of Machine Design.
Van Amringe's Davies' Surveying.
Warren's Sanitary Drainage.
Nicholl's Railway Builder.