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ABSTRACT

The syllabi for the grade 11 biology, chemistry, physics and technician science courses taught in the Technical Schools of the Education Department of Victoria (Australia) each contain a listing of the topics to be taught, the scope and depth of treatment, suitable textbooks, possible demonstrations and laboratory work, and, in the case of the outline of the chemistry laboratory course, warnings about possible hazards. The syllabus for the grade 11 general science course is not included in the package, although background notes for the teacher using this syllabus are included. [Not available in hard copy due to marginal legibility of original document.] (AL)

A68/607
Tech.Sch.Br.

EDUCATION DEPARTMENT, VICTORIA.

LEAVING TECHNICAL SYLLABUS.

LEA 751 - GENERAL SCIENCE (1964).

NOTES ON SYLLABUS.

1. Classes following this course will differ widely in the standard of work previously covered, and in the interest they show in various sections of the course.

2. Teachers are advised to develop some sections of the syllabus more fully, and diminish others accordingly, to suit the interests and abilities of their students.

3. The following notes are provided to assist teachers in developing Sections A and B of the syllabus.

FORM 5 GENERAL SCIENCE.

NOTES TO SYLLABUS.

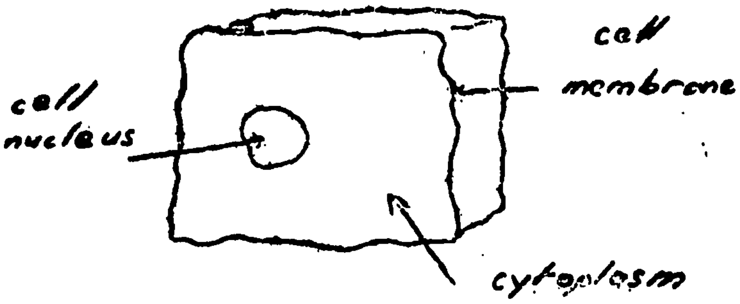
MAN AND HIS LIVING ENVIRONMENT.

1. The Physical Basis of Life.

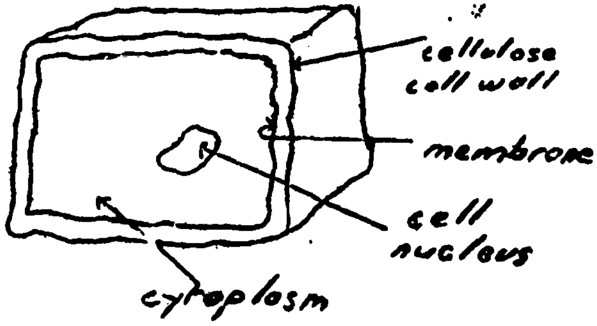
(a) The basic building material of all living organisms is protoplasm, a greyish jelly-like material with varying degrees of viscosity. It is an extremely complex mixture of compounds, composed mainly of oxygen, carbon, hydrogen and nitrogen, but also containing many other elements in small quantities. Proteins, fats, carbohydrates, mineral salts, vitamins and water, taken into the organism as food, supply the elements required for the synthesis of protoplasm.

(b) The protoplasm of living things is organized into units or cells, each of which is made up of a nucleus, surrounded by cytoplasm, which, in turn, is enclosed in a cell membrane. In plants a cell wall surrounds the cell membrane. The nucleus contains important thread-like structures, called chromosomes, which control the identity, and characteristics of the particular species of animal or plant. Each kind of animal and plant has its specific number and type of chromosomes. For example, all humans have 46 chromosomes in the nucleus of every body cell; the rabbit has 22, the chicken 18, the house-fly 12, the mosquito 6, maize 20, pea 14, primrose 14 etc.

Typical Animal Cell



Typical Plant Cell



(c) Protoplasm, partly because it is so complex, is continually changing chemically; for example, carbohydrates are oxidized by uniting with oxygen to form carbon dioxide and water, releasing energy as heat energy and muscular energy. Non-living material cannot do this.

Also, protoplasm can reproduce itself; a cell divides to form two similar cells; these again divide to form four cells, these again divide to form four cells, and so on, in the development of a new plant or animal, or increasing in size of a growing one.

2. Classification of Living Things into Kingdoms.

(a) Living things were previously classified into Animal and Plant Kingdoms, but because of the existence of some forms of life which have some characteristics of both, or neither, modern practice is to place these border-line cases in small kingdoms of their own.

(b) Characteristics of Plants, Animals and the Smaller Kingdoms.

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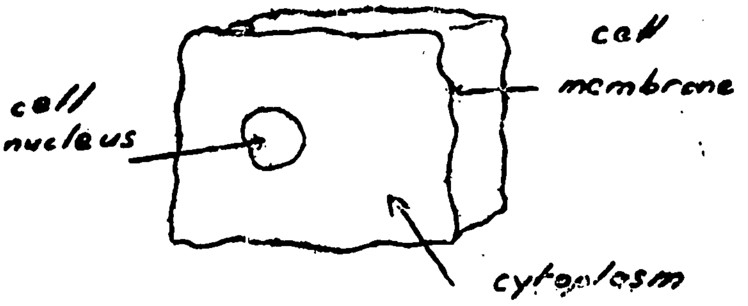

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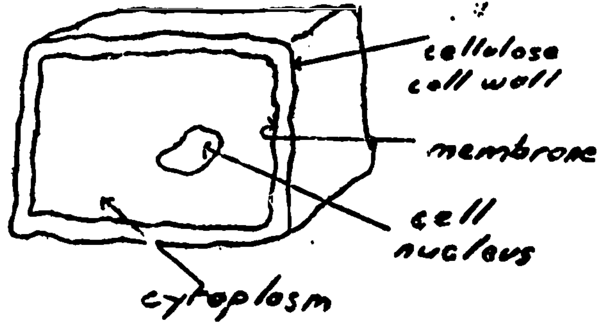

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(b) Characteristics of Plants, Animals and the Smaller Kingdoms.

Plant Kingdom	Animal Kingdom	Smaller Kingdoms
1. Cells have a cellulose wall around the cell membrane.	1. Cells have no cell wall around the cell membrane.	1. May or may not exist as cells; bacteria, fungi are cellular, viruses are not.

2. Plants synthesize their own food from simple components.	2. Animals take in other living things, and reduce to simple components for absorption.	2. Many are parasitic.
3. Most plants remain in a fixed position.	3. Most animals can move about.	3. May or may not be capable of movement.
4. Most plants keep on growing actively throughout life.	4. Most animals have a terminal growth.	4. Limited specialisation of cells, therefore difficult to distinguish between growth and reproduction.

3. <u>The Animal Kingdom</u> may be divided into ten phyla or divisions, the distinguishing characteristics of which are as follows. (It is suggested that one example of each phylum (or class in the case of the large Arthropod and Chordate phyla) be examined for the distinguishing characteristics, and drawn, for practical work).

Phylum	Characteristics
(a) <u>Protozoa phylum (single-celled).</u> Examples - amoeba, euglena, paramecium.	(i) Single-celled. (ii) Live in water. (iii) Move by pseudopodia, flagella or cilia.
(b) <u>Profiera phylum (pre-bearers).</u> Example - sponges.	(i) Aquatic. (ii) Possess pores through which water circulates. (iii) Simple organization.
(c) <u>Coelenterate phylum. (hollow-bodied).</u> Examples - hydra, obelia, jelly-fish, anemones.	(i) Body composed of many varied cells in two layers. (ii) Live in water, mostly marine. (iii) Single digestive cavity. Food and waste use same opening. (iv) Have stinging cells on tentacles.
(d) <u>Platyhelminth phylum. (flat-worms).</u> Examples - planarian worms, liver fluke, tape-worms.	(i) Flat worms. (ii) Many parasitic.
(e) <u>Nematode phylum. (round-worms).</u> Examples - hookworms, threadworms.	(i) Round worms, cylindrical unsegmented, pointed at both ends. (ii) Many parasitic. (iii) Three layers of cells; no true body cavity. (iv) Continuous digestive system.
(f) <u>Annelid phylum. (segmented worms)</u> Examples - earthworms, beach-worms, leeches.	(i) Segmented worms, cylindrical body. (ii) Three layers of cells. (iii) True body cavity. (iv) A few forms are parasitic.

(g) Arthropod phylum.
(jointed limbs).

Examples - Insect class
Crayfish class
Spider class.

- (i) Segmented body with hard exo-skeleton.
- (ii) Jointed limbs.
- (iii) Three layers of cells with a true body cavity.
- (iv) Some are important vectors of disease.

(h) Mollusc phylum
(soft-bodied).

Examples - mussels, snails, limpets, octopuses.

- (i) Soft body, often with shell,
- (ii) Three cell layers with true body cavity.
- (iii) Muscular foot - for creeping, ploughing or grasping.

(i) Echinoderm phylum.
(spiny-skinned).

Examples - starfish, brittle-stars, sea-urchins.

- (i) Radially arranged.
- (ii) Spiny skinned fitted with hard plates.
- (iii) Three cell layers with true body cavity.
- (iv) Possess tube feet.
- (v) All marine.

(j) Chordate phylum.
(hollow, dorsal nervous system).

- (i) A skeletal axis at some stage of life cycle.
- (ii) Paired gill slits at some stage in life cycle.
- (iii) Three cell layers and true body cavity.
- (iv) Hollow dorsal central nerve cord.

4. Physiology of Man. Although the syllabus differentiates between the various systems in man, it is essential to point out to students that they are interdependent, and this must be emphasised at various points in their study.

(a) Chemistry of Digestive System. Carried out by enzymes - catalysts which aid the chemical decomposition of food to simple substances which may enter the blood stream or be utilised in some other way. Enzymes are found in various parts of the alimentary canal, are specific for certain food constituents, are effective in certain media and at body temperature. Chemical reaction for food simplification is hydrolysis.

Location	Foodstuff	Enzyme	Medium	Product
Mouth	Starch	ptyalin	alkaline	complex sugar
Stomach	Protein	pepsin	acid	simpler proteins
Small Intestine	Complex Sugar	maltase	alkaline	simple sugar
	Simpler Protein	trypsin	alkaline	amino acids
	Fats	lipase	alkaline	glycerol and fatty acids.

The final products, simple sugar and amino acid, are soluble, simple substances capable of being absorbed into the blood stream via the villi of the small intestine. The amino acids are absorbed by various cells around the body and used to manufacture new protoplasm. Glycerol and fatty acid are re-synthesised to fat after being absorbed by the cells of the villi. Fat molecules are too large to enter the blood stream directly. Fat enters the lymphatic system and is discharged into the vascular system by the thoracic duct. Minerals salts and vitamins are needed in small amounts to make some of the other chemical substances of the body, e.g. the enzymes. They can be absorbed from foods without digestion.

(b) Chemistry of Respiratory System. It should be pointed out that respiration strictly refers to the cell process of producing energy, but this section should include the chemistry of the system. The exchange of gases in the lungs - oxygen from lungs to blood and carbon dioxide from blood to lungs - is due to the physical process of diffusion. Most of the oxygen which enters the blood oxidses the haemoglobin of the red blood cells to oxy-haemoglobin. This oxidation depends on the concentration of oxygen. If the concentration of oxygen is lowered, as it is in the cells where oxygen is being used, the reaction is reversed, and the oxy-haemoglobin is reduced. Concentration of carbon dioxide also affects this in that the oxygen-carrying capacity of haemoglobin is reduced in acid solution. Within the cell, sugar, which has been brought there in the blood stream, is oxidised by the oxygen, also brought in the bloodstream, to form carbon dioxide and water with the release of energy. This energy enables the cell to function. Fats can also be respired, so can amino-acids - with a nitrogenous waste left over. The carbon dioxide, as a waste product of respiration, is transported by the blood back to the lungs where it is expired. A little carbon dioxide present is dissolved in the blood, a little as carbonic acid, but the largest portion is transported as a bicarbonate (sodium or potassium bicarbonate). In the lungs differences in CO_2 pressure in deoxygenated blood and lung spaces make CO_2 pass from the blood into the lung spaces from which it is expired.

(c) Excretion. The waste products of cell function are eliminated from the body by excretory mechanisms. The chief excretory organs are the kidneys, the lungs and the skin. Elimination of carbon dioxide from the combustion of sugar has been treated above as part of the body's respiratory functions. The sweat-glands are mainly concerned with the regulation of body temperature, but have a small excretory function as well. Sweat contains the same substances as urine in more dilute solution. The kidneys from the main excretory mechanisum in the body. Waste products of protein metabolism in cells (urea, salts and other organic compounds) are taken to the kidneys by the blood. The blood vessels divide and divide in the kidney until they are very fine. At this stage water and all substances with small molecules are filtered into special tubules in the kidney. The cells around the tubules in a different part of the kidney are able to re-absorb selectively substances which are of value to the body and to refuse absorption to others. These substances and water collect into the main tubule of the kidney and are conveyed to the bladder.

(d) Nervous System is a system of special cells which are used to co-ordinate the operation of body mechanisms. The cells are specialised in that they are provided with long processes which join up cell with cell. They are used to transmit messages from sense receptor areas around the body to the brain or spinal column from which messages are relayed by the processes of similar cells to motor cells (cells which are capable of achieving movement), if such is desirable.

(e) Glands. Hormone-producing glands provide the second means of communication within the body. A hormone is a chemical of specific function released into the blood from the gland to initiate a response in some other part of the body. The rate of response is very slow in comparison with the reaction from a of oxygen. in the cells where oxygen is being used, the reaction is reversed, and the oxy-haemoglobin is reduced. Concentration of carbon dioxide also affects this in that the oxygen-carrying capacity of haemoglobin is reduced in acid solution. Within the cell, sugar, which has been brought there in the blood stream, is oxidised by the oxygen, also brought in the bloodstream, to form carbon dioxide and water with the release of energy. This energy enables the cell to function. Fats can also be respired, so can amino-acids - with a nitrogenous waste left over. The carbon dioxide, as a waste product of respiration, is transported by the blood back to the lungs where it is expired. A little carbon dioxide present is dissolved in the blood, a little as carbonic acid, but the largest portion is transported as a bicarbonate (sodium or potassium bicarbonate). In the lungs differences in CO_2 pressure in deoxygenated blood and lung spaces make CO_2 pass from the blood into the lung spaces from which it is expired.

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(f) Control of Body Temperature. When food material is oxidised in the cells of the body energy for muscular movement is released, and when muscles work kinetic energy changes to heat energy. Man is an animal of constant blood temperature and excess heat energy must be dissipated. In the main, this is accomplished by evaporation of perspiration from the surface of the body. Some of the latent heat necessary for this evaporation is taken from the blood flowing through vessels in the skin. A temperature control centre in the brain regulates the rate of perspiration excretion.

5. Plant Kingdom.

Division	Characteristics	Examples
(a) Thallophytes	1. Body (thallus) may show some differentiation of cells but no true roots, stem or leaves.	algae (from single cells to large sea-weed)
	2. May reproduce asexually or sexually.	fungi
	3. All contain chlorophyll and manufacture food.	
	4. Natural environment is water.	
(b) Bryophytes	1. Simplest land plants, but still need water for fertilization.	mosses liverworts
	2. Possess chlorophyll and manufacture food.	
	3. Have no roots, but are attached by hair-like processes called rhizoids.	
	4. Produce spores in capsules which open when conditions are right to produce new plants.	
(c) Tracheophytes	1. Advanced land plants.	ferns
	2. Possess chlorophyll and manufacture food.	gymnosperms (exposed seeds) pines
	3. Have fully differentiated vascular system of roots, stem, leaves.	angiosperms (enclosed seeds)
	4. Reproduce by spores or seeds.	flowering plants.

