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ABSTRACT

The major portion of this booklet contains detailed specifications for the content of science courses for grades 10-12 in the Arts and Science, Business and Commerce, and Science, Technology, and Trades Branches of Ontario secondary schools. Chemical, physical, and biological topics are emphasized. Brief notes on other science courses are provided. These courses were prepared for introduction in 1965, and are "experimental in that they will be subject to review." (AL)

Curriculum RP-17
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ONTARIO
DEPARTMENT OF EDUCATION

SCIENCE

Courses of Study for the

FOUR-YEAR PROGRAMME

and

Comments on the Courses of Study for

THE FIVE-YEAR, TWO-YEAR, AND OCCUPATIONAL PROGRAMMES

U.S. DEPARTMENT OF HEALTH,
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These courses are experimental in that they will be subject to review.
Suggestions for their improvement will be welcomed.

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COURSES OF STUDY IN SCIENCE

GRADE	A. & S.	B. & C.	S. T. & T.
9 - 4 year and 5 year	Curriculum I:1(e) Pages 40-50	Curriculum I:1(e) Pages 40-50	Curriculum I:1(e) Pages 40-50 Curriculum RP-17 Page 16
10 - 5 year	Curriculum I:1(e) Pages 51-60	Curriculum I:1(e) Pages 51-60	Curriculum I:1(e) Pages 51-60
- 4 year	Curriculum RP-17 Pages 4-10	Curriculum RP-17 Pages 4-10	Curriculum RP-17 Page 4 and Pages 15-20
11 - 5 year	Curriculum S.17A Physics	Curriculum S.17A Physics	Curriculum S.17A Physics
- 4 year	Curriculum RP-17 Page 4 and Pages 11-14	Curriculum RP-17 Page 4 and Pages 11-14	Curriculum RP-17 Page 4 and Pages 20-24
12 - 5 year	Curriculum S.17 Chemistry Pages 11-24 (1964-65 and 1965-66)		
- 4 year			Curriculum RP-17 Pages 4, 20, 21 Pages 25-30

N.B. 1. Two-year Programmes see Curriculum RP-17, Page 3

2. Diversified Occupational Programme see Curriculum RP-17, Page 3

3. Industrial Chemistry, Curriculum RP-27: Four-year Programme, Pages 94-97; Five-year Programme, Pages 192-194

4. Industrial Physics, Curriculum RP-27: Four-year Programme, Pages 98-102; Five-year Programme, Pages 195-197

5. Biology for Grade 11 of the Four-year Programme, see Curriculum RP-50

6. Geology for Grade 11 of the Four-year Programme, see Curriculum RP-47

THE FOUR- AND FIVE-YEAR PROGRAMMES

ALL BRANCHES

Grade 9

1. The course of studies as outlined for Grade 9 in Curriculum I:1(e) will be taught to students in each Branch.

2. It is suggested that all units listed in the course of studies be taught, but that local curriculum committees should feel free to select the topics to be treated intensively or extensively. The detailed outlines under each topic should be considered as suggestions only as to the depth and direction of treatment. Committees should arrange their local course outlines in such a way as to avoid undue repetition in higher grades.

3. It is suggested that all schools adhere to the policy of teaching the physical science topics during the first part, and the biological topics during the latter part of the school year.

4. In the development of courses, heads of departments of science and physical education should work together to avoid unnecessary duplication. Parts common to these courses which are experimental in nature should be stressed in science classes. Duplication of descriptive anatomy should be avoided. Attention is drawn to duplication in topics 3, 4, and 5 on pages 49 and 50 of Curriculum I:1(e).

THE FIVE-YEAR PROGRAMMES, ALL BRANCHES

Grade 10

1. The course of studies as outlined for Grade 10 in Curriculum I:1(e) will be taught to students in all Branches.

2. It is suggested that all units listed in the course of studies be taught, but that local curriculum committees should feel free to select the topics to be treated intensively or extensively. The detailed outlines under each topic should be considered as suggestions only as to the depth and direction of treatment. Committees should arrange their local course outlines in such a way as to avoid undue repetition in higher grades.

3. It is suggested that all schools adhere to the policy of teaching the biological topics from September until December and the physical science topics for the balance of the school year.

4. The Grade 10 science course is designed to prepare students for the physical science courses in Grades 11 and 12. Energy relationships should receive close attention. The topics of physics in the courses of Grade 10 and Grade 11 should be closely integrated to reduce to a minimum the time required for review in Grade 11.

Grade 11

1. The new course in Physics, Curriculum S.17A, has been designed to follow logically from the new courses for Grades 9 and 10. Its emphasis on basic principles and modern developments is considered to be equally suited to students in all three Branches who intend to proceed to higher education.

2. Care must be taken to avoid presenting the Grade 11 course in the same pattern as has been customary in Grade 13. It is recommended that the instruction in mechanics be primarily experimental with stress on the comprehensive interpretation of units. The function of problems should be to clarify and exemplify the concepts studied experimentally.

Grade 12

1. The Grade 12 Chemistry outlined in Curriculum S.17 is to be followed with Grade 12 classes of all Branches until June, 1966.

2. A new course in Chemistry, Curriculum S.17D, is being prepared for Grade 12. The date of introduction will be announced later.

THE TWO-YEAR PROGRAMME

Grade 9

1. Curriculum I:1(e) should form the basis of the Grade 9 course of studies. Topics within the general framework suggested may be varied by local curriculum committees to meet the needs and interests of the students involved.

2. Such a course will provide a general science background for those who will have a limited amount of science when they leave school.

Grade 10

Local curriculum committees should feel free to select from any of the suggested courses of study from Grades 9 to 12 to provide material that will meet the needs and interests of the students involved in this programme. It is quite possible that different courses should be provided for different classes if their employment aims are widely divergent.

THE DIVERSIFIED OCCUPATIONAL PROGRAMME

No course of study has been prepared at a provincial level for this group. It is recommended that courses be provided at a local level to meet the needs and interests of the students involved.

2. It is considered probable that much of the effective science teaching will be done in close association with the teaching of the special skills to this group.

3. On this basis, these students may receive either a formal course in science or an informal introduction to scientific methods in connection with their practical courses.

4. In the latter approach, the science teacher may be expected to give full co-operation to the teacher of the practical subjects.

