UNIVERSITY OF ILLINOIS BULLETIN
ISSUED WEEKLY
Vol. XVI SEPTEMBER 16, 1918 No. 3
[Entered as second-class matter December 11, 1912, at the Post Office at Urbana, Ill., under Act of August 24, 1912.]

HIGH SCHOOL MANUAL

STANDARDS AND GENERAL RECOMMENDATIONS FOR ACCREDITING OF HIGH SCHOOLS

OFFICE OF HIGH SCHOOL VISITOR

PUBLISHED BY
THE UNIVERSITY OF ILLINOIS, URBANA
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INTRODUCTORY.

For about forty years the University of Illinois has extended to such high schools of the state as have sought approval and have been found to maintain satisfactory standards of instruction the privilege of entrance to the University on certificate of such of their graduates as might seek admission.

The basis for granting such privilege to high schools has been visitation and inspection. For the past twenty-two years this has been through a special officer of the University whose title is that of High School Visitor. Previous to that time it was done through committees of the faculty.

In this work of visitations for the purpose of establishing the accredited relation between high schools and the University the aim has been to aid the high schools, in a constructive way, to develop their normal functions toward the communities which they serve. To further this purpose in more recent years annual conferences have been held. To the same end the University has also sought to cooperate with school authorities in counties in such a manner as to bring about better standards of high school work in villages able to maintain only two or three years of high school work.

The following information in regard to entrance requirements, standards required for accrediting, and the material equipment of schools has been compiled for the purpose of furthering the ends and aims as above mentioned. This manual is for the use of school superintendents and principals, and school boards.

I

ADMISSION

GENERAL STATEMENT

An applicant for admission to any of the colleges or schools of the University must be at least sixteen years of age. Candidates for admission to the college of Dentistry (Chicago) must be eighteen and candidates for admission to the School of Pharmacy (Chicago) must be seventeen years of age.

Women are admitted to all departments under the same conditions and on the same terms as men.

Students may be admitted at any time, but should enter if possible at the beginning of the fall semester (in September), or at the beginning of the spring semester (in February). Students can seldom enter the College of Engineering to advantage except at the opening of the school year in September.

The entrance requirements for the undergraduate departments including the the colleges of Liberal Arts and Sciences, Commerce and Business Administration, Engineering, and Agriculture, and the School of Music, amounting in each case to 15 units of high-school work, will be found in detail in the University Register.

For the *College of Law*, for admission to the *three-year course*, two years (60 semester hours) of college work in arts, letters, and science in a recognized college or university; for admission to the *four-year course*, one year (30 semester hours) of college work.

The Library School requires a bachelor's degree in arts, letters, or science from an institution having standards equal to those of the University of Illinois.

The College of Medicine (*Chicago*) requires, in addition to 15 units of high-school credit, two years (60 semester hours) of college work in an institution having standards equal to those of the University of Illinois.

For the *College of Dentistry* (*Chicago*), 15 units of preparatory work in an accredited high school or academy or a state normal school, made up as follows: English, 3 units; mathematics, 2 units; physics, 1 unit; electives from lists B and C (see pages 7-8), 6 units; free electives, 3 units.

The School of Pharmacy (*Chicago*), requires graduation from an accredited high school with 15 acceptable units, or the equivalent.

ENTRANCE REQUIREMENTS OF THE UNDERGRADUATE COLLEGES.

High School Graduation

A candidate for admission *by certificate* must be a *graduate* of an accredited high school or other accredited school.

An applicant who has not been graduated from an accredited school must pass entrance examinations in the following subjects, amounting to 5 units[1]:

English composition	1 unit
Algebra (to quadratics)	1 unit
Additional subjects to be designated by the University authorities	3 units
Total	5 units

The remaining 10 units necessary to make up the 15 units required for admission may also be made in entrance examinations or may be offered by certificate from any accredited school.

Number of Units Required

Fifteen units of high-school or other secondary-school work, in acceptable subjects (see Lists A, B, and C below), must be offered by every candidate.

Prescribed Subjects

Summary

The 15 units offered for admission must include:

I.	Certain subjects *prescribed alike for all* curriculums (see List A below)	6 units
II.	Certain *subjects prescribed in addition for the individual curriculum* which the student wishes to enter	1 to 4 units
III.	Enough *electives from list B* (*below*) to make, with the subjects prescribed for all courses (List A) and those prescribed for the individual course of the student's choice, a total of 12 units	5 to 2 units
IV.	*Three additional units*, which may be chosen either from list B or from the Additional Electives of List C (below)	3 units
	Total	15 units

LIST A

English (composition and literature)	3 units
Algebra[2]	1 unit
Plane geometry	1 unit
Physics, or chemistry, or botany, or zoology, or physiology, with laboratory work	1 unit
Total	6 units

LIST B

		Units
Latin	36 to 144 weeks	1–4
Greek	36 to 108 weeks	1–3
French	36 to 144 weeks	1–4

[1] A unit is the amount of work represented by the pursuit of one preparatory subject, with the equivalent of five forty-minute recitations a week, through 36 weeks; or, in other words, the work of 180 recitation periods of forty minutes each, or the equivalent in laboratory or other practise.

[2] One and one-half units of high-school algebra are prerequisite for registration in all college courses in mathematics, and college mathematics is prerequisite for courses in physics and advanced chemistry. It is necessary, therefore, for students who intend to pursue curriculums involving college mathematics, physics, or advanced chemistry, including the curriculums in household science, chemistry, and chemical engineering, the pre-medical curriculm, or curriculums in commerce and business administration in which university courses in mathematics are prescribed, to present for admission to the University, or make up after entrance, *one-half unit of advanced algebra* in addition to the required unit of List A.

German	36 to 144 weeks	1–4
Spanish	36 to 144 weeks	1–4
[1] Italian	36 to 72 weeks	1–2
[1] Norwegian	36 to 72 weeks	1–2
[1] Swedish	36 to 72 weeks	1–2
[1] Polish	36 to 72 weeks	1–2
English (4th unit)	36 weeks	1
[2] Advanced algebra	18 to 36 weeks	½–1
Solid geometry	18 weeks	½
Trigonometry	18 weeks	½
[3] History	36 to 144 weeks	1–4
Civics	18 or 36 weeks	½–1
Economics and economic history	18 or 36 weeks	½–1
Commercial geography	18 or 36 weeks	½–1
Astronomy	18 weeks	½
Geology	18 or 36 weeks	½–1
Physiography	18 or 36 weeks	½–1
Physiology	18 or 36 weeks	½–1
Zoology	18 or 36 weeks	½–1
Botany	18 or 36 weeks	½–1
Physics	36 to 72 weeks	1–2
Chemistry	36 to 72 weeks	1–2

LIST C[4]		*Units*
Agriculture	36 to 108 weeks	1–3
Bookkeeping	36 weeks	1
Business law	18 weeks	½
Commercial arithmetic	18 weeks	½
Domestic science	36 to 72 weeks	1–2
Drawing, art and design	18 or 36 weeks	½–1
Drawing, mechanical	18 or 36 weeks	½–1
[5] Manual training	36 to 72 weeks	1–2
Music	36 to 72 weeks	1–2
[6] Shorthand and typewriting	36 or 72 weeks	1–2

For more complete details as to entrance requirements see the University Register, a copy of which may be had, on request, from the Registrar.

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[1] Not accepted in satisfaction of the foreign-language prescription of the College of Liberal Arts and Sciences or of the School of Music, but only as an elective.

[2] See foot-note, page 7.

[3] Greek and Roman history, 1 unit; medieval and modern history, 1 unit; English history, ½ or 1 unit; American history, ½ or 1 unit.

[4] The subjects named in List C must be taught in accordance with specifications which are set forth in the High School Manual.

[5] In giving credit for manual training the University specifies that the work is to be done by competent teachers, as determined by inspection, and that credit shall not exceed one unit for 360 forty-minute periods of work, including the necessary drawing and shop work.

[6] These two subjects must be offered together, no credit is given for either one offered separately.

II
UNDERGRADUATE SCHOLARSHIPS

(For circulars giving more detailed information concerning these scholarships, apply to the Registrar of the University.)

COUNTY SCHOLARSHIPS

A law passed by the General Assembly of the State of Illinois at the session of 1905 and embodied in the General School Law of 1909 provides that one scholarship may be awarded annually to each county of the State. The holder thereof must be at least sixteen years of age, and a resident of the county to which he is accredited. No student who has attended the University of Illinois is eligible for a scholarship. The holder of a scholarship is relieved of payment of the matriculation fee ($10.00 payable once, upon entrance) and incidental fees for four years ($30.00 a year) in any department of the University other than the professional school. The term "professional schools," as here used, includes the College of Law, the Library School, the College of Medicine, the College of Dentistry, and the School of Pharmacy.

A competitive examination, under the direction of the President of the University, and upon such branches of study as the President may select, is held, upon the first Saturday in June of each year, at the county court house in each county by the County Superintendent of Schools. Questions for the examinations are furnished in advance to the County Superintendents.

The successful candidates in the examinations must then meet in full, either by certificate from an accredited high school or by passing entrance examinations at the University, the requirements for admission to the freshman class, and must register the following September.

In case the scholarship in any county is not claimed by a resident of that county, the President of the University may fill the same by assigning to that county from some other county the student found to possess the next highest qualifications.

A student holding a scholarship who shall make it appear to the satisfaction of the President of the University that he requires leave of absence for the purpose of earning funds to defray his expenses while in attendance, may, in the discretion of the President, be granted such a leave of absence, and may be allowed an extension of his scholarship for not more than two years (making not more than six years in all from the beginning of the scholarship). Such extension will not be granted unless the student has been in attendance at the University for at least one full semester, nor unless the student's average grade during the period of his attendance has been at least 80 per cent, exclusive of grades in military science and physical training.

GENERAL ASSEMBLY SCHOLARSHIPS

The same act by which the county scholarships described above were established also provides that each member of the General Assembly may nominate annually one eligible person from his district for a scholarship in the University, granting the same privileges as the county scholarships.

A member of the General Assembly who wishes to nominate a candidate for a scholarship should file the name and address of his nominee as early in the spring as practicable and not later than June 1, with the President of the University and also with the County Superintendent of the county in which the nominee resides.

The nominee is then required, under the statute, (1) to pass the scholarship examination—the same that is given to competitors for the county scholarships on the first Saturday in June, under the County Superintendent; (2) to meet in full, either by certificate from an accredited high school or by passing entrance examinations at the University, the requirements for admission to the freshman class; and (3) to register in the University the following September.

If a nominee fails to make a passing grade (70) in the scholarship examination he may not receive the scholarship. In this case notice will be sent to the member of the General Assembly who made the nomination, who is then entitled to nominate a second candidate. This second candidate is subject to all the requirements stated above; the scholarship examination will be given him at the University on the Wednesday preceding the fall registration days (in 1918, September 11).

A General Assembly scholarship may be extended under the same conditions as a county scholarship.

SCHOLARSHIPS IN CERAMICS

The University offers annually to each county in the State one scholarship, awarded by the Trustees of the University, upon the nomination of the Illinois Clay Workers' Association, to applicants who intend to pursue either of the courses in ceramics (Ceramics, and Ceramic Engineering). These scholarships are good for four years and relieve the student from the payment of the matriculation fee ($10.00, payable once, upon entrance) and the incidental fees ($30.00 a year).

The candidate must be at least sixteen years of age, must be a resident of the county for which he is nominated, and must meet *in full, before entering*, by certificate from an accredited high school or by passing entrance examinations at the University, the requirements for admission to the freshman class.

SCHOLARSHIPS IN AGRICULTURE AND HOUSEHOLD SCIENCE

The University offers every year to each county in the State, except Cook and Lake, and to each of the first ten congressional districts, one scholarship for prospective students of agriculture in the College of Agriculture and one for prospective students of household science in the College of Liberal Arts and Sciences or the College of Agriculture.

Appointments to scholarships in agriculture are made by the Trustees of the University upon the recommendation of the Executive Committee of the Illinois Farmers' Institute; and to scholarships in household science upon the recommendation of the County Domestic Science Associations, or, for counties and districts in which there are no domestic science associations, on the recommendation of the Illinois Farmers' Institute. Persons who have already attended the University are not eligible.

Candidates who are able to meet in full the requirements for admission to the freshman class are eligible to appointment at 16 years of age. Candidates who cannot meet these entrance requirements are eligible to appointment as special students (in the College of Agriculture) at 21 years of age.

Acceptable candidates, residents of counties or districts for which appointments have been made, not exceeding five in number from any one county or district, may be assigned to counties or districts for which no recommendations are made. The first nominee from each county or district, if duly qualified, is awarded the scholarship at the time of registration. Other nominees must pay the regular fees on registration. Assignments to counties and districts for which there are no nominees registered are made on October 15, at which time the nominees so assigned to counties or districts other than their own receive rebates of the full amount of the matriculation and incidental fees paid.

The scholarships are good for two years and relieve the holders from the payment of the matriculation fee ($10.00, payable once, upon matriculation), and the incidental fees ($30.00 a year). If, before a scholarship expires, the holder satisfies in full the requirements for admission to the freshman class of the college in which he or she is enrolled the term of the scholarship may be extended to four years from the date of the student's matriculation.

MILITARY SCHOLARSHIPS

Students who have had three semesters of class instruction in military science and four semesters of drill practice are eligible for appointment as commissioned officers of the University Corps of Cadets. To those attaining this rank, special military scholarships, good for one year, and equal in value to the university incidental fees for the year, are open. The amount of these scholarships is paid to the holders at the close of the academic year. Appointments in the Corps of Cadets are made on the recommendation of the Commandant of Cadets, confirmed by the Council of Administration.

OTHER SCHOLARSHIPS

For scholarships in the College of Law, see page 203 of Register for 1917-18.

III

THE ACCREDITING OF HIGH SCHOOLS.

1. CONDITIONS.

High Schools or Academies are inspected for accrediting on application from the principal, superintendent or board of education. All applications should be made, *not later than January 30* of a given school year, to the University High School Visitor. Upon receipt of such application blanks will be sent to the applicant for a full and complete report on the conditions existing in high school or academy.

The general conditions looked for in the preliminary report from a school are:

1. Is the length of school year at least 36 weeks ($8\frac{1}{2}$ calendar months or 9 twenty-day months) of actual school work?

2. Is the financial condition of the district capable of sustaining a school at such standards as will assure reasonable efficiency?

3. Are there as many as four teachers below the high school in the high-school district?

4. Are there three or more teachers, including superintendent or principal, devoting full teaching time to high-school work? In the case of the superintendent at least half of his time should be given to high-school teaching and the other half to supervision.

5. Are the recitation periods at least 40 minutes in length *exclusive of time required for the movement of classes?*

6. Are consecutive double periods provided for all unprepared work, such as laboratory, shop, drawing?

7. Is the material equipment of the school adequate for the work it undertakes?

8. Are text-books well chosen?

9. Do any teachers have more than seven periods per day of recitation and laboratory work?

10. Are the teachers apparently well prepared for their work?

The studies and exercises of the high school are much more varied in character than those of the elementary schools. This is due to the fact that the development of civilization has resulted in building up widely varying interests as represented in the field of learning. The necessity for wide variation in subjects taught is also apparent in the widely varying needs of the different occupations for which the schools are expected to prepare.

This state of things adds greatly to the problem of selecting high school teachers. The number of subjects offered in a given curriculum as well as the relationship existing among these subjects needs to be taken into consideration. The employment of all the teachers qualified to teach only a few common subjects, as language and history, or mathematics and physics, will leave some important subjects entirely unprovided for. Teachers should be so selected as to provide as equitably as possible for the teaching of all subjects offered in the curriculum.

The very nature of the subjects to be taught in high schools calls for a high grade of scholarship. Here the thought processes are to be developed and the pupils taught to find out the truth for themselves in the study of books and of nature. Above all, ideals of good scholarship are to be inculcated, a process for which no mere smattering of the subjects to be taught can possibly qualify the teacher.

At the same time it is quite as desirable that the teacher possess those personal qualities which are essential in those who are to undertake the control and direction of the activities of high school girls and boys. Teachers should therefore be selected for the quality and strength of character which they are found to possess.

Thus scholarship and personality become the prime considerations. Of course there is an advantage in favor of the teacher who has, along with these qualities, a reasonable amount of experience; but experience alone can not make up for either one of the fundamental qualities named above. It frequently happens that Boards pay a good price for experience when if the character of that experience were known it would be found to disqualify rather than to recommend the employment of the candidate.

One of the requirements which should be understood by the candidate seeking employment is the capacity and willingness of the teacher to do "team work,"—to cooperate with principal and teachers in those little extraordinary services which the individual in any community should contribute to the common good.

In the matter of scholarship the Senate of the University of Illinois recently approved the following recommendation from the Committee on Educational Policy:

"That a statement be issued by the University to the effect that it is important to the welfare of the high schools of the State and to the high-school work of the high-school graduates that only those who have had four years' work of college grade beyond the four-year high-school course, or who have done work equivalent to the same, should be appointed in accredited high schools as teachers of the subjects of the ordinary high-school curriculum—exclusive, that is, of music and vocational and industrial subjects."

Thus while the University does not say to the accredited high schools that only teachers having the grade of scholarship mentioned will be approved, especial emphasis is put upon this standard as relating directly to the welfare of the high schools.

Attention may here be called to the fact that a similar standard of scholarship is required by the North Central Association of Colleges and Secondary Schools in its accrediting of high schools. Also that most of the states granting subsidies to high schools require a similar qualification on the part of high-school teachers. California goes even beyond this and requires master's degrees in many cases.

The source of supply of high-school teachers must necessarily be chiefly from the colleges and universities, including normal schools doing four years of work of college grade. In all these institutions some one is assigned the duty of answering calls from superintendents and boards for the recommendation of teachers to fill vacancies that have arisen or new positions that have been created in certain high schools.

To such committees or secretaries having in charge the appointments work of an institution school authorities desiring teachers may apply usually with the expectation of prompt attention to such calls and of reliable recommendations as to the character of the candidates named.

Generally speaking the superintendent or principal of a high school should be permitted some choice in the matter of teachers to be employed. In fact, if these officials are what they should be, they should be requested to nominate their assistants subject to approval by the Board.

2. METHODS.

If the report returned by the school applying for credit is satisfactory a visit for inspection will follow as soon as practicable. The Visitors report the results of their inspection to the committee on accrediting of schools and this committee makes recommendation to the Council of

Administration. If a school is found satisfactory a report is sent from the office of the High School Visitor together with a card on which is given a schedule of credits. Later a certificate of accrediting is sent out from the office of the University Registrar.

Accredited schools are visited at least once in three years, and oftener when deemed necessary. The University reserves the right to reconsider the accrediting of a school at any time in case of marked deterioration of work.

Each student coming to the University from an accredited high school or academy should request the principal of the school to send to the University Registrar a certificate showing the period of his membership in the high school, the fact of his graduation, the subjects he has taken in his course, the number of recitations in each subject, the length of recitations in minutes, the amount accomplished, and his average grade in each subject. For the particulars of these reports the high-school principal is often obliged to depend upon records made before the commencement of his own term of service in the school, and these records should consequently be regularly kept and preserved in a way to include all the information called for by the student's certificate above described.

In the matter of accrediting special emphasis will be placed on the preparation which pupils have as a basis for promotion to the high school. The training in English, as evidenced in its use by pupils, is considered particularly important here.

In the case of pupils from a two or three year high school who complete their work in a high school accredited by the University the work must be duly accepted and approved by the accredited high school receiving such pupils as fairly equivalent to the work of the receiving school. In other words the *credit must be transferred* so that it is certified as from the school where such pupils' work has counted towards graduation at par with the school's regular pupils. No such certificate should be granted unless a pupil has had at least one full year's work in the school certifying.

The University reserves the right to question the creditability of any four year high schools which commonly accept the work of students from two or three year high schools without first determining its equivalence to their own work. A similar reservation would apply in cases where a high school graduates students who have not completed the required work for graduation.

IV.

DESCRIPTION OF SUBJECTS WHICH MAY BE ACCREDITED AND ACCEPTED FOR ADMISSION.

The schedule of subjects accepted, together with the number of units of credit which may be given to each, will be found under admission requirements (see pp. 6 and 7).

In addition to the following descriptions and outlines of the various units of work acceptable for entrance reference should be made to recommendations as finally adopted by the High School Conference. These will be found published in the proceedings of the conference, a full set of which should be kept in the library of each accredited high school.

1. AGRICULTURE.

Courses in agriculture should be arranged for periods of not less than 36 weeks. Such a course may be accepted for one unit of entrance credit, and two such courses may be accepted for two units, provided the work covered by each course is so closely related in its parts as to constitute one of the generally accepted divisions now recognized in agricultural work. At least one-half the time should be devoted to laboratory work, and note-books should be presented. Seven periods of 40 minutes (two double) per week is the minimum.

The University now grants credit for three units of work in agriculture where a well trained teacher is employed and a suitable curriculum and equipment arranged. The following outline may serve as a basis for organizing a curriculum. The general practice now is to take up separate courses in different phases of agriculture rather than to offer a general course as was the practice in the early introduction of this subject into the high school.