6. Plant Physiology.

(a) Photosynthesis. The raw materials of photosynthesis are water from the soil, carbon dioxide from the air, light from the sun and chlorophyll in the green parts of leaf and stem. Most photosynthesis occurs in leaves. Water enters the leaves by way of roots and stem. Carbon dioxide passes into the leaf through pores (mostly on the underside of the leaf) called stomates. These two substances enter the cells of root and leaf by a process called diffusion. Fluids pass through porous membranes

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Plants synthesise fats and proteins as well as carbohydrates. The other elements of fats and proteins are obtained from the soil in the form of soluble salts which enter the plant with water. How the salts enter the cell against the higher concentration inside the cell is not clearly known, but certainly the living protoplasm of the cell must do work to accomplish this. It is impossible in a non-living cell. Fertile soils contain essential mineral elements but infertile soils must be supplied with these for complete cell nutrition. It must be emphasised that the salts added to soil must be soluble; insoluble salts are valueless, unless they may be changed to soluble salts in the soil. Deficiencies of minerals lead to stunted growth, poor fruit ,formation etc.

(b) Respiration. Energy is necessary for the growth of the plant, and certainly plant cells must do work as described above. Hence, respiration in plants is essential. Sugar is oxidised to water and carbon dioxide with the release of energy.

Sugar + oxygen = carbon dioxide + water + energy. This is the overall chemical action of respiration. Actually, there are a large number of chemical reactions which occur. The above gives the initial substances and the final products. The energy is parcelled out as respiration proceeds. Some of the sub-products of the respiratory process are used by the plant in the synthesis of fats and proteins.

(c) Reproduction and Growth. The part of the flower concerned with reproduction is the flower. It forms the fruit from which the seeds are distributed. The four rings of the flower should be shown with the functions of each part - sepals, petals, stamens, carpels. In some species, stamens are present in one flower and carples in another, e.g. pumpkin, but the majority of flowers have stamens and carpels in the one flower. The stamens are the long stalks which support the anthers containing pollen grains, the male gamete. The female gametes are contained in the ovules which occupy the ovary at the base of the carpels. The flower depends on wind or animals to transfer the pollen grains from the anthers to the sticky stigma of the carpels. This is called pollination - self pollination in the same flower, cross pollination in different flowers. A pollen tube grows down through the carpel from the pollen grain and the male gamete is formed in the pollen tube. The mature ovule is ready, the pollen tube enters and the male gamete fertilises the ovum (female gamete) in the ovule, and the zygote is produced. After fertilization, the zygote grows into the embryo, the ovule into the seed and the ovary into the fruit. From the single cell, other cells are produced by division, the cells grow to full size and become differentiated for various functions. The mature seed contains a very great number of miniature cells. Thus mitosis has occurred but there is practically no cell enlargement or differentiation. The seed becomes dry which is a resting stage capable of being maintained for a considerable time without death. Water is necessary for germination. The seed swells with intake of water and chemical processes (metabolism) which have slowed to a minimum during the resting stage are accelerated. The root cells become larger and the root appears. The cells of both root and shoot divide and enlarge, but cell division is soon confined to the tips of root and shoot. The ultimate shape and size of the plant depend upon conditions of environment. Under normal conditions the plant will maintain normality from seed to old age. These conditions are light, temperature and gravity. When the flowering plant has reached maturity certain cells become differentiated as pollen mother cells and by meiotic division pollen cells are formed with half the number of chromosomes. Other cells have become, by meiosis, female gametes or ova - and with these for complete cell nutrition. It must be emphasised that the salts added to soil must be soluble; insoluble salts are valueless, unless they may be changed to soluble salts in the soil. Deficiencies of minerals lead to stunted growth, poor fruit ,formation etc.

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(d) Plant Behaviour. Plants show responses to certain stimuli. No matter how a seed is placed in the soil, the root will always grow down and the shoot up. This is called geotropism. The tip of the shoot is sensitive to light, and the plant may be bent in the direction of light. This is accomplished by greater cell growth on one side of the stem at the point of bending - a hormone being transmitted from the tip to that point. The light response is called phototropism.

7. Other Kingdoms. There are small organisms which have some of the characteristics of animals and some of the characteristics of plants.

(a) Bacteria are very small, but are of varying sizes. They are often classified by their shape:- round, straight rods, twisted rods. The food requirements of bacteria vary considerably. Some sort of bacteria will grow on almost anything. Bacteria reproduce by fission. Each cell grows to full size and then divides in two by a wall across the cell. When there is enough food, growth and fission coccur quite rapidly. Some bacteria are harmful, others are of advantage to man.

(b) Fungi consist mainly of a system of fine thread-like processes. The visible part is the fruiting body which produces spores by means of which reproduction occurs. The threads are mainly concerned with nutrition. These may secrete digestive juices and the products of digestion outside the thread are then absorbed. The thread is surrounded by food material waiting to be absorbed. The threads may enter the cells of the host or grow between the cells while pushing special branches into the surrounding cells and gaining food from them. They may kill the cells and continue to live on the cells which they have killed. The largest fungus is the mushroom. Almost all of what we call the mushroom is the fruiting body.

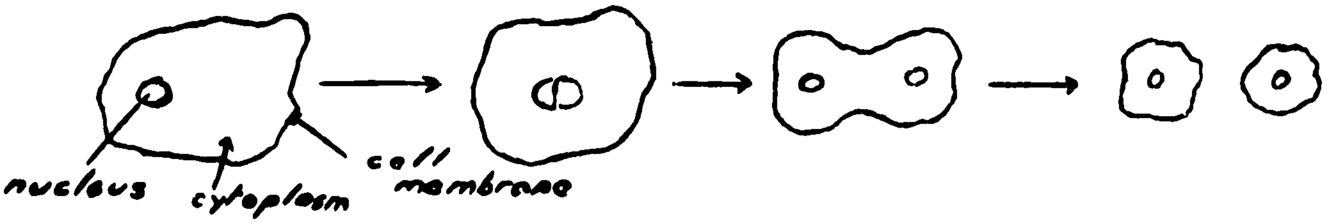
(c) Viruses are the simplest forms of life so far known. They are not cellular in structure but are crystalline. They consist of a particle containing a protein combined with nucleic acid. They live in the living cells of the host. They do not grow but multiply; and hence a culture cannot be prepared as for bacteria or fungi. They are isolated as other proteins. Viruses cause specific symptoms in the host and a particular virus will only infect certain hosts. They are found in plants and in animals in which they cause disease - measles, mumps, poliomyelitis, common cold, myxomatosis, tobacco mosaic.

8. Reproduction.

In the living organism, growth or enlargement may take place either by an increase in the volume of individual cells, due to abundancy of food, and certain metabolic processes, or by an increase in the number of cells. Life is a complex process by which the protoplasm and its components are being continually changed.

Asexual Reproduction. Growth due to an increase in the number of cells requires the reproduction of cells to form similar cells, complete with nucleus and the chromosomes it contains, cytoplasm, cell membrane, etc. This type of cell division is called mitosis, and in addition to being responsible for growth of an animal or plant, is also the mechanism of asexual (non-sexual) reproduction. The nucleus divides within the cytoplasm, followed by division of the cytoplasm into two similar complete cells.

Simplified representation of mitosis.

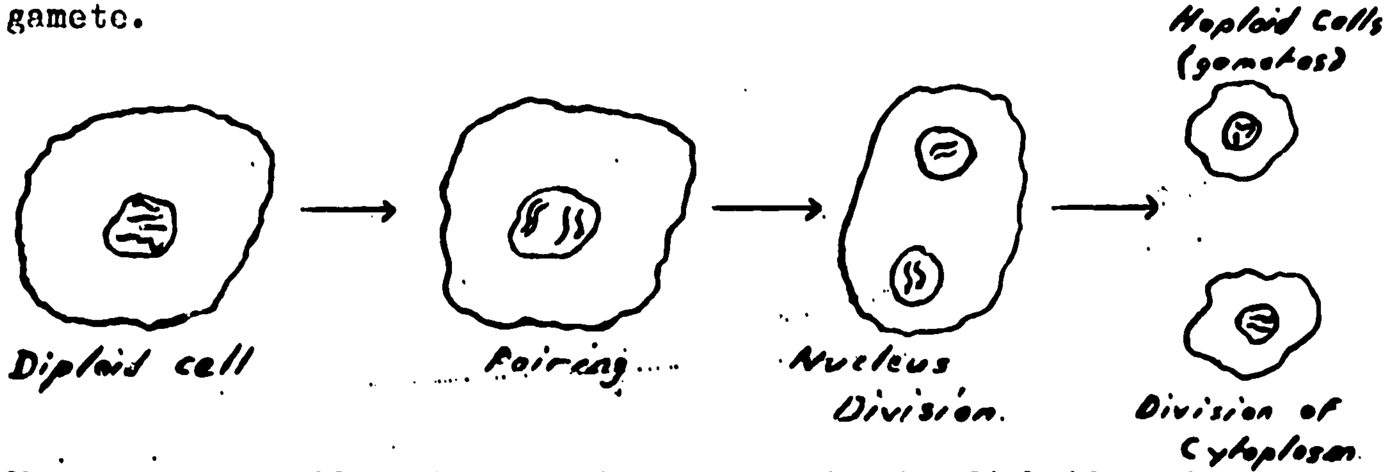


Sexual Reproduction.

In order that a new individual may originate as a single complete cell, two "half-cells" or haploids, are required. The production of these haploid cells, the gametes, is the function of the reproductive organs; i.e.in a typical flower, the ovary at the base of the pistil, and the anther at the tip of the stamen; in animals, the ovaries and the testes.

The uniting of the haploid cells, the gametes, to form a single complete diploid cell, called the zygote, is termed fertilization. If the male gamete, and the female gamete are to combine to form the zygote, it is obvious that the nuclei of the gametes must contain half the number of chromosomes of the complete cell, otherwise the number of chromosomes in the nucleus would double with each generation.

The type of cell division which produces the gametes is called meiosis. In the complete cell nucleus, the chromosomes must be in pairs of similar types, so that one of each pair is present in each gamete.



Meiosis of a cell with four chromosomes in the diploid cell.

The zygote cell may be regarded as the blue-print, the chromosomes of the nucleus containing all the information required for the formation of the new individual;

e.g.	- sweet pea. -	shape of leaf (not a poppy leaf), shape of flower, colour of flower, height, type of seed pod etc.
	- cat -	shape of ears (cat's ears, not a rabbit's ears) tail, nose, teeth, paws, colour of fur, etc.
	- humans -	colour of hair, colour of eyes, height, size etc.

The zygote, a diploid cell, then commences to divide by mitosis, into 2, 4, 8, 16 etc. cells, to form the millions of cells required for the new individual, the cells acquiring their specialist functions according to their position; e.g. in the root, stem or leaf of the new plant, in the skin, stomach, muscles, or eye of the new animal.

9.Heredity.

Why are off-spring similar to their parents in some respects, and different in others?

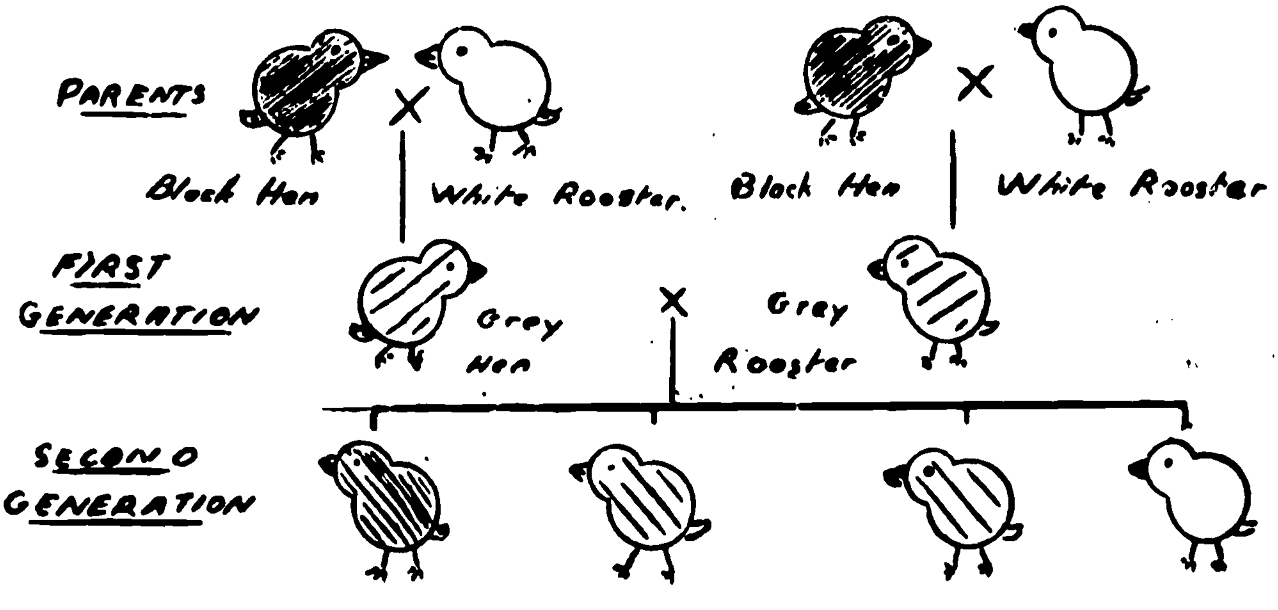
If a pure black Andalusian hen, is mated with a pure white Andalusian rooster, all the first generation off-spring are grey.

If a grey hen, and a grey rooster, each from the first generation, are mated, some of the second generation are black, some are grey and some are white. Over a large number of second-generation off-spring from grey first-generation parents, the colours are in the ratio

1 black, 2 grey, 1 white.

To account for these results, it must be remembered that the normal diploid cells of the first generation greys resulted from the combination of a haploid cell , or egg, from a black hen, and a haploid cell, or sperm, from a white rooster. The chromosomes of the egg from the black hen must carry some factor responsible for the black colour; this factor is called a gene. Similarly the chromosomes of the sperm from the white rooster must contain a gene responsible for the white colour. They grey colour of the first generation must be due to the fact that, in each diploid cell, is one chromosome carrying black genes, and a similar chromosome carrying white genes.

The haploid cells produced in the reproductive organs of the first generation males and females, will therefore contain either black genes, or white genes, due to the method of separation of the chromosome pairs in meiotic division. Upon mating, four combinations are possible, as shown diagrammatically below.

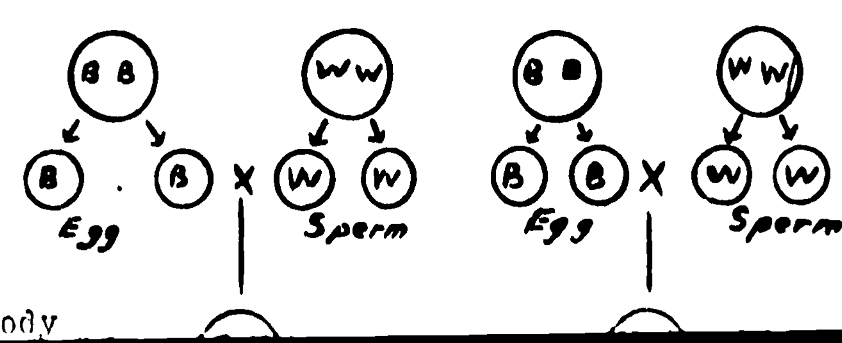


Representing this in terms of the colour chromosomes of the cells accounts for the colours obtained, the chromosomes responsible for black and white colouring being shown by B and W respectively.

Parents

Diploid body cells containing two colour chromosomes.

Haploid gametes containing one colour chromosome.