THE FOUR-YEAR PROGRAMME

In developing four-year programmes teachers have the opportunity of building courses which are adapted to the capabilities and aptitudes of students and to the special interests of the community. These courses should be designed to stimulate and maintain interest and to provide an opportunity for students to achieve at this level. The suggestions listed below, may assist in avoiding the parallelism which tends to destroy the function of the four-year courses.

(a) separate courses of study
(b) a variety of text-books (e.g. class sets)
(c) freedom of choice of topics and of time spent on each topic
(d) variation in depth depending on the interest and aptitude of the students
(e) different examinations throughout
(f) increased emphasis on experimentation in small groups
(g) increased emphasis on relationships of concepts to environment
(h) increased credit for term work
(i) decreased emphasis on technical terminology
(j) decreased emphasis on mathematical problems

* Having developed a course of study in accord with the principles outlined above, the teacher may find that no single text on the approved list will serve his purposes. Subject to the approval of the local board, he may decide to use partial sets of several texts and reference books which may include some of the excellent titles now available in paper back editions.

THE ARTS AND SCIENCE BRANCH AND THE BUSINESS AND COMMERCE BRANCH

Grade 10

Unit 1 BOTANY: FLOWERING PLANTS

1. General Structure of the Plant

(N.B. Portions of some of the topics in this unit have been taken in Grade 8, Unit I. Teachers should avoid the unnecessary repetition of familiar introductory material. They should also try to select for detailed examination flowers, fruits, and seeds that have not been studied in earlier grades. In every case structure should be emphasized only as related to function).

(a) A practical study and examination of a buttercup (or mustard), a toadflax, (or snapdragon) and a composite flower such as chicory, burdock, sunflower, under the following headings:

(i) Root - kind of root system
(ii) Stem - texture (wood or herbaceous): habit of growth
(iii) Leaf - simple or compound; venation; arrangement
(iv) Flower - description; cohesion (relationship of like parts) and adhesion (relationship of unlike parts) of the sepals of the calyx, of the petals of the corolla, of the stamens, and of the carpels of the pistil; comparison of ray and disc florets in the head of a composite flower;
(v) Fruit - description

(b) The occurrence of flowers and fruits on

(i) Deciduous trees - maple, willow
(ii) Coniferous trees - pine, spruce

2. Pollination

(a) Reference to definition, types, and agencies as developed in Grade 8, Unit 1
(b) Adaptations to ensure cross-pollination - preference for foreign pollen; dioecious plants; time of maturation of essential organs
(c) Microscopic examination of pollen

3. Fertilization

Brief description of the union of male and female nuclei to form the zygote and endosperm

4. The Structure of Seeds as Applied to their Function

(a) Brief description of formation of seeds
(b) Examination of a bean or pea seed to study its structure and the origin and uses of its parts
(c) Observation of the stages in the germination of a bean or pea seedling
(d) The uses of seeds, e.g. sexual reproduction and the development of new varieties; carrying the plant through a period of unfavourable conditions (dry or cold weather) increasing the number of offspring

5. The Structure of Fruits as Applied to Function

(a) Definition - a ripened ovary containing seeds Other parts such as the receptacle, calyx, stigma, or style may form part of the fruit
(b) Examples

6. Vegetative and Sexual Reproduction

(a) The advantages of each type of reproduction
(b) Vegetative reproduction from stems (including subterranean stems) and leaves

7. The Structure of a Woody Stem as Applied to Function

(a) Examination of stems to distinguish bark (cork and phloem), cambium, xylem (heartwood and sapwood), rays, pith; their position and uses
(b) The cause and significance of annual rings

8. The Structure of a Leaf as Applied to Function

(a) Microscopic examination of a cross-section of a leaf and of the surface view of the epidermis
(b) Position, description, and uses of the cuticle, epidermis, guard cells, stomata, palisade, and spongy parenchyma, chloroplasts, veins
(c) The function of the guard cells in controlling the rate of transpiration

Unit 2 BOTANY: NON-FLOWERING PLANTS

1. Fungus Plants

(a) General characteristics compared with chlorophyll-bearing, flowering plants
(b) Mushroom:
  (i) Examination to show the structure of each part, their functions
  (ii) Method of obtaining food
  (iii) Method of reproduction - spores and mycelium
  (iv) Edible and poisonous mushrooms compared
(c) Bread-mould:
  (i) Laboratory growth of some bread-mould
  (ii) Microscopic examination to identify mycelium, hyphae, sporangium, and spores
  (iii) Importance and uses of moulds - decomposition of waste; medicinal products
(d) Yeast:
  (i) Laboratory growth of yeast in a sugar solution
  (ii) Microscopic examination of yeast cells
  (iii) Methods of reproduction - budding spores
  (iv) Experiment to collect and identify the gas produced by yeast in sugar solution
  (v) Economic importance of yeasts, fermentation processes, bread-making
(e) Fungus diseases:
  Brief discussion of athlete's foot, smuts, rusts, mildews and blights
  Use of fungicides
(f) Discussion of fungi as parasitic or saprophytic

2. Bacteria

(a) Laboratory culture of bacterial colonies on a suitable medium
(b) Bacterial shapes - bacillus, coccus, spirillum
(c) Economic importance:
  (i) Harmful bacteria - food spoilage, diseases
  (ii) Useful bacteria - soil fertility, decomposition of organic matter, legume bacteria, bacteria in a septic tank; other uses: making vinegar, sauerkraut, sour milk, cheese

(d) Control of Bacteria
  (i) Harmful to foods - pasteurization, refrigeration dehydration, chlorination, sterilization by heat or chemicals, smoking meat, sugar in canning, brine in pickling
  (ii) Harmful to plants - use of fungicide
  (iii) Harmful to animals - immunization, antibiotics, antiseptics

3. Viruses

The uncertainty of their classification as living organisms. Developing only in living cells. Importance in plant and animal diseases, e.g. tobacco virus, smallpox

Unit 3 BOTANY: HEREDITY AND ENVIRONMENT

1. Heredity

Most of the important characteristics of a plant are determined when fertilization occurs. The offspring receives factors or determiners of characteristics from both parents. Reference to Mendel's experiment with tall and dwarf peas. Discussion of a simple example of a monohybrid cross. Technical terms not required

2. Environment

The possible effects on the development of a plant arising from the following environmental factors
(a) Climate - precipitation, temperature, light
(b) Soils - mineral content, porosity
(c) Other animals and plants - competition for light, water, and minerals destruction of plants by animals; parasitic diseases; symbiosis, artificial pollination of plants by man

3. Plant Communities and Succession of Communities

(a) Examples of communities, water types, marsh types, woodlot types
(b) Changes from one type of community to another (water type into climax forest type)

Unit 4 FORCE, WORK, ENERGY, POWER

This unit should be illustrated by simple experiments and demonstrations, wherever possible.