In the Agricultural Section of the High School Conference, Nov. 20, 1908, the following outline of work in agriculture for secondary schools was presented:

Study of Soils

Physical composition of the soil.

Formation and transporting of soils.

Classification of soils with reference to texture.

Moisture relations of soils.

Different forms and movements of soil moisture.

Experiments to determine the percent of capillary, hygroscopic and total moisture in soils under different conditions.

Experiments to show how soils of different textures differ in their power to retain moisture and to raise it by capillary force.

Experiments to determine and to compare the percent of pore space in different soils.

Experiments to show that the capacity of soil to absorb and hold water depends upon the amount and character of the pore space.

Experiments to determine the percent of humus in soils.

Experiments to show how humus in soils affects their moisture relations.

Experiments to determine the real and apparent specific gravity of soils.

Study of temperatures of different soils.

Experiments to show effect of color on temperature of soils.

Experiments to show difference in temperature on drained and undrained soils.

Experiments to show the effect of lime on the texture of clay soils.

Experiments to show effect of organic matter on the texture of clay soils.

Study of causes, effects and control of soil erosion.

Experiments to show how soil moisture may be conserved by mulches.

Study of Plants and Crops

Study of root systems of plants and their relations to the soil.

Study of the stem and leaf in their relations to light and air.

Study of the flower in its relation to the seed and plant breeding.

Experiments in germination of seeds under different conditions of planting, temperature, heat, moisture, etc.

Experiments in soil fertility to determine essential plant foods.

Experiments to show the effect of each of the elements, nitrogen, phosphorus, and potassium on plant growth.

Experiments to show effect of lime on acid soils.

Experiments to show the power of bacteria living on the roots of legumes to secure nitrogen from the air.

Special Studies in Corn

Corn judging.

Testing of seed for germination.

Care of seed.

Corn breeding.

Experiments to show power to control different characters in corn by selection of seed.

Further Courses Recommended for Schools Prepared to Give More Extended Time to the Work

Study of breeds and types of farm animals.

Study of feeds, balanced rations and principles of feeding.

Study of milk, its composition, care and testing for butter fat.

Study of the more common diseases of farm animals, their symptoms and treatments, together with their causes and means of prevention.

Study of poultry.

Judging live stock.

Improvements of animals and plants.

Study of legumes, alfalfa, clover, cowpeas and soy beans.

Study of oats, wheat and grasses.

Study of the farm garden.

Preparation and use of insecticides and fungicides.

Study of weeds, their habits of growth and dissemination and how to eradicate them.

Study of farm machinery, farm buildings and cement construction.

NOTE—For further outlines see circular on Four Years' Work in High School Agriculture, published by the College of Agriculture. Also Four Years' Course in Agriculture, recommended by the Illinois Educational Commission, Report of 1910.

See also discussions, reports and recommendations in Conference Proceedings of subsequent years.

2. ASTRONOMY.

In addition to a knowledge of the descriptive matter in a good text-book, there must be some practical familiarity with the geography of the heavens, with the various celestial motions and with the positions of the conspicuous naked-eye heavenly bodies.

3. BOOKKEEPING.

The unit of work in bookkeeping for college entrance should consist of a working knowledge of both single and double entry bookkeeping for the usual lines of business. The student should be able to change his books from single to double entry and from individual to proprietorship. At least one set of transactions should be kept by single entry and at least two sets by double entry in which the uses of the ordinary bookkeeping books and commercial papers should be involved. The student should be drilled in the making of profit and loss statements and of balance sheets and should be able to explain the meanings of the items involved in both kinds of instruments. The work should be done under the immediate supervision of a teacher and the student should devote at least ten periods of not less than forty minutes full time in class each week for one academic year.

4. BIOLOGY.

The following reports of the Committee on Minimum Essentials of the Courses in Zoology, Botany, and Physiology were tentatively adopted by the Biology Section of the Conference in 1917.

A. *Botany*

FINAL REPORT ON THE MINIMUM ESSENTIALS FOR HALF-YEAR COURSE IN BOTANY.

By J. L. PRICER, Normal, Ill.

Although the committee on minimum essentials was not asked specifically to report electives also, we have thought it best to do so and to arrange both in some definite sequence so as to afford a working course for young teachers who do not feel able to arrange their own course.

The sequence here presented has been thoroughly tested by the writer and has been found to offer great teaching advantages and to be well suited to a half-year course beginning in February. If these topics are fully developed, they constitute a sort of continued story, each lesson preparing for the next and in turn throwing some light on previous lessons.

Topics regarded as essentials are preceded by the sign: *, while topics which are regarded as electives are preceded by the sign: ‡.

I. Flowers, Fruits, Seeds, and Seedlings. Five Weeks.

*1. Structure of two or more typical flowers, including the ovules and their parts. Geranium flowers and some variety of Narcissus can usually be secured from greenhouses in February.

*2. Pollination and the relation of flowers and insects.

*3. Fruits such as bean pod, corn kernel, apple, cocklebur. Identify parts of the flower in the fruit.

*4. Seeds, such as bean, corn, caster bean, pumpkin. Identify parts of the ovule in the seed. Parts of the embryo.

*5. Foods stored in corn kernel, including tests for starch, fats and proteins and microscopic study of thin sections. Note that food is stored within the cells usually in insoluble form.

*6. Starch digestion, using germinated barley grains and a ½ per cent starch suspension. Test for the disappearance of starch with iodine solution and for the appearance of sugar with Fehling's solution. Compare with digestion of starch by saliva.

*7. Demonstrate the process of respiration in germinating seeds by growing them in an enclosed vessel and testing the air about them for oxygen and carbon dioxide.

*8. Demonstrate the process of delayed germination in such seeds as the cocklebur, lupine and clover. Value of the property to the species. Its importance in the extermination of weeds.

‡9. Various methods of seed dispersal. Enormous number of seeds produced by some plants. A good demonstration of this can be had by securing a large pig weed in the fall, threshing out the seeds and estimating the number by weighing and counting one gram.

II. Roots, Stems and Leaves. Five Weeks.

*1. Roots and root hairs. Roles of the root system. Contrast with stems.

*2. Demonstrate the process of osmosis and apply it to the absorption of materials from the soils by roots. ‡Chemical elements taken from the soil by roots.

‡3. External features of stems, including methods of branching and elongating the axis, bud arrangement, homologies of thorns and tendrils. Climbing plants and rosette plants.

*4. Microscopic study of some woody plant such as Aristolochis. ‡Microscopic study of pine wood and some monocot stem, such as corn.

*5. Gross structure of woods used for finishing and furniture. Fitness of different woods for different purposes. Structural features of wood that give decorative effect in finishing lumber. Study decayed oak wood to get these features.

‡6. Pruning, budding and grafting. Relation of cambium and callous to these processes.

‡7. Trees and shrubs and their uses in decorative planting.

‡8. External structure of leaves. Forms of leaves, leaf arrangement, tropic responses in leaves. Light exposure in grasses and rosette plants.

*9. Microscopic structure of leaves. The epidermis with its stomates and a cross section.

*10. The process of photosynthesis. Demonstrate the need of light, carbon dioxide, and a suitable temperature. Show that oxygen is a waste product of the process. Contrast with respiration. Emphasize the importance of the process to the living world.—The sole source of food.

*11. Translocation and storage of food. Advantages gained by biennial and perennial plants by storing food in roots, stems and other organs at other times. Advantages to man of the concentration of foods in storage organs. Contrast the storage process with digestion. Definition of food.

*12. Transpiration. Loss of water, the great danger to plant life. Structural features which enable plants to expose enormous surfaces to the dry air. Cutin, cork, and the vascular system. Recall absorptive powers of roots. The important role of water in plant growth. Value of irrigation.

III. Algae and Fungi. Three Weeks.

‡1. Microscopic study of Gloeocapsa, Oscillatoria, Ulothrix, Vaucheria and Oedogonium. Primitive sexual reproduction in Ulothrix. Sex organs in Vaucheria and Oedogonium. Economic relations of algae. Food for water animals, and injury to water supplies.

*2. Microscopic study of the bacteria found in a hay culture. Identify the three different forms. Relations to the food of the hay and to the protozoan animals of the culture. Powers of digestion and absorption of food. Method and rate of multiplication. Conditions favorable and unfavorable to growth. Parasites and saprophytes. Disintegration of organic matter and return of fertility elements to the soil. Relations to soil nitrogen.

Methods of protecting food against the attacks of bacteria. Animal and plant diseases caused by bacteria.

*3. Miscroscopic study of yeast. Demonstrate the production of carbon dioxide and alcohol. The enzymes invertase and zymase. Wild yeasts and cultivated yeasts. The processes of wine, bread, and bread making.

‡4. The life and work of Pasteur. Benefits to man of the science of bacteriology.

*5. Microscopic study of several different kinds of mold. Methods and enormous powers of reproduction. Digestive and absorptive capacity of molds. Inoculate sound fruits and vegetables with different molds and observe the results. Means of preventing mold action on foods. If possible show the presence of mold spores in the air by culture methods.

‡6. Study a downy and powdery mildew as examples of parasitic fungi. Note their methods of reproduction and distinguish between phycomycetes and ascomycetes. Material for this study should be collected in the fall.

*7. Rusts and smuts. Work out the life history of wheat rust and of corn smut. Methods of control.

‡8. Mushrooms. Study of structure of several different types of fleshy fungi.

Note the method of bearing the spores and the great number of them. Identify a few forms of edible mushrooms. Teach the structure of the poisonous Amanita.

IV. Bryophytes and Pteridophytes. One Week.

‡1. Work out the life history of some liverwort, including the alternations of generations. Note the structure of the gametophyte. Lack of cutin, vascular system and roots, and consequent limitation to small size and to living in moist situations.

*2. Life history of some common moss including the alternation of generations. Note that the sporophyte is larger than in the case of liverworts and that it is approaching independence.

‡3. Life history of some common fern including alternation of generations. Note the independent sporophyte, true roots and vascular system. Large size of plants correlated with the structural features.

V. Reproduction in Gymnosperms and Angiosperms. Two Weeks.

*1. Study the cones of the Austrian pine and work out all the details of reproduction including the alternation of generations. Note that the female gametophyte is still a many celled structure and forms the endosperm of the seed surrounding the embryo. Make clear the fundamental identity between the reproduction in the seed plants and the higher seedless plants.

*2. In a similar way study reproduction in the Angiosperms working out all the details of pollination, development of male and female gametophyte, double fertilization, development of the embryo and endosperm and the maturing of the seed. Study several flowers with reference to their adaptations to cross or self pollination.

VI. Heredity and Plant Breeding. One Week.

*1. Pupils should be given some more or less detailed account of Mendel's life and work, of the so-called Mendelian laws, and of the process of transmission of hereditary characters. Illustrative material such as hybrid corn, hybrid fowls, or other available hybrids or pictures of them may serve to illustrate the transmission of unit characters. This material should be given in a well illustrated text, but if it is not in the text used, it may be given by lectures, with illustrative material, or it may be gotten from reference books.

*2. Along with the above, pupils should be given some notion of the work that is being done in the way of plant improvement through a knowledge of the laws of heredity. The breeding of disease resistant and drouth resistant plants and plants of greater productivity should serve as illustrations and the methods practised in plant breeding should be discussed. Some mention of human heredity and eugenics might be made in the way of application.

VII. Classification of Plants. One Week.

‡1. Pupils should be given something of the history of this phase of botany, including the life and the work of Linnaeus, the artificial and the natural systems of classification, and the fact that the latter is based on the doctrine of evolution. The characters of the four main divisions should be discussed in the way of review and then the pupils should be given some practise in the tracing of plants by means of a key. This should serve as a review of the structural features of plants as well as to give the pupils some notion of the general field of taxonomy.

B. *Physiology.*

Outline for an Eighteen Weeks' Course in Physiology.

Principal G. J. Koons, Township High School, Pontiac.

I. Introduction. One Week.

Essential.

Importance of study. Scope and divisions of subject. Man's place in the animal kingdom. Physiological division of labor. Relation of structure to function. Protoplasm. Cell structure and reproduction.

Optional.

Brief historical account. Demonstration of cell structure and reproduction with microscope or lantern. Kinds of tissues. Demonstration of common tissues.

II. Foods. Two Weeks.

Essential.

Necessity. Kinds. Sources of food supply. Composition and energy. Selection and preparation. Correct diets. The school lunch. Dangers in water and milk supplies.

Optional.

Composition of different kinds. Food charts. Simple methods of detecting adulterations. Safe methods of storing and preserving. Mistakes in diet. Is alcohol a food?

III. Digestion and Absorption. Two Weeks.

Essential.

Purpose of digestion. Structure and function of organs. The teeth. Oral hygiene. Secretion and action of digestive ferments. Digestion and absorption in the mouth. Importance of careful mastication. Digestion and absorption in the stomach. Digestion and absorption in the intestines. How food reaches the tissues.

Optional.

Demonstration of the viscera of cat, rat, or rabbit. Swallowing. The pupil should be able to trace in a clear and accurate manner the food from the time it enters the mouth until it is built up into the tissues. Causes of indigestion. Common diseases and disorders of the digestive organs. Intestinal parasites. Effect of alcohol on digestion and the digestive organs. How to keep the digestive organs in good working order.

IV. The Blood and Its Circulation. Two weeks.

Essential.

Composition of the blood. Structures and function of different parts. Structure, adaptation and function of organs of circulation. Course of the blood through the body.

Optional.

The malarial parasite and the blood. Demonstration of beef or sheep's heart. Demonstration of capillary circulation in frog's foot, tadpole's tail or fish's tail. Lymph and lymphatic vessels. Cause of fainting. Influence of alcohol on temperature of the body and the organs of circulation. Athletic heart. Headache remedies. So-called blood purifiers.

V. Respiration. One Week.

Essential.

Purpose. Necessity for oxygen. Structure, adaptation and function of organs of respiration. Breathing. Exchange of gases. Necessity for ventilation. Methods of ventilation. The sleeping room. Special attention should be given to colds and tuberculosis.

Optional.

Respiration in lower animals. Demonstration of "plucks" secured from butcher shop. Lung capacity. Internal respiration. Artificial respiration. Demonstration of methods of artificial respiration. The lung-motor. Dangers from breathing dust. Proper methods of sweeping and dusting. Outdoor sleeping. Drafts. Breathing exercise. Diseases of the organs of respiration. Preventive measures.

VI. The Skin and the Elimination of Waste. One Week.

Essential.

Functions of the skin. Structure. Hair and nails. Action of clothing and hygienic points to be observed. Bathing.

Optional.

Effect of overheated and underheated rooms on the skin. Effects of humidity. Cause of fever. Chills. Chilling lowers body's resisting power. Common skin diseases. Inflammation. Corns. Warts. Bunions. Ingrowing nails. Structure and functions of the kidneys. Effects of alcohol on the kidneys.

VII. Supporting Tissues. One Week.

Essential.

The human skeleton. Structure. Composition and growth of bones. Kinds and structures of muscles. Exercise. Simple exercses for developing and keeping body in good condition.

Optional.

Pupil should be able to name and identify on skeleton the important bones. Articulation. Importance of correct posture in sitting. Skeletal deformities and their causes. Demonstration with microscopic slides of different kinds of muscles. Training and development. Comparative value of different kinds of exercise.

VIII. The Nervous System. Three Weeks.

Essential.

Protected position. Parts. Structure and function of different parts. Sympathetic nervous system. Reflex action. Hygiene of nervous system. Rest. Play. Sleep. Principles of habit formation.

Special senses. Structure and function of the organs of the special senses. Proper light for reading. Lighting of homes and school rooms. Care of the eyes.

Optional.

Tobacco, alcohol and drug habits. Pain. Nervous disorders. Mental hygiene.

Demonstration of structure of eye with beef or hog's eye. Demonstration of structure of ear with model. Methods of testing hearing and sight. Defects of vision and how remedied. Trachoma.

IX. Accidents. Emergencies and Care of the Sick. One week.

Essential.

Importance of a cool head and quick action in accidents and emergencies. Discussion and demonstration of what to do in case of drowning, asphyxiation by gas, freezing, broken limbs, bleeding, poisoning, sprains and burns. Special attention should be given to what to do in case the clothing catches fire.

Optional.

The home medicine cabinet. What it should contain. Simple household remedies and their use. Proper care of the sick. The sick room. Food for the sick.

X. Home and Public Sanitation. Four weeks.

Essential.

1. Organisms that cause diseases. Bacteria: Classes, characteristics, reproduction, conditions favorable for growth. How they get into the body. Diseases caused by bacteria. Diseases caused by organisms other than bacteria as pyorrhea, malaria, ringworm and hookworm.

2. Hygienic and sanitary measures based on knowledge of parasites causing disease: food preservation, disinfection, vaccine and serum treatments, protection from and elimination of flies, protection from and elimination of mosquitoes.

3. Preventive measures and treatment of common diseases caused by parasites. Special attention should be given here to common communicable diseases. Bulletins on these diseases published by the State Health Department will furnish valuable material.

4. Prevention of disease by the individual. Importance of fresh air, pure food, pure water, healthful exercise and sufficient sleep. Causes of lowered resistance. Use of proper methods of dusting and sweeping. Prompt and proper treatment of cuts and wounds. Cooperation with civic authorities. How to Live, published by Funk and Wagnalls Company, is a good reference book for this subdivision.

Optional.

1. Prevention of disease by civic authorities. Care of the streets. Care of public places. Public water supply. Sewage and drainage. Supervision of sale of milk and other foods. Quarantine regulations. Medical inspection of schools.

The subject of sex hygiene is left to the judgment of the teacher. In some places it has been prohibited by the board of education. In others the results are reported as unsatisfactory. Some arrange to have the subject presented by physicians. A woman physician is secured to talk to the girls and a man to the boys.

Reference. Much helpful material may be found in the following books:

Ritchie's Primer of Sanitation. World Book Co.

Ritchie's Human Physiology. World Book Co.

Hartman's Laboratory Manual for Human Physiology. World Book Co.

Rettger's Elements of Physiology and Sanitation. A. S. Barnes Co.

Fisher and Fisk's How to Live. Funk and Wagnalls Co., N. Y.

Allen's Civics and Health. D. C. Heath & Co., Chicago.

Abridged Red Cross Textbook on First Aid. P. Blakiston's Sons Co., Philadelphia.

Rosenau's Preventive Medicine and Hygiene. D. Appleton & Co.

MacNutt's Manual for Health Officers. John Wiley & Sons, N. Y.

C. *Zoology.*

Minimum Essentials of an 18-Weeks' Course in Zoology.

This course was reported in detail at this meeting a year ago, when the results of a series of questions regarding it were given. These were printed in the Proceedings of the Conference under date of Jan. 8, 1917, pages 84-86 and 94. Further consideration of the proposed outline and further questioning of interested teachers have led us to change the plan slightly, in that differentiation is now made between essentials and optionals and that the outline is more full as to details. Thus we have a course of fifteen weeks work in seven animal phyla or classes, and an outline of suggested work in certain others. The remaining three weeks probably would be used in reviews, examinations, or holidays, and in expansion of some exercises or insertion of new ones, as the teacher may desire.

Before stating the revised course we would again call attention to the aim of the committee. We were not instructed to formulate a full course of study nor did we understand that our report would be adopted by and used by every accredited high school in Illinois. Those cities offering a year course will necessarily disregard it except as it might offer a nucleus for a fuller outline. The smaller schools feel the need of a guide course because their equipment is likely to be incomplete or disorganized, because the teacher often teaches other subjects also and is too busy to watch closely each subject and each topic, and because the teacher's tenure of office being short the course often suffers revision. We do not think of "compelling" anyone to do anything, but we offer the zoology outline as a means of standardization to those caring to use it.

Our suggested course follows:

Respectfully submitted,

Harold B. Shinn for Zoology.

Suggested Order of Studies.

September to January.

1. Insects.
2. Spiders.
3. Birds (given here because of fall migration).
4. Protozoans.
5. Sponges.
6. Coelenterates.
7. Flat and Thread Worms.
8. Earthworm.
9. Crustaceans.
10. Molluscs.
11. Fishes.
12. Amphibians.
13. Reptiles.
14. Mammals.

January to June.

1. Mammals.
2. Birds.
3. Reptiles.
4. Amphibians.
5. Fishes.
6. Protozoans.
7. Sponges.
8. Coelenterates.
9. Flat and Thread Worms.
10. Earthworm.
11. Molluscs.
12. Crustaceans.
13. Spiders.
14. Insects.

Insects. Four Weeks.

1.—Morphology and physiology of one form of local importance, as locust, bee, fly, mosquito, or a true bug.

2.—Adaptations to aquatic, burrowing, terrestrial, aerial, predaceous and other habits, in leg and wing; to respiration in various habitats; to changes of season, of habitat, and of food.

3.—Feeding habits and means of treating insect pests; studies of pests locally important.

4.—Economic forms of products; pollination, seed and fruit formation; disease transmission, personal and public sanitation.