Only diploid body

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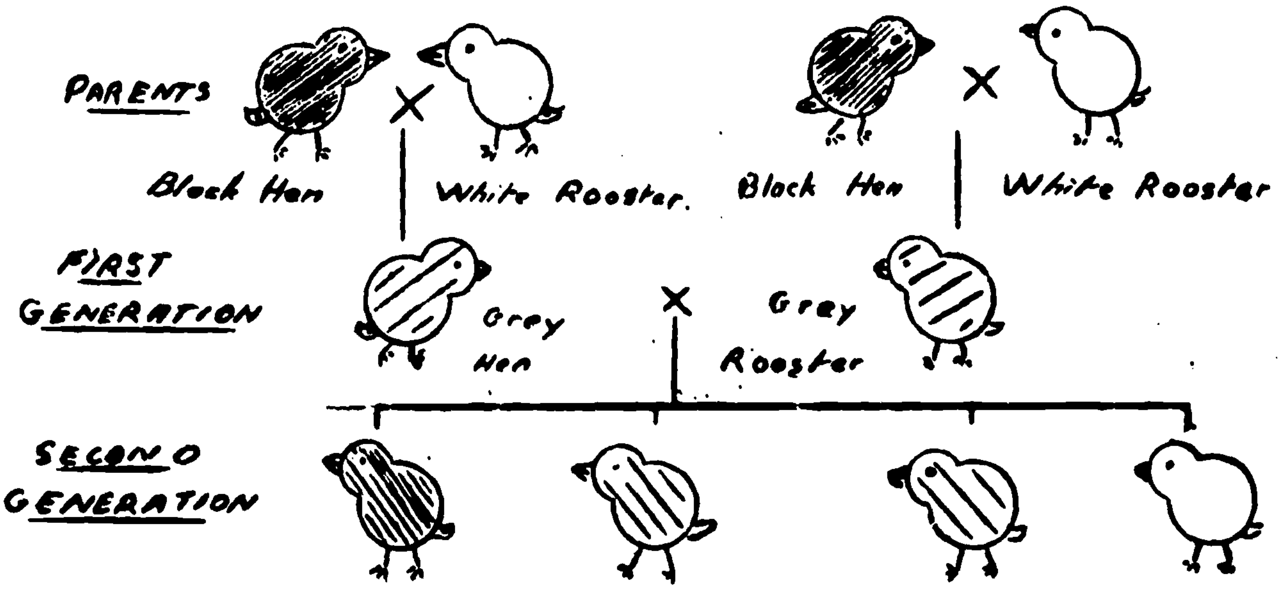

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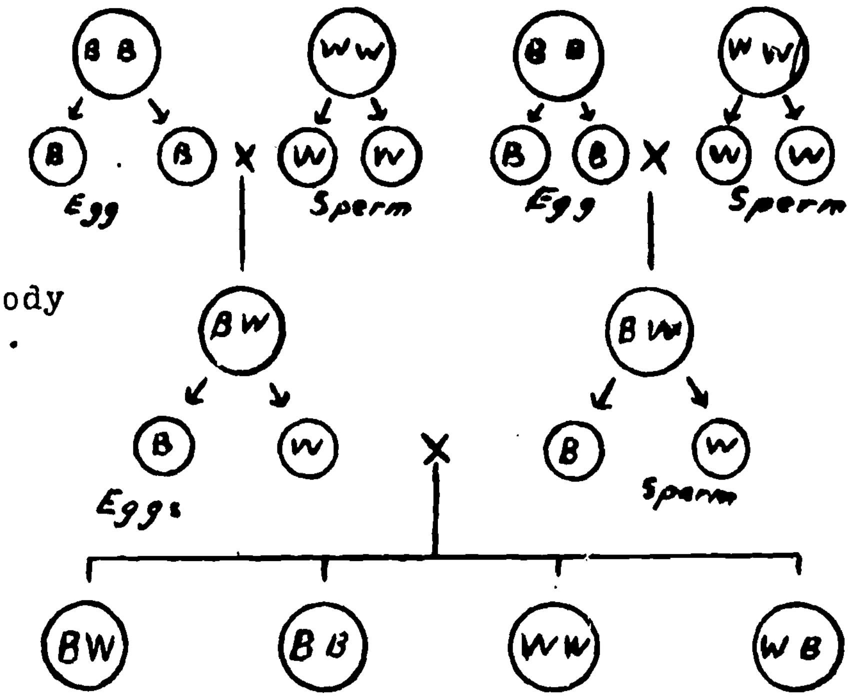


Parents

Diploid body cells containing two colour chromosomes.

Haploid gametes containing one colour chromosome.

First generation

Only diploid body cells possible.

Haploid gametes.

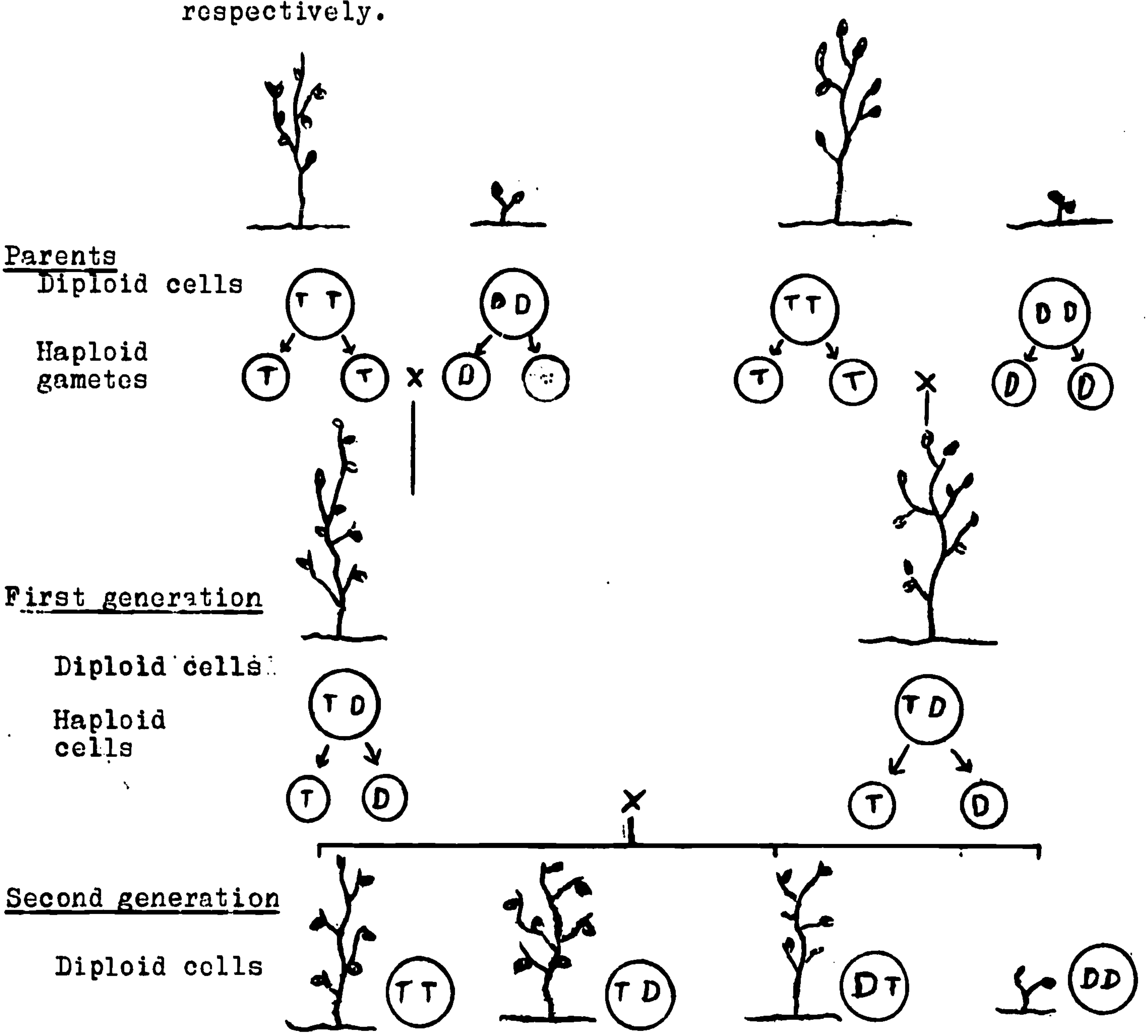
Second generation

Four possible combinations to form diploid body cells.

The first detailed experiments of this type were performed by a monk, Gregor Johann Mendel, using pea plants, in an Austrian monastery during the years 1857-1866.

He discovered, however, that the first generation is not always intermediate in characteristics between the parents, but may closely resemble one or the other. For example, tall plants crossed with dwarf plants yielded only tall plants in the first generation. Red-flowered plants crossed with white-flowered plants yielded only plants with red flowers.

In the second generation the two characteristics showed, but were in a three to one ratio: The reason for this is shown by the following diagram, in which the chromosomes responsible for tall and dwarf heights are indicated by T and D respectively.



Evidently the gene responsible for tallness in the plant is dominant, and that responsible for dwarf growth is recessive, as indicated by the ratio of the plants in the second generation. The factors of dominance and recessiveness in the genes of the chromosomes is very common, and is an explanation of differences between parents and their children, and between children of the same family. For example, brown eyes are dominant over blue. So far, we have considered inheritance of a certain characteristic as being due to a corresponding pair of genes, but because chromosomes of a nucleus may carry hundreds of genes, it is obvious that their effect in controlling inherited characteristics will be extremely complex. For example, Mendel's experiment plants in the first generation. Red-flowered plants crossed with white-flowered plants yielded only plants with red flowers.

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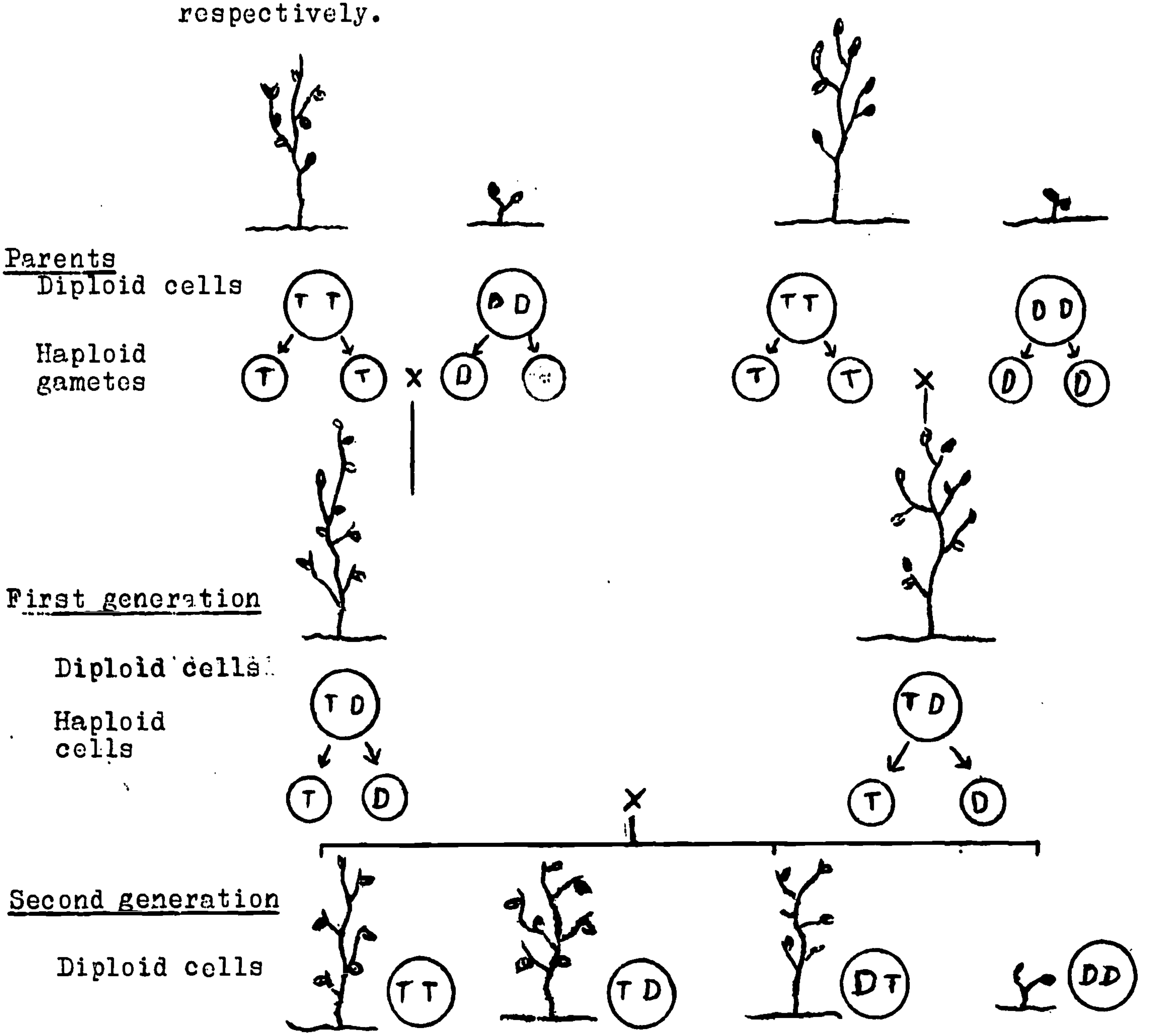

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In humans, eye colours and skin colours seem to be controlled by several pairs of genes, resulting in a very wide range of differences. The number of possible combinations of the hundreds of genes contained in the 23 pairs of chromosomes in the nucleus of the human cell produces individuals with a unique character and identity.

Also, the effect of genes is partially limited by environment, as has been shown by studies of the lives of identical twins raised in different surroundings, and children who have been transferred from one environment to another. Availability of food, care, sources of knowledge, living conditions, and personal relationships all influence the development of the individual from the genes present in the chromosomes of the original gamete.

10. Evolution

An excellent account is given in Biology - Heath. (Kroeber, Wolff and Weaver) Chapters 32-35.

LEAVING TECHNICAL SYLLABUS.

GENERAL SCIENCE.

NOTES ON THE COURSE:-

Work on some sections may be diminished in order to develop other sections more fully.

"B" BEHAVIOUR OF MATTER.

ATOMIC STRUCTURE. 1.

Atomic Number and Mass Number.

Present concept of atomic structure - built from three fundamental building blocks - protons, neutrons and electrons - and that atoms differ only as a result of different combinations of these particles.

Mass number (A) of an atom is equal to the number of protons plus the number of neutrons (N). Since atoms are electrically neutral the number of "planetary." electrons must be the same as the number of protons in the nucleus and this is the atomic number often abbreviated as (Z).

Mass number = atomic number + number of neutrons.

i.e. $A = Z + N$.

It is often convenient to describe an atom by placing its mass number as superscript and atomic number as subscript.

e.g. ${}^{238}_{92}U$ or ${}^{238}_{92}U$

Electrons move about the nucleus in more or less definite regions called shells or energy levels. - thus effectively occupying the relatively vast empty space around the nucleus. These electrons form an electronic field about the nucleus which gives the atom its volume and thus excludes other atoms. Several examples of electron configuration.

Atoms in partnership.

The vast majority of substances we see around us are combinations of two or more elements.

Although atoms are electrically neutral; any two atoms will feel a force between them if they are sufficiently close together that their orbiting electrons tend to overlap. Sometimes the attractive force is sufficiently strong to bond the two atoms together into what is called a molecule.

Atoms of different elements have different combining capacity.

eg. HCI $NaCI$
H_2O $CaCI_2$
NH_3 $AICI_3$
CH_4 CCI_4

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eg.	HCI	NaCI
	H_2O	$CaCI_2$
	NH_3	$AICI_3$
	CH_4	CCI_4

Valance means "combining capacity".