1. Force

(a) Examples of force involving gravity, magnets, wind, muscles, springs, explosions
(b) Relation of force to motion. Newton's First Law
(c) Units of force - pound, gram
(d) The difference between mass and weight
(e) The role of friction (advantages and disadvantages). Use of adhesives and lubricants

2. Work

(a) The meaning of mechanical work
(b) Measurement of work done when a body is raised
(c) Units of work - foot-pound and gram-centimetre
(d) Simple problems
(e) The lever in terms of force and work. Mechanical advantage. Moment of a force
(f) Machines; lever, pulley, inclined plane. Practical examples of each

3. Energy

(a) Definition of energy. Kinds of energy
(b) Simple illustrations of transformation of energy
(c) The law of Conservation of Energy - the evidence on which such a generalization is based.
(d) Energy transformations in
    (i) The hydro-electric system
    (ii) The automobile or power lawnmower
    (iii) The sun

4. Power

(a) Definitions of power and horsepower
(b) Measurement of horsepower, e.g. a person walking or running up stairs (experimental)

Unit 5 HEAT

This unit should be illustrated by simple experiments and demonstrations, wherever possible.

1. Heat as Form of Energy: production by transformation from other forms of energy. Experiments to illustrate some of these transformations

2. Measurement of Heat

(a) The calorie and the British Thermal Unit as measures of heat
(b) Measurement of the quantity of heat absorbed or released when the temperature of a given mass of water is altered
(c) Simple problems

3. Heat Capacity

Simple experiments to compare the heat capacities of different substances
The significance of the high heat capacity of water in relation to climate

Unit 6 LIGHT

This unit should be illustrated by simple experiments and demonstrations wherever possible.

1. Transmission of Light

   (a) Sources of light in several transformations of energy
   (b) Experiment to determine whether a material medium is necessary in the propagation of light
   (c) Demonstration of rectilinear propagation of light. Experiment on the formation and characteristics of the image formed in a pin-hole camera
   (d) Discussion of the velocity of light

2. Reflection of Light

   (a) Experiments with plane mirrors to develop the laws of reflection of light and to show the paths of light to the eye
   (b) Regular and diffuse reflection illustrated by a light beam directed against a wall and against a mirror. Direct and indirect lighting

3. Refraction of Light

   (a) Demonstration of the refraction of light using
       (i) air and water
       (ii) air and glass
   (b) Explanation by means of waves
   (c) Experiments to trace the path of light through
       (i) a rectangular glass prism
       (ii) a triangular glass prism

4. Colour

   (a) Experiments to show the formation of the spectral hues from white light and the formation of white light from the spectral hues
   (b) The reflection and absorption of light as related to the colour of objects

Unit 7 ELECTRICITY

1. Static Electricity

   (a) Experiments on the electrification of substances - ebonite rubbed with fur, glass rubbed with silk.
   (b) Experiments to distinguish two kinds of electrification.
   (c) Experiments on electrical attraction and repulsion.
   (d) Examination of the structure and function of the metal leaf electroscope
   (e) Experiments on electrification by induction. Shielding.
   (f) Experiments to identify conducting and insulating substances
   (g) The movement of electrons as illustrated by a spark discharge

2. Current Electricity

   (a) The idea of current electricity as a flow of electrons in a solid.
   (b) Experiment on the presence of a magnetic field about a conductor in which there is an electron flow (Oersted's experiment)

(c) Experiment on the use of a compass needle to detect an electron flow and to distinguish its direction
(d) Experiment to show the nature and form of the magnetic field about a conductor in which there is an electron flow (using iron filings)
(e) Experiments to develop the rule for determining the direction of the electron flow
(f) The electromagnet and some of its applications
(g) The electric circuit. Experiments to show series and parallel circuits Domestic circuits
(h) Experiments on the heating effect of an electron flow. Transformation to heat and light (toaster, incandescent lamp)
(i) Structure and application of fuses
(j) Electrical units - coulomb, ampere, volt, watt, kilowatt-hour
(k) Simple problems on electrical energy

Unit 8 CHEMICAL ENERGY

1. Photosynthesis

(a) Reference to photosynthesis as a means of transforming radiant energy into chemical energy
(b) Reference to the transformation of energy in a cell illustrating the use of foods in supplying energy. The caloric value of foods

2. The Voltaic Cell

(a) Experiments to show the structure and function of the voltaic cell as a source of electric current.
(b) The voltaic cell as a means of transforming chemical potential energy into electrical energy
(c) Other types of batteries and storage cells (dry cell and lead storage battery)

3. Oxidation

Oxidation as a means of releasing energy in various forms, e.g. heat, light
(a) Experiments to show the part that oxygen plays in the burning process
(b) Experiments with burning magnesium, sodium, carbon, sulphur, to show differences in the properties of reactants and resultants such as state, colour, odour, solubility and nature of solution, energy content
(c) The flame, its structure and composition, illustrated by the bunsen burner or the candle.
(d) Experiment to determine the products formed by the bunsen burner or candle flame or the burning of other fuels. Differences in energy released. The caloric value of fuels.
(e) The meaning in relation to oxidation of burning, low temperature oxidation, ignition temperature, spontaneous combustion Demonstration experiment with phosphorus
(f) The structure and action of an ordinary match

THE ARTS AND SCIENCE BRANCH AND THE BUSINESS AND COMMERCE BRANCH

Grade 11

The ultimate aim of the course is adequate understanding of the concepts and principles involved. This aim is best served if the experimental approach is emphasized. In many instances class experiments should be stressed. Whenever possible, the qualitative and descriptive aspects of the topics should be emphasized rather than the quantitative.

Pupil records should include well-labelled diagrams; observations and conclusions must be expressed in clear, concise English.

Pupils should be taught to support generalizations by applications which are to be found in abundance in the world about them.