Optional Topics.

1.—Modes of development and their adaptation changes during metamorphosis.

2.—Preparation of economic, life history, or type collections, of coloration boxes, of habitat photographs, or of local sanitary maps or charts.

3.—Anatomy, internal; (well taught by means of paper models).

Spiders. Two Days.

General external morphology, natural history and development.

Protozoa. One Week.

Cell physiology and anatomy. These studies, illustrated by living or stained material and original paper models, should be more carefully treated than by others in the course, to be efficient and brief. The story of gametes and of the evolution of sex is hardly proper here except as optional work.

Sponges. One Day.

Anatomy is not of essential importance. Commercial fisheries, to be studied by means of the text or encyclopaedia as informational reading, with demonstration specimens.

Coelenterates. Two Days.

Evolution of the metazoa, often stressed in the study of this phylum, is not advised here, but rather should attention be directed to either a brief study of corals and their geological-geographical importance or else to a reading lesson upon hydroids and jelly fishes. Structure may be well shown by preparation of a paper model, or "cut out," of the hydra, as a type study.

Flat and Thread Worms. Three Days.

The vinegar eel furnishes living material. Other forms may be used as museum material and life histories taught by means of diagrams. Tape-worm; Trichina; Hookworm; Ascarus.

Earthworm. One Week.

Individual dissections are strongly advised, with preparations of paper models to reproduce the dissection. The physiology of a relatively simple animal.

Crustacea. Three Days. Optional.

Intensive study of the crayfish is not advised, but a rather simple theme, as "Segmentation plus Protection." Minute forms of the plankton; lobster and crab fisheries; specialization and degeneration may be stressed for crab and barnacle.

Mollusca. One Week. (and)

External morphology only of mussel (or) snail, with their life history, ecology, or economics; button manufacture; pearl and oyster fisheries.

Fishes. One Week.

External morphology as an aquatic adaptation.

Studies in natural history and ecology of local game and food fishes. Ecological survey of a local pond or stream, to show distribution, light or bottom relations, etc., is advised.

Amphibia. One Week.

Life history of a frog; adaptations for double life while adult (circulation and respiration). Or Dissection of a simple vertebrate; its physiology.

Reptiles. Two Days.

Anatomy not important. Natural history of examples of lizards, snakes, and turtles and crocodiles. Or, evolution of birds and mammals before and through age of Reptiles.

Birds. Three Weeks. Essential Topics.

1. Recognition of common forms, 25 in spring work and 15 in fall work; field observation, construction of nest boxes, shelters, etc.
2. Economics of various wild types, graminivorous, insectivorous, etc.
3. External and internal morphology as adapted to flight; skeleton, musculature, and respiration.

Optional Topics.

1. Migration; times and methods.
2. Plumage; structure, molting, and uses.
3. Formation of the egg and story of its development.
4. Structure of the egg and utility of its form.
5. Poultry (fowls and pigeons). Types and breeds can be used in school or visited. Home projects may be accredited and are highly advisable.

Mammals. Four Weeks.

1. RODENTS (rat or rabbit) may be used to show relation of teeth to diet, edibility, disposition, home, habits, death rate and birth rate.

2. UNGULATES (cow, horse, sheep, or pig) illustrate methods of breeding and genetics, beasts of burden, sources of food, gregariousness and ease of domestication, means of defense, coloration, etc. Families may be discussed as for sponges.

3. CARNIVORA. Terrestrial and aquatic types, with families and examples may be stressed for adaptation, ecology, and natural history. A dog show conducted in the laboratory serves to add interest to the course and to exemplify types and breeds and natural history.

4. PRIMATES. By use of texts and reference books types are studied, with prehistoric man and the factors contributing to his development and supremacy. Geographic distribution of races.

5. THE MINOR ORDERS may be studied briefly.

The above studies of mammals should be illustrated by as many living and mounted specimens as can be secured; by skeletons, skulls, and teeth; by pelts or manufactured products; by lantern slides, magazine articles, bulletins, and reference books. Regional maps showing the wild forms known to be within the school district may be made and records of observations kept, as for birds. A cream separator can be borrowed or visited. A Babcock test secured and butter churned in a cream whip and samples passed through class on soda crackers. Considerable field work can be done as individual projects or class trips; muskrat lodges, beaver meadows, mouse tunnels beneath the snow, tracks, and burrows are legitimate material, as well as local dairies and creameries.

5. BUSINESS LAW.

The amount of business law which is accepted is indicated by the ground covered in any of the ordinary text-books on the subject, such as Spencer's Elements of Commercial Law, Burdick's Business Law, and White's Elements of Commercial Law.

6. CHEMISTRY.

The instruction must include both text-book and laboratory work. The work should be so arranged that at least one-half of the time shall be given to the laboratory. The course as it is given in the best high schools in one year will satisfy the requirements of the University for the one unit for admission. The laboratory notes, bearing the teacher's indorsement, must be presented as evidence of the actual laboratory work accomplished. Candidates for admission may be required to demonstrate their ability by laboratory tests.

Following is a revised copy of an "Outline of Experimental Work in Chemistry" as reported to the High School Conference November 24, 1911:

1. Physical and Chemical Changes.

The experiments suggested in any of the manuals in the reference list, or in the text used.

2. The Production of Chemical Changes.

a. Heat. Heat sugar in an evaporating dish.
b. Electricity. Electro-plating with copper. (Instructor).
c. Light. Expose blue print paper to light.
d. Trituration. Rub together mercury and iodine in a mortar.
c. Solution. (1) Mix baking soda and tartaric acid, both dry.
(2) Dissolve baking soda and tartaric acid separately in water and then mix the solutions.

3. Mixture and Compounds.

4. Oxygen.

a. Preparation of oxygen.
(1) By heating mercuric oxide.
(2) By heating mixture of potassium chlorate and manganese dioxide.
b. Properties of oxygen.
Color, taste, smell.
c. Chemical behavior.
(1) At ordinary temperature on charcoal, sulphur and phosphorus.
(2) At higher temperature on charcoal, sulphur, phosphorus, iron wire or watch spring.
(3) Oxidation of all types.

(4) Combustion.
(5) Role of oxygen in life.
(6) Ozone.

d. Weight of a liter of oxygen. (Instructor).
e. Chemical Equations "begun."

5. Hydrogen.

a. Preparation of hydrogen.
   (1) By electrolysis (Instructor)
   (2) By action of sodium on water.
   (3) By action of zinc and iron on dilute hydrochloric and sulphuric acids.
   (4) By action of zinc and iron on acetic acid. (Instructor)
b. Properties.
   (1) Color, odor, taste.
   (2) Weight as compared with air. Leave bottle of hydrogen uncovered. Pour hydrogen upward from one vessel to another. (Fill soap bubbles or small toy balloons with hydrogen). (Instructor).
   (3) Diffusion. Occlusion.
c. Kinetic theory of gases reviewed and extended.
d. Chemical behavior.
   Burning of hydrogen; heat of flame; color of flame.

6. Water.

a. Occurrence of water in wood.
b. Hydrates.
   (1) Heat crystals of copper sulphate; when white, treat with drop of water—Taste? Solubility?
   (2) Heat alum on iron plate as in (1).
   (3) (a) Treat washing soda crystals as in (1)
       (b) Exhibit and interpret crystals of various substances that are partially dehydrated. (Instructor).
c. Efflorescence of sodium sulphate.
d. Deliquescence of calcium chloride.
e. Vapor tension reviewed or taught and then expanded to include gases, liquids, and solids.
f. Vapor tension of gum camphor and moth balls used in explaining their uses.
g. Decomposition of water by electric current. Reviewed. See VL. (1)
h. Displacement of hydrogen from water by iron.
i. Synthesis of water by means of eudiometer. (Instructor)
j. Synthesis of water by means of hydrogen and copper oxide. (Instructor)
k. Distillation of water. (Instructor)
l. Simple tests for impurities in water.

(1) Organic matter.
(2) Chlorides.
(3) Carbonates and bicarbonates.
(4) Calcium compounds.
(5) Sulphates.

m. The testing of water for industrial, sanitary, domestic, etc., purposes.

n. Solutions.
(1) Molecular theory[1] of solutions.
Kinetic theory further extended.
(2) Physical equilibria[2] of the gaseous liquid and solid states of a substance.

7. Chlorine.

a. Preparation.
(1) Making chlorine by means of hydrochloric acid and manganese dioxide.

b. Properties of chlorine.

c. Chemical behavior of chlorine.

d. Bleaching. Commercial uses of bleaching. Commercial manufacture of bleaching powder.

e. Commercial manufacture of chlorine by the Deacon process. Liquid chlorine. Catalytic Actions. Action of Manganese Dioxide and Potassium Chlorate Reviewed. Action of Powdered Glass or Sand $KClO_3$.

f. (1) Dry steam and chlorine when heated yield hydrochloric acid and oxygen, thus 2Cl plus H_2O equals 2HCl plus O.
(2) Hot gaseous 2HCl and oxygen yield water and chlorine thus: 2HCl plus O equals H_2O plus Cl.
(1) and (2) are reversible reactions.

g. Chemical equilibrium developed.

8. Hydrochloric Acid.

a. Preparation of hydrochloric acid from sodium chloride and sulphuric acid

b. Properties of hydrochloric acid.

c. Chemical behavior of hydrochloric acid.

d. Commercial manufacture of hydrochloric acid.

*9. Fluorine.

*10. Hydrofluoric Acid.

a. Preparation from calcium fluoride. Properties.

b. Etching of glass.

*11. Bromine.

Preparation from potassium bromide.
Study of properties.

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[1] See especially "General Chemistry" by Alexander Smith; Chaps, IX & X.

[2] General Chemistry by Alexander Smith, pp. 115 to 127; also McFarland's Principles of Chemistry, pp. 144-154, and Richard's Industrial Water Analysis Notes for Engineers.

*12. Hydrobromic Acid.

Action of sulphuric acid on potassium bromide.

*13. Iodine.

a. Preparation from potassium iodide.
b. Properties.
   Solubility in water, alcohol, potassium iodide solution and carbon disulphide.
c. Tinctures. Manufacture and use.
d. Effect on starch paste.
e. Displacement of iodine from potassium iodide by means of chlorine and bromine.

*14. Hydriodic Acid.

Action of sulphuric acid on potassium iodide.

15. Acids Bases and Salts. Ionization.

Effects of ionogens upon the boiling point and freezing point. Upon osmotic pressure. Molecular weight. Use of theory in calculations.
Modern methods of making water analyses.

a. Test distilled water: (1) as to taste, (2) action on litmus, (3) conductivity.
b. Repeat 1, 2, 3 of a, using solution of sodium hydroxid (Caustic soda). Try its solution effect on solution of ferric chlorid. A substance which in solution has such action is called a BASE.
c. Repeat 1, 2, 3 of a, using solution of hydrogen chlorid (Hydrochloric acid). Try its action on baking soda. A substance whose solution gives such effects is an *ACID*.
d. To 5cc. sodium hydroxid solution add hydrochloric acid drop by drop with constant stirring till a strip of litmus suspended in the solution is just violet in color. Evaporate to dryness, moisten with water and dry again. Repeat b and c using solution of this solid. Such a substance is a *SALT* and the process by which it is obtained is NEUTRALIZATION.

16. Valence.
17. Knowledge of Chemical Equations extended.
18. Neutralization.
19. Law of Definite Proportions.
20. Law of Multiple Proportions.
21. Law of Equivalent Proportions.

22. Avogadros Hypothesis.

23. The Atmosphere.

a. Proportion of oxygen and nitrogen by the phosphorus method.
b. Proportion of O and N by the pyrogallic acid method.
c. Presence of water vapor by means of calcium chloride.

d. Presence of carbon dioxide by means of lime water. Ventilation. Recent researches on effect of CO_2.
e. Weight of liter of air. (Instructor)
f. Dust in the air.
g. Atmospheric pressure.
h. Humidity and health.
i. Biology and physiography of the air, touching especially c, d, f, and h.
*j. The rare elements of the atmosphere. Argon, helium.
For several good experiments, see various H. S. manuals in Physiography. krypton, neon, xenon.
k. Liquid Air, Low temperatures. Commercial preparation of liquid oxygen.
l. Study of the element, nitrogen.

24. Ammonia.

a. Preparation of ammonia:—
By means of ammonia chloride and calcium hydroxide.
b. Properties.
c. Chemical behavior.
d. Artificial refrigeration.
(1) Freeze water surrounding a test tube containing ether which is vaporized by pumping through the same a stream of air by means of a bicycle pump.
Effects of the reduction of pressure upon a gas reviewed and expanded. Critical temperature and pressure.
(2) Evaporate ether in a watch glass immersed in water by placing same under receiver of an air pump and exhausting the air.

25. Nitric Acid.

a. Preparation of nitric acid from sodium nitrate.
b. Chemical behavior of nitric acid.
c. Solubility of nitrates.
d. Reduction of nitric acid by means of nascent hydrogen and formation of ammonia.
e. The manufacture of nitric acid and nitrates by means of electricity.

26. Nitrification.

Soil bacteria. Commercial methods in use.

27. Oxides of Nitrogen.

*a. (1) Preparation of nitrous oxide ammonium nitrate. Properties of nitrous oxide. (Instructor)
(2) The production of anaesthesia. Modern methods in use in surgery and dentistry.
b. Preparation of nitric oxides by means of copper and nitric acid. Properties of nitric oxide.
c. (1) Preparation of nitrogen peroxide from nitric oxide by contact with air.

(2) Formation of NO_2 from NO by contact with the air at ordinary temperatures. The formation of N_2O_4 from NO_2 at lower temperatures. Conditions of dissociation. Equilibrium equations.

28. Phosphorus.

a. Examination and comparison of waxy phosphorus and red phosphorus.
b. Action of phosphorus and iodine.
c. Preparation of phosphine. (Instructor)

29. Arsenic.

a. Examination of the element. Examination of arsenic trioxide. Reduction of arsenic trioxide.
b. Preparation of arsine and decomposition by heat. Marsh's test for arsenic.
c. Insecticides and fungicides.

*30. Antimony.

a. Properties.
b. Preparation of stibing. Comparison with arsine.

*31. Bismuth.

a. Properties.
b. Periodic Grouping Discussed. See references under Periodic Law.

32. Sulphur.

a. Properties.
   (1) Examinations of roll sulphur.
   (2) Preparation and examination of amorphous sulphur by distillation of sulphur and condensing in a beaker of cold water.
   (3) Preparation and examination of monoclinic sulphur by cooling molten sulphur in a crucible.
   (4) Preparation and examination of rhombic crystals of sulphur by decomposition from carbon disulphide solution. (Instructor)
b. Chemical behavior of sulphur. Action of heated sulphur upon iron filings and copper foil. Formation of sulphur dioxide by burning.

33. Hydrogen Sulphide.

a. Preparation from ferrous sulphide.
b. Properties: Solubility in water, combustion. Use of hydrogen sulphide as a precipitant of metals from solution.

34. Sulphur Dioxide.

a. Preparation.
   (1) By burning sulphur.
   (2) By action of copper upon sulphuric acid. (Instructor)
   (3) By action of sulphuric acid upon sodium sulphite.

Properties: Color, odor, solubility in water, action of solution toward litmus, bleaching power.

*35. Sulphur Trioxide.

Preparation by passing sulphur dioxide and air over platinized asbestos. (Instructor)

36. Sulphuric Acid.

a. Preparation from sulphur trioxide. (Instructor)
*b. Preparation by lead chamber process. (Instructor)
c. Commercial manufacture of sulphuric acid by the contact process. Catalytic action reviewed and expanded.
d. Properties of sulphuric acid.

*37. Additional Theory.

a. Molecular masses.
  (1) Vapor density methods.
  (2) Osmotic pressure methods.
  (3) Boiling point and freezing point methods.
b. Atomic masses.
  (1) Exact atomic masses.
  (2) Law of Dulong and Petit.
  (3) Determination of formula of a compound.
c. Laws of Simple and multiple Volumes.
d. Thermochemistry.
  (1) Law of Dulong and Petit reviewed.
  (2) Definition of units.
  (3) Heat of formation.
  (4) Heat of reaction.
  (5) Typical exothermic and endothermic reactions.

38. Carbon.

a. Use of charcoal or boneblack as filters.
b. Action of oxygen upon heated carbon; showing the formation of carbon dioxide by its action on lime water.
c. Reduction of copper oxide by means of charcoal.

39. Carbon Dioxide.

a. Show presence of carbon dioxide in breath by means of lime water.
b. Liberation of carbon dioxide from carbonates by means of acids.
c. Properties of carbon dioxide:
  Color, odor, taste, weight as compared with air, effect upon flame or spark, action of carbon dioxide upon caustic potash or lime water. Show how presence of carbon dioxide in water causes calcium carbonate to dissolve.
d. Decomposition of carbon dioxide by burning magnesium.
e. Oxidation of powdered charcoal by means of potassium nitrate.

40. Carbon Monoxide.

a. Preparation of carbon monoxide from oxalic acid.
b. Properties: Burning carbon monoxide. Reduction of copper oxide by carbon monoxide.

44. Additional Compounds of Carbon.

a. Acetylene, etc.
b. Soaps.
c. Alcohols.

41. Study of Flames.

a. Flame produced by jet of illuminating gas in atmosphere of air or oxygen. (Flame produced by jet of oxygen in atmosphere of illuminating gas. Instructor)
b. Kindling temperature of gases. (Instructor)
   (1) Try lighting gas by means of hot wire estimating kindling temperature by shade of wire which will ignite flame.
   (2) Cooling effect of wire gauze on burning gas.
   Application to safety lamp.
c. Structure of flame. Reduction of oxides and oxidation of metals by means of blow pipe.

*42. Boron.

Preparation of boric acid from borax. Flame test. Borax beads.

43. Silicon.

a. Preparation of silicic acid. Water glass.
b. The manufacture of glass. The kinds of glass.
c. The manufacture of carborundum.

*44. Lithium.

45. Sodium.

a. Examination of piece of sodium, action of air upon it, action of sodium upon water reviewed.
b. Electrolytic preparation of sodium hydroxide.
c. The commercial manufacture of sodium carbonate and sodium bi-car bonate. Uses in the arts and in daily life.
d. Sodium in agriculture.
e. Sodium amalgam.

46. Potassium.

a. Examination of piece of potassium; action of air upon it; action of potassium upon water. (Instructor)
b. Extraction of potassium carbonate from wood ashes.
c. Manufacture of potassium hydroxide from potassium carbonate.
d. Potassium in the industries and in daily life.
e. The manufacture of fertilizers by electrical methods.

47. Ammonium.

a. Preparation of ammonium amalgam from sodium amalgam and ammonium chloride.
b. Theories of classification of ammonium based upon experimental evidence in (a) and in references cited.

48. Test for Alkali Metals.

a. Action of alkalies on ammonium salts reviewed.

b. Detection of members of alkali group by means of flame tests.

49. The Periodic Law. Study of Curves. Their Significance. Recent Investigations.

References: Newth's Inorganic Chemistry; Alex Smith's General Chemistry; Remsen's College Chemistry; Hessler & Smith's Essentials of Chemistry; Dobbin & Walker's Chemical Theory; Venable's Rise and Development of the Periodic Law; Mendelejeff's Principles of Chemistry; Science—June 29, 1900, July 6, 1900, Nov. 10, 1911.

50. Calcium Group.

a. Preparation of calcium chloride from limestone.

b. Preparation of lime from limestone.

c. Slaking lime—manufacture of lime water; use of lime water to detect carbon dioxide.

d. Manufacture of Plaster of Paris from Gypsum; uses of Plaster of Paris.

e. Preparation of Calcium Carbide.

f. Cements. The cement industry. Mortar.

g. Test for calcium by formation of calcium oxalate in solutions.

h. Flame reactions of barium, strontium and calcium.

i. Comparison of the elements of the calcium group and their compounds.

51. Magnesium.

a. Examination of magnesium.

b. Burning of magnesium.

c. Citrate of magnesium. Uses.

d. Commercial uses illustrated in face powder, pipe covering, electric fuses, etc.

e. Test of magnesium.

f. Preparation of compounds of magnesium from magnesite.

52. Zinc.

a. Examination of zinc.

b. Action under blow pipe.

c. Study of paints.

d. Action with acids reviewed.

e. The formation of zincates. Explained by ionic theory.

53. Copper.

a. Examination of copper.

b. Action with acids.

c. The preparation of copper nitrate.

d. Displacement of copper from its compounds by zinc and iron.

e. Precipitation of copper sulphide by means of hydrogen sulphide.

f. The refining of copper by electrolytic deposition.

g. Oxidized copper.
h. Alloys.
i. Hydrates.
j. Flame tests.
k. Cuprous compounds.
l. Insecticides and fungicides.

54. Mercury.

a. Examination of mercury.
b. Action with acids.
c. Mercurious and mercuric compounds.
d. Amalgams. Use in electrical work.
e. Preparation of Nessler's solution by the student. Uses.