The electrons in the outermost shell of an atom play a very active part in the formation of compounds. For this reason the electrons in an incomplete outer shell are called the valance electrons.

The valence electrons are either

(i) transferred from the outer shell of one atom to the outer shell of another atom (ionic bonding) or

(ii) shared among the outer shells of the combining atoms (covalent bonding).

Atoms in partnership.

This produces chemical bonds.
eg. 1. Ionic bonding.

Na reacts with CI to form NaCI - single electron in M shell of Na atom is transferred to the M shell of CI atom.

Na atom now has stable electronic configuration of Ne.

CI atom now has stable electronic configuration of Ar.

The particles which are produced by this transfer of an electron are no longer electrically neutral atoms.

They are an electrostatically charged
solium ion - single excess + ve charge
chlorine ion - single excess - ve charge

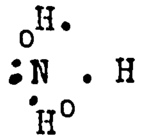
eg. z. Covalent bonding

The central nucleus of each atom in the molecule remains separate, distinct, and unchanged. The linking is done by the electrons. Instead of each electron circling just round its own nucleus as in the three separate atoms, they weave a complicated pattern round all three and bind them into a single molecule. Using electron - dot structures.

e.g.

$H^{o} + .\overset{..}{\underset{..}{CI}}: \rightarrow H^{o}.\overset{..}{\underset{..}{CI}}:$

Similarly for NH_3



"B" BEHAVIOUR OF MATTER.

ISOTOPES. 2.

Existence of isotopes.

The existence of atoms of the same element with different mass numbers was established by the English chemist Soddy 1911. It was he who gave them the name "isotopes".
Not all elements have different isotopes in nature e.g. Na, AI, P. However, many elements, like carbon, have two isotopes and some have more.

e.g. $_{6}C^{12}$ $_{1}H^{1}$ $_{6}C^{14}$ $_{1}H^{2}$ $_{1}H^{3}$

He^{3}_{2} He^{4}_{2} $_{2}He^{6}$

$_{3}Li^{6}$ $_{3}Li^{7}$ $_{3}Li^{8}$ $_{3}Li^{9}$

$_{92}U^{234}$ $_{92}U^{235}$ $_{92}U^{238}$

Tin has as many as ten.

Neutrons stabilise the nucleus, which would otherwise tend to fly apart due to electrostatic repulsion of the protons. Just as there is an optimum mixture of sand and cement to give maximum strength, so there is also an optimum proportion of neutrons for maximum strength.

Stable isotopes - that is those which do not spontaneously break-up usually contain just slightly more neutrons than protons.

As relative numbers become more and more unbalanced the structure becomes more unstable, and tends to break off fragments until the number of protons and neutrons are balanced. Such an isotope is said to be radio active.

Nuclei of atoms also become unstable as they get very large, and so we find that the elements with high atomic numbers e.g. radium, thorium, uranium are radioactive.

Radioactivity

Many kinds of radiations can be emitted, but the most usual are α . β and γ rays.

If nucleus has too many protons for stability - it has a tendency to emit α particles (helium nuclei)
$\therefore$ Z is reduced by 2.
A is reduced by 4.

If nucleus has too many neutrons for stability, it has a tendency to emit β particles (electrons). These electrons originate from the nucleus by conversion of a neutron into a proton, and an electron is ejected.
$\therefore$ Z is increased by 1.
A remains constant.

Both α and β particles are often accompanied by γ rays, which are very short wavelength X-rays and have no charge and no mass. Positrons (β^{+}) are emitted from some artificially produced. r.a. isotopes
$\therefore$ Z is decreased by 1.
A remains constant.

The radioactive decay process.

The activity of a r.a. material decreases with time at a rate characteristic for each r.a. isotope.

The rate at which an isotope disintegrates (or decays) cannot was he who gave them the name "isotopes".

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$_{92}U^{234}$ $_{92}U^{235}$ $_{92}U^{238}$

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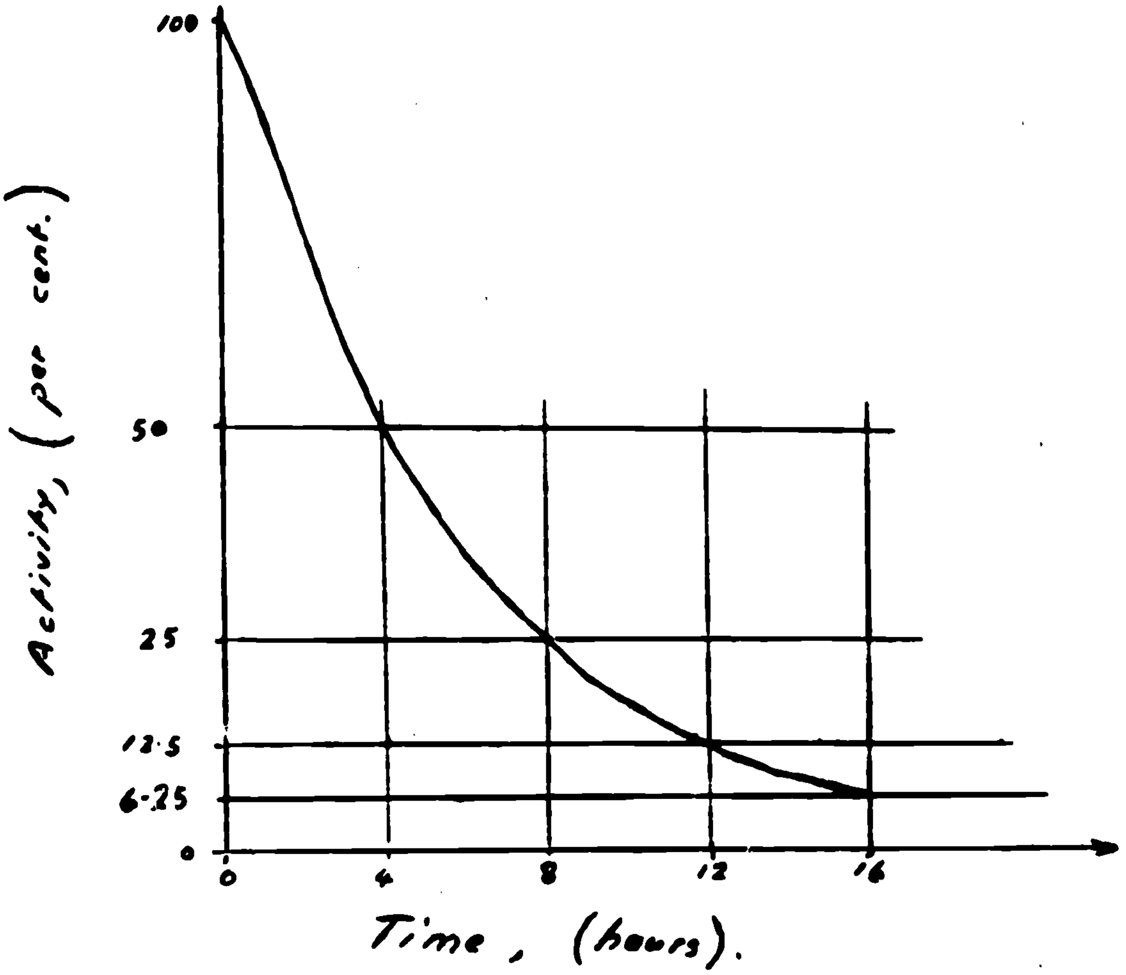
The radioactive decay process.

The activity of a r.a. material decreases with time at a rate characteristic for each r.a. isotope.

The rate at which an isotope disintegrates (or decays) cannot be altered by temperature, pressure or any other physical means.

Figure below is a plot of the decay of a r. a isotope which decreases in activity by 50 per cent every 4 hours.

100% activity initially.
50% activity after 4 hours
25% activity after 8 hours
etc.



The time required for r.a. isotope to lose 50 per cent of its activity is called its half-life.

eg. $T_{\frac{1}{2}}$ of ${}_{88}Ra^{226}$ is 1, 620 yrs.

If 10 gm. ${}_{88}Ra^{226}$ exist now only.

5 gm. will remain in 1620 years. time.
and only 2.5 gm. will remain in 3240 yrs. time.

Uranium disintegration series discussed.

(b) Uses of radio-active isotopes.

Carbon dating.

The rare carbon isotope ${}_6C^{14}$ is used for dating archaeological relics. Only living creatures breathe in C^{14}_6. When they die they get no more, and what they have decays. In a living creature, one of every million million (10^{12}) C atoms is a C^{14}_6. The half-life of ${}_6C^{14}$ is approx. 5,900 years. Thus a mummy found in A.D. 1950 with only one ${}_6C^{14}$ per 2 x 10^{12} atoms would be 5900/2 years old or thereabouts. It would date from some time not very far from 1000 B.C. for A.D. (1950-2950) = 1000 B.C.

A mummy with one C^{14}_6 atom per $4x10^{12}$atoms would date from around about 3950 B.C. and so on:

Technological.

Present day uses of r.a. isotopes mostly exploit the penetrating power of beta and gamma radiation emitted as an isotope decays.

e.g. thickness gauging
- level controlling
- check of the filling of containers
- tracking leaks
- silt movements
- radiography

Medicinal

When introduced into biological system in minute amounts does not interfere with normal behaviour of the body (-must not stay in system too long - max. 2 weeks).

Uses (1) study of metabolism of protein of body.

(2) study of abnormalities with gland eg. (1) I^{131} may be administered orally or intravenously and it is taken up selectively by thyroid gland. In 1 or 2 hrs. 40% will be in thyroid gland of human body if it is functioning normally.

- if 80% T.G. is overactive.
  if 5% T.G. is underactive.

Radioactivity

Medicinal

e.g. (2) determining whether melanoma (black tumour) is malignant

- constituents for growth of cell is P.
- needs more P than healthy part of body.
- introduce r.a. phosphorous and most would be taken up by a malignant tumour.
- compare r.a. phosphorous activity over suspected growth with healthy tissue.
- if it is very great then it is certain to be malignant tumour.
- if this can be diagnosed and detected early it may be cut out surgically..

Effects of Radiation on Man.

Units in which atomic radiation is measured - only two sorts of units are really essential for ordinary understanding, the curie and the rontgen.

The curie (c) measures the output of a radioactive source in nuclear disintegrations per second.

(1 curie (c) = 3.7×10^{10} d.p.s.)
. 1 mc = 3.7×10^{7} d.p.s.)
. .1 uc = 3.7×10^{4} d.p.s.)

The rontgen, r, measures the dose received per unit volume of tissue resulting from ionization.

The absorption of energy in tissue is somewhat greater than in the same mass of air.

The energy equivalent of the rontgen is
83 ergs/gm of air
93 ergs/gm of tissue
Submultiples commonly used are mr and ur

i.e. a rontgen refers to the quantity of the radiation which is actually absorbed.

Natural radiation.

- Form earth - uranium, thorium and potassium in natural rock 90 - 20 mr/yr.
- From air - radon and thoron gases 2mr/yr.
- From water - 0mr/yr.
- From inside our bodies.

  Ra^{226} products - 2 mr/yr K^{40} - 21 mr/yr
  C^{14} 1 mr/yr
- From cosmic rays - mysterious rays from outside our solar system (charged nuclei of, $_1H^1$ and $_2He^4$ mainly) - 33mr/yr at sea level.

Total affect from nature.
From rocks + soil 20 - 90
From clean country air 2
From drinking water 0
From inside our bodies 24

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From inside our bodies 24
From cosmic rays 33 - 40

Total from 79-156 mr/yr.

If we take the average annual dose over the whole world as 100 mr. and 30 yr. as a generation, the average dose per person per generation is approx. 30 x 100 = 3,000 mr.
= 3r. (see section on permissable doses).

Man-caused radiations.

Nuclear explosives launch a certain amount of radio-active material of long life into the upper reaches of the earth's atmosphere. This material continues to drift down, falling ultimately on earth or foliage.

Any activity, such as mining, which causes men to spend a great deal of their living time underground, may give these men backgrounds very different from the normal one. Luminous paints contain normally some radium.

Aeroplane instrument board with 100 dials gives a pilot a dose of about1,300 mr/yr (equal to dose from all cosmic rays.

Radioactivity

Man caused radiations.

Students may well be advised, if wearing their luminous wrist-watches in bed , to keep their hands outside the bed clothes. Lead pyjamas have also been suggested.

Summary.

When ionizations due to r.a. occur in our bodies, their affects are extremely complex.

Three main kinds of effects.

1. kill cells - in particular young or growing cells.
2. can start cancer i.e. effect on healthy cells.
3. altering of sex cells in a way which affects the heriditary factors passed on and cause mutations.
   - cause idiocy
   - abnormalities - 6 fingers, no limbs, small heads etc.
   - haemophilia.

Permissable doses.

Four critical organs
- skin to depth of $7mg/cm^2$
- blood forming organ
- gonads
- eyes

Maximum 300 mr/week for all except
- skin (600 mr/week)
- hands and forearms)
- feet and ankles.) 1500 mr/week.
- head and necks)

Usually a single measurement is made of whole of body exposure.
- limit of 300 mr/week.

Ten times the weekly dose can be accepted provided it is received in any period of 13 consecutive weeks. Genetic effects and long term individual effects.
- accumulated gonad dose up to age of 30 should be $<$50r.
- whole body dose during lifetime $<$200r. (this can be achieved by limiting exposure to 5r/yr.

Measurement of radiation.

Geiger counters

Scintillation counters

Photographic film.

Discussions can be held concerning personal protection, shielding design and waste disposal.

"B" BEHAVIOUR OF MATTER.

EQUIVALENCE OF MASS AND ENERGY. 3.

$E = mc^2$

where E = energy in joule
m = mass in kilogram
c = velocity of light (3×10^8 m/sec.)

Einstein in 1905 suggested that mass and energy may be equivalent in accordance with above formula.

Individual protons and neutrons may be considered as being immortal and cannot be annihilated to create energy. The only mass component which is available for conversion to energy is that small excess mass which is associated with the "binding energy" of the nucleus.

A ${}_{92}U^{235}$ nucleus can fission in a number of ways. Using the known values of the atomic weights we may calculate the mass defect and hence energy release.

$$ {}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{57}La^{148} + {}_{35}Br^{85} + 3\,{}_{0}n^{1} $$

Mass equation is:-

$$235.124 + 1.009 \rightarrow 147.961 + 84.938 + 3.027 + (E)$$

L.H.S. = 236.133
R.H.S. = 235.926 + (E)
∴ Mass defect (E) = 0.207 atomic mass units.

This mass defect may be then converted to energy.

The energy release from the complete fission of 1lb. of ${}_{92}U^{235}$
= 10.3 million kilowatt - hour.

For more full details see.
"An Introduction to Nuclear Science" - Carswell, Gardner, Pryor + Henderson and others.

A chain reaction is one in which the material or energy which initiates the reaction is also one of the products.

A nuclear reactor is a device in which the controlled fission of r.a. material produces new radioactive substances and energy.

A converter reactor is a device that uses one type of fissionable material to produce a nearly equal quantity of another fissionable material.

eg. Producing ${}_{94}Pu^{239}$ from ${}_{92}U^{238}$ by neutrons from the fission of ${}_{92}U^{235}$ in natural uranium.

Power production from nuclear reactors which serve as sources of heat energy - simple details and principles.

Synthetic elements:-

Transuranium elements are those with more than 92 protons in their nucleus.

These have been prepared by bombardment of the nuclei of uranium or more complex elements with neutrons, alpha particles, or other "nucleas bullets".

Refer Modern Chemistry
- Dull, Metcalfe and Williams
Chapter 39.