PHYSICS

THE ARTS AND SCIENCE BRANCH AND THE BUSINESS AND COMMERCE BRANCH

Grade 11

Unit 1 MECHANICS

1. Measurements

   (a) Review measurements as taken in Grade 9
   (b) The accuracy of measurements. No measured quantity is completely accurate. Approximate measurements

2. Motion and Force

   (a) Explain the terms motion, speed, velocity and acceleration
   (b) Review examples of force studied in Grade 10 and extend the concept of force to include direction
   Discuss gravitation as a property of all matter
   Gravitational force between objects depends on the masses of the objects and the distance between them
   (c) Review Newton's First Law of Motion
   Inertia as a property of matter. Simple experiments to show inertia in both stationary and moving objects
   Examples of inertia
   (d) Newton's Second Law of Motion. A qualitative discussion of the relation of acceleration to force and to mass
   (e) Newton's Third Law of Motion. Examples
   (f) A discussion of Newton's Laws as they apply to rockets, space travel, and other events of current scientific interest

3. Work, Energy, and Power

(a) Review the meaning of "work" in mechanics
(b) Recall the meaning of "energy". Classify as kinetic or potential
Heat as the kinetic energy of molecules
(c) The conservation of energy
Study of a simple pendulum. The sum of the kinetic and potential energy remains a constant (neglecting friction)
(d) The sum of the kinetic and potential energy of fluids is also a constant (Bernoulli's Principle)
(e) Simple applications of Bernoulli's Principle
(f) The meaning of "power" in mechanics

4. Archimedes' Principle and the Law of Flotation

Problems should be introduced where applicable in this section.

(a) Review the meaning of density and specific gravity. Various units for stating density. The relation of density to specific gravity.
(b) Class experiment to illustrate Archimedes' Principle
(c) Use Archimedes' Principle to find the specific gravity of a solid and a liquid
(d) Class experiment to illustrate the Law of Flotation. Buoyancy as it applies to submarines, ships, balloons, etc.
(e) The Principle of the hydrometer. Practical applications

Unit 2 LIGHT

1. Transmission, Reflection, and Refraction

(a) A brief review of light transmission covered in Grade 10
(b) Review and extend the work on reflection to include demonstrations using a concave mirror. Method of locating images by diagram
(c) Review refraction. Extend to include index of refraction
Critical angle and total reflection

2. Lenses

(a) Experiments to show the effect of (i) a convex lens (ii) a concave lens on a beam of parallel rays
(b) Experimental study of real and virtual images formed by a convex lens
(c) Method of locating images by diagram for convex and concave lenses

3. Applications

A general understanding of two or three of the following:
(a) the camera and the projector
(b) the normal eye and eye faults with their correcting lenses
(c) simple and compound microscopes
(d) refractor telescopes, celestial and terrestrial
(e) the functions of the prisms in the prism binocular

Unit 3 HEAT

1. Review the Following, Using the Kinetic Theory as the Unifying Concept:

   (a) Transfer of heat
   (b) Expansion
   (c) Thermometry
   (d) Quantity of heat
   (e) Changes of state

2. Calorimetry

   (a) Design of a calorimeter to minimize heat transfer
   (b) Review specific heat
   (c) Review heat of fusion
   (d) Careful experimental determination of the heat of vaporization of water considering possible sources of error
   (e) Simple problems

Unit 4 ELECTRICITY

1. Electrostatics

   (a) A brief review of the concepts covered in Grade 10
   (b) Discussion of the electrical structure of solids and explanation of the preceding effects
   (c) Charging a conductor by induction. Explanation

2. Current Electricity

   (a) Brief discussion of the transformation of mechanical, chemical, and radiant energy into electrical energy
   (b) The transformation of electrical energy to heat energy
   (c) Review the power rating of electrical appliances. Establish the kilowatt-hour as a unit of energy. Problems, including the cost of electrical energy

3. Electromagnetism

   (a) Brief review of magnetism
   (b) Demonstration of induced magnetism; discussion of permeability
   (c) Review of the magnetic field about conductors where electrons are moving in
      (i) a straight wire
      (ii) a single loop
      (iii) a helix or coil. The left-hand rules
   (d) Experiments to determine the relation between the strength of the magnetic field and
      (i) the magnitude of the current
      (ii) the number of turns in the coil

(e) Experiment to show effect of the permeability of the core material on the strength of the magnetic field
(f) Practical applications of electromagnets
(g) Electromagnetic induction: experiments to illustrate the production of a potential difference by moving a magnet into, or near, a coil
(h) Factors determining the magnitude of the induced potential difference
(i) Experiment to illustrate the production of an induced current by opening and closing a primary circuit coupled with a secondary circuit
(j) Development of Lenz's Law: the direction of the induced current (electron flow); the application of energy conservation to electro-magnetic induction
(k) The alternating current generator. The use of slip rings
(l) The development of the two-segment commutator to convert an A.C. generator to a D.C. generator
(m) The simple D.C. motor
(n) Transformers. The structure and action of step-up and step-down transformers
(o) Applications of transformers. The distribution of electrical energy

Unit 5 TOPICS IN MODERN PHYSICS

1. Electronics

(a) Conduction through gases
(b) Cathode rays
(c) X-rays
(d) Photoelectricity
(e) Thermionic emission
(f) Rectification
(g) Amplification
(h) Application of rectifiers and amplifiers in radio communication
(i) A brief discussion of the application of the above principles in television

2. Atomic Structure

(a) A brief historical treatment of the discovery of the nature of the electron
(b) Radioactivity
(c) A brief historical treatment of the discovery of the nature of the nucleus
(d) A simple concept of the hydrogen atom (Bohr).
(e) Structure of the nucleus; atomic number; mass number; isotopes

3. Nuclear Physics

A brief treatment to give a basic understanding of:
(a) Simple nuclear reactions
(b) Nuclear fission
(c) Nuclear fusion

4. Living in an Atomic Age

(a) Benefits of the atomic age
(b) Radiation hazards

THE ARTS AND SCIENCE BRANCH AND THE BUSINESS AND COMMERCE BRANCH

Grade 12

For the Arts and Science and the Business and Commerce Branches, a new course of study will be available for September, 1965.