55. Silver.

a. Examination of silver.
b. Preparation of silver nitrate from a ten cent piece.
c. Formation of silver chloride in solution. Action of light upon haloger compounds of silver. Photography.
d. Reduction of silver chloride by means of zinc and dilute sulphuric acid.
e. Action of silver under blow pipe.
f. Common industrial processes for the preparation of silver.

56. Aluminum.

a. Study of aluminum.
b. Action with acids and alkalies.
c. Precipitation of aluminum hydroxide. Sodium aluminate.
d. Testing of alums for ammonium and potassium.
e. Make alum from clay.
f. Mordants and lakes. Dyeing.
g. Electrolytic preparation of aluminum.
h. The ceramic industries.
i. Domestic uses of the metal.
j. The glass industry reviewed and additional processes studied.
k. Ceramics.

57. Lead.

a. Examination of lead.
b. Action with acids.
c. Action under blow pipe.
d. Action of nitric acid on red lead (minium). Action of red lead under blow pipe.
e. A comparative study of the oxides of lead.
f. A study of the carbonate in paints.
g. Ionic studies of lead.
    (1) In storage batteries.
    (2) Action of water on lead pipes. Pitting of boilers.
    (3) Electrolytic action on pipes.
h. *Optional.* The paint industry.

58. Tin.

a. Examination of tin.
b. Action with acids.
c. Reduction of mercuric chloride by stannous chloride.
d. Tin salts as mordants. Lakes.

59. Iron.

a. Examination of iron.
b. Action of iron with acids.
c. Change of ferrous compounds to ferric compounds and conversely.
d. Commercial methods of preventing corrosion. Bower's Barff process.
e. The industrial preparation of iron. Vanadium steel. Tungsten steel.

*60. Manganese.

Reduction of potassium permanganate by means of ferrous sulphate.

*61. Chromium.

a. Action of acids on chromates and alkalies on dichromates.
b. Use of chromium compounds in dyeing.
c. Pigments.

*62. Gold.

a. Properties of gold.
b. Action with acids. Solution in aqua regia.
c. Test for gold. Reduction with stannous chloride and formation of purple of Cassius.

NOTE.—For Household Chemistry the teacher is referred to University Bulletin No. 24 (Feb. 9, 1914).

7. CIVICS.

It is believed that the high-school course in civics should deal fundamentally with the local social organization of institutional life and industries, with the general nature of a democracy, and with the duties and obligations of citizens in a democracy.

This should be followed by a good brief treatment of the organization and character of government in the United States and a discussion of the meaning of the ballot as an obligation of citizenship.

8. DOMESTIC SCIENCE.

The University now accepts two units of credit in domestic science. These two units may be comprised of work as follows:

(a) An equivalent of 180 hours of prepared work with at least two recitation periods a week in foods. (b) An equivalent of 180 hours of prepared work with at least one recitation period a week in clothing. (c) An equivalent of 180 hours of prepared work with at least two recitation periods a week on the home. (Two periods of laboratory work are considered equivalent to one period of prepared work.) Of the foregoing, (a) will be accepted as a unit's work; or two half units from (a) and (b), or (a) and (c), or (b) and (c) will be accepted as a unit's work. The work is to be done by trained teachers with individual equipment, as determined by inspection.

For a more detailed outline of courses see Syllabus of Domestic Science and Domestic Art for the High Schools of Illinois (University Bulletin No. 24, Feb. 1914). This is the syllabus revised and adopted by the Domestic Science Section of the High School Conference November, 1910, and is the approved basis for accrediting high-school work in this department.

9. DRAWING.

Free-hand or mechanical drawing, or both. Plates or drawing books must be presented where entrance is on examination. The number of credits allowed depends on the quantity and quality of work done.

A. *Free-hand.*

Following is a course in outline for free-hand drawing as approved by the Manual Arts Section of the High School Conference, November, 1910:

Basis for credit—1 Unit—240 Hours.

Approximately one-third of the time should be given to representative drawing and two-thirds to decorative composition, design, constructive design and crafts work.

FIRST YEAR

1. Pictorial—
   Plant Study—Flowers, sprays of leaves, seed pods, etc., in full values of light, shade and color.
   Object Study—Furniture, interiors, etc. Perspective, scientific apparatus, vase forms, common objects.
   Mediums—Pencil, charcoal, colored crayons, water color, pen and ink.
2. Decorative Composition—Two values.
   Plant forms, object study.
   Plant analysis (for purposes of design.)
   Mediums—Pencil, brush, ink, charcoal.
3. Design—(Space divisions, conventionalized plant forms.)
   Decorative units, borders, surfaces, illustrating balance and rhythm.
   Arrangements of straight lines (tile designs).
   Collection of insect and plant forms to be used as motives for design.
   Mediums—Pencil, brush, ink, water color, charcoal.
4. Constructive Design—
   Designs for tiles, candlesticks, tea caddies, nut bowls.
   Decorations inlaid and incised.
5. Craft—
   Pottery, to be finished in biscuit or glaze.

6. Lecture Course—
   Utility—Practical talks on the fitness for service and beauty of decoration in the common objects for home use. Streets attractive and ugly.
   Beauty—Study of Greek life—spirit of the people—vase forms, their proportion and decoration.

Second Year

1. Pictorial—
   Plant Study—Still life—Landscape—Pose—Scientific Apparatus.
   Mediums—Pencil, charcoal, brush and ink, colored crayons, water color.
2. Decorative Composition—Three values.
   Plant Study—Landscape—Pose—Scientific Apparatus, used for decorative effects in covers, etc.
   Plant analysis—(For purposes of design.)
3. Design—(Conventionalized plant forms.)
   Intensity scales.
   Color balance.
   Decorative arrangements for wall papers, etc.
   Conjugated arrangements of lines, straight and curved, in borders, corners, surfaces, repeats.
   Color schemes for interior decoration.
   Lettering and illuminating.
4. Constructive Design—
   Designs for mats, card cases, pocket books, book covers, large table or lamp mats.
5. Craft—
   Embossed leather, ooze leather, colored.
   Mediums—Oil colors and gasoline, Easy dye.
6. Lecture Course—
   Utility and beauty: Interior decoration, wall decoration and spacing.
   Arrangement of furniture for center of interest and harmony of effect.
   History: Historic Ornament, Egyptian, Greek, Roman, Moorish, Byzantine, Gothic, Renaissance.

Third Year

1. Pictorial—
   Plant study—Cast drawing in three tones—Still life—(Reference to College requirements.)
   Post drawing—Landscape.
   Mediums—Pencil, water color, charcoal.
2. Decorative Composition—
   Plant forms—Pose—Landscape.
   Mediums—Ink, water color, charcoal.
3. Design—
   Accidental confusion of colors brought into harmony.
   Study of Japanese prints.
   Schemes of color for interior decoration.
   Plans for a school park or play ground.

4. Constructive Design—
    Designs for a belt buckle, watch fob, ink pot, lantern.
5. Craft—
    Copper, etched or decorated with enameling.
6. Lecture Course—
    Utility and beauty; Discussion of landscape and civic architecture of the immediate neighborhood.
    History: History of Painting; Italian, Spanish, Dutch, Flemish.

FOURTH YEAR

1. Pictorial—
    Antique casts—Composition from famous masters.
    Pose Drawing—Landscape.
    Mediums—Water color, charcoal.
2. Decorative Composition—
    Landscape.
    Mediums—Water color, charcoal.
3. Design—
    Color harmony by interchange.
    Colors of semi-precious stones and their use in design.
    Rythmic measures and proportions in Architecture.
    Planning of the rooms of a house with samples of curtains, carpets, wall papers if possible.
    Medium—Designers' Colors, pencil, pen and ink, water colors.
4. Constructive Design—
    Designs for scarf pins, rings, cuff links, etc.
5. Craft—
    Silver with simple pierced decorations and semi-precious stones.
6. Lecture Course—
    Utility and Beauty: Handicrafts of the present century.
    History: History of Painting; German, French, English and American.
    Ethics: Imitation in furniture, etc. What principles are involved in the present craftsman movement.

NOTE.—Instrumental drawing to be given as needed to meet requirments of practical designing and construction. Book binding, furniture construction, wood block printing (decorative composition in landscape, figure study, plant study, etc.) may be substituted for one year of any craft. Stenciling to be given in connection with design if there is sufficient time.

B. *Mechanical Drawing.*

A half unit of this is required as part of the first unit in manual training. Where a school can properly equip for it, and employs a suitable teacher, it is desirable that at least an additional unit be offered in this department. The demand for good draughtsmen is very strong and is likely to continue so.

10. ECONOMICS.

The principles of economics, with economic history, as given in any good elementary text-book.

This subject has been made the basis of special study by a committee of the Commercial Section of the High School Conference. The following syllabus was adopted by that Section in 1916:

I. Some dominant characteristics of the present economic order.
- A. The nature of Economics as a Social science.
- B. The creation of wants. Human needs.
- C. Cost of marginal utility.
- D. The principle of cooperation.

II. Production.
- A. The factors of production.
  - 1. Land.
    - a. The point of diminishing returns.
    - b. Forces affecting the law of diminishing returns.
  - 2. Labor.
    - a. Population vs. Land.
    - b. The Malthusian theory.
    - c. The kinds of division of labor.
  - 3. Capital.
    - a. Capital and non-capital goods.
    - b. The creation of capital.
    - c. Corporation capital.
    - d. Large and small scale production.
    - e. The entrepreneur's function one of capital.

III. Exchange.
- A. Value.
  - 1. Supply and demand.
  - 2. Normal price under fair competition.
  - 3. Monopoly value.
  - 4. The law of Monopoly.
- B. Money.
  - 1. Standards of value.
  - 2. Bimetallism.
  - 3. The gold standard.
  - 4. Fiat money.
  - 5. Ms. forms of money.
  - 6. The movement of money.
- C. Banking.
  - 1. Banking institutions: Bank credit; discounts; reserves.
  - 2. State and National banking laws.
  - 3. Federal Reserve Bank.

D. International Trade.
   1. Nature of; advantages of—
   2. The balance of trade—how "favorable".
   3. International trade restrictions.
      a. The revenue tariff.
      b. The protective principle.
      c. Recent tariff history.

IV. Distribution.

A. General Considerations.
   1. Relation of income to the three factors of production.
   2. The difference between real and money income.
   3. Classes of income.

B. Rent.
   1. Rent vs. Interest.
   2. Rent under uniform intensity of cultivation.
   3. Rent under actual conditions.
   4. The capitalization of rent.
   5. The law of diminishing returns as applied to rent.
   6. The unearned increment. Present methods of taxing unearned increments.

C. The Wages of Labor.
   1. Demand and supply.
   2. The effect of labor saving machinery on demand.
   3. The subsistence theory of wages.
   4. Supply of labor in different occupations.
   5. The wage contract. (Eight hour day, classes of labor, etc.)
   6. Problems of Labor organizations.
      a. Collective bargaining.
      b. Economic justification of labor organizations.
      c. Contracting types of labor organizations.
      d. Arbitration.
         1. voluntary.
         2. compulsory.
      e. Labor legislation.
      f. Immigration and the labor problems.

D. Interest.
   1. Why interest can be paid. Time values.
   2. The investment and replacement of capital.
   3. The rate of interest. Gross and net interest.

E. Profits.
   1. The wages of the entrepreneur.
   2. Gains of bargaining.
   3. Gains of non-competition, monopoly gains.

V. Public Finance.

A. Revenues.

1. Taxation.
    a. General characteristics.
        1. The equity of taxation.
        2. Direct and indirect taxes.
    b. Kinds.
        1. Customs duties.
        2. Internal revenues.
        3. General property tax,—inheritance, corporation, etc.
        4. Income tax.
2. Minor sources of revenue. War tax, license, fines, etc.

B. Expenditures.
1. Justification of increase.
2. Waste in Expenditures.
    Useless offices, Harbors and Rivers Bill, etc.

VI. Social Reforms, or Economic Functions of Government.
1. The conservation of National resources.
2. The problem of monopolies.
3. Transportation.
4. Socialism.
5. The single tax.
6. Labor arbitration.

Note: This may be shortened.

VII. A History of the Early Economic System.
1. Ancient economic ideas.
2. Economic ideas of middle ages.
3. Adam Smith and the classical school.
4. The growth of the historical school.
5. Early American economists.
6. Present trend of economic thought.

Note: This may come before section II.

Proposed texts suitable for high school economics

E. J. Bullock: Introduction to the Study of Economics. Silver, Burdett and Company.

J. L. Laughlin: The Elements of Political Economy. American Book Company.

Burch and Nearing: Elements of Economics. Macmillan.

Ely and Wicker: Elementary Principles of Economics.

Suggested readings and texts for supplementary material

VanHise: The Conservation of Natural Resources.

Jenks: The Trust Problem.

Johnson: American Railway Transportation.

Henry George: Single Tax.

Sparzo, J.: Elements of Socialism.

Suggested works for use of teachers

F. M. Taylor: Principles of Economics, Published by the University of Michigan.

Chapters 8, 9, and 10 on Price Determination.

Chapters 2 and 3 on Production.

Ely: Outlines of Economics. Macmillan.

Hamilton, W. H.: Current Economic Problems, University of Chicago Press.

Gide and Rist: History of Economic Doctrines. D. C. Heath and Company.

11. ENGLISH COMPOSITION AND RHETORIC.

Correct spelling, capitalization, punctuation, paragraphing, idiom, and definition; the elements of rhetoric. The candidate will be required to write two paragraphs of about one hundred fifty words each to test his ability to use the English language. This work counts for one unit.

12. ENGLISH LITERATURE.

(a) Each candidate is expected to have read certain assigned literary masterpieces, and will be subjected to such an examination as will determine whether or not he has done so. With a view to a large freedom of choice, the books provided for reading are arranged in the following groups, from which at least ten units are to be selected, two from each group. Each unit is here set off by semicolons.

I. The Old Testament, comprising at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings, and Daniel, together with the books of Ruth and Esther; the Iliad, with the omission, if desired, of Books XI, XIII, XIV, XV, XVII, XXI; the Odyssey, with the omission, if desired, of Books I, II, III, IV, V, XV, XVI, XVII; Virgil's Aeneid. The Iliad, the Odyssey, and the Aeneid should be read in English translations of recognized literary excellence.

For any unit of this group a unit from any other group may be substituted.

II. Shakespeare's Merchant of Venice; Midsummer Night's Dream; As You Like It; Twelfth Night; Henry the Fifth; Julius Caesar.

III. Defoe's Robinson Crusoe, Part I; Goldsmith's Vicar of Wakefield; Scott's Ivanhoe or Quentin Durward; Hawthorne's House of Seven Gables; Dickens' David Copperfield or Tale of Two Cities; Thackeray's Henry Esmond; Mrs. Gaskel's Cranford; George Eliot's Silas Marner; Stevenson's Treasure Island.

IV. Bunyan's Pilgrim's Progress, Part I; The Sir Roger de Coverley Papers in the Spectator; Franklin's Autobiography (condensed); Irving's Sketch Book; Macaulay's Essays on Lord Clive and Warren Hastings; Thackeray's English Humorists; selections from Lincoln, including the two Inaugurals, the Speeches in Independence Hall and at Gettysburg, the Last Public Address, and the Letter to Horace Greeley, with a brief memoir or estimate; Parkman's Oregon Trail; either Thoreau's Walden or selection from Huxley's Lay Sermons; Stevenson's Inland Voyage and Travels with a Donkey.

V. Palgrave's Golden Treasury (First Series), Books II and III, with especial attention to Dryden, Collins, Gray, Cowper, Burns; Gray's Elegy in a Country Churchyard and Goldsmith's Deserted Village; Coleridge's Ancient Mariner and Lowell's Vision of Sir Launfal; Scott's Lady of the Lake; Byron's Childe Harold, Canto IV, and Prisoner of Chillon; Palgrave's Golden Treasury (First Series), Book IV, with especial attention to Wordsworth, Keats, and Shelley; Poe's Raven, Longfellow's Courtship of Miles Standish, Whittier's Snow Bound; Macaulay's Lays of Ancient Rome and Arnold's Sohrab and Rustum; Tennyson's Gareth and Lynette, Lancelot and Elaine, The Passing of Arthur; Browning's Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, Hervé Riel, Pheidippides, My Last Duchess, Up at a Villa—Down in the City.

(b) In addition to the foregoing the candidate will be required to present a careful, systematic study, with supplementary reading, of the history of either English or American literature.

(c) The candidate will be examined on the form and substance of certain books in addition to those named under (a). For 1918 the books will be selected from the list below. The examination will be of such a character as to require a minute study of each of the works named in order to pass it successfully. The list is:

Shakespeare's Macbeth; Milton's Comus, L'Allegro, and Il Penseroso; Burke's Speech on Conciliation with America, or Washington's Farewell Address and Webster's First Bunker Hill Oration; Macaulay's Life of Johnson, or Carlyle's Essays on Burns.

The work outlined in (a), (b), and (c) counts for two units.

(d) The three units in English composition, rhetoric, and literature, as described above, are required for all students. A fourth unit may be obtained for one full year's additional work in the study of English and American authors.

SPECIAL NOTE.—*Schools receiving pupils from elementary schools where the English training is very weak may be required to give four units of work for three units of credit.*

13. FRENCH.

First year's work.—Elementary grammar, with the more common irregular verbs. Careful training in pronunciation. About 100 pages of easy prose should be read.

Second year's work.—Advanced grammar, with all the irregular verbs. Elementary composition, and conversation. About 300 pages of modern French should be read.

Third year's work.—Intermediate composition, and conversation. About 500 pages of standard authors should be read, including a few classics.

Fourth year's work.—Advanced composition, and conversation. Standard modern and classical authors should be read and studied to the extent of 700 pages.

14. GEOGRAPHY.

A. *Commercial Geography.*

The subject of geography is greatly neglected in our high schools. The commercial aspects of it should furnish an excellent opportunity for laying the foundation for a more intelligent study of economics. This course might very properly precede the half year course in economics where given.

The amount and character of the work accepted in this subject is indicated by the scope of such books as Redway's Commercial Geography, Adam's smaller book on the same subject, the text-books of Brigham, or Robinson, or Trotter's work.

B. *Physical Geography.*

The amount and character of the work required may be seen by referring to the texts of Gilbert and Brigham, or Davis; the recitations must be supplemented by at least an equal amount of time devoted to laboratory work. The laboratory exercises should follow one or more lines such as are indicated below. Each student should prepare a note-book showing what he has done.

(a) Studies in mathematical geography in which map and scale only are used. These should embrace such topics as length of a degree in longitude in various latitudes; length and breadth of continents, etc., in degrees and miles; relative latitudes of places; distances between cities, etc., in degrees and miles; difference in length of parallels and meridians; problems in time; location of time belts, etc.

(b) Studies of local topographic features which illustrate the various phases of stream work. Each study should include a drawing or topographic map of the object, and a full, clear description of the way in which it was formed.

(c) Studies of glacial deposits as shown in terminal and ground moraines, kames, eskers, etc.; distribution of dark and light colored soils; occurrences of lakes, ponds, gravel beds, clay banks, and waterbearing strips of sand and gravel.

(d) Studies of stream work as shown in the topographical sheets which may be obtained from the United States Geological Survey at a nominal cost.

(e) Studies of the form, size, direction and rate of movement of high and low barometer areas, and the relation of these to direction of wind, character of cloud, distribution of heat, and amount of moisture in the air, as shown in the daily weather maps. Later these studies should lead to the making of weather maps from the data furnished by the daily papers, and to local prediction of weather changes based on the student's own observation.

(f) Studies of the climate of various countries compared with our own, the necessary data being derived from such topographic, rainfall, wind, current, and temperature maps as are found in Sydow-Wagner's or Longman's atlases.

NOTE.—For a good Physiography syllabus for the state of Illinois see Conference Proceedings for 1913, pp. 174-197. See also Proceedings for 1917, pp. 192-222, for a syllabus of a second year course in High-School Geography.

15. GEOLOGY.

The student must show familiarity with the principles of dynamic and structural geology, and some acquaintance with the facts of historical geology as presented in Scott's Introduction to Geology, Brigham's Text-book of Geology, or an equivalent, together with at least an equal amount of time spent in laboratory and field work. The laboratory work should follow one or more of the lines indicated below, and note-books should be presented showing the character and amount of work done. (a) Studies of natural phenomena occurring in the neighborhood which illustrates the principles of dynamic geology. Each study should include a careful drawing of the object and a written description of the way in which it was produced. (b) Studies of well-marked types of crystalline, metamorphic, and sedimentary rocks which will enable the student to recognize each type and state clearly the conditions under which it was formed. (c) Studies of minerals of economic value, including the characteristics of each, its origin, and the uses to which it is put. (d) Studies of the types of soil occurring in the neighborhood, including the origin of each and the cause of differences in appearance and fertility.

16. GERMAN.

It is recommended that pupils be trained to understand spoken German and to reproduce freely in writing and orally what has been read. Whatever method of teaching is used, however, a thorough knowledge of grammar is expected. No attempt is made in what follows to give more than a general outline for the work of successive years, but the German department welcomes inquiries from teachers who wish further suggestions in the planning of courses.