LEAVING TECHNICAL SYLLABUS.

GENERAL SCIENCE.

B. BEHAVIOUR OF MATTER (continued).

Items 4 and 5.

MOTION.

(Leading to Space Travel)

References: "Modern Physics" by Dull, Metcalfe and Williams.
"Basic Physics" Vol. I, Martin and Connor.
"Modern Earth Science" by Ramsey and Burckley
"A Journey through Space and the Atom" by Butler and Messel.

NOTE: M.K.S. Units should be used throughout this section.

Revise mass, force, velocity and acceleration. Classify as vector or scalar quantities. Problem solving.

MOMENTUM.

Introduce by a demonstration such as rolling spheres. Change mass and velocity and examine effect of collision. Cricket and tennis balls would be suitable for this. Classify as a vector quantity. Measurement (M = m. v), conservation and simple problems as listed below:

(i) Collision of one moving body and one stationary body with resulting velocities in one sense.

(ii) Collision of one moving body and one stationary body with resulting velocities in two senses.

(iii) Collision of two bodies moving in same direction with same sense.

(iv) Collision of two bodies moving in same direction with opposite sense.

NEWTON'S SECOND LAW OF MOTION.

Rate of change of momentum leading to F = k.m.a., the magnitude of constant k depending on units chosen for F, m and a. Problem solving involving F = m.a.

PROJECTILES.

Path of projectiles. Use of sight on rifle, qualitative treatment.

Motion formula.

$$v = u + a.t.$$
$$s = u.t. + \tfrac{1}{2} a.t.^2.$$
$$v^2 = u^2 + 2.a.s.$$

Problems involving projectiles, horizontal projection only.

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(Leading to Space Travel)

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NEWTON'S LAW OF UNIVERSAL GRAVITATION.

VERIFICATION OF LAW OF GRAVITY.

Experimental Treatment.

MASS OF THE EARTH.

Comparison between mass of the Earth and that of other bodies in the Solar System.

CIRCULAR MOTION.

Motion caused by a force of constant magnitude acting at right angles to the direction of motion of a body.

CENTRIPETAL FORCE.

Calculation of simple problems.

CENTRIFUGAL FORCE.

Treat as a reaction force equal in magnitude and direction but opposite in sense to centripetal force. It should be emphasised that centripetal force is the force that restrains a body to a circular path.

EQUILIBRIUM.

Conditions for equilibrium of a particle and a body. Simple problems.

THE MOTION OF EARTH SATELLITES.

Artificial and the natural satellites, getting into space, the moon and planets, escape velocity, calculation of orbital speed, apogee, perigee.

The extent of the work to be covered in this section is set out in "Modern Earth Studies", chapter 5, and "Modern Physics", chapter 4.

WEIGHT AND WEIGHTLESSNESS.

NOTE: "Conditions for Equilibrium of a body" should be treated before commencing this section.

Develop idea of weightlessness from a consideration of freely falling bodies and bodies in accelerating lifts. Weightlessness in space flight; discussion of problems and their solution.

WORK, ENERGY AND POWER.

The Joule and the Watt simple problems.

HEAT AND WORK.

Suggested treatment is as set out in "Modern Physics".

First law of thermodynamics.

Second law of thermodynamics.

Meaning of the terms.

"Adiabatic process" and "Isothermal process".

Simple applications of each process.

HOW HEAT ENERGY IS USEFULLY EMPLOYED.

Essential features of any heat engine.

(a) External combustion engine. Steam produces a force against a piston in a reciprocating steam engine or on the blades of a turbine, thus causing motion. Simple diagrams to illustrate the principle of these engines. Uses of each.

(b) Internal combustion engine. This engine eliminates the need for a boiler. Pressure built up by burning combustible gases exerts force on a piston or on the blades of a turbine and causes motion. Simple diagrams

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The rocket as an example of an internal combustion engine that does not depend on air for its oxygen supply and may thus operate beyond the Earth's atmosphere. Use of rocket for space travel; range of operation limited because refueling at present impossible. Necessity for development of a nuclear powered rocket.

Details of rockets may be obtained from "A Journey through Space and the Atom".

Item 6.

WAVES AND WAVE MOTION.

References: P.S.S.C. Chapter 26.
Modern Physics (Dull, Metcalfe, Williams) Unit 2 Chapter 12 & 13.
Man and his Physical Universe.
Martin & Connor Vol. 3 Chapter 39 - 45.

Comparison of energy transfer by motion of particles (eg. electricity, heat) with energy transfer from sun to earth, radio waves leading to explanation of the terms wave and particle wave. Meaning of terms associated with waves - crest, trough, wave length, amplitude.
Transerve and longitudinal waves simply treated (Long coiled springs (compression type) useful for demonstration). Speed of waves - frequency of waves.
Meaning of terms in phase and out of phase leading to interference of waves, constructive and destrictuve. Reflection refraction and diffraction as demonstrated by water waves in a simple ripple tank (or wave projection tank). Reflection of waves can also be demonstrated by sending a pulse along a long coiled spring.

SOUND:- caused by vibrating source - medium necessary to carry vibrations: Demonstration such as suspended pith ball touching vibrating tuning fork. Comparison of movement of air particles due to sound compared to movement of particles in the spring for a longitudinal wave. Simple explanation of ear as a receiver - diagram of ear. Range of frequency for human ear - inaudible sound both high and low frequencies - uses of same. Speed of sound - effect of medium on same (simple qualitative treatment). Relation between frequency emitted and pitch heard and intensity emitted and loudness heard. Simple explanation: include table of intensity level of familiar sounds between threshold of hearing- 0decibels, to threshold of pain - 120 decibels. Beats - demonstration and explanation.

PHYSICAL BASIS OF MUSIC.

Difference between noise and musical note. Demonstrate with vibrating strings, (or were) of similar material and diameter, to show effect of length on frequency and therefore pitch. Overtones or harmonies and their effect on the sound wave produced. Quality of sound produced and its dependence on harmonies.
(Different musical instruments producing same note as example).
Harmony and discord - as examples of beats per second .
Major chords - 3 tones with vibrations in ratio 4. 5. 6.
The major diatonic scale, simply treated.

ACCOUSTICS.

Growth of intensity of sound in halls etc. - reverberation. Methods of decreasing reverberation. Effect of excessive absorbing materials.

SOUND PROOFING.

Excluding sound from room, preventing sound from leaving room, structure born sound, vibration of moving machinery ie. motors etc.

"B" BEHAVIOUR OF MATTER.

LIGHT. 7.

Nature of Light. Refer "Basic Physics" M + C Vol.3 Chap.46.

Electromagnetic Spectrum. Refer. An Introd. to N.S. Chap.5.

Speed of Light - Michelson's - Octagonal Mirror Method
Refer Basic Physics M + C Vol. 3. Chap.52.

Brief mention only of principle involved in Light meters.

Laws of Reflection at a plane Surface) Refer "Basic Physics"
Real & Virtual Images) M+C, Vol. 3.
Multiple Reflections.) Chap. 47.

Refraction laws) Refer "Basic Physics"
Atmospheric refraction.) M+C Vol. 3.
Chap. 47-(1,2,3,4,8,9,11,13,14.

The Eye - Refer "Basic Physics" M+C
Vol.3. Chap. 51-(6).

Polarization of Light. - Refer "Basic Physics" M+C
Vol.3. 56-(1,2,3,14).

"B" BEHAVIOUR OF MATTER.

ELECTRONICS. 8.

Thermionic emission - brief explanation of principles.

Applications of above to valves. Use of transistors in radio and television etc. - may be developed further at the discretion of the school.
Opportunity here for students to engage in project or research work.

(Typical breakdown of this section.

e.g. (i) What is meant by electronics?
"Electronics may be defined as the branch of science concerned with the emission, behaviour, and effects of electrons."

(ii) Direct and Alternating Currents. Graphical representation of radio, audio and power frequencies.

(iii) Thermionic emission. Explanation in terms of kinetic theory of matter. Formation of space charge surrounding heated objects.

(iv) The diode valve and how it conducts. (Historical Ref.) Application to half-wave rectification. Battery charging as application.

(v) The valve with the third electrode.

(vi) Triode valve as an amplifier. Simple circuit using one valve. The reasons for grid bias and a load resistor should be understood.

(vii) Three functions of radio valves
- to amplify
- to oscillate (produce A.C.)
- to rectify (change A.C. to D.C.)

(viii) Transistors - comparison with vacuum tubes on electrical and mechanical basis.

(ix) Radar - radio detecting and ranging (Principle only).)

Refer - Modern Physics. (Dull, Met. & Will).

Basic Electronics (Parts 1, 2 and 3)
(" A Common Core" Technical Press).

Basic Physics M + C Vol. 2. Chap. 36, 37.

Item 9.

METEOROLOGY.

All of this material may be obtained from "Modern Earth Science".

THE EARTH'S ATMOSPHERE.

The atmosphere, composed mainly of nitrogen and oxygen, extends to an altitude of at least 1000 miles above sea level. It may be divided into four parts: troposphere, stratosphere, ionosphere, and exosphere.

Natural processes such as the carbon dioxide and nitrogen cycles help to maintain the proper balance of the life-supporting gases. Intense heat of the young planet probably drove off the earth's original atmosphere of hydrogen and helium. Subsequent chemical activity and volcanic discharge of gases apparently led to the present atmosphere. According to locality, the air may contain pollutants resulting from industry, automobile exhausts, and nuclear testing. Periods of temperature inversion make air pollution a potential health hazard.

The bulk of the weight of the atmosphere is within 3.5 miles of the earth's surface. Barometers of several kinds are used to measure the pressure exerted by the atmosphere.

The portion of the sun's energy that reaches the earth's surface is absorbed and in turn heats the lower part of the atmosphere. This phenomenon is known as the "greenhouse effect". Rainbows and mirages are visible phenomena due to the effects of the atmosphere on light from the sun.

WINDS.

Unequal heating of the earth's surface produces temperature differences which cause pressure differences. The pressure differences create winds and air currents. Warm air above the equator rises and flows toward the poles while polar air descends and moves toward the equator. This movement of air in combination with the rotation of the earth establishes a system of wind belts and calms.

Winds do not move directly north or south but are deflected by the Coriolis effect. According to Ferrel's law, winds in the northern hemisphere drift to the right; in the southern hemisphere they are deflected to the left.

Seasonal shifting of the vertical rays of the sun causes a migration of the wind and pressure belts, amountingto about 6°. As a result of this shifting, some areas may be in two different wind belts during the course of a year.

At high altitudes the mixing of warm equatorial air with cold polar air creates systems of high-speed winds that appear to have a great effect on the weather pattern. Further understanding of these systems will have a great influence on the accuracy of long-range weather forecasting.

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Variations in temperature and pressure over small areas of the earth result in local winds.

WATER IN THE ATMOSPHERE.

Atmospheric capacity for absorbing and retaining moisture is regulated by temperature: the higher the temperature, the greater the capacity. Humidity is a general term for atmospheric moisture. Absolute humidity is the weight of water vapor per unit volume of air; relative humidity is the ratio of weight of water vapor to capacity at a certain temperature.

WATER IN THE ATMOSPHERE (Cont.)

Humidity is measured by an instrument called a hygrometer. It consists of two thermometers, one of which is kept moist by means of a damp wick. Relative or absolute humidity can be calculated by determining the difference between the reading of wet- and dry-bulb thermometers.

If air is cooled below its saturation point, condensation will occur. Depending on elevation and temperature, dew, fog, frost, or clouds may result.

Clouds are formed mainly by the upward motion of masses of air, which are cooled by expansion. Cloud droplets collect around a condensation nucleus, which may be a particle of dust, smoke, salt, or some other substance.

Within clouds, coalescence or crystallization of water droplets around ice crystals may produce rain. If the enlarged, six-sided crystals do not melt while falling, the result is called snow. Sleet and hail are forms of rain that is frozen near the ground.

WEATHER CHANGES.

Release or absorption of heat in the atmosphere is the primary cause of weather changes because it affects temperature, humidity, and winds.

Air masses are formed when the atmosphere is stagnant over an area for a limited time. As air masses move across the earth, temperature and humidity are slowly modified, producing weather changes.

The boundary between two air masses is a front. It is named after the advancing air mass. Interaction of air masses and the subsequent development of fronts form cyclones and anticyclones.

Tropical oceanic storms accompanied by strong winds and heavy rain are called hurricanes. Tornadoes form during hot humid days in continental areas. Although they cover a small area and are shortlived, they are the most violent storms. Rising columns of warm air occurring simultaneously with downdrafts of cooler air produce thunderstorms characterized by gusty winds, short periods of heavy rain, lightning, and possibly hail.

WEATHER PREDICTION.

Weather is the condition of the atmposhere at a certain place and time. In the middle latitudes the basic problem in weather prediction is the interpretation of highs and lows moved by the prevailing westerlies.

Basic equipment for weather forecasting consists of some type of maximum-minimum thermometer, barometer, anemometer, wind vane, and rain gauge. Other specialized equipment includes radar and the radiosonde.

Every six hours widely distributed stations send their observations to a collection centre. The information is plotted on a map at a point corresponding to the location of the reporting station. A complete plot for a reporting area is called a station model. After all station models are recorded, points of equal pressure are connected on the plot by isobars.

Detailed 24-hour or general 5-day forecasts are made up from interpretation of weather maps, using experience of similar conditions and understanding of laws governing air movement.

A66/94
Tech.Sch.Br.

EDUCATION DEPARTMENT, VICTORIA.

LEAVING TECHNICAL SYLLABUS.

LEA 771 TECHNICIAN SCIENCE "A" (1966).

I. GENERAL.

1. This is a new syllabus which will operate from 1966.

2. It is designed to provide a more suitable science course for students intending to complete automotive, electrical, mechanical or production technician courses.

3. The teaching should be planned so that -

   (a) the treatment of Physics topics is generally much less rigorous, and where appropriate more along qualitative lines, than that required for similar topics in the syllabus LEA 761 Physics (1964);

   (b) emphasis be given constantly to the nature, importance and application of scientific method;

   (c) the study of absolute units introduced in Form IV be continued, but that major emphasis be given throughout the course to the use of practical units;

   (d) in the case of prospective electrical technicians the section on Electricity and Magnetism be extended to provide a fuller approach specifically associated with the trade theory for that course.

4. An appropriate programme of practical work, comprising not less than ten experiments, should be planned to cover Sections A to D of the syllabus.

5. (a) Examination will be by one external three-hour paper, with a pass conditional on satisfactory completion of practical work.

   (b) The paper will contain a wide choice of questions.

6. The following books are recommended for teacher reference:

(K & McK)	Keighley & McKimm,	The Physical World, Vol.I.	(Macmillan)
(W, W & M)	Weber, White & Manning,	Physics for Science and Engineering,	(McGraw-Hill)
(Walker)	Walker,	National Certificate Mechanical Engineering Science,	(Aust.Pub.Co.)
(Reynolds)	Reynolds,	Mathematics and Science for Engineering Technicians' Courses, Bk.One	
(Rogers)	Rogers,	Physics for the Enquiring Mind	(O.U.P.)
(Carswell)	Carswell, Gardner, and others.	An Introduction to Nuclear Science	(Aust.Atomic Energy Comm. Inf.Sec.)