SCIENCE

THE FOUR-YEAR PROGRAMME

THE SCIENCE, TECHNOLOGY, AND TRADES BRANCH

Objectives

(a) To arouse curiosity regarding natural objects and phenomena, in order to develop an understanding of the elementary facts of nature

(b) To teach pupils to observe accurately, to draw logical conclusions from their observations, and to state them clearly and concisely

(c) To develop the ability of the pupil to organize and correlate facts

(d) To interpret correctly the printed page

(e) To develop a better understanding of the fundamental principles of science as applied to materials, machines, and processes with which pupils come in contact

To realize these objectives laboratory instruction should be organized to permit pupils to work individually or in small groups. The number of pupils working together will depend, to some extent, on the size of the class, on the equipment available and on the topics studied. For certain topics, where the order in which the experiments are taken is not fixed, the experiments may be carried on simultaneously.

Teachers may find it necessary to set up certain pieces of apparatus as permanent equipment to be in readiness for frequent use. Whenever possible, other equipment used should be assembled by the pupils.

Some teachers may wish to make greater use of the "unit", or "topical", plan. Such a plan of study follows the growing interests of the pupils and, where the organization of the instruction permits, teachers should not hesitate to rearrange the content of the courses to suit this unit plan.

In employing the unit plan the teacher will organize the greater part of the course of study under a number of units, projects, or problems, which will require for their solution investigation, experimentation, close observation, and reporting by the students working in groups. Usually groups are working on different projects (or for variation of the plan, on separated aspects of the same general project) at any one time since groups will vary in their rates of working and since the amount of equipment available may be somewhat limited.

The course of study may not be fully covered merely by the completion of a required number of units. The scientific method will have been set up, however, and the interest of the students so aroused as to permit effective use by the teacher of lesson presentations of the well-known formal type, together with pupil centred discussions and reviews. Units chosen to implement this plan should take into account the age grade of the pupils, equipment available, size of class, and other pertinent factors. Units might be built around such topics as, Heating Our Homes, Water Systems for Our Homes, Rust and Corrosion.

The unit plan, of course, cannot be operated successfully without complete advance planning and preparation by the teacher. There must be available to the pupils sufficient instruction aids, and illustrative and resource materials organized in an orderly environment, to enable them to profit from this plan.

The time alloted to the study of General Science in the Science, Technology, and Trades Branch may not be sufficient to complete all the topics outlined. Teachers should select from these courses the content best suited to the needs of the pupils. Approved methods of teaching should not be sacrificed to cover every detail of the course. Where classes are large, they should be divided for at least one double period per week to permit the pupils to do experimental work.

Suitable text-books, as well as books of reference, should be provided in laboratories and in classrooms where science is studied. Illustrative material, such as pamphlets, charts, process diagrams, and sample products should also be procured and filed for ready reference. Pupils should be encouraged to use these books and materials to secure additional information on the topics studied, and to understand the practical application of scientific principles and to realize their value.

Note: Each school has the privilege of changing the order of presentation of the topics of Grades 10, 11, and 12 to suit its convenience.

Grade 9

The course of study for Grade 9 is that outlined in Curriculum I.1(e) Science Intermediate Division. Where a local curriculum committee has modified this course to suit the needs of the community, the modified course may be followed.

Grade 10

Note: Since some of the topics of this course have been introduced in the earlier grades, some review or teaching of these topics may be necessary.

The principles involved in this course should be developed through experiments, and these, as far as possible, should be performed by the pupils. In each case, practical applications should be considered and discussed in their relation to industry, and suitable problems should be used extensively.

The teacher should observe extreme caution when dangerous chemicals and highly volatile liquids are used.

1. Heat

The calorie: measuring calories; heat lost or gained; the large calorie; the energy value in foods; the British Thermal Unit; the use of the B.T.U.

Specific heat; comparison of some specific heats; the use of water as related to its high specific heat

Heat transfer: conduction; convection currents; transfer of radiant energy

2. Change of State

Review fusion and solidification; change of volume, latent heat of fusion; latent heat of vaporization; conversion of water to steam; expansion of water when frozen

3. Force, Energy and Power

Types of force: tension; compression; shear reacting forces; measurement of force; Hooke's law

Pressure: Pascal's law

Molecular force: surface tension; adhesion; cohesion; capillary action

Force and motion: Newton's first law; Newton's third law

Energy: potential and kinetic; conversion of chemical energy into heat; conversion of one form of energy into another

Power: the units of work; the lever as a machine; relation between effort and lead; the meaning of power; the watt; the horsepower

4. Combustion and Slow Oxidation

The rusting of iron filings or steel wool; slow oxidation of linseed oil; spontaneous combustion

The composition of air; liquid air as a cource of commercial oxygen, nitrogen and neon; the gases, argon, neon, krypton, xenon, radon; the commercial uses of these gases

Oxygen: physical properties; the combustion of charcoal, sulphur, magnesium and iron in air, and in oxygen; the physical and chemical properties of the products

Hydrogen: preparation and properties; the presence of hydrogen in fuels

Carbon dioxide: properties and uses; properties of carbon monoxide; the production of carbon monoxide in combustion of fuels; carbon monoxide poisoning

Combustion of candle wax, alcohol, and coal to discover the products of combustion; complete and incomplete combustion; the explosive nature of fumes and dust

Corrosion: atmospheric oxidation of metals; methods used to combat corrosion; protection from corrosion such as surface coating, galvanizing, and plating; preparation of metals for soldering and welding; fluxes

Optional Topics

Word equations and symbol equations for some of the changes discussed. The meaning of element and compound

5. Fire Fighting

Starting fires: kindling temperature: the high and low kindling temperatures of fuels

Putting out fires: the reduction of temperature below the kindling temperature; the need of oxygen for combustion; the use of smothering gases; methods of putting out gasoline and other liquid fires; fire extinguishers

Methods of fireproofing paper, cloth, and wood

6. Solutions

Review the use of water as a solvent

The composition and characteristics of anti-freeze solutions, and of storage battery electrolyte; experiments, (i) to determine the density of these solutions by means of an hydrometer, and (ii) to show the capacity of an electrolyte to conduct a current of electricity; application of the information obtained from the density readings; a brief discussion of the industrial use, as solvents, of water, alcohol, acetone and lacquer solvents

7. Lubrication and Lubricants

Friction: how it is produced; the effect of friction; the need for and action of lubricants; types of lubricants; viscosity and S.A.E. ratings; the effect of temperature changes on viscosity; flash point