First year's work.—At the end of the year pupils should be able to read intelligently and with accurate pronunciation simple German prose, to translate it into idiomatic English, and to answer in German easy questions on the passage read. A few short poems may well be memorized. Elementary grammar should be mastered up to the subjunctive as arranged in most books for beginners. Easy prose composition rather than the writing of forms will be the test of this grammatical work in entrance examinations given by the University.

Second year's work.—Only modern writers should be read, preference being given to material which has a distinctly German atmosphere and which lends itself readily to conversational treatment in the class room. The regular recitations should afford constant oral and written drill on the elementary grammar of the previous year. In addition, the beginner's book should be completed, but more importance is attached to accuracy and facility in simple modes of expression than to a theoretical knowledge of advanced syntax.

Third year's work.—Most of the time should be devoted to good modern prose. There should be some work in advanced prose composition—based on German models—and the daily recitations should continue to afford abundant oral practise. Pupils ought by this time to understand spoken German fairly well.

Fourth year's work.—At the end of this year a pupil should be able to read at sight any prose or verse of moderate difficulty. He should also be able to express himself orally or in writing with considerable readiness and a high degree of accuracy. It is recommended that work in composition take the form of free reproduction of portions of the texts studied rather than translation of English selections. The reading should be divided about equally between modern and classical authors.

17. GREEK.

First year's work.—The exercises in any of the beginning books, and one book of the Anabasis or its equivalent.

Second year's work.—Two additional books of the Anabasis and three of Homer, or their equivalents, together with an amount of Greek prose composition equal to one exercise a week for one year.

Third year's work.—Three additional books of the Iliad, three of the Odyssey, and Books VI, VII, VIII of Herodotus, or an equivalent from other authors.

18. HISTORY.

One, two, or three units may be presented, to be chosen from the following list:

Ancient history to 800 A. D., one unit.

Medieval and modern history, one unit.

English history, one-half or one unit.

American history, one-half or one unit.

Examinations for entrance will be given in all these subjects. The examination for each unit is intended to cover one full year of high-school work.

The plan of including Ancient and Medieval history in one year course and giving a full year to modern European history may be substituted for the first two units named above.

19. LATIN.

First year's work.—Such knowledge of inflections and syntax as is given in any good preparatory Latin book, together with the ability to read simple fables and stories.

Second year's work.—Four books of Caesar's Gallic War, or its equivalent in Latin of equal difficulty; the ability to write simple Latin based on the text.

Third year's work.—Six orations of Cicero; the ability to write simple Latin based on the text; the simpler historical references and the fundamental facts of Latin syntax.

Fourth year's work.—Six books of Virgil's Aeneid, with history and mythology; the scansion of hexameter verse.

The reports of the committees of the High School Conference on First, Second, Third and Fourth Year Latin, as given in the Proceedings for 1911, 1913, 1914, and 1916 contain many helpful suggestions for high-school teachers of Latin.

20. MANUAL TRAINING.

The requirement for one unit is the equivalent of 360 forty-minute periods in manual training following the syllabus prepared by the manual-training section of the High School Conference.

Following is the conference recommendation approved as a basis for accrediting Manual Training:

Outline of a One-Year Course in Woodworking for High Schools

This course is intended to occupy 120 hours—ten 40-minute periods a week for 18 weeks, or five 40-minute periods a week for 36 weeks, and presupposes that pupils have taken a 60-hour course in the grammar school before entering.

GROUP	PROCESSES	PROBLEMS
I—Review of the fundamental tool processes taught in the grammar school. Saw, plane, chisel and laying out tools. *Grooved joints and halving.*	Measuring, squaring, gauging, sawing, boring, chiseling, rules for sharpening tools, planing cylinder, use of screws and nails, carving finishing.	Bench-hook. Specimen of wood for museum Book-rack Nail-box Tool-box Towel-roller
II—More exact work in planing to make a *glue joint.*	Planing joints, gluing, clamping, surfacing, sand-papering.	Drawing board Tee-square
III—Construction by means of *mortise and tenon joint.*	Laying out duplicate parts, cutting mortise, testing mortise, sawing tenon, gluing and clamping, scraping, finishing.	Taboret Book shelves involving keyed construction Stool Seat
IV—Construction involving the *miter joint.*	Designing a frame for a given picture, planing parallel edges and sides in the construction of a miter-box, rabbeting, sawing the miter-box, laying out and cutting a brace.	Framing a picture Bracket
V—Construction involving the *dovetail joint.*	Laying out and cutting dovetails, planing corners, inlaying, finishing.	Tool-chest Treasure-box Box for drawing instruments Book slides
VI—Construction involving the *panel.*	Planing, fitting, gluing, clamping, putting on hinges, finishing.	Screen Cabinet Bookcase Desk
VII—*Wood turning* Note:—This group may be omitted or may be substituted for a part of V and VI.	Spindle turning cylinder, cone, convex curve, concave curve, compound curve; turning on face-plate, chuck turning, finishing and polishing in the lathe.	Practice exercise Spool, Box with cover. Legs for a stool, Tray Indian clubs, Rosette. Tool handle, Mallet, Circular picture frame

The other half-year, given preferably as a parallel course, but acceptable as preceding the woodwork, is a course in mechanical drawing, outlined as follows by the Conference:

GROUP	PROBLEMS	RELATION TO OTHER SUBJECTS	RELATION TO INDUSTRY
I—Straight lines measurements. use of tee-square and triangles in drawing horizontal, vertical and inclined lines. Use of ruling pen. Conventional lines. Freehand working sketches.	Rectangular frame triangular frame, trysquare, Bracket Box. Bench-hook	*Geometry*— Straight line determined by two points or one point and a direction. Division of right angle into halves and thirds.	*Drafting*— Practical methods of drawing straight lines and angles of 90°, 60°, 30°, 45°. *Woodworking.*
II—Circles, use of compasses, use of center lines, cross hatching sections.	Ring Circular picture frame Flower pot Cylinder head Circular box	*Geometry*—	*Woodturning*
III—Tangents, finding centers and points of tangency.	Torous, Gland, Crank, Face-plate, Bearing, Link	*Geometry* — A tangent to a circle is perpendicular to a radius at the point of tangency.	*Manufacture of Engines and Machinery.*
IV—Planes of projection — projecting to horizontal and vertical planes. revolution of planes construction geometric figures.	Rectangular prism Octagonal prism Hexagonal prism Pentagonal pyramid Triangular pyramid	*Geometry*— Construction of hexagon, octagon and pentagon. *Descriptive Geometry*—revolution of planes and points.	*Drafting* — Practical methods of constructing octagon and hexagon, having given a side or the diagonal or the diameter.
V—*Revolution of solids.* (a) two views of object with sides parallel to planes of projection. (b) ditto, object tipped to a given angle with the horizontal plane (c) ditto, object tipped to giving angle with the vertical plane. (d) ditto, object tipped to giving angles with both planes.	Cube Cross Angle Block Square pyramid Rectangular prism Triangular prism	*Descriptive Geometry*—revolution of solids.	*Architectural and Engineering Drafting.*

GROUP	PROBLEMS	RELATION TO OTHER SUBJECTS	RELATION TO INDUSTRY
VI—*Developments* (a) Prism (b) Cylinder (c) Pyramid (d) Cone	Prism cut by a plane. Cylinder cut by a plane. Pyramid cut by a plane. Funnel, pan.	*Analytic Geometry* Construction of ellipse, plotting curves.	*Tinsmithing*—. *Pattern drafting.*
VII—Intersections (a) centers in the same plane. (b) centers in different planes.	Cylinder cut by a prism. Two cylinders of different diameters intersecting. Sphere cut by a prism.	*Analytic geometry* Plotting curves.	*Cornice-making*— Patterns for intersecting parts.
VIII—*Lettering* Emphasis on (a) placing (b) form (c) slant (d) spacing (e) stroke.	Gothic alphabet and figures. Texts in freehand hairline, gothic, stump writing.	*Design* — study of composition.	*Commercial designing. Drafting.*
IX—*Working Drawings* Furniture	Towel-roller table, stool, screen, cabinet	*Woodworking.*	*Furniture designing and manufacturing.*
X—*Working Drawings* Machine part	Wrench, pulley coupling, pillow block.	*Machine tool work.*	*Manufacture of Machinery.*
XI—*Building plan* Floor plans and elevations or perspectives.	Summer cottage, railway station, small surburban house.	*Freehand drawing.*	*Architecture Building.*

Suggested Treatment of Problems in Bench Work

PROBLEM	RELATED DRAWING AND DESIGN	RELATION TO OTHER SCHOOL SUBJECTS	RELATION TO INDUSTRY
Bench-hook	Working drawing to be made, or working drawing given to work from.	*Botany.* — Study of pine tree, how trees grow, sap wood and heart wood.	*Lumbering.* — Logging, sawing, seasoning.
Specimen of wood for museum.	Working drawing.	*Botany.*—Study of selected trees, characteristics of different woods, classification of woods.	*Manufacture of Nails.* —Process, sizes. *Forestry.* — Geographical distribution of varieties, trees studied, tree planting.
Book-rack.	Design freehand the contour of end and base. Make design for ends. Make working drawing to scale and full size drawing of end. Study of color of finish.		*Furniture making.* — Selection of wood with reference to cost, ease in working, durability, finishing. *Manufacture of Sandpaper.* — How made, grades.

PROBLEM	RELATED DRAWING AND DESIGN	RELATION TO OTHER SCHOOL SUBJECTS	RELATION TO INDUSTRY
Towel-roller	Working drawing (Design may be made for back and ends)	*Geometry.*—To inscribe an octagon in a square.	*Manufacture of screws.* —How screws are made, kinds of screws, for wood, sizes.
Drawing-board	Working drawing.	*Botany.*—Study of annular rings in wood.	*Cabinet making.* — Selection and use of wood with reference to shrinkage and warping. *Manufacture of Glue.*—What glue comes from and how refined.
Tee Square	Working drawing.	*Botany.*—Porous woods, and close-grained woods —ash and maple, for example.	*Instrument Making.* — Selection of woods for smoothness and for holding of shape.
Stool	Freehand Sketch constructive design, followed by working drawing.	*Botany.* — Study of Medullary rays in wood.	*Millwork.* — Quarter sawing..

For the second unit in manual training to be used for entrance credit, selection may be allowed as follows:

1. Machine Drawing,—120 or 240 hours.
2. Wood Turning and Pattern Making, including principles of molding, 120 hours.
3. Wood Turning and Furniture and Cabinet Making, 120 or 240 hours.
4. Forging, 120 hours.
5. Machine Shop Practice, 120 or 240 hours.

Any combination of the above groups may be made, provided at least 120 hours of work are offered from each group. (For complete outline of the above courses, see Conference Proceedings, 1910, pp. 49-58.)

21. MATHEMATICS.

A. *Algebra.*

Fundamental operations, factoring, fractions, simple equations, involution, evolution, radicals, quadratic equations and equations reducible to the quadratic form, surds, theory of exponents, and the analysis and solution of problems involving these.

It is believed that the instruction in Algebra in our high schools would be greatly improved and unified if teachers of this subject generally would adopt the suggestions embodied in the following outline.

This syllabus was discussed and approved by the Mathematics Section of the High School Conference of 1908:

Time and Place for Algebra in the High School Course

The best division of subject matter with reference to time is to give: first, a year of elementary algebra (first course) so arranged as to enable the pupil to solve such problems as are within his comprehension and to arouse his interest in algebra as a tool for the solution of problems which are impossible, or very difficult, by unaided arithmetic means. To this end it is highly desirable to include the treatment of quadratic equations and to omit much in the line of abstract manipulations and formal proofs. This first course in algebra should be followed by one year of plane geometry, and the two together should constitute the minimum requirement in mathematics for a high school course. This should be followed by the elective work; one-half year of algebra (second course), intended to meet the need of those pupils who desire full preparation for college and comprising a more formal treatment of the principles employed in the first course, together with advanced chapters. This should come not earlier than the first half of the third year in the high school course. Then, if given at all in the curriculum, this should be followed by one-half year of solid geometry and one-half year of trigonometry.

The early introduction of the quadratic equation in the first course enables the pupil to solve many concrete problems that appeal to him as worth while and this is certainly much more serviceable to the pupil who takes only the required mathematics than the juggling with symbols which so often comprises a large part of the work of the first y ar. Furthermore, nothing seems lost to the pupil who continues algebra because of deferring the formal demonstrations and certain difficult topics and manipulations, to give time for the treatment of the quadratic equation. The study of plane geometry between the first and second courses in algebra affords a fruitful field for concrete algebraic problems, and serves to visualize the algebra, while the plane geometry is much more concrete to the average high school pupil than the more formal parts of the second course in algebra.

Correlation Between Arithmetic and Algebra

From the start in algebra the pupil should understand that each letter or combination of letters means a number. The frequent introduction of Arabic numerals for the letters tends to make algebra real to the high school pupil. It is undesirable to attempt to draw a sharp line of distinction at any point between arithmetic and algebra. The two subjects should be closely correlated; that is, the operation of arithmetic should suggest the principles of algebra and each principle of algebra should be illustrated by numbers of the Arabic notation. All exercises involving letters should be interspersed with similar exercises involving Arabic numbers.

Illustrations of multiplication: —

45		40+ 5		40+ 5		4a + 5b
23		20+ 3		20+ 3		2a + 3b
——	or	————	or	————	or	————
135		120+15		800+100		$8a^2+10ab$
90		800+100		120+15		$12ab+15b^2$
——		————		————		————

Problems of arithmetic such as, for example, those in percentage and interest, constitute a considerable body of applications for algebraic solution during the first year. To be more specific, let us consider the problem from arithmetic, of finding the simple interest on $900 at 4 per cent for 3 years. This is given in dollars by

$$\frac{(900)\quad(4)\quad(3)}{100} = 108$$

Next, let simple interest, principal, rate, and time in years be denoted by i, p, r, and t respectively. Then formula

$$i = \frac{prt}{100}$$

appears as a generalization of the above simple numerical case, and should be made the basis of numerous problems.

Syllabus of a First Course in Algebra. One Year

The committee does not deem it desirable to dictate an order of topics. However, in presenting the following outline, it is our purpose to suggest such an arrangement as seems to give a natural development and one suited to the needs of the pupil, both in his everyday experience and in preparing him for the elementary courses in applied science.

An explanation and discussion of significant points under each group of topics in the outline follows immediately the group of topics. The numbering of groups in the outline and that of the discussions mutually correspond; for instance 1d contains the discussion of topics marked 1, and 2d the discussion of topics marked 2.

Outlines of topics:

1. Arithmetic problems in addition and subtraction of numbers which have a common factor; removal and insertion of parentheses, literal notation, multiplication and division of polynomials by monomials; problems leading to linear equations involving only positive integers; translating English sentences into equations and vice versa.

1 d. The purpose here is to extend the operations of arithmetic to include positive numbers represented by letters and at once to introduce the solution of simple equations and problems. Frequent translation of English into algebraic language, and vice versa, emphasizes the value of the algebraic symbol.

2. Negative numbers; addition, subtraction, multiplication and division extended to negative numbers; positive integral exponents; transposition in equa-

tions; solution of equations; verification of solutions by substitution; identities; simple simultaneous equations; graphs of simple equations; elimination by addition and subtraction; exercises and problems interspersed.

2 d. The introduction of negative numbers should be preceded by concrete illustrations to show their convenience. This can be done by reference to temperature below and above zero; credits and debits, bank deposits and withdrawals, north and south latitude, east and west longitude, opposite directions, etc. Problems yielding equations with negative solutions should next be introduced, showing need of such numbers in order to make possible the solution of the equation involved. In general, the solution should be regarded as incomplete until the result is verified. This is both a logical and a pedagogical requirement; furthermore, this affords a most valuable exercise in the manipulation of algebraic symbols. The interpretation of results is an important part of algebra which is too much neglected. It is useful to present some problems which lead to equations which are identical in form but whose solutions lead to very different interpretations. As simple illustrations, consider the following:

a. A and B start from the same point to walk in opposite directions. At the end of one hour they are 8 miles apart, and A walks three miles farther per hour than B. How far does each of them walk?

b. Discuss the problem of finding the score in a baseball game if the sum of the runs is 8 and the difference of the runs is 3.

Both problems yield the equations:

$$x + y = 8$$
$$x - y = 4$$
$$\text{and } x = \tfrac{1}{2},\ y = 2\tfrac{1}{2}$$

satisfy these equations, but for problem b the solution has no interpretation, while in problem a it has a very definite interpretation.

The word *transpose* should not be used by the pupil in beginning the study of equations, but the process should be interpreted as the operation of addition or subtraction applied to the members of an equation.

The study of the graph in the first year is not an object in itself and should be used only in so far as it can be profitably made to throw light on the solution of problems and equations.

3. Division as the inverse of multiplication; multiplication and division of polynomials by binomials; first notion of fractions, ratio and proportion; equations involving fractional coefficients; simple problems in proportion (formal treatment being deferred); simultaneous equations in two and three unknowns (with different methods of elimination); verification of solutions of equations by substitution; exercises and problems.

3 d. An operation and its inverse can often be taught together advantageously. This is the case with subtraction and addition, division and multiplication, root extraction and involution, factoring and special cases of multiplication. Some simple cases of proportion follow soon after division in the outline of topics. This is done in order to introduce the language of proportion in problems, but any formal treatment of proportion is deferred until near the end of the first year.

As used in the syllabus, the word "excersise" is understood to mean the formal manipulation of algebraic symbols, and the word "problem" is understood to indicate the translation of given conditions into graphic form, or into the language of the equation and the solution of the resulting equation. It is believed that about equal emphasis should be given to each.

4. Factoring—Special products and factors taught together as inverse operations; meaning of quadratic expressions and factors of such expressions; problems leading to quadratics to be solved by factoring; H. C. D. and L. C. M. by the methods of factoring; multiplication and division of polynomials by polynomials.

4 d. The early introduction of quadratics by the method of factoring affords a useful application of factoring and the solution of an important class of problems which are entirely practicable for first year pupils, but which otherwise would be postponed to the later course and so lost to a large number of students.

5. Square root; radicals of the second order and fractional exponents only so far as demanded for an elementary treatment of quadratics; approximate evaluation of numerical expressions containing radicals; exercises and problems.

5 d. Radicals and fractional exponents should be treated together with the emphasis on the latter. The manipulations which involve complicated fractional exponents belong to the later course, but some manipulations of forms involving the square root are important for the first year. The rationalization of fractions with binominal denominators and all radical expressions above the second order may well be deferred.

The object and desirability of rationalizing an expression should be thoroughly understood by the student before he does the mechanical work. To ask the student to accept $\sqrt{5/5}$ as a simpler form than $\sqrt{1/5}$ is confusing if the student does not know the purpose for which one is simpler than the other. The distinction between a rational and an irrational number should be made clear. In particular, a rational number should be defined *directly* (as a number which is equal either to an integer or to a fraction whose numerator and denominator are integers), and not negatively (as a number not involving radicals). Problems from mensuration give a meaning to radicals. For example, diagonals of squares and cubes, altitudes and areas of equilateral triangles, etc., afford abundant applications of radicals of the second order and add interest and understanding to the subject.

6. Solution of quadratics by completing the square and verification of the solution by substitution; simultaneous equations where one is linear and one quadratic, or quadratic systems of simpler forms such as $4x^2-3y^2=1$, $3x^2+4y^2=7$, $y^2=5x-4$, $2x^2+y^2=8$; exercises and problems.

6 d. The exercises and problems under this head are numerous, interesting and practical and belong properly to the first year, as is made possible by the order of topics given in this outline.

7. Fractions reduced to common denominators by factoring; addition and subtraction of fractions; multiplication and division of fractions; fractional equations with problems leading to the same; simultaneous fractional equations.

7 d. The formal treatment of fractions is deferred until near the close of the first year in order to give place to the early treatment of quadratic equations and problems. This change does not affect the unity of the subject, since no preceding work requires operations with fractions having literal denominators.

As here used, the term "fractional equation" means an equation with the unknown appearing in the denominator. Fractional numerical coefficients should be used throughout the course.

8. Proportion and variation, formal treatment; exercises and problems.

8 d. While the language of variation may well be regarded as an antiquated form of expression for which the equation could better be substituted, yet we must prepare for the applications to the sciences in which its use is conventional; for instance, in physics it is usual to say that force varies as acceleration, rather than that force is a constant times acceleration. Proportion and variation should come in the first course in order to prepare for the solution of a large class of problems which arise in the experience of the pupil.

Topics to be Omitted from the First Year's Work

Complicated factoring; complicated complex fractions; simultaneous equations in more than three unknowns; binomial theorem; cube root, remainder theorem; imaginaries and extensive manipulations of radicals; difficult cases of simultaneous quadratics; theory of exponents, theory of quadratics; H. C. D. and L. C. M. by the method of continued division; inequalities; indeterminate equations; difficult general solutions and discussions.

Syllabus of a Second Course in Algebra. Half Year

This is the final high school course for students who wish simply full preparation for college work and should not be given earlier than the third year of the course.