II. DETAILED SYLLABUS.

SECTION	SCOPE	NOTES.
(A) MECHANICS.		
1. Physical quantities and units.	Physical quantities and their measurement. Units -fundamental and derived. Revise the Absolute and M.K.S. systems and introduce the Gravitational or Engineers' system of units with the "slug" as the unit of mass. Use the latter system whenever possible throughout the course.	K & McK. (pp 1-24) **Walker** (pp 56-61)
2. Vector and scalar quantities	Addition, subtraction and resolution. Simple applications involving velocities and forces. Restrict resolution to two components at right angles for a single vector. Introduce the concept of pressure producing a resultant force.	W. W & M. (p 13) and K. & McK. (pp 125-137) omitting paragraphs 8. 10 and 8. 11. Reynolds (Book One) pp 6 to 13)
3. Velocity and acceleration	Introduce through displacement-time and velocity-time graphs and develop the equations for uniformly accelerated rectilinear motion. (Derivations not required for examination purposes.) Deal also with freely falling bodies.	Walker (pp 1-27) and K & McK. (pp 97-106(
4. Solids in motion.	Momentum -quantitative treatment as far as given in the first reference quoted. Qualitative treatment as in "Walker" p.55. Newton's Laws of Motion and Gravitation. Mathematical examples to be relatively simple and can be selected from those in W.W.& M. pp 43-44. In exercises on lifts give the acceleration and for problems on inclined planes consider only the motion under gravitational forces.	W.W & M. (pp 104-105) K & McK. (p 118) K & McK. (pp 106-117) Other suitable examples from Walker (pp 61-63 and exercise 5)
5. Friction, Work and power.	Co-efficient of friction, laws of friction, methods of reducing friction, necessity for friction. Work-concept, units and problems. Power -units and problems. Measurment of brake horsepower. (Principle only)	K & McK. (pp 149-155) K & McK. (pp 140-145) Further exercises from Reynolds Bk.1. (pp 27-33)

SECTION	SCOPE	NOTES
6. Energy	Types, units. Change in K.E.= work done by resultant force. Simple problems only.	K & McK. (pp 145-149) Selected problems from W.W & M. (pp 77-78)
7. Equilibrium	Equilibrium as a state of zero acceleration. Concurrent coplanar forces-conditions for equilibrium and simple problems.	Walker (pp 129-137)
	In the case of motion on a rough inclined plane deal with graphical determination of reaction.	Walker (pp 140-143)
	Parallel force systems. Levers, centres of gravity and stability. Couples. Problems associated with same.	K & McK. (pp 163-179)
8. Angular motion	Radian, angular displacement, velocity and acceleration.	Walker (pp 28-34)
	Relationship between angular and linear velocities for motion in a circular path, velocity change, acceleration and centripetal force.	Walker (pp 75-79)
(B) PHYSICAL STATES OF MATTER.		
1. Kinetic theory and gas laws.	Concepts of temperature, pressure,volume and heat to be included in a discussion of kinetic theory. Kinetic theory-explanation of (i) effect of pressure on F.P. and B.P. (ii) Evaporation and its cooling effect.	
	Revise Boyle's Law and Charles' Law. Introduce absolute temperature scale and absolute pressure as distinct from gauge pressure. Exercises on combined laws.	Walker (pp 217-224)
2. Measurement of temperature and heat.	Thermometers-expansion, thermoelectric and optical types and their uses. Thermopile. Heat-measurement of specific heat.	W. W & M. (pp 191-192)
	Heating of water at constant pressure, sensible heat, latent heat, superheat. Calorimetry-use method of mixtures for determining specific heat and condensation method for determining latent heat.	Walker (pp 225-230) Reynolds (pp 38-40) Selected examples from W. W & M. (p 214).

SECTION	SCOPE	NOTES
3. Solutions	Gas-gas, liquid-gas, solid-gas, liquid-liquid, liquid-solid, solid-solid systems. Solvent, solute. Saturation. Deal descriptively with various common applications and discuss some common solubility curve.	
(C) WAVES AND RADIATION.		W. W & M. (pp 243-247)
1. Wave motions	Concept of a wave -velocity, frequency and wavelength. Introduction to electromagnetic spectrum. Discuss factors affecting the speed of a compressional wave in an elastic medium but avoid rigorous mathematical treatment.	
	The relationship between velocity frequency and wavelength to be known and simple problems solved.	
	Practical applications of longitudinal waves - (i) Modes of vibration of a stretched cord. (ii) Sound waves - resonance. (Qualitative treatment only)	W. W & M. (pp 253-257)
2. Properties of waves.	Properties of sound waves refraction reflection, inteference and dispersion. (Qualitative treatment only)	W. W & M. (pp 258-260)
	Electromagnetic waves, light as an example of transverse wave motion.	W. W & M. (pp 461-463)
	Speed of light (Descriptive only)	W. W. & M. (pp 470-1)
	Refraction in solids, liquids and the atmosphere (Qualitative treatment). Laws of refraction.	W. W & M. (pp 490- and 501)
	Reflection of light-laws of reflection, regular and diffuse reflection, plane mirrors, optical lever, spherical mirrors, location of conjugate foci, principal focus, location of images for convex and concave mirrors.	W. W & M. (pp 476-482)
	Dispersion by a prism chromatic aberration in a lens, achromatic prisms and lenses, prism spectroscope and types of spectra. Method of measuring distribution of energy in the spectrum.	W. W & M. (pp 529-533)
	Interference - simple descriptive treatment, interference fringes.	W. W & M. (pp 550-554)
	Diffraction (W.W _ M.para.47-4)	W. W & M. (p.556)
	Polarization as a property of transverse waves only (Introduction and W. W & M. para.48-1 only)	W. W & M. (pp 563-4)

SECTION	SCOPE	NOTES
(D) ELECTRICITY & MAGNETISM.		
1. Magnetism	The Domain theory of magnetism (W.W & M.par.33-11) Types of magentic materials and their behaviour (W. W & M. para's 33-4 and 33-7). Explanation of behaviour of diamagnetic, paramagnetic and ferromagnetic materials without reference to permeability. Magnetization curves for M.S. and CI using terms "magnetic flux density" and "magnetizing force". Saturation.	W. W & M. (pp 372-378)
2. Electrical	Galvanometers (moving magnet, moving coil and moving iron instruments)-construction, simple descriptive treatment of principles of operation, characteristics of each and their particular uses. Revise modifications necessary for conversion to ammeter or voltmeter. (Qualitative treatment only)	Selected exercises from W. W & M. (pp 367-8)
3. Electrical circuit	Revise and extend relevant sections of the Form 4 Trade Electricity and Magnetism syllabus. Definition of electric charge and electric current. Further exercises on Ohm's Law involving resistances in series and in parallel. Discuss the departure from Ohm's Law for non linear conductors.	Rogers (pp 503-510 and 526) Selected examples from W. W & M. (pp 326-331) and Reynolds Bk.1 (pp 50-58) Refer W. W & M. (p 313 Q19)
4. Electrical energy and power.	Electrical energy-units, simple calculations Power-units, simple examples Transformation of electrical to heat energy, Joules equivalent. Wattmeter and Watthourmeter-construction and principle of operation treated simply.	W.W & M. (pp 388)
5. Induced EMF's and current	Lenz's Law. Faraday's Law and expression for induced EMF in a single conductor. Exercises. Principles of A.C. and D.C. generation.	W.W & M. (pp 397-400 and selected examples from pp 400-1)

SECTION	SCOPE	NOTES
(E) ATOMIC PHYSICS.	(Qualitative treatment only)	
1. Atomic structure	Proton, neutron, electron. Simple Bohr-Rutherford picture of the atom. Mass number. Isotopes.	Carswell and selected sections from W. W & M. (pp 588-594)
2. Radioactivity	Natural radioactivity. Half life. Decay of uranium. (Uranium series not to be examinable) Alpha and Beta particles, gamma radiation, distinguishing properties, artificially induced radioactivity. Radio isotopes of hydrogen, carbon and nitrogen.	

A63/1032

EDUCATION DEPARTMENT, VICTORIA.

LEAVING TECHNICAL SYLLABUS.

LEA. 761 - PHYSICS (1964).

1. GENERAL

1. The aim of this course is to apply the unifying concepts of energy and momentum to aspects of classical Physics.

2. Throughout the course students should be aware of scientific method, both theoretical and practical, in formulating scientific laws and theories, and also the use to which this is put in scientific development.

3. An approved course of practical physics should be taken concurrently with this course.

4. The subject will be examined externally.

5. Appendix A contains further course details including explanations and suggestions concerning the extent to which topics could be developed.

II. DETAILED SYLLABUS.

MECHANICS

Distinction between quantity and unit (2). Quantities having fundamental units:- mass, length, time, temperature and electrical current. M.K.S. and British system of units (3). Derived units.

Vector and scalar quantities. Resolution of vectors (6). Addition and subtraction of vectors by resolution (apply to all vectors occurring in the syllabus).

Equations of uniformly accelerated rectilinear motion. Velocity - Time graphs. Horizontal projection under gravity.

Momentum. Conservation of momentum (7). Newton's laws of motion. The absolute units of force (8). Application of Newton's laws to one body moving in a straight line. Work, energy and power, The Joule and the foot poundal (9). The watt and the foot poundal/sec. (10). Kinetic energy. Work done by the resultant force = gain in Kinetic energy. Potential energy.

Equilibrium defined as a state of zero acceleration. Dynamic and static equilibrium. Moment of a force about a point. General conditions of equilibrium (11) (12) (13).

Angular displacement, angular velocity and angular acceleration. Equations of uniformly accelerated circular motion. Relationship between tangential velocity and angular velocity. Radial acceleration and centripetal force restricted to a circular path (14). Angular momentum of a particle (15).
$L = I\alpha$ applied to a particle.

HEAT.

Introductory and qualitative treatment of the Kinetic theory of matter. Changes of state. Heat energy used to change state (latent heat) and to change temperature (specific heat). Unit of heat:- Joule (16). The Kinetic theory explanation of:-
(i) The effect of pressure on freezing point and boiling point.
(ii) Evaporation and cooling due to evaporation. Vapour pressure. Saturated and unsaturated vapours. Law of partial pressures.
Measurement of latent heat by a condensation method $L = \frac{Q}{m}$

Measurement of specific heat by a continuous flow method $C = \frac{\Delta Q}{m \Delta T}$

Measurement of saturated vapour pressure by a boiling point method. Variation of density with temperature.

ELECTRIC FIELDS IN FREE SPACE.

The Coulomb as a number of electron charges. The law of force between point charges (rationalized form). Permittivity of free space. Electric field. Lines of force. Electric field strength. Electric field strength due to a point charge. Electric potential and potential difference. Equipotential surface. Potential in the field of a point charge and isolated conducting sphere. (No derivation required). Capacitance of an isolated conducting sphere. Absence of field inside a statically charged conductor. Energy in an electric field. Energy = $\frac{1}{2} CV^2$ (no derivation required). The parallel field. $[E = \frac{V}{S}]$ Capacitance of a parallel plate capacitor (no derivation required). Motion of an electron projected at right angles into a uniform electric field.

FLOW OF CHARGE

Elementary atomic structure leading to a descriptive account of conductors, semi-conductors and insulators including a discussion of free and bound charges (17). Flow of charge constitutes a current. $\Delta q = i \Delta t$. Conventional and electron current. Ionic conduction in gases, liquids and solids (18). The general current-field relationship leading to saturation current. Resistance $R = \frac{V}{i}$ (19).

Temperature variation of resistance. Balanced Wheatstone Bridge. Conductivity. Potential gradient. Work done by a current. Energy conservation principle applied to simple electric circuit. Electromotive force (20). Internal resistance of a cell (21). Power. The kilowatt-hour as an additional unit for electrical energy. Heating effect of an electric current.

MAGNETIC FIELDS IN FREE SPACE.

Law of force for long parallel currents. $F \propto \frac{i_1 i_2}{a}$. Right hand screw rule for direction. The ampere. Permeability of free space. Magnetic induction from $F = i\,l\,B$. Force on a moving charge (derivation not required for examination purposes). Magnetic fields. Lines of magnetic flux. Motion of an electron projected at right angles into a uniform magnetic field.

FERRO-MAGNETIC MATERIALS.

Domain theory of ferro-magnetism. Explanation of the following phenomena in terms of Domain Theory:- (1) Magnetisation (2) magnetic saturation (3) residual magnetism.

WAVES, RADIATION AND ELECTRONS.

(a) Waves - concept of a wave. Transverse and longitudinal waves (22). Frequency, period, wave length, wave number, $C = \lambda f$ Experimental investigation of wave phenomena. Properties of waves (23) reflection, refraction, interference (as a general property of waves) polarisation (as a characteristic of transverse waves), Laws of reflection. Image formation by plane reflecting surfaces. Production of a parallel beam by a parabolic mirror. Laws of refraction (24).

$$\frac{\sin i}{\sin r} = \text{const.} = {}_1n_2 = \frac{n_2}{n_1} = \frac{C_1}{C_2} \qquad (25)$$

Deviation in reflection and refraction (26).

(b) Radiation - Brief descriptive treatment of electro-magnetic waves including spectrum with particular reference to the relationship between frequency and colour in the visible spectrum.

(c) Electrons - Experimental observation of the photo-electric effect. The photo-electric effect conflicting with the classical theory. The photon $E = h\,f$. The Einstein energy equation $\frac{1}{2} m v^2_{max} = h\,f - W_0$ The observation of emission spectra from gases. Postulates of the Bohr theory (27).

APPENDIX A TO LEA. 761 - PHYSIC (1964).

MECHANICS.

1. The delta notation (Δ) is to be used throughout the course to denote change.

2. Quantities should be described as physical concepts.

3. The use of C.G.S. units should be kept to a minimum.

4. The concept of a standard to be taught rather than the actual physical conditions.

5. Errors to be discussed in practical work.

6. Resolved parts of a vector to be explained as the components of the vector in two directions.

7. Conservation of momentum restricted to one dimension.

8. The newton and poundal to be taught. All other units to be regarded as conversions of absolute units.

9. Joule and foot poundal to be taught. All other units to be regarded as conversions of absolute units.

10. The conversion 1 H.P. = 550 ft.lb.wt./sec. = 746 watt should be taught.

11. The algebraic sum of moments around any point in the system is to be stressed in the general conditions of equilibrium.

12. The distinction between the line of action of a force and the point of application of the force to be stressed.

13. It should be stressed that moment is a vector quantity.

14. The derivation of radial acceleration should be carefully shown but it is not required for examination purposes.

15. Angular momentum must be defined as the moment of linear momentum.

HEAT.

16. The calorie and the British Thermal Unit to be shown as conversions of the Joule.

FLOW OF CHARGE.

17. Semi-conductors have been included to show the gradation in conducting properties of solids. The explanation of conductors, semi-conductors and insulators should be in terms of free and bound electrons. Semi-conductors should be restricted to intrinsic semi-conductors of which Beryllium, Silicon and Diamond are examples.

18. Ionic conduction in liquids is not to include the action at the electrodes.

19. Methods of measuring resistance to be dealt with in practical sessions.

20. Distinction between electromotive force and potential difference to be explained.

21. Method of measuring the internal resistance of a cell to be dealt with in practical sessions.

WAVES, RADIATION AND ELECTRONS.

22. A suitable apparatus to demonstrate transverse and longitudinal waves should be used.

23. It is suggested that a ripple tank (see P.S.S.C. text book for details) be used to introduce and study wave phenomena.

24. Demonstrate refraction at two parallel surfaces, two inclined surfaces and two curved surfaces restricting the latter to simple convex and concave lenses.

25. $1 \longrightarrow 2$ represents relative refractive index. n, represents the absolute refractive index of medium one, c ,represents the velocity of light in medium one.

26. Laws of reflection and refraction to be studied by wave fronts rather than by geometric optics.

27. The predictions and limitations of the theory should be discussed.

Discussion may be extended in suitable cases to the derivation of the following quantities (derivations will not be required for examination).