The deterioration of a lubricant by dilution, dust, and sludge formation; the effect of the oil filter

A comparison of suspensions and solutions

8. Metals and Alloys

The composition, characteristics and use of cast iron, wrought iron, carbon steel, plumber's fine solder, wiping solder, brazing solder, low melting point alloys, metals for bearings, and stainless steel

The production of a simple alloy, such as solder. Comparison of the melting point of the alloy with those of the metals used

9. The Composition and Classification of Foods (optional)

Water in Foods: experiments to show that foods contain water, and how the percentage of water may be determined in such foods as fresh vegetables, fresh fruits, cereals, butter

Carbohydrates: an experiment to detect the presence of starch in flour, potatoes, etc. An experiment to contrast sugar with starch in respect to solubility and taste. An experiment to show the presence in starch of (i) carbon, (ii) hydrogen and oxygen (as shown by the condensation of water). An experiment to show the conversion of starch to sugar (i) by the action of saliva, or (ii) by boiling with dilute hydrochloric acid. (Note change in appearance, action on hot Fehling's solution or Bendict's solution)

Fats: experiments to show that fats (i) are insoluble in water, (ii) are soluble in carbon tetrachloride, (iii) produce a persistent greasy translucent spot on paper. An experiment to detect the presence of fat in butter, nuts, cheese, whole milk, etc.

Proteins: the composition and occurrence; experiments to show (i) that proteins are characterized by a disagreeable odour when being charred, (ii) the spot test with nitric acid and ammonium hydroxide

Mineral Salts: an experiment to show the presence of ash or mineral matter in such foods as rolled oats and potatoes, by gently burning until combustion is complete

The Combustion of Common Foods: a discussion of the role of carbohydrates, proteins, fats, mineral salts, and water in the diet, and the relative proportions of the food constituents listed above in such common foods as flour, rice, beans, honey, butter, lard, salad oil, peanut butter, meat eggs, fish, cheese. Experiments to show that milk contains (i) water, (ii) sugar, (iii) fat, (iv) casein and albumen, (v) mineral matter; the value of milk as a food

A brief discussion of the Carbon Cycle: recall photosynthesis, stressing the absorption of energy in a reaction which is the reverse of the oxidation of carbon-containing substances

10. Elementary Mineralogy (optional)

Physical Mineralogy

Physical properties of minerals (omit hardness)

Scale of hardness as used in the identification of minerals

Identification of quartz--massive, jasper, flint; identification of feldspars; comparison of orthoclase and plagioclase feldspars

Native minerals--identification of gold, silver, copper, sulphur, graphite, coal

Sulphides and arsenides--identification of iron pyrites, copper pyrites, galena, molybdenite, smaltite, zinc blende

Chlorides, fluorides, and carbonates--identification of halite, fluorite, calcite, dolomite, magnesite, malachite, azurite

Silicates--identification of hornblende, augite, garnet, olivene, epidote, tourmaline, mica, chlorite, serpentine, kaolin

Phosphates and sulphates--apatite, barite, celestite, gypsum, wolframite, scheelite

Rocks:

Common rock-forming minerals

Definition of a rock; classification of rocks

Igneous rocks--formation; identification of granite, syenite, diorite, gabbro, diabase basalt, fine-grained, even-textured rocks such as felsite and basalt, very fine-grained glassy rocks such as porphyry

Sedimentary rocks--formation; identification of conglomerate, breccia, sandstone, shale

Metamorphic rocks--formation; identification of gneiss, schist, quartzite, slate

Chemical Mineralogy:

The use of the blow-pipe; reduction and oxidation of litharge in the blow-pipe flame

Identification of arsenic, antimony, bismuch, copper, iron, lead, silver, and sulphur, by means of chemical tests

11. Botany (optional) - see Curriculum I 1(e), Grade 10

A brief treatment of lowering plants: general structure; pollination; fertilization; seeds, fruits. A brief treatment of non-flowering plants: fungus plants; bacteria; viruses

Grades 11 and 12

These Courses of Study are based upon the scientific requirements of the Shop Work Courses for Science, Technology and Trades Branch.

While every effort should be made to have pupils follow an experimental course, or treat the topics as pupil-research topics, the presentation of many of the topics requires discussion by the class. The pupil should be encouraged, therefore, to acquire knowledge and understanding through his own individual efforts, and to make use of suitable reference and illustrative materials, which should be available in a properly indexed form.

The core topics are listed, and those parts indicated with an asterisk are suggested as enrichment topics, to be used as circumstances warrant. If time permits, it may be desirable to include topics which apply to local industries. In the Chemistry course, some teachers may wish to stress such topics as agricultural chemistry, metals, polymers, and plastics.

Note: These topics need not be taken in the same order as listed here.

Grade 11

Physics

1. Accurate Measurements

Review of units of linear measure (English and Metric); practice in the use of the steel rule and calipers; construction and use of vernier calipers and micrometer; problems involving volume of regular solids using vernier calipers, tolerances, significant figures; measurement of masses of the foregoing solids and determination of buoyancy

Fine measurement of volumes and masses may be best combined with experimental work on density and specific gravity. See topic 2

2. Mechanics of Fluids

Experiments to determine the density of liquids by using the specific gravity bottle and the hydrometer; the specific gravity of heavy solids; solids lighter than water; fluids by means of the hydrometer. A discussion of the various scales in use

Problems on density and specific gravity

3. Machines

Review of Grade 10 work. An experimental study of the three classes of levers to determine the mechanical advantage of each. The classification and use of such levers as are found in the shops

A study of the class, mechanical advantage, and application of the pulley, toothed gear, wheel and axle, inclined plane. Study and classification of the wedge, the screw, the differential pulley, and complex machine parts

A study of the mechanical advantage and efficiency of some simple machines which use these principles

Rules for calculations and problems

4. Force

Review the meaning and kinds of force

The units for measuring force: pound, gram; the meaning of H.P.; a demonstration of B.H.P.