Outline of Topics

1. Review of fundamental operations; manipulation of signs; simple equations; and simultaneous equations with graphs much more extensively used than in the first course.

1 d. The review implies a more critical examination than that given in the first course. The exercises and problems should be similar to those used in the first course, but not the same ones. They should be more difficult and more technical.

2. Statement of assumptions and demonstrations of theorems pertaining to fundamental operations. The effort should be to make broad assumptions which the pupil readily accepts, e. g. the commutative, distributive, and associative laws are to be assumed—not proved.

2 d. While formal demonstrations of principles are, in general, out of place in the first course, it is highly desirable that some work of this nature should be included in the second course, especially as the study of geometry has intervened and the pupil should now come to see that argumentation is not limited to geometrical theorems, but is just as important a part of algebraic work.

3. The solution of quadratics by formula; theory of quadratics; graphic work on quadratics; simultaneous quadratics, which should include the special case reducible by elimination to the solution of quadratics; exercises and problems.

3 d. It should be made clear by the instructor that the solution of a pair of simultaneous quadratics cannot, in general, be effected by quadratic methods and that only special cases are considered in this course. The graph can be made to serve a most important part at this point in interpreting geometrically the solutions.

4. Formal treatment of factoring with the factor theorem; H. C. D. and L. C. M. by the method of continued division; exercises; problems which involve factoring in the solution.

4 d. A definition of prime factor as applied to algebraic expressions is essential to determine to what extent factoring should be carried, for example: Is $x-y=(\sqrt{x}+\sqrt{y})(\sqrt{x}-\sqrt{y})$ a legitimate case of factoring in this course? The factor theorem can be made to do valuable service in solving some higher degree equations.

5. Complex fractions and fractional questions; exercises and problems.

5 d. The question of equivalent equations needs careful treatment in connection with clearing of fractions when there are literal denominators.

6. Proofs of theorems on exponents and radicals: exercises on radicals; equations and problems involving radicals.

6 d. Here as in the first course a rich field of applications may be found for radicals and radical equations, and these give life and interest to the subject which no amount of mere manipulation can afford.

7. Review and further applications of proportion and variation; binomial theorem; proof by mathematical induction for positive integral exponents; logarithms; progressions.

Many exercises and problems and much graphic work throughout the course to bring each topic close to its applications.

7 d. Special attention should be given to applications of the topics enumerated under this head. For instance, simple problems from physics for variation and proportion and problems in interest and annuities for logarithms.

General Remarks

No matter how good the text-book, a teacher should study carefully the adaptation of problems to his class. Problems made by the teacher and given out by him in general lend life and enthusiasm to the class work. It is of first rate importance that the problems should appeal to the pupil as raising some question whose answer is worth while. In this connection all problems which require the pupil to exercise his common sense as to the legitimacy of the result are to be commended. This is especially true of problems involving interesting data, the facts concerning which may be known from other sources.

In borrowing material from the sciences for problems, great care must be exercised lest we assume knowledge on the part of the pupil which he has assimilated. The borrowing should be from *below* rather than from *above*, or the emphasis is thrown entirely away from the point involved. In the first course arithmetic should be an important source for problems. The usual problems of interest, percentage, and proportion can well be solved by algebra. This is also decidedly true of problems presented under the name of mental arithmetic. As there should be no sharp line of distinction between arithmetic and algebra, methods which have an algebraic bearing should not be discouraged in arithmetic. The main object in this connection is to develop the pupil by generalization and it should be regarded as a good indication of progress if he early tends toward algebraic methods rather than the more special methods of arithmetic.

For the second course geometry and physics should offer a fruitful source for problems. In fact, problems of the lever and of uniform motion taken from physics may well be brought into the first year course, provided they are introduced by a careful grading up through a number of special numerical cases before a law is stated. Literal equations should never be introduced except as a generalization after a series of special cases leading up to the generalized form. The formula is a most important feature of algebra, but it should come at the end of a well graded development and not as an abstract statement at the beginning.

Many problems can well be made to depend upon a single formula such as $s=\frac{1}{2}gt^2+at+b$ for uniformly accelerated motion. These problems may impose a large variety of conditions and lead to solutions for the various letters involved. Likewise, several problems may well be made to depend upon a single formula of geometry such as $v=\frac{1}{3}H\ (B+b+\sqrt{Bb})$ for the volume of a frustum of a cone.

Definitions should be clear and unambiguous and be introduced just where needed in the development of the subject. For example, the word "transpose" if used at all in solving equations, should not be defined as "the process of removing a term from one side of the equation to the other by changing its sign." which is entirely misleading. Again the word "cancel" if used at all, should be defined so as to indicate exactly the circumstances under which cancellation may take place, so as to avoid such ludicrous blunders as

$$\frac{\cancel{3}x-4}{\cancel{3}y+5} \quad or \quad \frac{\cancel{2}\cancel{p}+3b}{\cancel{p}-\cancel{2}c}$$

It is quite as important to drill upon the things which can not be done as upon those which can properly be done. For example $\sqrt{a+b}=\sqrt{a}+\sqrt{b}$. For this purpose nothing is so effective as the substitution of Arabic numerals for the letters.

The notion of functionality and the use of the function symbol may doubtless be introduced much earlier than is done at present. This has been advocated in a recent German report on elementary algebra. It is convenient in evaluating algebraic expressions. For example, if $F(a. b) = a^2 + 4ab - b^2$, to find the $F(2, 3)$, we have $F(2, 3) = 2^2 + 4.2.3 - 3^2 = 4 + 24 - 9 = 19$. The committee purposely make no recommendations on this and many other forms and methods of presentation, which teachers adopt, depending upon their own training, the quality of their pupils in particular classes and the time at their disposal.

B. *Commercial Arithmetic.*

The amount of work to be covered is represented by that found in any of the ordinary first-class texts on the subject, such as Finney's, Bookman's, Rowe's "New Essentials," Thurston's, and Baker's. Instruction should constantly attempt to emphasize the relation of arithmetic to business customs and procedures.

This subject is accredited for one-half unit and must be preceded by two years of high-school mathematics. The assumption is that the course given will be on a basis befitting a more advanced understanding of mathematical principles and processes than those given in the elementary school.

C. *Geometry.*

The following syllabi on Plane and Solid Geometry adopted by the 1911 High School Conference is readily worthy of the common use of our high schools as a means of unifying and strengthening the high-school courses in this subject.

Plane Geometry. Special emphasis is placed on the ability to use propositions in the solution of original numerical exercises and of supplementary theorems.

(b) *Solid and Spherical Geometry.* Applications to the solution of original exercises are emphasized.

Revised Report of the Geometry Committee
to the
High School Conference, University of Illinois
November, 1911

A. Educational Values of Elementary Geometry.

The teacher of Geometry, as well as the teacher of other subjects, should have a reason for the inclusion of his subject in the course of study. Geometry, in common with other subjects, is entitled to a place in the curriculum because of

(a) its training in logical thinking and with power to concentrate its attention,

(b) its training in exact use of language,

(c) its development of the "pictorial imagination", the ability to visualize objects, relations, and conditions,

(d) its proof of the familiar mensuration formulas used in arithmetic,

(e) its utilitarian and practical value in the arts and sciences,

(f) the aesthetic values which its study affords.

B. Position in High School Course.

In agreement with the Algebra Syllabus adopted by this Conference (published in the High School Manual for 1909-10) the first course in Geometry should continue through the second year, following Algebra; a second elective course of one-half year should come in the second half of the third or in the fourth year.

C. Definitions, Axioms, and Assumptions.

Guiding Principles. 1. Precision in definitions should be required specially when given in student's own words. Care should be taken not to define such basal notions as, "point", "straight line", "angle", etc.

2. The first course in geometry is not a place to attempt a statement of the minimum number and of the independence of axioms. This belongs to a course in the Foundations of Geometry.

3. A free use of assumptions is recommended, yet it is essential that all propositions used explicitly in a formal demonstration be recognized either as previously proved or as belonging to the list deliberately left unproved.

4. Care should be taken that such terms as "obviously", "it is self evident", "it is easily seen", etc., do not cover careless and inaccurate thinking.

5. Definitions and assumptions should be introduced when needed.

Fundamental Assumptions Listed. 1. Things[1] equal to the same thing are equal to each other.

2. If equals be added to or subtracted from equals, the results are equal.

3. If equals be multiplied or divided by equals, the results are equal. (Division by zero excluded.)

4. Like powers and like positive roots of equals are equal.

5. For finite magnitudes, the whole is greater than any of its parts, and is equal to the sum of all its parts.

6. If unequals are operated on in the same way by positive equals, the results are unequal in the same order.

7. If unequals are added to unequals in the same order, the sums are unequal in the same order; if unequals are subtracted from equals the remainders are unequal in the reverse order.

8. A number may be substituted for its equal in an equation or in an inequality.

9. If the first of three numbers is greater than the second and the second is greater than the third, then the first is greater than the third.

10. A straight line may be produced to any required length.

11. Two points determine a straight line.

12. The shortest path between two points is a straight line.

13. Any figure may be moved from one place to another without altering its size or shape.

14. Through a point one line only can be drawn parallel to a line.

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[1] "Things" here refers to numbers which are numerical measurements of geometric magnitudes

15. A circle may be described with any point as a center and any line segment as a radius.

*16. All straight angles are equal.

*17. All right angles are equal.

*18. From a given point in a line only one perpendicular can be drawn to the line.

*19. Equal angles have equal complements and equal supplements.

20. Circles with equal radii are equal.

*21. The sum of two adjacent angles whose sides lie in the same straight line equals a straight angle.

22. The length of a circle is greater than the perimeter of any inscribed polygon and less than the perimeter of any circumscribed polygon.

23. The area of a circle is greater than the area of any inscribed polygon and less than the area of any circumscribed polygon.

*24. Two lines parallel to the same line are parallel to each other.

*25. The bisectors of vertical angles lie in a straight line.

26. A diameter bisects a circle and the surface of a circle.

27. A straight line intersects a circle at most in two points.

D. Introductory Work.

This introductory work is designed to lead the pupil gradually into demonstrative Geometry. Beginning informally, as class exercises not requiring previous outside preparations, this work should develop

(a) neatness and accuracy in drawing figures;

(b) familiarity with terms to be used in later work, as perpendicular bisector, complement, bisector, etc.;

(c) a recognition of the fallibility of the pupil's judgment, and a recognition of the necessity for logical proofs;

(d) some appreciation for the usefulness of Geometry.

Only so much of this introductory work is recommended as will carry the pupil safely over into demonstrative Geometry. Care should be taken to guard against the mistake of requiring formal demonstration of theorems which seem obvious to the pupils without proof. Introductory work may be selected from such work as the following:—

1. Problems on complementary and supplementary angles.

2. Constructing triangles when given three sides, two sides and included angle, two angles and included side.

3. Comparison of two triangles constructed with same given parts, using tracing paper or cloth, leading to the three cases of congruent triangles. Simple inaccessible distance problems.

4. Construction of perpendicular bisector of a line.

5. Drawing of perpendicular bisectors of sides of triangle, medians, and bisectors of angles.

6. Drawing of circumscribed and inscribed circle of a given triangle.

7. Drawing of a triangle, square, hexagon inscribed in a given circle.

8. Sufficient use of geometrical optical illusions.

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*The starred assumptions may be taken as theorems for informal proof or as statements of facts in the contest without special emphasis, if preferred.

9. Graphic proof of the Pythagorean Theorem with problems depending on it.

10. "Views" of prism, cylinder. Simple mechanical drawings.

11. Sum of angles of triangle by cutting out angles and juxtaposing; algebraic problems concerning angles of polygons, isosceles triangle, and exterior angles.

12. Angles related to parallels cut by a transversal; algebraic problems.

13. Construction of paths of points moving according to simple conditions.

It is desirable that each pupil be provided with simple and inexpensive compass, ruler in inches and centimeters, and a protractor.

E. Exercises and Problems.

1. Guiding Principles. (a) The purpose of problems is to emphasize principles and theorems, and problem work is in general a means rather than an end.

(b) There should be numerous simple problems and exercises rather than a few difficult ones; there should be some oral exercises.

(c) Some exercises should come immediately after the theorems which they apply and there should be a good list at the end of chapters.

(d) Geometry should be given a concrete setting by the use of some problems from real life for the sake of clearness and interest. It is valuable to ask the students to find illustrations of abstract theorems from their own experience.

The following illustrate the meaning of concrete problems:—

(a) How high will a 40-foot ladder reach on a house if its foot is placed 5 feet from the side of the house?

(b) How could a carpenter's square be used to test whether or not a notch in the edge of a board is a true semi-circle?

(c) With only a mirror and a yard stick, how could one measure the height of a pole?

(d) Why is a step ladder made three-sided rather than four-sided?

Lists of concrete problems are available in some of the later texts and in "School Science and Mathematics" (Oct. 1911, page 662 and others). Care should be taken to select problems which are real applications of geometry and which involve only terms familiar to the student.

2. Algebraic Methods. The use of algebra in geometry (a) correlates Algebra and Geometry, (b) gives practice in translating symbols into English, (c) leads to simpler notation, and (d) leads to the notion of functionality.

Illustrations of the algebraic method:—(a) Given in the right triangle ABC, c the hypotenuse, a and b the two legs; x projection of b on c, y the projection of a on c; to prove $c = a + d$. (Wentworth 371, p. 162)

(b) Given a the hypotenuse and b the sum of the two legs; to construct the right triangle.

Solution: $x + y = b$, $x^2 + y^2 = a^2$. Solving $x = \frac{1}{2}(b + \sqrt{2a^2 - b^2})$ $y = \frac{1}{2}(b - \sqrt{2a^2 - b^2})$, which values may be constructed with ruler and compass. (Sanders p. 211)

(c) Given line $AB = 4r$ and C its middle point; on AB, AC, and CB semicircles are constructed. To draw a circle touching the three circles.

Solution: Let x = radius of required circle; then $(x+r)^2 = r^2 + (2r - x)^2$, and solving, $x = \frac{2}{3}r$. (Young p. 179.)

3. Locus problems. Locus problems deserve a place in Geometry because

(a) they introduce motion into our geometric notions, which would otherwise be entirely static,

(b) they are necessary in the solution of many construction problems,

(c) they develop the important notion of functionality.

In all locus proofs the two defining properties of a locus of a point should be emphasized, namely, (1) all points lying on the locus must satisfy the given conditions, and (2) all points which satisfy the given conditions must lie on the locus.

Illustrations of locus problems:—(a) Find the locus of all points at a constant distance from a fixed line.

(b) Find the locus of a point equidistant from two fixed points.

(c) What is the locus of the centers of circles tangent to a line at a given point?

In the study of loci advantage should be taken of the opportunities to introduce space notions. Thus, the locus of a point always a fixed distance from a fixed point in space is a sphere; of a point a fixed distance from line, is a cylindrical surface; etc. In general it is desirable throughout the course in Plane Geometry to call attention to the corresponding space forms of Solid Geometry.

F. Limits and Incommensurables.

The limit notion is needed to define such things as "length of a circle" (the limit of the perimeter of an inscribed, or circumscribed, polygon as the number of sides become infinite), "area of a circle", "surface of a sphere", etc., and therefore should be included in Elementary Geometry. A correct, though not most precise definition of a limit should be given and great care should be taken to avoid the commonly used but incorrect words "never reach." The following definition is recommended: "The limit of a variable is a constant such that as the variable approaches this constant their numerical difference becomes and remains less than any previously assigned positive number, however small."

The "Fundamental Theorems of Limits" as ordinarily stated, should be omitted as trivial. The following theorem should be introduced and used to show the existence of limits in Elementary Geometry: "If a variable always increases (decreases) and is always less than (greater than) some finite constant then it has a limit." Make this theorem seem true by illustrations, attempt no proof for it. Proofs of incommensurable cases should be omitted or postponed but some notion of the meaning of "incommensurable" should be developed.

G. Omissions.

List of omissions recommended: 1. Square of side of triangle opposite acute angle, etc.

2. Square of side of triangle opposite obtuse angle, etc.

3. Division into mean and extreme ratio.

4. Inscribed decagon.

5. Calculation of π by perimeter of inscribed and circumscribed polygon. Verify the value of π by some simpler method.

6. Proofs of theorems on limits.
7. Proofs of incommensurable cases, but not the incommensurable idea.
8. Maxima and minima.
9. Sum of two sides equal to twice the square of half the third increased, etc.
10. Difference of square of two sides, etc.
11. Square of bisector of angle equal to product of two sides, etc.
12. In any triangle the product of two sides equal to diameter of circumscribed circle multiplied, etc.

H. Emphasis.

The following topics should receive special emphasis:—

1. Congruance of triangles.
2. Similar triangles.
3. Pythagorean theorem.
4. Properties of circles.
5. Mensuration theorems.

I. Outline for Plane Geometry.

In the following outline certain important theorems (those starred) have been taken as nuclei about which are grouped related theorems. In this way important theorems are singled out for special emphasis and the content of the course is suggested.

I. Congruent Triangles. *1. Triangles are equal if two sides and included angle, two angles and included side, or three sides, in one have equals in the other.

2. Propositions on right triangles.
3. Propositions on isosceles triangles.
4. Circumscribed and inscribed circle of triangle.

II. Parallels and Parallelograms. *1. If two parallels are crossed by a third line the alternate interior, the alternate exterior, and the exterior interior angles are equal.

2. Angles having parallel sides are equal or supplementary.
3. Lines perpendicular to the same line are parallel.
4. Propositions on parallelograms.
5. If parallels intercept equals on one transversal they intercept equals on every transversal.
6. Sum of angles of a triangle.
7. Sum of interior angles of a polygon.

III. Circles. *1. In the same circle or equal circles, equal chords are equidistant from the center, and converse.

*2. Central angle is equal to its intercepted arc.

*3. Equal chords subtend equal arcs, and converse.

4. Measurement of angle when the vertex is
   at the center of circle,
   between the center and the circle,
   on the circle,
   outside the circle,
5. Tangents from the same point are equal.

6. If two circles intersect, the line of centers is perpendicular bisector of common chord.

IV. Similar Triangles. 1. If a line is parallel to one side of a triangle, it divides the other two sides proportionally, and converse.

*2. Triangles are similar when
they are equiangular,
two sides are proportional and included angles are equal,
three sides are proportional.

3. Product formulas.
4. Similar right triangles.
5. Pythagorean theorem.
6. Trigonometric ratios.
7. Similar polygons may be divided into corresponding pairs of similar triangles, and converse.
8. Perimeters of similar polygons are proportional.

V. Regular Polygons. *1. Regular polygons of the same number of sides are similar.

2. Length of circles are proportional to their radii.
$C = \pi r$
Some simple method of verifying value of π
3. Circles may be circumscribed about or inscribed in any regular polygon.
4. Side of hexagon is radius of circumscribed circle.
5. Inscribed equilateral polygon is regular.

VI. Areas. *1. Area of rectangle is product of base by altitude.

2. Of parallelograms.
3. Of triangle.
4. Of trapezoid.
5. Of similar triangles.
6. Of similar polygons.
7. Of regular polygon is ½ perimeter by apothegm.
8. Of circle.

Outline for Solid Geometry.

Throughout the course in Solid Geometry efforts should be made to relate the work to Plane Geometry wherever possible. Special emphasis should be placed upon the real grasp of space notions and theorems; pictures, stereoscopic views, and models may be used to assist in grasping space relations but too great a use of such aids may work against the visualizing habit which is one of the chief values of Solid Geometry. Solid Geometry offers excellent opportunities for algebraic symbols and methods; it is recommended that mensuration rules be written in algebraic form but read in the translated English form. Logarithms may be used in computation problems if the second course in Algebra precedes Solid Geometry.

Additional Assumptions: 1. Two intersecting lines, two parallel lines, a straight line and a point outside that line, or three points not in a straight line, determine a plane.

*2. The intersection of two planes is a straight line.

*3. The projection of an oblique line on a plane is a straight line.

*4. Every plane section of a cone through its vertex is a triangle.

*5. Every plane section of a cylinder throughout an element is a parallelogram.

6. The shortest distance on a sphere between two points is the minor arc of the great circle joining them.

I. Theorems closely related to Plane Geometry.

1. If two parallel planes are cut by a third plane the intersections are parallel.

2. If a line is parallel to a plane, then the intersection of that plane with any plane through the line is parallel to the line.

3. Equal oblique lines from a point in a perpendicular to a plane cut off equal distances, and converse.

4. Angles having sides parallel in same order are equal.

5. The plane bisecting a line at right angles is the locus of points equidistant from the ends of the line.

6. If two lines are cut by three parallel planes corresponding segments are proportional.

7. The angle a line makes with its projection on a plane is the least angle it makes with any line in the plane.

8. Two planes perpendicular to the same plane are parallel.

II. Lines and Planes.

*1. A line perpendicular to two lines at their intersection is perpendicular to their plane.