(i) Kinetic Energy $T = \frac{e^2}{8\pi \epsilon_0 r}$

(ii) Potential energy $U = \frac{-e^2}{4\pi \epsilon_0 r}$

(iii) Total energy $T + U = \frac{-e^2}{8\pi \epsilon_0 r}$

(iv) Quantization of angular momentum $mvr = \frac{nh}{2\pi}$

(v) Quantized values for $r = (\text{const.})\, n^2$

(vi) Energy in an orbit = $-$ (const.) $\frac{1}{n^2}$

(vii) Energy of radiation $hf = W_2 - W_1 = (\text{const.})\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

28. The following books are recommended for students and teacher reference:

Sears and Zemansky	-	College Physics.
Semat	-	Physics.
Resnick and Halliday	-	Physics for Students of Science and Engineering.
Starling and Woodhall	-	Physics.
Martin and Connor	-	Basic Physics.
		Physics for Enquiring Mind.

Not much time should be devoted to the accurate plotting of graphs, but the student should have some practice in the solution of equations in one or two unknowns. In addition, some practice should be given in alternative methods of solving an equation, e.g. $x^3 - 2x + 1 = 0$ from $y = x^3 - 2x + 1$ and $y = 0$; from $y = x^3$ and $y = 2x - 1$; from $y = x^3 - 2x$ and $y = -1$. Suitable examples for "simple families of curves" would be, e.g. $pv = k$; valve characteristic curves; examples from engineering journals.

Topic 9

Examination questions on this topic should be straightforward, and not require algebra of any greater complexity than in other parts of the syllabus.

Of the four forms given for the straight line, most emphasis should be placed on the first two, as being more useful in Calculus. The work on the circle should include its equation given the centre and radius, and the converse (this will involve teaching the expression of $ax^2 + bx + c$ as the sum of difference of two squares), together with the equation to the circle through three given points as an application of the solution of simultaneous linear equations.

For exercises on "straight line of best fit", examples should be drawn from as wide a field as possible, Physics, Chemistry, Engineering, etc.

The equations for the simpler loci should be built up, not memorized, and should include: the plane locus of P such that (i) PA = PB (A, B fixed points); (ii) PA = k PB (k constant; A, B fixed points); (iii) PS = e. PM, where e is a constant $\geqslant$ or $<$ 1, S a fixed point (focus) and PM is the distance from a fixed straight line (directrix). In this section, numerical cases only are to be treated. The graphs of the conics should be drawn, using the focus-directrix definition. With a better class, it may be possible to show various geometrical properties of the conics, e.g. the sum/difference of the focal distances is constant for the ellipse/hyperbola; a "ray" from the focus of a parabola is "reflected" parallel to the axis.

A.64/ 633.
Tech.Sch.Br.

EDUCATION DEPARTMENT, VICTORIA

LEAVING TECHNICAL SYLLABUS.

LEA 742 - CHEMISTRY 1965

I GENERAL

1. This syllabus replaces the syllabus for General Chemistry Lea. 741.

2. The aims of this subject are:-

   (a) to study the properties of the commoner elements and some of their more important compounds.

   (b) to study relationships in properties through the use of systematic classifications where possible, e.g. the activity series of metals.

   (c) to explain structure and observed phenomena, wherever possible, in terms of atomic physics and physical chemistry.

3. The pre-requisite qualifications for this subject are Intermediate Technical Examination Mathematics II and Science II, or an approved equivalent, or higher qualifications.

4. The written part of this subject will be examined externally and the practical part internally. A pass in this subject will not be granted unless a satisfactory year's practical work has been completed.

5. The detailed syllabus for this subject is set out below.

II DETAILED SYLLABUS

A. WRITTEN PART

THEORETICAL.

Topic 1. Atomic Structure and Atomic Weight

Evidence for the discrete nature of matter (1). Atomic structure: electrons, the nuclear atom, mass spectrometric evidence for protons and neutrons in the nucleus. Atomic number and mass number. Isotopes. Definition of an element (2). Atomic weight (3).

A simple treatment of the Bohr-Rutherford model of the atom leading to the arrangement of electrons in shells (omitting details of electronic sub-shells) (4).

Topic 2. Electronic Theory of Valency

Ionic compounds. The electronic structures of ions related to the structures of the corresponding atoms. Electrovalency.

Molecular compounds. Electron sharing and methods of representation. Covalency.

Molecular and empirical formulae.

Topic 3. The structure of Matter.

The solid crystalline state(5); ionic, molecular, covalent or atomic (i.e. giant molecules) and metallic crystals (6).

Liquids; qualitative explanation of vapour pressure, boiling, evaporation and electrical conductivity.

Gases; the laws of Boyle and Charles, absolute temperature scale, the equation $pv/T = k$, calculations based on these laws, a qualitative treatment of the kinetic-molecular theory of gases as a theoretical model to explain the gas laws.

Topic 4. Pure Substances and Mixtures.

A brief review to survey such useful generalizations as: pure substance, metals, non-metals, compounds; mixtures, examples and separation.

Solutions of solids in liquids (7). Unsaturated, saturated and supersaturated solutions. The concept of the saturated solution as a system in dynamic equilibrium.

Topic 5. Chemical Formulae and Equations

Empirical formulae from quantitative analysis. Use of valency tables to systematize empirical-formula-writing.

Gram molecular weight and gram molecular volume (8). The application of Avogadro's Law to determine the relative masses of molecules of pure substances in the state of gas or vapour (9). Experimental estimation of molecular weight of gases from mass, volume, temperature and pressure (10).

Derivation of molecular formulae from empirical formulae and molecular weights (11). Formula weights and molecular weights (12).

Chemical equations, their significance and use (13). The chemical equation as representing stoichiometric relationships between the substances entering into the reaction (14). Simple stoichiometry (15).

Topic 6. Ionic Theory and Applications

A simple treatment of conductivity (16). Degree of dissociation and ionization. The classification of acids and alkalis according to degree of dissociation (17).

Simple ionic equations, especially for electrolysis (18) and ionic- association reactions such as precipitation, neutralization (19) and displacement of CO_2, SO_2, etc., from the corresponding salts.

Oxidation and reduction as electron transfer and the use of partial ionic equations to derive the complete equation. Classification of electrode reactions as redox reactions.

A - WRITTEN PART - DESCRIPTIVE

Topic 7. Metals

Reducing properties of metals: their reactions with water, steam, acids and salt solutions (20) leading to the activity series (21).

Gases; the laws of Boyle and Charles, absolute temperature scale, the equation $pv/T = k$, calculations based on these laws, a qualitative treatment of the kinetic-molecular theory of gases as a theoretical model to explain the gas laws.

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Oxidation and reduction as electron transfer and the use of partial ionic equations to derive the complete equation. Classification of electrode reactions as redox reactions.

A - WRITTEN PART - DESCRIPTIVE

Topic 7. Metals

Reducing properties of metals: their reactions with water, steam, acids and salt solutions (20) leading to the activity series (21).

Further comparison of properties of metals (22). Comparison of their oxides and hydroxides, including the amphoteric nature of some oxides and hydroxides.

The commercial production of more important metals from their ores (23). The uses of sodium, iron copper, aluminium and magnesium, correlated with their properties (24)

Metallic corrosion and its prevention (25).

Topic 8. Hydrogen and Oxygen see below

Topic 9. Carbon

Occurrence in organic materials. Allotropes; diamond graphite in various forms, sources, uses. Activated charcoal.

Carbon dioxide: its laboratory and technical production, physical and chemical properties, uses.

Carbonic acid and carbonates: solubility in water and the reaction of acids and effect of heat on carbonates of sodium, calcium and zinc, and of bicarbonates of sodium and calcium (29).

Production and uses of quicklime and slaked-lime. Types of hardness in water, their formation and methods of removal (30). Stalactites and stalagmites.

Carbon monoxide: its properties. Fuels: production of producer gas, water gas, semi-water gas, town gas (coal gas, Lurgi gas, reformed petroleum gas) (31). Combustion of gaseous fuels (32).

The ability of carbon to form long chains in molecules illustrated by the alkane hydrocarbons (33).

Topic 10. Nitrogen

The nitrogen cycle (34). Nitrogen fixation.

Nitric acid: its preparation (35) and properties; its action on metals (36). Uses. Solubility and stability of nitrates (37). Preparation of nitrogen dioxide from copper and nitric acid.

Ammonia: laboratory preparation and properties. Ammonium salts (38).

Topic 11. Phosphorus

White and red forms of the element. Phosphorus pentoxide and its reaction with water to form orthophosphoric acid. Preparation of the sodium orthophosphates. Calcium orthophosphates and superphosphate (39).

Topic 12. Sulphur

Occurrence as free sulphur and as sulphides (40)
Hydrogen sulphide: its preparation and properties (41)
Sulpher dioxide: its preparation (42) and properties.
Sulphur trioxide: laboratory preparation. Sulphuric acid production by the contact process, its properties and its importance. Sulphates and bisulphates (43)

Topic 13. Chlorine

Sodium chloride; occurrence and uses (44), electrolysis in diaphram cells (45).

Hydrogen choride: its preparation (46) and properties of the gas and of aqueous hydrochloric acid (47). chlorides (48).

Chlorine: its preparation (49) and properties.

physical and chemical properties, uses.

Carbonic acid and carbonates: solubility in water and the reaction of acids and effect of heat on carbonates of sodium, calcium and zinc, and of bicarbonates of sodium and calcium (29).

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Hydrogen choride: its preparation (46) and properties of the gas and of aqueous hydrochloric acid (47): chlorides (48).

Chlorine: its preparation (49) and properties.

Topic 8. Hydrogen and Oxygen

Oxygen: Occurrence in air. Its laboratory and technical production(26). Its physical and chemical properties.

Hydrogen: Laboratory and technical production (27). Its physical and chemical properties, its uses (28).

NOTES ON THE SYLLABUS OF LEAVING CHEMISTRY

1. Diffusion of gases and dissolving of solids into liquids. Modern development in high magnification electron and field-emission microscopes and some historical references may also be used but is not required for examination.

2. An element is composed of atoms, all of which have the same atomic number.

3. Atomic weights based on ^{12}C = 12 must be used; the general principle of mass spectrometers may be discussed but without detail.

4. A sufficiently advanced treatment will envisage the electrons as occupying concentric single shells, and will emphasize the relation between the properties of the atom and the number of electrons in its outer shell.

5. A simple descriptive account of the crystalline state, and the difference between crystalline and non-crystalline matter should be given, the essential point being regularity of arrangement. Methods of determining crystal structure are excluded from the syllabus.

6. Sodium chloride, dry ice, diamond and copper etc. may be used as typical examples of these respective types. Properties such as electrical conductivity, lustre, etc., correlated as far as possible with structure.

7. This section revises and extends the corresponding section in the FormIV Technical Schools' syllabus.

8. The importance of the gram-molecular volume in chemical calculations should be stressed. Students should be able to handle problems in which the density of gases is expressed in grams per litre.

9. The simple logic of this should be carefully taught.

10. i.e. by Regnault's method. The determination of the vapour densities of substances which are not in the gaseous state at ordinary laboratory temperatures is specifically excluded.

11. Sufficient examples should be given for candidates to work readily such problems in examination.

12. Formula weights and molecular weights to be calculated from the respective formulae and the atomic weights involved. The formula weight should be used for all substances of which the molecular weight cannot be determined, e.g. metallic oxides, salts, etc.

13. The steps in writing a chemical equation, i.e. the equation in words, then the insertion of the formula of the substance in each term of the equation, then the balancing of the equation, should be carefully taught. Examples will be freely obtained in the descriptive section of the syllabus.

The stoichiometric aspect of the chemical equation should be stressed from the beginning.

14. This is most important.

microscopes and some historical references may also be used but is not required for examination.

2. An element is composed of atoms, all of which have the same atomic number.

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13. The steps in writing a chemical equation, i.e. the equation in words, then the insertion of the formula of the substance in each term of the equation, then the balancing of the equation, should be carefully taught. Examples will be freely obtained in the descriptive section of the syllabus.

The stoichiometric aspect of the chemical equation should be stressed from the beginning.

14. This is most important.

15. Careful teaching should be given to calculations where the weight of a resultant is calculated from the weight of a reactant. This may be combined with steps involving the grammolecular volume, and the application of the equation $p_1v_1/T_1 = p_2v_2/T_2$ for a given sample of gas.

16. i.e. that certain classes of substances, when dissolved in water, dissociate into charged atoms or groups of atoms known as ions, that these ions are positively and negatively charged, that the magnitude of the charge is definite and is a simple integral multiple of the natural unit of charge, that this multiple is known as the valency of the ion. This section of the work should be associated with topic 2, and this natural unit of charge, i.e. the charge on univalent ion, identified with the charge of the proton and the electron.

17. A lecture bench demonstration showing the variation in conductivity of solutions of electrolytes according to the nature of the electrolyte and the concentration of the solution may be given, using a pair of electrodes wired in series with an electric light globe and connecting directly to the A.C. supply. It may then be explained that from the conductivity the degree of dissociation may be obtained. No knowledge of the Arrhenius equation is required. Examples of the degree of dissociation should be given: classification into strong and weak electrolytes and non electrolytes is sufficient. The modern view that strong electrolytes are completely dissociated in dilute solution should be mentioned.

18. Confined to (i) the electrolysis of simple inorganic salt solutions, of hydrochloric acid, and of dilute sulphuric acid, using noble metal or other inert electrodes, (ii) the electrolysis of sulphate solution using zinc or copper electrodes, and (iii) the electrolytic production of aluminium.

19. Clear ideas on neutralisation and salt formation are essential if the descriptive portion of the subject is to be properly understood. The essential action of neutralisation, viz. the combination of the hydrogen ions of the acid with the hydroxyl ions of the base to form water should be stressed.

20. Emphasis should be placed on the ease with which metals can supply electrons in chemical reactions e.g. act as reducers.

21. The positions of the following metals in the activity series should be known: K, Na, Ca, Mg, Al, Zn, Fe, Sn, Pb, Cu, Hg, Ag, together with the characteristic valencies of their ions in aqueous solution.

22. Formation of oxides by direct combination of the metals with oxygen and some examples of direct combination with other elements, e.g. iron with sulphur. The oxidation of silver and copper by dilute and concentrated nitric acid.

23. The general principles of production of the following:-

(a) Metals normally produced by electrolysis of fused salts: sodium, magnesium, aluminium. Preparation and purification of ore for the electrolytic cell are not required, nor is cell construction for sodium and magnesium. The construction and operation of an electrolytic cell for producing aluminium from bauxite dissolved in fused cryolite should be given without technical detail.

(b) Metals normally produced by reduction with carbon monoxide (carbon): iron, zinc, tin, lead. Preparation of oxide from sulphide or carbonate should be known, but not purification, or operational details. Electrolytic processes for zinc production and copper refining should be mentioned. The chemistry involved in production of iron should be given in adequate detail.

(c) The production of copper from cuprous sulphide by partial oxidation should be mentioned without detail.

(d) Metals normally occurring native, or having thermally unstable oxides: gold, platinum, silver and mercury. No details required.

24. The reasons for the technical uses of these metals should be given. The importance of alloys, particularly those of aluminium and magnesium, should be taught, but no details of such alloys will be required for examination purposes. The liability of aluminium to attack by alkali, and of magnesium to ignition when heated in air, should be mentioned.

25. Limited to iron and aluminium. A simplified treatment of rusting of iron, its protection by galvanising and tin-plating, and the different behaviour of these forms should be given. The importance of the surface oxide film in preventing corrosion of aluminium should be known.

26. One laboratory preparation, either from potassium chlorate-manganese dioxide mixture, or from hydrogen peroxide should be known. The technical production by liquefaction of air and subsequent distillation should be mentioned without detail.