Experiments to determine: the equilibrant and resultant of parallel forces; equilibrant and resultant of two forces acting at an angle; verification of the law of the parallelogram of forces

A discussion of the moment of force; the application of the moments of force to the lever and the wheel and axle

Study of: friction coefficient of; laws of motion--helicopters, jets; projectiles; Bernoulli's principle--speed indicators, pitot tube

Mechanics of motion: impulse and momentum; acceleration due to gravity and in machines;"g" factor

5. Electricity

Review current electricity, and the meaning of work, energy,and power with emphasis on gravitational potential energy

A study of electromotive force and factors controlling electric current flow; magnetic effects of electric current; applications of electro-magnetism; D'Arsonval galvanometer; the ammeter and voltmeter

An experiment to determine the resistance of a conductor using the voltmeter-ammeter method. Simple problems involving Ohm's law

Experiments to show induced currents--principle of the induction coil

Simple experiments to illustrate the fundamental principles of the A.C. and D.C. transformer, motor and generator (structural details are not required)

Heating and lighting effects of an electric current, fuses, and circuit breakers

Industrial uses of electric current: (1) welding, (2) electric furnace, (3) electric lamps (incandescent, mercury vapour, soldium vapour, neon, fluorescent)

*Thermocouple to measure temperature, (A.C. and D.C. currents); induction; transformer; radio-tube electronics; transistors; photo-electric cells

6. Light Energy

A discussion of light as radiant energy--two concepts

Experiments to show: the composite nature of white light; the colours of the solar spectrum; reflection from plane surfaces; images in plane mirrors and curved mirrors; refraction of light; the uses of lenses

Applications of curved mirrors--headlight, rear vision; lenses--eye, camera, movies, stereo pictures, projection

The physical nature of colour; Newton's experiment; the colour of objects in white light

The structure of the human eye, and methods of correcting defects with glasses

*Colour blindness; colour mixing; Kodachrome; 3D colour process; 3D movies

7. Lighting for Vision

A study of the accepted standards of illumination used in modern lighting for home, school, factory, display, flood lighting; the law of inverse squares; the incandescent lamp measurements; the principle involved in and use of a light meter

*The meaning of plane-polarized light. Simple experiments to show the nature and effects of polarized light, using a pair of polarized disks; the application of polaroid to automobile driving as glare prevention with sun glasses

8. Heat

Review or study of heat units, and heat capacity. An experimental study of: specific heat of water; specific heat of metals; heat of fusion of ice; heat of vaporization of water; heat of vaporization of other liquids; the effect of increased and decreased pressure on the boiling point of liquids

Application of the above principles as in heating and refrigeration

Review of hydrometry. The principle of air conditioning, particularly in respect of moisture content

9. The Lead Storage Cell

An experiment to show: electroplating with copper sulphate solution; the preparation of the electrolyte

Review of the use of the hydrometer and discussion of the use of the density-concentration tables

An experiment to "form" a storage cell, using lead plates, with a reference to the composition of the plates before and after forming. "Discharging" the cell and the alteration of potential as shown by the voltmeter; degree of discharge

A discussion of the charging of the cell with special reference to the transformation of electrical energy to chemical potential energy; and the discharging of the cell in terms of the reverse transformation of energy

The efficiency of the commercial storage battery; a comparison of the output of electrical energy with the input of electrical energy; reference to the dissipation of some energy in heating the cell and decomposing the electrolyte

10. Metallurgy

A discussion of the kinds and sources of iron ores, such as sulphides, oxides, carbonates. Separation from the rock, concentration and extraction. Flotation, roasting, and reduction

The construction of the iron blast furnace, and reference to the heat exchange in a stove

A demonstration of carbon monoxide as a reducing agent. Recall the dangerous properties of carbon monoxide

An examination of the constituents of the blast furnace charge, and the purpose of each substance, in the operation of the blast furnace

The construction and use of the iron cupola

The composition and characteristics of cast iron, carbon steel, and wrought iron

A brief study of the manufacture of steel by (1) the acid Bessemer process, (2) the basic open-hearth process

The heat treatment of steel; methods and purpose of annealing, hardening, tempering; surface hardening by (1) case hardening, (2) nitriding. This should be co-ordinated with projects in heat treatment in the machine shop

The composition and characteristics of types of steel: tool, nickel, tungsten, manganese, stainless, silicon

11. Alloy Steels and Alloying Metals

The meaning and purpose of alloys

Review of properties of metals and chemical reactions serving as tests

Some common alloys and their industrial applications

The replacement series of metals

A discussion on corrosion and its prevention

Grade 12

Chemistry

1. The Meaning and Purpose of Chemistry as Compared with Physics

Review of the states of matter. The use of the physical properties of a pure substance in its identification

2. Chemical Change

Experiments to show chemical change in contrast with physical change and methods for distinguishing between them. Heating mercuric oxide; electrolysis of water; light on silver halide, catalytic action of manganese dioxide. How new substances are formed, energy change

3. Mixtures

The meaning of mixtures, and the difference between a mixture and a pure substance

Experiments on separating mixtures: magnetic; filtering; settling; starch filtering; flotation; solvent extraction; distillation; freezing; crystallization

A study of the application of these types of separation in industry

4. Elements and Compounds

An experiment on the decomposition of a compound

A comparison of mixtures and compounds

The meaning of an element and a compound: definition; method of naming; the structure of the atom; simple chemical reactions; reacting weights and atomic weights; symbols, formulae, equations, valency

The gas laws; measurement of gases; changing the volume, pressure or temperature of a gas. Problems on the application of the gas laws

The molecule and determination of molecular weights

5. Oxygen

Review the composition of air

Experimental review of oxygen - preparation, properties, test, uses (e.g. oxy-acetylene welding, oxygen masks, oxygen tents)

6. Hydrogen

Experimental review and extension of work on hydrogen preparation from water and from acids, properties, test, uses (e.g. oxy-hydrogen torch, weather balloons, constituent of gaseous fuels, hydrogenation of fuels)

7. Solutions

Review and extend work on solutions to include:

Comparisons of characteristics of solutions with those of mechanical mixtures

Examples of solutions. These should be varied enough to show the existence of solutions in different physical states: e.g. air, including water vapour; low-melting alloys; gold and copper alloys; oil or grease in carbon tetrachloride; DDT in kerosene; carbonated beverages

Meaning of terms: solvent, solute, solubility (relative and quantitative); saturated, unsaturated, and super-saturated solutions; solubility curve (to illustrate change of solubility with temperature). Factors which affect the rate of solution

8. Acids, Bases, and Salts

Experiments to show the combustion in oxygen of carbon, sulphur, and red phosphorus; the reaction of these oxides with water, and the effect of their solutions on litmus

Acidic oxides--acid anhydrides: hydrochloric, nitric and sulphuric acids

An experiment to show the combustion of magnesium in oxygen

A demonstration of the combustion of sodium in oxygen

The reaction of these metallic oxides with water, and the effect of their solutions on litmus. Basic oxides--basic anhydrides

Discovery of further properties of acids (dilute) using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste as shown by soda water, vinegar, sour milk, etc.