2. Every line perpendicular to a line at a point lies in a plane perpendicular to the line at that point.

3. Through a point only one plane can be drawn perpendicular to a line.

4. If a line is perpendicular to a plane every plane through the line is perpendicular to the first plane.

5. If two planes are perpendicular, any line in one, perpendicular to their intersection, is perpendicular to the other plane.

6. If two intersecting planes are each perpendicular to a third their intersection is perpendicular to that third plane.

7. The locus of a point equidistant from sides of a dihedral is the bisecting plane of the dihedral.

III. Spheres.

1. Every plane section of a sphere is a circle.

2. A plane tangent to a sphere is perpendicular to the radius at point of tangency.

3. The distances of a circle on a sphere from its poles are equal.

4. If a point on a sphere is at a quadrant's distance from the other points not at the extremities of a diameter, then it is the pole of the great circle through the two points.

5. A spherical angle is measured by the arc it intercepts on a great circle having its pole at the vertex of the angle.

IV. Polyhedral angles and spherical triangles.

1. The sum of two face-angles of a trihedral is greater than the third.

2. The sum of the face-angles of a polyhedral is less than 4 right angles.

3. Two trihedral angles are equal or symmetric when two dihedrals and included face-angles, two face-angles and included dihedral, or three face-angles, in one have equals in the other.

4. The sum of two sides of a spherical triangle is greater than the third.

5. The perimeter of any polygon is less than 360°.

*6. Two spherical triangles are equal or symmetric when they have

$A=A'$	$B=B'$	$c=c'$
$a=a'$	$b=b'$	$C=C'$
$a=a'$	$b=b'$	$c=c'$
$A=A'$	$B=B'$	$c=c'$

7. If one spherical triangle is the polar of a second then the second is also the polar of the first.

*8. In two polar triangles any side of one is the supplement of the opposite side of the other.

9. The sum of the angles of a spherical triangle is more than two and less than six right angles.

V. Mensuration.

1. Lateral areas of prism, cylinder, regular pyramid, cone, and frustum.

2. Area traced by line revolving about an axis in its plane.

3. Spherical areas; zone, sphere, lune, and spherical triangle.

4. Volumes.

(a) Rectangular parallelopiped; by counting cubes formed by passing planes.

(b) Right prism, and cylinder as limit of inscribed prism as number of sides of base become infinite.

(c) Cavarlieri's Theorem: "Two solids having bases equal in area and equal altitudes are equal in volume if every two plane sections at same distance from base are equal in area." (Beman and Smith Geometry, p. 298). Illustrate without proof.

(d) Oblique prism and cylinder, by proving equal in volume to right prism and cylinder using (c).

(e) Pyramids and cones having same altitudes and bases equal in area are equal in volume; use (c).

(f) Volume of triangular pyramid.

(g) Any pyramid or cone, as sum, or limit of sum, of triangular pyramids.

(h) Frustum as difference in volumes of two pyramids or cones.

(i) Sphere as equal in volume to certain cylinder having two cones removed from its volume, using (c).

(j) Spherical segments using (c).

5. Sensible use of approximations in measurements and computations.

D. *Trigonometry.*

The work should cover the field of plane trigonometry, as given in standard text-books, including the solution of right and oblique triangles. Special emphasis is placed upon the solution of practical problems, trigonometric identities, and trigonometric equations.

22. MUSIC.

Following are the Definitions of Units for Accrediting:

Courses in Harmony, History of Music and Musical Appreciation will be accredited on the same basis as other High School courses, namely: Five hours of recitation per week and five hours of preparation per week for 36 weeks will receive one unit of credit. Five hours of recitation per week without preparation will receive one-half unit. Written work will be required in all courses, but preeminently in Harmony.

I. HARMONY, FIRST YEAR.

Elements of musical notation; Construction of Major and Minor scales; Keys; Signatures; Intervals; general and specific; Key relationships; Consonances and Dissonances; Triads, Primary and Secondary; Inversions of Triads; Chord Progressions; Simple Melodies harmonized with Tonic dominant and Sub-dominant harmonies.

SECOND YEAR.

Review of Triads; Seventh chords, Primary and Secondary; Harmonization of simple Melodies with Triads and Seventh Chords; Harmonic Analysis; Original Work.

II. History of Music: A Text-book course, with recitations and written work, touching the beginnings of music, and including a fairly comprehensive study of the development of music since A. D. 1600 and acquaintance with the lives and productions of the greatest composers and performers. One year.

III. Music Appreciation based upon the standard choruses and instrumental selections from the works of the great composers of each epoch, with instructions in Elementary Theory, Sight-Singing and Ear-Training. One year.

IV. A composite course may be offered including Harmony, History of Music and Musical Appreciation, any two of these subjects, and subject to the same regulations, with the added specification that in such a course at least one recitation per week in Harmony, with written preparation, shall be included. Two years.

V. Regulation regarding Teachers.

No High School Music will be accredited for entrance to the University where the Teacher of Harmony or History of Music to be offered for accrediting has not had at least a year of study in the subject to be taught in some professional training school, unless he has received a diploma or degree from some recognized institution for the training of musicians or music teachers.

23. PHYSICS.

One year's high-school work covering the elements of physical science as presented in the best of the current high-school text-books of physics. Laboratory practise in elementary quantitative experiments should accompany the text-book work. The candidate's laboratory note-book will be considered as part of the examination.

Following is a syllabus for a one year course in Physics as adcpted by the Physical Science Section of the High School Conference, November, 1912:

Syllabus for Physics.

I. Introduction.

- A. Metric system.
  - Linear measure, units: meter, centimeter.
  - Square measure: centimeter only.
  - Cubic measure: cubic centimeter, liter.
  - Mass: kilogram, gram and decimal parts.
- B. States of matter. Defined and explained. Kinetic theory of matter.
- C. Properties of matter, illustrated and explained. This should include a study of the evidences of molecular motions and molecular forces in solids, liquids and gases.
- D. The moisture in the air. Including a study of conditions necessary to the formation of dew, fog, rain, snow, etc.
- E. Evaporation. The conditions affecting it and the results produced by it.

II. Force and Motion.

- A. Forces: kinds, their measurements and graphic presentation.
- B. Motion forms. Newton's laws of motion: inertia, momentum, and reaction.
- C. Resolution of forces. Uses, applications.
- D. Moment of force, defined, explained. Parallel forces.
- E. Gravitation and Gravity.
  1. General law.
  2. Causes of variation in weight.
  3. Weight is proportional to mass.
  4. Center of gravity, how determined.
  5. States of equilibrium. Stability.
- F. Falling bodies.
- G. Curvilinear motion, centrifugal force.

III. Work and Energy.

- A. Work, definition, measurement.
- B. Energy, five forms, two kinds, formulas, measurement.
- C. Power, units, relation, problems.
- D. Machines, use terms "effort" and "resistance." Mechanical advantage.

E. Lever, three classes, applications.
F. Wheel and Axle and Pulley, applications.
G. Inclined plane. (Effort parallel to incline.)
H. Efficiency and Friction. Measurement, uses.
I. Power tests of motors and engines.

IV. Hydrostatics.
- A. Gravity pressure: varying depth, area, density of liquids, direction, shape of vessel. Communicating vessels. Problems on rectangular areas only.
- B. Pascal's law. Areas given, applications.
- C. Laws of buoyancy.
  1. Archimedes' principle.
  2. Laws of flotation.
  3. Problems.
- D. Specific gravity and density.
  1. Specific gravity of solids.
     Bodies denser than water. Problems.
  2. Specific gravity of liquids.
     a. Bottle method. Problems.

V. Pneumatics.
Gas pressure due to (1) gravity, (2) molecular motion.
- A. Weight and pressure of the air.
  1. Evidences (qualitative).
  2. Measurement. Use of barometer.
- B. Relation of volume and pressure. Boyle's law.
- C. Applications: Pumps,—air, lift, force, use of air dome; siphons, balloon.

VI. Heat.
- A. Heat, definition, its sources and effects.
- B. Temperature, measurement. Thermometers, their construction and limitations.
- C. Expansion:
  a. of solids, (qualitative).
  b. of liquids, anomalous expansion of water.
  c. of gases, absolute zero. Law of Charles.
- D. Modes of Transmitting Heat.
  1. Conduction }
  2. Convection } discussed and illustrated.
  3. Radiation }
  4. Applications in heating and ventilation.
- E. Heat and Work.
  a. Mechanical equivalent.
  b. Explanation of the action of heat engines.
- F. Measurement of heat. Calorie and B. T. U. Specific heat.
- G. Change of state. Heat of fusion and vaporation.
  Determination, effects, applications.

VII. Magnetism and Static Electricity.

- A. Magnets: natural, artificial, permanent, temporary.
- B. General properties of magnets.
- C. Magnetic induction and the molecular theory of magnetism.
- D. The earth's magnetism as shown by:
  1. Magnetic compass.
  2. Magnetic dip and declination.
  3. Magnetic induction of the earth.
- E. Electrification by friction, kinds of electric charges.
- F. Conduction and theories of electricity.
- G. Electrostatic induction and electric fields.
  Distribution of charges.
- H. Electric condensers and capacity.

VIII. Current Electricity.

- A. Electric circuits and conditions necessary for the production of electric currents.
- B. The simple cell, action, polarization and local action.
- C. Practical voltaic cells.
  1. Leclanche, wet and dry. } Construction, Action, Uses.
  2. Daniell cell.
- D. Magnetic effect of electric currents.
  1. Electromagnet, electric bell, telegraph.
  2. Relation between current and magnetic field.
  3. Use in current measuring instruments: voltmeter and ammeter.
- E. Resistance and Ohm's law.
  1. Conditions affecting resistance.
  2. Effect of combining conductors in parallel series.
  3. Measurement.
     - a. Volt-ammeter method.
     - b. Wheatstone bridge method.
- F. Chemical effect of an electric current.
  1. Electrolysis of water.
  2. Electroplating.
  3. The storage battery.
- G. Electric power and its determination.
- H. The heat effect of electric currents.
  1. Fuse wire.
  2. Electric heating and cooking.
  3. Arc and incandescent lamps.
- I. Electro-magnetic induction.

  Law { Production, Intensity, Direction } Illustrated by magnets and coil with bar magnet.

J. The dynamo—two-pole field, single rotating loop or coil, alternating and direct.
K. Simple electric motor, two poles. Efficiency of an electric motor.
L. The induction coil and transformer. Uses. Differences.
M. The telephone.
N. Wireless telegraphy.

IX. Sound.
A. Nature, source, speed, medium.
Reflection of sound, echoes.
B. Waves and wave motion.
Illustrated by water waves showing reflection, refraction and interference.
C. Characteristics of sound.
1. Intensity—conditions affecting.
2. Pitch, and rate of vibration.
3. Quality and overtones.
D. Interference, beats, discord.
Resonance, Sympathetic vibrations.
E. Musical scales, diatonic and tempered, uses.
F. Laws of vibrating strings and air columns.
G. Types of musical instruments.
Vibrating { plates or membranes, strings. air columns.

X. Light.
A. Rectilinear propagation of light, speed.
1. Shadows.
2. Pinhole camera.
B. Photometry.
1. Intensity of light (source) and intensity of illumination distinguished.
2. Law of inverse squares.
C. Reflection.
1. Law of reflection.
2. Regular, diffused.
3. Plane mirrors, position and character of image.
D. Refraction.
1. Definition and explanation.
2. Refraction of parallel sided plates.
3. Refraction by prisms and lenses.
E. The formation of images by lenses.
1. Converging and diverging lenses.
2. Position and character of images formed by converging lenses.
F. Optical instruments.
1. Eye, camera.
2. Microscope, simple, compound. Telescope.

G. Color and spectra.
   Dispersion, achromatic lenses. Uses of spectra.

H. Interference and polarization.
   The nature of light.
   Medium, length and character of waves.

Suggested List of Experiments in High School Physics.

Mechanics.

(Twelve of the starred experiments are recommended as a minimum.)

I. Preliminary.
- *1. Measurement of length. Compare English and metric measurements.
- 2. Measurements of volume. (Teach use of calipers.)
- 3. Vernier calipers.
- 4. Micrometer calipers.
- *5. Study of graphs. (Use graph to show the relation between English and metric units.)

II. Mechanics of solids.
- *6. Parallelogram of forces.
  - *a. Problem: Crane stresses or some other practical exercise involving balanced forces acting at angles with one another.
- *7. Parallel forces.
  - *a. Problem: Center of gravity.
- *8. The lever and the principle of movements.
- *9. The inclined plane. (Efficiency of a machine.)
- *10. The pulley. The wheel and axle. (Mechanical advantage.)
- *11. Elasticity and Hooke's law by:
  - *a. Calibration of a spring or by use of Jolly balance.
  - *b. Bending rods.
  - c. Twisting rods.
- 12. Cohesion. The breaking strength of a wire.
- 13. Friction.
- *14. Falling bodies.
- *15. The pendulum.

III. Mechanics of Fluids.
- *16. Density of water. (Use of beam balance.)
- *17. Archimedes principle.
  - a. Bodies that sink in water.
  - b. Bodies that float in water.
- *18. Specific gravity of solids denser than water.
  - a. By a spring or beam balance.
- *19. Specific gravity of solids less dense than water.
  - a. By a beam or spring balance.
- *20. Specific gravity of a liquid by:
  - a. Spring or balance beam.
  - b. Specific gravity bottle.
  - c. A constant weight hydrometer.

d. A U tube.

e. A Y tube.

*21. Measuring air pressure. Use of a barometer.

*22. Measurement of pressure:

*a. Of liquids at varying depths.

b. Of gas or water pressure.

*23. Boyle's law.

Heat.

(Five of the starred experiments are recommended as a minimum.)

*1. Testing the fixed points of a mercury in glass thermometer.

*2. Relative conductivity of various solids.

*3. Coefficient of linear thermal expansion of a solid.

*4. Calorimetry. Mixing water at different temperatures and determining the thermal capacity of the calorimeter.

*5. Determination of specific heat by the method of mixtures.

*6. Determination of heat of fusion.

*7. Determination of heat of vaporization.

*8. Determination of dew point of the atmosphere.

9. a. Determination of the change of volume of a gas at constant pressure, with change of temperature.

b. Determination of the change of pressure of a gas at constant volume.

10. Fixing of melting and solidifying point.

*11. Vapor tension of alcohol.

Electricity and Magnetism.

(Ten of the starred experiments are recommended as a minimum.)

*1. Fundamental facts of magnets.

*2. To map the field of a magnet.

a. By blue print.

b. By a compass.

3. Magnetic induction and the earth's magnetism.

4. Production of static electricity by friction. A study of conductors and insulators.

5. Electrostatic induction, condensers.

*6. Study of simple galvanic cells.

*7. Study of the magnetic field about wires carrying an electric current.

*8. Study of the electromagnet.

*9. Study of electric bell, telegraph, sounder or relay.

*10. Study of a galvanometer or ammeter, using same in electric circuits. Ohm's law.

11. Study of two fluid galvanic cells.

*12. Study of electrolysis.

13. Electromotive forces of various cells by:

a. Use of volt-ammeter.

b. Use of ammeter with a constant resistance.

*14. Arrangement of cells in connection with varying external resistance.
*15. Measurement of resistance of wires by:
  a. Wheatstone bridge method.
  b. Volt-ammeter method.
*16. A study of resistance connected in series and in parallel.
17. Effect of temperature upon resistance of wires.
*18. Electromagnetic induction.
*19. Study of dynamo or motor.

Sound.

(Three of the starred experiments are recommended as a minimum.)
*1. Study of wave motion by use of wave trough.
*2 Velocity of sound in air.
*3. Wave length of sound in air.
*4. Number of vibrations of a tuning fork.
*5. Interference of sound.
*6. Laws of vibrating strings or air columns.

Light.

(Six of the starred experiments are recommended as a minimum.)
1. Images formed by a pin-hole aperture.
*2. Photometry.
  a. Study of the effect of distance upon intensity.
  b. Comparison of intensities.
*3. Law of reflection, images in a plane mirror.
*4. Images in a concave mirror.
5. Images in a convex mirror.
*6. Study of refraction by plate, prism, lens.
*7. Index of refraction of glass or water.
*8. Determination of the principal focus of a convex lens and a study of real and virtual images formed by it.
*9. Study of two of the following:
  a. Refracting telescope.
  b. Compound microscope.
  c. Opera glass.
*10. Study of spectra.

Practical Applications.

The following list gives a few of the applications of the principles involved in the various experiments or cases in which they must be taken into consideration.

Exp. No. Mechanics.

6. Wind and current pressure on sails and rudder of a ship, on planes of an aeroplane, on rudder of canal boat.
7. Bridge trusses. Single and double tree.
8. Shears, nut-cracker, crowbar, nail puller, balance, steel-yard, pump-handle, boat oar, bracket, safety-valve, human arm, pincers, wheel-barrow.

9. Screw, wedge, ladders, lifting jack, screw press, gang plank, vise, screw propeller, air fan, inclined railroads.
10. Block and tackle, geared cap-stem, windlass, derrick, water wheels and turbines.
11. Spring balance, spiral springs and wagon springs. Structural beams and trusses, shafting.
12. Suspension bridge, two lines.
13. Bearings, friction gears, belting, brakes, wheels on roadway.
14. Range of projectiles.
15. Clocks, determination of acceleration of gravity, metronome, work of bureau of standards.
17. Balloons, ships, life preservers, floating dock. Buoyancy of air.
20. Lactometers, Alcoholometers.
    Testing for adulteration of milk, oil, etc.
    Gravitational separation of liquids, cream separator.
21. Study of pumps, open manometer, siphon.
22. Construction of dams, siphon, standpipe, hydrostatic press.
23. Diving bell, caisson, closed manometer, compressed air, air brakes, bellows.

Sound.

1. Illustration of phenomena of wave motion.
   Stationary waves, reflection, refraction, interference.
2. Acoustics of buildings.
   Organ pipes (length of) echoes.
3. Comparison of pitches, measurement of time intervals.
5. Harmony.
6. Stringed instruments.

3, 4, 5. Theory of music.

Heat.

1. Calibration of thermometers. Bureau of standards.
2. Great variation in conducting power of substances.
3. End rollers on bridges. Dial thermometers. Spacing of railroad rails. Compensation pendulum, balance wheel. Metallic thermometers. Thermoregulators (thermostats).

S. Heating and ventilation. Convection currents in nature, trade winds, ocean currents.

6. Ice in refrigerator, cooling of buildings.
7. Steam heating. Steam engine. Ice making, cold storage.
8. Hydrometers, fogs, clouds, rain, snow.
9. Gas, thermometer.
10. Alloys, waxes.

S. Better understanding of heat engines.

Light.

S. Eclipses.

1. Action of camera.
2. Comparison of light intensities.

3, 4, 5. Optical instruments, reflectors for vehicle lamps, search lights, etc., sextant.

6. Displacement of objects through glass.
Position or direction of immersed objects.
Reflection by right angled prism.

8, 9. Optical instruments, microscopes, telescopes, collimator, eyeglasses, projection lantern, photographic camera, stereoscopes.

10. Spectrometer and spectrum analysis.

S. Saccharimeter, polariscopes.

Electricity and Magnetism.

1, 2, 3. Ship compass, dipping needle, etc. Magnetic separation of metals. Magnetic charts, etc., of Bureau of Commerce and Labor.

4, 5. Electrometers, lightning rods, condensers, Roentgen rays, generators, etc., brush discharge from high potential lines, static charge produced by belts, grounding by combs.

9. Electromagnetic apparatus, sounders, relays.

10. Galvanometers, ammeters, voltmeter. Measurement of electric current, etc.

8, 9, 10. Meters.

16. Calculation of electric circuits, use of tables, transmission, lighting, traction system, etc.

17S. Safe carrying capacity.

S. Electric lighting, electric heating. Heating irons. Use of tables.

13, 14. Terminal potential of current sources.

18, 19. Telephone, induction coil, induction motor, dynamo, motors, transformers, electric lighting and motive power.

24. SHORTHAND AND TYPEWRITING.

These subjects must be taken together; no credit is given for either one by itself. *For one unit*, the time requirement is two periods daily of not less than forty minutes each for one year of thirty-six weeks, and the standard of attainment is 75 words a minute in taking dictation and 25 words a minute in the transcription on the machine of such dictation. *For two units*, the time requirement is two periods daily of not less than forty minutes each for two years of thirty-six weeks, and the standard of attainment is 100 words a minute in taking dictation and 35 words a minute in the transcription on the machine of such dictation. Accuracy in spelling, punctuation, capitalization, and paragraphing should be emphasized; and attention should be given to the care of the machine, methods of copying, manifolding, etc.

25. SPANISH.

First year's work.—Elementary grammar, including thorough drill in the irregular verbs; careful training in pronunciation, and translation of simple Spanish when spoken; reading of about 100 pages of easy prose; simple composition and dictation.

Second year's work.—In addition to the foregoing, about 300 pages of modern prose; elementary syntax; dictation, composition, and translation of spoken Spanish continued.

V.

THE PROGRAM OF STUDIES.

Frequently the request comes for a model "course of study" for a given high school. The University has refrained from offering such a model or models lest these become fixed types and impede the progress of readjustments which become necessary from time to time. At the same time it is recognized that the practise so common among smaller high schools of radically changing the program (course) of studies from year to year is greatly to be deplored. It is one of the great causes of irregularity and inefficiency in this type of schools, and school authorities would do well to avoid such frequent and commonly unnecessary changes.

Another cause of weakness is to be found in the effort to make the program of studies include too much for the teaching force or the material equipment of the school. In this effort recourse is frequently had to some plan of alternation by which two high-school grades are thrown together in the same subject. This is a practice which can be safely indulged in only to a very limited extent in high-school work.

As previously stated the University requires three teachers as a minimum for accrediting a four-year high school. These three teachers, one of whom is principal of the school, should not carry more than the sixteen recitations included in a straight four-year, four-subject program. Not more than two alternations can be permitted in such cases, and the school would, in most instances, be better off without these. This would permit the offering of only two electives.

The following suggestions are offered as a basis for arranging a program (course) of studies for a four-year high school employing the teaching time of three or more teachers:

Grouping of Subjects by Grades

First Year.	Second Year.
*English	*English
*Algebra	*Plane Geometry
History, Ancient	History, European
Physical Geography ½ yr.	Zoology ½ yr.
Botany ½ yr.	Physiology ½ yr.

First Year.	Second Year.
Latin	Latin
German	German
French	French
Drawing and Art Work	Drawing and Art Work
Manual Training	Manual Training
Business Training	Business Training
Domestic Science	Domestic Science
Agriculture	Agriculture
Music	Music
Physical Training	Physical Training

Third Year.	Fourth Year.
*English	English
History, English or European	American History ½ yr.
Chemistry or Physics	Civics ½ yr.
Solid Geometry ½ yr.	Physics or Chemistry
Advanced Algebra ½ yr.	Economics ½ yr.
Latin	Trigonometry ½ yr.
German	Latin
French	German
Spanish	French
Commercial Geography	Spanish
Business Training	Drawing and Art Work
Manual Training	Manual Training
Drawing and Art Work	Business Training
Domestic Science	Domestic Science
Agriculture	Pedagogy or Educational Psychology
Music	Agriculture
Physical Training	Music
	Physical Training

It will be seen that all subjects usually offered in high schools are hereby included. The starred subjects, with one unit of science (either Physics, Chemistry, Botany, Zoology, Physiology, or Physiography, with laboratory work), are required for admission to all courses in the University. These together with additional subjects required by particular colleges or departments of the University should be kept in mind where a school is desiring to become accredited. (See Admission Requirements, pp. 6-8).

In making up a program for a three-teacher school enough subjects (besides those prescribed) should be selected from each year group to make up not to exceed 18 units for the four years. If any additional election should be desired this may be managed by making it class election instead of individual, assuming, that the teachers are prepared to handle the subjects chosen. For instance, the choice might be between two languages. The language which the class as a whole, or which a majority would elect, would be the one taught for a given year or more. In a similar way vocational work might be handled, subject to limitations as to equipment and teaching ability. A certain amount of work in music and physical training may be permitted as extra. Such a plan may be used so as materially to increase the flexibility of a program of studies for a small high school.

As the number of teachers increases there may be an increase in individual election, but always with the increase in enrollment and consequent dividing of grades into sections as a controlling factor.

School authorities, in introducing new courses, such as commercial, manual training, domestic science, agriculture, should take into consideration their ability to equip properly for them and also the difficulty of providing competent instructors. Courses which are only in the experimental stage, such as general science, should be left to the stronger schools which can afford the experiment until some definite conclusion is reached as to what such a course should be and where it should come in the program.

VI.

SUGGESTIONS FOR THE EQUIPMENT OF LABORATORIES.

Primarily this problem should be considered in the plans for building a high school. Important considerations in connection with building plans are: 1. The proper lighting of rooms to be used for various laboratory purposes. Where the microscope is to be much in use a north light, and an abundance of it is desirable. In the matter of preserving life forms for biological work, on the other hand, direct sunlight is desirable.

In a physical laboratory there is need of direct sunlight in connection with the study of light. Otherwise the light should be ample for close observation in experiments.

In rooms used for drawing and art work a north light should be planned unless overhead light is possible. The latter is the ideal light for such work.

2. The building in of suitable cases, cupboards, etc., for taking care of apparatus and supplies.

3. Equipment with good substantial tables for experimental work.

4. The provision of good ventilation, and of hoods to take off gases and fumes from the chemical laboratory.

5. Convenience of water supply, with lavatories and sinks, and with aquaria in the biological department.

6. A gas plant should be provided for chemistry, and is practically indispensible where domestic science is to be included in the program.

LABORATORY APPARATUS.

Physics: This should be selected on the basis of experiments to be undertaken, as suggested in the syllabus, p. 70. The aim should be to provide as far as possible for individual work. Hence it is that the amount and cost will vary with the number of pupils to be supplied and the number of experiments to be undertaken. Whatever is bought will need to be replenished from year to year, as such material tends to become rapidly depleted.

Under existing conditions there will be considerable fluctuation in prices of apparatus for physics. Approximately, however, the standard equipment for a small high school enrolling not more than six pupils in physics would involve an investment of about $200. (See Physical

Set No. 2, p. 280, Catalog F. No. 118. Central Scientific Co., Chicago.)

In such a case the students should perform experiments in rotation rather than in group, in most instances, so as to give individual experience. For each increase in number up to six there should be added approximately $100 for duplicates. Counting twenty-four as the maximum size for a laboratory section this would give a total approximate minimum cost of $500.

For a complete working laboratory the cost would be approximately $1000 as a minimum.

The above figures, however, do not include fixtures, such as cases, tables, work-bench, lavatory, etc. Tables for the physics laboratory should be solidly built and heavy enough to give steadiness and firmness.

The minimum cost for a class of six of a suitable table would be $50 to $60. This may be taken as a unit for minimum cost without gas or electric outlets attached. For a more complete laboratory equipment and a class of twenty-four the cost would be approximately $350 to $400.

Cases for storing apparatus may be built in or furnished complete. They should be well built, capable of shutting out dust, and with glass fronts.

Chemistry: The same general principles apply as in physics. In both cases it is a good plan to determine on the extent and nature of the experimentation and then submit lists of experiments to reliable houses with request for prices of apparatus and materials necessary.

The greatest cost in the equipment for chemistry will be in the fixtures to be provided as necessary for successful work. A very good and complete outfit for chemicals and apparatus may be obtained for approximately $75.

A good chemistry table for sixteen pupils, with gas and water attachments, reagent racks, individual cupboards and drawers, and with an Alberene stone top will cost about $300 plus the freight. To this should be added storage cases and a fume hood.

Biology: This includes Botany, Zoology, and Physiology. The laboratory should be provided with dissecting instruments and simple microscopes. There should also be as many compound microscopes of good grade as would be necessary to provide one for each group of four or six. If practicable there should also be a good lantern with projecting microscope attachment.

The following report on Illustrative Materials for High School Biology Courses given at the Conference for 1914 is of special value for its helpful suggestions:

Your committee, appointed to make recommendations as to the illustrative materials with which high schools should be supplied in order to give in a satisfactory way the courses in Botany and Zoology, beg to make the following report:

1. We desire to express our conviction that every school should, regularly and with some system, undertake to build itself up in this regard. By following this practice thru a period of years any school may supply itself with the minimum necessities, without financial strain.

2. It is possible, for convenience, to divide the illustrative necessities into two main groups:—(a) those that must be purchased outright, and (b) those that may be made gradually by students of successive classes, if only they are supplied with the necessary raw materials. This latter group is somewhat larger than we may at first sight believe. Furthermore, whenever it is possible for some such materials to be made by students the very making may become a means of increasing interest and of giving fuller meaning to the course.

3. We desire also to insist that most teachers do not use as fully as they should the supply of illustrative material which nature affords. The individual work in fields and forests, in swamps and in the waters, in parks and gardens, in green-houses and zoological gardens furnishes a means of illustrating courses which our formal use of the laboratory and class room cannot at all replace.

4. In detail we make the following suggestions as to what should be held in the mind of the teacher of Biology and the directors of schools as an objective:—

a. *Museums.* Small synoptic collections illustrating the main phyla and classes of animal kingdom and the main groups of plants are very valuable. These should not be large and should be built up by successive classes, teachers, and friends of the school rather than got by purchase. Money should go into the cases, containers, and preserving materials, rather than into specimens. It will be necessary to buy some specimens,—as sponges, corals, and other sea forms. Aside from such synoptic collections, built up by successive classes, two particularly interesting lines of addition are open to the museum of a high school: (1) considerable numbers of certain kinds of objects (e. g. snail shells, or leaves, or insect species) arranged, to illustrate the *range of variation*, may be mounted for display; (2) skeletons may be prepared and mounted, or other specially excellent dissections by members of a class may be preserved. Such original contributions by students may well be labeled and credited to the student preparing it. Such a museum does not need to be large to be exceedingly valuable; but it should be fairly representative and synoptic.

b. *For living materials, plant and animal.* Some green-house facilities, if only a sunny window, for winter use, and outdoor beds for spring, are desirable for first-hand supply of botanical material. A corner in the local greenhouse can often be rented.

There should be one aquarium of some size, if possible with running water. A number of battery jars or other glass vessels of various sizes, insect cages, life-boxes, and the like are essential. Students can make many of these boxes and cages, and even small wood aquaria with one or more glass sides. A small fund should be set apart for such purposes and be available without unnecessary delay. All these things are valuable to insure having organisms when they are needed, to allow experiments and continued observations on habits, and to allow study of development. The library should have at least one good book containing suggestions for making such apparatus and the care of living animals. We commend Ganong's "Teaching Botanist" as an aid in the organization of the museum and in other respects. If the school room is not kept heated at night these life supplies may be kept in a suitable basement room during the coldest weather.

c. *The local collection of living materials.* We feel that something is lost if classes are not encouraged to collect as much of the needed local material as possible for themselves. Field work should be so organized that at least some of this shall be done. In connection with this sort of work a home-made map, drawn to suitable scale, of the locality for several miles around the school may be perfected, if the locality at all lends itself to this treatment. All important topographic points that have to do with plant and animal life should be located. The roads, streams, springs, ponds, and other special habitats of specially interesting plants and animals should be indicated. There should also be a card catalog or indexed book in which are inserted the locality on the map where special types of plants and animals are discovered from year to year. In a few years such an arrangement will illustrate some of the local facts of geographic distribution, as well as be an aid to each incoming class in finding what it needs. It will be necessary always to purchase some materials for laboratory, and museum work.

The following is a reliable list of dealers in materials for laboratory work:

A. A. Sphung, North Judson, Ind. Live or preserved frogs, crayfish, turtles, etc.

H. M. Stephens, Dickinson College, Carlisle, Pa., Zoological and Botanical materials for class use.

C. S. Brimley, Raleigh, N. C., Reptiles, Amphibians, and Fishes, living or preserved. A good reference for the winter months.

Biological Supply Co., 106 Edgerton St., Rochester, N. Y. Plant and animal materials for laboratory; slides.

Marine Biological Laboratory, Woods Hole, Mass. Preserved materials for Botany, Zoology and Embryology.

Saint Louis Biological Laboratory, St. Louis, Mo. Microscopic and Lantern Slides.

Chicago Biological Supply House, 5542 Kimbark Ave., Chicago. General biological supplies.

The Anglers' Bait and Mfg. Company, 913 W. Randolph St., Chicago. Live and preserved animals.

F. J. Burns and Company, 214 W. South Water St., Chicago. Live and preserved animals.

Powers and Powers, Station A, Lincoln, Nebraska. Prepared slides, smaller live animals.

d. *Microscopes.* If microscopes are used only for demonstration purposes there should be at least two good standard instruments with powers ranging from 50-500, so that both low and medium power views can be shown at the same time. There should also be one oil-immersion objective for occasional high power demonstrations.

If microscopes are to be used as a regular part of the laboratory work, as we feel they should be, there should be *at least* enough to supply each pair of pupils in the largest section with one complete, standard instrument. We believe that no laboratory section in Biology should contain more than 24 members for one instructor. Twelve microscopes can be made to serve such a section.

There should be a simple dissecting microscope for each pupil or each pair of pupils.

e. *Microscopic slides.* These may be divided into four groups: (1) temporary slides, which teachers and pupils may make freely. The teacher should become expert in making these and enabling his pupils to do so; (2) permanent mounts of interesting objects small enough to be stained and mounted whole. There are very many such which are valuable. It should not be necessary to purchase these. The teacher should be supplied the necessary material and learn to make, stain, and mount these; (3) temporary or permanent mounts where free-hand sections may serve all necessary ends. The teacher should be able to make, stain, and mount these; and (4) permanent mounts of materials where expensive apparatus is necessary for imbedding, sectioning, grinding, etc. These can be bought much more cheaply than made, and the apparatus necessary to make them is hardly to be sought in the ordinary high schools.

We append a suggestive list of especially valuable microscopic slides that should be purchased and used at least as demonstrations in high school courses. These should be the best of their kind,—clear, typical, and perfectly stained.

1. Cell structures, cell-arrangement, and cell-division as seen in longitudinal section of root tip of *Tradescantia or Hyacinth.*
2. Cross-section of leaf, showing structure of this basal organ of all nutrition.
3. Cross and longitudinal sections of monocotyledonous and dicotyledonous stems.
4. Cross-section of a root.
5. Cross-section of ovary of lily or other suitable plant, showing relation of the parts.
6. Longitudinal section of young flower or leaf bud showing the beginning of floral parts, or of the foliage suits.
7. Section of another showing pollen-formation.
8. Longitudinal section of pollinated pistil showing pollen tubes, etc.
9. Some properly stained bacteria,—as *Spirillum*, *Bacterium*, *Baccillus*, etc.
10. Section of hymeniun of Ascomycete and Basidiomycete.
11. Cleavage, morula, and gastrula of some form like the starfish.
12. Sections of tadpoles of 1 to 3 weeks to show how animal cells come to be related in tissues and organs, as well as the relations of the organs. Good to compare with (1).
13. Cross and longitudinal sections of *Hydra.*

14. Section thru vertebrate eye in visual axis.
15. Section of compound eye in axis of ommatidium.
16. Longitudinal and cross section of bone.
17. Longitudinal section of tooth.
18. Cross-section of stomach or intestine, showing coats, glandular-absorptive surface, etc.
19. A Golgi preparation showing ramifications of neurons.
20. Section thru skin of animal.
21. Section of injected liver.
22. Ciliated cells.
23. Cross and long (several segments) sections of earthworm.

f. *Projection apparatus.* We believe that a projecting lantern with opaque projector and a projecting microscope should in time be provided for each high school. The usefulness of such a lantern would not of course be confined to the courses in Biology. This would demand also the gradual accumulation of a limited number of well selected lantern slides and microscopic slides.

g. *Illustrative books.* So much success has attended photography, both gross and microscopic, and the reproduction of these pictures in books that every school should supply itself with some books illustrating natural history to aid in identifying the plants and animals discovered by the classes and in visualizing such as the student may not be able to find in his own locality. Under this head comes illustrated natural histories, flower-books, bird-books, butterfly-books, the reptile book, and the like,—as well as some larger texts showing figures of dissections and microscopic structures in plants and animals.

h. *Charts.* Very effective charts for both Botany and Zoology are issued by a number of firms. These are valuable, but expensive. Each school should perhaps have a limited number of these charts illustrating certain features of life not readily illustrated in some other ways.

Of even more value, however in some respects, are home-made charts, drawn from figures and tables in books and periodicals. They may be made on paper or on paper reinforced by cloth. They may be mounted on a roller or kept flat. Ingenious devices to display them can be made by the pupils themselves. Ink may be used, put on with a brush, or colored crayons may serve. A spray of shellac, from an atomizer after the crayon marks are made, will keep the crayon from spreading. There is almost no limit to the number of charts,—of lines or simple shaded surfaces,—which classes and teachers may make by copying figures from books, nor to the help they render in making structures clear. The selection and making of such charts with their lettering and interpretation is very valuable work for the pupils. The school should furnish the materials for making these charts.

i. *Blackboard drawings as illustrative material.* The committee desires to emphasize the importance of the ability of the teacher to make simple freehand diagrams before the class. Every teacher should give time to cultivate this power to his full capacity, and to use whatever drawing ability the members of the class may have. These diagrams should not be made too complex. They are valuable because of their simplicity and the consequent emphasis on essentials, and on the fact that they grow under the eyes of the pupils.

Geography. For this work there should be plenty of good government survey charts giving topography. There should also be thermometers, barometers and other apparatus for observing and recording weather conditions. A good commercial cabinet will help to bring before the pupils in concrete forms the leading commercial products.

Agriculture: The apparatus will be determined by the courses to be offered and can not, therefore, be estimated. See 1914 Conference Proceedings, pp. 109-110, for valuable suggestions as to materials. See also p. 84, Proceedings of 1913.

When it has been fully settled as to the course or courses to be offered it is suggested that treatment similar to that recommended for physics and chemistry be followed. The Wm. Welch Co., and Central Scientific Co., are among those prepared to furnish quotations on apparatus for agriculture.

Manual Training: For this there will need to be individual or bench equipment and a general equipment. The minimum cost of bench equipment, including bench, will be about $16.00 to $18.00. The corresponding general equipment would be about $75.00 for twenty pupils. The range of cost above this to a very liberal equipment will be about $35.00 for individual desk, and $215.00 general for twenty pupils.

Drawing: For both mechanical and free-hand drawing suitable tables should be provided. There are many varieties and prices. Ordinarily pupils are required to get their own sets of instruments, pencils, crayons, colors, etc. Whether these are purchased by the school or by the pupils, good varieties should be selected and designated for use of the school.

Domestic Science: Like agriculture the equipment will be determined by the courses to be offered.

The Problem of Heat for Laboratory Use in Small Schools.

This problem appears not only in physics and chemistry but also and most emphatically, in domestic science work. Two solutions are possible in the latter case: The use of gas, and the use of electricity. The latter, where there is an all-day current, has proven very satisfactory, both as to effectiveness and cost. But it does not meet the needs of the chemical laboratory..

For all purposes, the local gas plant seems to be most desirable. To meet this need some such plan as that provided by the Detroit Heating and Lighting Company, of Detroit, Michigan, is believed to be most desirable.

Bookkeeping: This will require a room well lighted, preferably without direct sunlight. There will also need to be desks selected, or large tables, suitable for use in handling the various books and papers.

DEALERS IN APPARATUS AND SUPPLIES FOR LABORATORIES.

C. H. Stoelting Co., 121 North Green St., Chicago.
Central Scientific Co., 460 East Ohio St., Chicago.
Chicago Apparatus Co., 40-42 West Quincy St., Chicago.
Wm. Gaertner & Co., 5347-9 Lake Park Ave., Chicago.
Henry Heil & Co., 212-214 South Fourth St., St. Louis, Mo.
Eimer & Amend, 205-211 Third Ave., New York City.
L. E. Knott Apparatus Co., Harcourt St., Boston, Mass.
E. H. Sargent & Co., 125-127 West Lake St., Chicago.
Bausch & Lomb Optical Co., Rochester, New York.
McIntosh Stereopticon Co., 35-37 Randolph St., Chicago.
Kewanee Manufacturing Co., Kewanee, Wis., (laboratory furniture).
Leonard Peterson & Co., 1240-1248 Fullerton ave., Chicago (laboratory furniture).
A. Daigger and Co., 54 West Kinzie St., Chicago.
Schaar and Company, 1025 South State St., Chicago.
Arthur H. Thomas Company, West Washington Square, Philadelphia.

DEALERS IN SUPPLIES AND EQUIPMENT FOR SHOP WORK AND MECHANICAL DRAWING.

Simmons Hardware Co., St. Louis, Mo.
Orr & Lockett Hardware Co., 71-73 Randolph St., Chicago.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City.
E. Dietzgen Co., Chicago.
Weber & Co., St. Louis.
A. S. Aloe Co., St. Louis.
E. H. Sheldon Co., Muskegon, Mich.
Grand Rapids Hand Screw Co., Grand Rapids, Mich.
Columbia School Supply Co., Indianapolis, Ind.
Keuffel and Esser Co., 516-520 S. Dearborn Street, Chicago.
U. S. Blue Print Paper Co., Chicago.
Frederick Post Co., Chicago.
Charles Pease Co., Chicago.
Scranton Correspondence School Co., Scranton, Pa.

VII.

OTHER BULLETINS PUBLISHED FOR THE USE OF HIGH SCHOOLS AND BOARDS OF EDUCATION.

On the High School Library; Bulletin No. 33, 1917.
Planning and Construction of High School Buildings; Bulletin No. 8, 1916.
Annual Report of High School Visitor: Bulletin No. 45, 1918.
Annual High School Conference Proceedings.

The above publications are distributed from the office of the High School Visitor, Room 254, Administration Building, University, Urbana, Illinois.

Additional copies of this Manual for use of teachers may be had in limited numbers on application by high school principals or superintendents.