Discovery of the effect of bases on the indicators used for acids

Experiments to show the reaction between acids and bases; the products of the reaction (neutralization), water, and a salt which is left as a residue upon evaporation of the water

A brief discussion of the commercial recovery and industrial importance of common salt (sodium chloride); a study of its properties; a study of the preparation and properties of hydrogen chloride and of hydrochloric acid

9. The Theory of the Ionization of Acids, Bases, and Salts

A demonstration of the electrolysis of cupric chloride solution, with an explanation in terms of charged particles

A discussion of the dissociation of cupric bromide, hydrogen chloride, when dissolved in water giving rise to electrically charged particles, called ions

A discussion of the hydrogen ion as the characteristic ion of acids; of the properties of acids (taste, effect on litmus and other indicators, action on metals, etc) as being due to hydrogen ions in the solutions

A discussion of the dissociation of sodium hydroxide in solution

A discussion of the hydroxyl ion as the characteristic ion of bases; the properties of bases (taste, effect on litmus and other indicators, caustic action on animal and vegetable matter, e.g., textiles) (mercerization of cotton), as being due to hydroxyl ions in the solutions

A discussion of neutralization as a quantitative reaction depending upon the removal of hydrogen ions and hydroxyl ions to form water

A brief discussion of the measurement of acidity in terms of hydrogen ion concentration

*How an atom becomes an ion

*The meaning and measurement of pH--the effect of pH on life and growth

10. Miscellaneous Topics

Titration in control laboratories and ionization. Equilibrium and mass action--reversible and complete hydrolysis, illustrated by copper bromide

An experiment to show commercial electroplating

The electrolysis of a sodium chloride solution and the recognition of the products

Refining of copper, silver and gold; production of chlorates and hydrogen peroxide

Electric furnaces for graphite, silicon, carborundum, carbide, alundum, phosphorus, carbon disulphide

11. Combustion and Fuels

Experiments to show that certain mixtures of gasoline or acetylene and air give complete combustion, and that others give incomplete combustion

A discussion of complete and incomplete combustion of hydrocarbons

Review the formation of carbon monoxide in the automobile engine, and during the combustion of coal or coke

Experiments to illustrate the complete and incomplete combustion of acetylene

The use of the oxy-acetylene flame for welding, with special reference to the correct mixture of oxygen and acetylene

Repeat the experiment to show the burning of iron in oxygen

The use of the oxy-acetylene flame for cutting, with special reference to the correct mixture of oxygen and acetylene

Review of the structure of the Bunsen burner and its flame

A discussion of the complete and incomplete combustion of natural gas or coal gas

A review of explosive mixtures with special reference to the "striking-back" of the flame of the Bunsen burner

A study of the oxidizing and the reducing zones of the gas flame

A discussion of the world locations of petroleum oil, and the methods and channels of distribution, with specific reference to the requirements of the British Commonwealth

Experiments to illustrate (1) the distillation of water, and (2) the fractional of a water-alcohol solution

A discussion of the principles of fractional distillation and cracking in petroleum refining

A brief discussion of types and grades of motor fuels; octane numbers

A recall of lubrication and lubricants, Grade 10

An examination of other petroleum products, with a brief outline of their uses

A brief discussion of other fuels such as coal, industrial gases

12. Limestone

The composition, properties, and uses of limestone

An experimental study of the preparation and properties of quicklime; the kinds of quicklime

An experimental study of the preparation and properties of slaked (hydrated) lime; the action of carbon dioxide on slaked lime

An experiment to show the preparation of lime-sand mortar, its initial set, and final hardening. Other uses of slaked lime

13. Gypsum

The composition, properties and uses of gypsum

Experiments to show:

(a) the action of heat on hydrate such as blue vitriol, and the action of water on the anhydrous residue

(b) the conversion of gypsum into plaster of paris
(c) the effect of the addition of water to plaster of paris

A discussion of other gypsum products such as wallboard, gypsum blocks, and acoustic materials

14. Cement and Concrete

A study of the composition, properties, and manufacture of cement

An experiment to study the initial set and final hardening of cement

A study of the composition and function of the components of concrete, effect of impurities, moisture, temperature, mixing, and the strength of the mix

A comparison of the setting of concrete with that of lime-sand mortar

How to determine quantities for concrete. The uses of concrete

Recall the expansion of water on freezing, and its application to the disintegration of concrete

Recall the action of carbonic acid on limestone, and discuss the similar disintegrating action on the calcium salts in concrete

15. Wood

A brief discussion of the chemical composition of wood

Experiments to show:

(a) the effect of heat on wood at various temperatures; the meaning of kindling temperature; wood as a fire hazard

(b) the protection of wood against fire by covering the wood with fire-proof coatings as sodium silicate. Other protective coatings: plaster, asbestos, fire-resistant paints, impregnation of the wood with chemicals such as ammonium phosphate, ammonium sulphate, or borax. The function of these non-combustible chemicals in diluting the combustile gases given off by the hot wood

(c) the open-tank process and the Kyanizing process for the preservative treatment of wood; methods employed for impregnating wood with preservatives

Brief discussion on:

(a) fungus decay of wood and the conditions necessary for the development of fungi in wood

(b) kiln drying for the preservation and seasoning of wood

(c) the application of paint, varnish, and lacquer to the preservation of wood; an experiment to compare the effect of air on a thin film of linseed oil and of mineral oil

16. Metals

A brief study of the properties and industrial application of metals such as aluminum, magnesium, lead, tin, zinc, copper, nickel, beryllium, cadmium

17. *Organic Chemistry

A brief study of straight-chain and ring-structure, alcohols, acids, esters, acetone, solvents, formaldehyde, ether

18. The Halogens

A brief study of the halogens to show that all chemical elements can be arranged in family groups, the members of which are closely related. This can be combined with a study of the Periodic Table

19. For Students of Electronics

*A discussion on radio-active metals and materials leading up to nuclear fission