27. Its technical production from water gas should be known.

28. Inportance of hydrogenation of carbon, fats, etc., may be mentioned but no technical details are required.

29. The effect of heating carbonates should be dealt with, and this aspect of their chemistry connected up with the production of quick lime, and the temporary hardness of water.

30 The essential chemistry of the processes of water softening by use of soda ash or lime, of clarification by precipitation of aluminium hydroxide, and of demineralization by synthetic ion exchange resins should be taught: other treatment is only required in broad outline.

31. A brief treatment of the essential chemistry and physics of the production of producer gas, semi-water gas and water gas. Only the briefest outline of the technical details will be required.

32 The thermo-chemical aspect of combustion should not be neglected, i.e. it should be clearly understood that a definite weight of a particuler fuel, on complete combustion, will produce a definite amount of energy (heat).

33. The general formula for the paraffins, and the gradation in physical properties should be related to the petroleum fractions: natural gas, petrol, kerosene, heavy oils, paraffin wax. The formula of methane should be given, and its presence in coal gas revised.

34. A simple treatment dealing with the chief points only.

35. Its production from sodium nitrate should be known. A brief outline of the Ostwald ammonia oxidation process should be given, but no chemical nor technical details will be required to be known for examination.

36. It should be known that the metal is oxidized only exceptionally by hydrogen ion, but usually by loss of oxygen from the nitrate radicle, as shown by the production of various oxides of nitrogen, depending on the metal and the dilution of the acid. Sufficient should be known of the oxides of nitrogen for this purpose, but details of their preparation and properties are not required.

37. Nitrates of sodium, heavy metals (typified by copper and lead)

should be mentioned.

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34. A simple treatment dealing with the chief points only.

35. Its production from sodium nitrate should be known. A brief outline of the Ostwald ammonia oxidation process should be given, but no chemical nor technical details will be required to be known for examination.

36. It should be known that the metal is oxidized only exceptionally by hydrogen ion, but usually by loss of oxygen from the nitrate radicle, as shown by the production of various oxides of nitrogen, depending on the metal and the dilution of the acid. Sufficient should be known of the oxides of nitrogen for this purpose, but details of their preparation and properties are not required.

37. Nitrates of sodium, heavy metals (typified by copper and lead) and ammonium should be considered.

38. Thermal decomposition of the chloride, sulphate, nitrate and carbonate.

39. The principle of conversion to a soluble form should be emphasized. Technical details are not required.

40. Only the chief sulphides should be mentioned, i.e. those of iron, zinc, lead and copper.

41. Solubilities of sulphides should be treated in the practical work.

42. The following methods of its preparation should be known:-

(a) In the laboratory by acidulation of a sulphite (there should be sufficient treatment of sulphurous acid and sulphites to cover this), and by the reaction between copper and concentrated sulphuric acid.

(b) Technically by the combustion of sulphur and by the combustion or roasting of pyrite, zinc blende or galena.

No details of technical plant are required to be known for examination.

43. Na_2SO_4 and $NaHSO_4$ as examples of two series of salts. Reaction with $Ba\ Cl_2$ and effect of heat on $NaHSO_4$.

44. A simple account of its properties, importance and technical production.

45. One type of cell e.g. the Nelson cell should be given. Caustic soda should be carefully treated as being one of the most important heavy chemicals.

46. Its preparation from common salt and as a by-product of the electrolytic manufacture of caustic soda should be known.

47. Note that hydrochloric acid is regarded as an entirely different substance from hydrogen chloride.

48. The preparation of chlorides should be used as an illustration of the methods of preparing salts in general,

e.g. (i) By direct union of the elements,

(ii) By the action of hydrochloric acid upon

- (a) metals
- (b) basic oxides
- (c) bases, and
- (d) salts of weaker acids,

(iii) By precipitation.

49 By oxidation of hydrochloric acid with manganese dioxide.

B - PRACTICAL PART

Time allotment 1½ - 2 hours per week.

This list is submitted as a guide for teachers.
As far as possible the practical work should be related to the course of lectures and it is suggested that such a practical course should include:

(a) an introduction to quantitative analysis.
(b) a study of the reactions of ions.
(c) experimental work related to the theory syllabus.

Notes:

The following treatment of the practical course is considered suitable:

1. Purification of potassium nitrate by recrystallization after filtration of a hot near-saturated solution with fluted filter paper and a short-stemmed funnel.

2. Solubility of potassium nitrate using the recrystallized salt by observing the temperature at which crystals appear on cooling a solution of known concentration. Construction of a solubility curve class results.

3. Empirical formula of magnesium oxide by combustion of a known mass of magnesium and weighing the residue after reheating with water.

4. Empirical formula of cupric and/or cuprous oxide by reduction of a known mass with town gas.

5. Degree of hydration of barium chloride by thermal dehydration of a known mass of the hydrated salt.

6. Molecular weight of carbon dioxide by weighing a flask full of the dry gas and measuring volume, temperature and pressure.

7. Properties of dilute hydrochloric acid including reactions with caustic soda solution, zinc, magnesium, iron and copper metals, copper oxide, and marble chips.

8. Sodium sulphate and bisulphate. (Use of volumetric apparatus). Titration of caustic soda solution with dilute sulphuric acid to the methyl orange end-point. Preparation of solutions of the salts and their reactions with barium chloride solution and with litmus.

9. Sodium orthophosphates. Titration of orthophosphoric acid solution with caustic soda solution. Preparation of solutions of each salt and their reactions with silver nitrate solution and with litmus.

10. Redox reactions and electron transfer. Oxidation of ferrous ions by chlorine and of zinc metal by cupric ions. Reactions carried out

This list is submitted as a guide for teachers.
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6. Molecular weight of carbon dioxide by weighing a flask full of the dry gas and measuring volume, temperature and pressure.

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9. Sodium orthophosphates. Titration of orthophosphoric acid solution with caustic soda solution. Preparation of solutions of each salt and their reactions with silver nitrate solution and with litmus.

10. Redox reactions and electron transfer. Oxidation of ferrous ions by chlorine and of zinc metal by cupric ions. Reactions carried out in test tubes and the products identified by suitable tests. Reactions then carried out in cells, e.g. two crucibles with a strip of filter paper as the salt bridge and with two platinum wire electrodes connected to a galvanometer.

11. Reactions of K^+ Na^+ Ca^{++} Mg^{++} and NH^+_4

12. " " Al^{+++} and Zn^{++}

13. " " Fe^{++} and Fe^{+++}

14. " " Sn^{++} and Pb^{++}

15. " " Cu^{++} and Ag^+

Note on 11 to 15. The order of listing is based largely on the activity series. Each cation is tested with:

(a) dilute hydrochloric acid (test solubility of silver chloride in dilute ammonia solution).

(b) caustic soda solution (test solubility of precipitates in excess reagent).

(c) dilute ammonia solution (test solubility of precipitates in excess reagent).

(d) hydrogen sulphide gas (test solubility of precipitates in dilute acid).

16. Carbonates and bicarbonates, e.g. zinc, magnesium and sodium carbonates and sodium bicarbonate. Reactions with dilute hydrochloric acid and ignition-tube thermal decomposition. Limewater test for evolved carbondioxide and reaction of the residues with dilute hydrochloric acid.

17. Hardness in water using distilled water as soft water and calcium bicarbonate, calcium sulphate and magnesium sulphate solutions as hard water. Formation of a curd with soap solution. Effect on soap solution after boiling and after addition of excess sodium carbonate.

18. Effect of heat on ammonium salts. Ignition tube thermal decomposition of the chloride, carbonate, sulphate and nitrate with appropriate tests to identify the evolved products.

19. Nitric acid. Properties as an acid: dilute solution with litmus, cupric oxide and marble chips. Properties as an oxidant: 4% solution with magnesium metal, 35% solution with copper and 70% solution with copper.

20. Effect of heat on nitrates. Ignition tube thermal decomposition of nitrates of copper, zinc, magnesium and sodium with glowing string and litmus tests for evolved gases and reaction of the residues with diluted hydrochloric acid.

21. Sulphuric acid. Reaction with water. Dehydration of hydrated copper sulphate, sugar and paper. Reaction with sodium chloride and sodium nitrate. Oxidation of copper.

22. Sodium sulphate and sodium sulphite. Reaction of each with dilute sulphuric acid, barium chloride potassium permanganate and potassium dichromate solutions. The precipitates obtained with $BaCI_2$ to be tested for solubility in hot dilute hydrochloric acil.

23 Hydrochloric acid and chlorides. Effect of warming dilute and concentrated hydrochloric acid.
Reaction of concentrated hydrochloric acid with manganese dioxide.
Reaction of concentrated sulphuric acid with sodium chloride.
Reaction of sodium chloride solution with silver nitrate solution and solubility of the precipitate in ammonia solution.

24. Reactions of CO_3^{--}, HCO_3^{-}, SO_3^{--} and S^{--}

25. " " CI^{--}, NO_3^{-} , SO_4^{--} and PO_4^{---}

(a) dilute hydrochloric acid (test solubility of silver chloride in dilute ammonia solution).

(b) caustic soda solution (test solubility of precipitates in excess reagent).

(c) dilute ammonia solution (test solubility of precipitates in excess reagent).

(d) hydrogen sulphide gas (test solubility of precipitates in dilute acid).

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17. Hardness in water using distilled water as soft water and calcium bicarbonate, calcium sulphate and magnesium sulphate solutions as hard water. Formation of a curd with soap solution. Effect on soap solution after boiling and after addition of excess sodium carbonate.

18. Effect of heat on ammonium salts. Ignition tube thermal decomposition of the chloride, carbonate, sulphate and nitrate with appropriate tests to identify the evolved products.

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20. Effect of heat on nitrates. Ignition tube thermal decomposition of nitrates of copper, zinc, magnesium and sodium with glowing string and litmus tests for evolved gases and reaction of the residues with diluted hydrochloric acid.

21. Sulphuric acid. Reaction with water. Dehydration of hydrated copper sulphate, sugar and paper. Reaction with sodium chloride and sodium nitrate. Oxidation of copper.

22. Sodium sulphate and sodium sulphite. Reaction of each with dilute sulphuric acid, barium chloride potassium permanganate and potassium dichromate solutions. The precipitates obtained with $BaCI_2$ to be tested for solubility in hot dilute hydrochloric acid.

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Reaction of concentrated hydrochloric acid with manganese dioxide.
Reaction of concentrated sulphuric acid with sodium chloride.
Reaction of sodium chloride solution with silver nitrate solution and solubility of the precipitate in ammonia solution.

24. Reactions of CO_3^{--}, HCO_3^{-}, SO_3^{--} and S^{--}

25. " " CI^{--}, NO_3^{-}, SO_4^{--} and PO_4^{---}

Note: on 24 and 25. Each anion to be tested with:

(a) dilute sulphuric acid
(b) conc " "

The gases evolved to be identified by appropriate tests and where necessary further tests to be applied, e.g. to distinguish CO_3^{--} from HCO_3^{-} and SO_4^{--} from PO_4^{---}.

26. <u>Identification of an unknown salt.</u> Salts containing a cation studied in experiments 11 to 15 and an anion studied in experiments 24 and 25. Identification by application of the tests specified in these experiments. The systematic group separation is not to be taught and mixtures of salts not to be given for identification.

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A.C.71/14 (C&R).

EDUCATION DEPARTMENT -VICTORIA

TECHNICAL SCHOOLS DIVISION

LEAVING TECHNICAL SYALLABUS

LEA 742

CHEMISTRY

PART II PRACTICAL COURSE

FORM V.

1971

This syllabus should be read in conjunction with LEA 742 Chemistry (1965) until a revised syllabus LEA 742 Chemistry Part I Theory is issued.

CURRICULUM AND RESEARCH BRANCH.

TABLE OF CONTENTS

LEA 742

CHEMISTRY (1971)

PART II - PRACTICAL COURSE

1. FOREWORD

1.1 This syllabus should be read in conjunction with LEA 742 Chemistry (1965) until a revised syallabus LEA 742 Chemistry : Part I - Theory (1971) is issued. No major changes are envisaged in the latter syallabus.

1.2 It is considered that the changes introduced will relate the practical work more closely to the theory, but still retain :
(a) an introduction to quantitative analysis;

(b) a study of the reaction of ions.

1.3 It is expected that this revised practical course will be satisfactory for a few years, during which time attention will be given to a major revision of the whole course.

2. AIMS OF THE COURSE

2.1 To develop the student's skills in technique and in the use of common chemical apparatus and reagents.

2.2 To familiarize the students with standard procedures such as weighing to constant mass, titration, testing precipitate solubility in excess reagent, and recording measurements to an appropriate accuracy.

2.3 To develop the student's ability to record all measured data honestly and correctly.

2.4 To encourage the student to use experimentation to solve problems and to test hypotheses.

3. GENERAL COMMENTS

3.1 Wherever possible students should carry out their own independent experimental work. Adequate apparatus and facilities should be available to permit this. Appendix A contains a detailed list of suggested apparatus.

3.2 Safety must be emphasized at all stages in the practical course. Further details are included in Appendix B.

3.3 To ensure effective teaching not more than fifteen students should be supervised by one teacher.

3.4 As practical work is an integral part of the chemistry course, it is suggested that the experiments outlined below should be done at times when the related theory is taught. It is suggested that an average of two to three periods per week be spent on practical work.

4. STRUCTURE OT THE COURSE

NOTES.

4.1 The course consists of a minimum of fifteen experiments.

4.2 The experiments are divided into :
Section A : mandatory experiments which may also be examined in the theory paper.
Section B : a range of optional experiments which might well be replaced by experiments which the teacher may care to develop.

5. THE PRACTICAL COURSE

5.1 Course Details

SECTION A

1. The reactions of the cations K^+,Na^+,Ca^{2+},Mg^{2+},Al^{3+},Zn^{2+},Fe^{2+}, Fe^{3+},Sn^{2+},Pb^{2+},Cu^{2+},Ag^+,and NH_4^+.
2. The reactions of the of the anions $CO_3^=$,HCO_3^-,$SO_3^=$,$S^=$,Cl^-, NO_3^-,$SO_4^=$,and PO_4^{3-}.
3. The use of conductivities as a means of classifying electrolytes. 1.
4. Simple acid-base titration, using the mole concept, to produce acid and normal salts. 2.
5. The determination of the empirical formula of a metallic oxide by oxidation or reduction, e.g.MgO, CuO, and the oxides of lead.
6 The determination of the molecular weight of a gas e.g. CO_2, freon, L.P., or any other suitable gas from measurements of its mass, volume, pressure, and temperature.
7. Determination of the electrochemical series using displacement and / or electrode potentials.

SECTION B

8. Ignition tube tests on nitrates, carbonates, bicarbonates, hydroxides, and oxides.
9. Flame tests using vision spectrometer. 3.
10. The identification of an unknown salt. 4.

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SECTION B

8. Ignition tube tests on nitrates, carbonates, bicarbonates, hydroxides, and oxides.
9. Flame tests using vision spectrometer. 3.
10. The identification of an unknown salt. 4.
11. The solubility curve of a salt.
12. The purification of potassium nitrate.
13. The purification of benzoic acid, using activated decolorizing charcoal; use m.p. to check purity.
14. Redox reactions as electron transfer, e.g. Zn/Cu^{2+}, Fe^{2+}/Cl_2,and $Fe^{2+}/KMnO_4$. 5.
15. Ignition tube tests for the thermal decomposition of ammonium compounds.

NOTES.

16. The preparation of chlorides. (Refer to note 48 of Leaving Technical Chemistry syllabus).

17. The hardness in water. 6.

18. A suitable two-stage preparation, e.g. MgO to $MgSO_4$ to $Mg(OH)_2$, or Cu to $Cu(NO_3)_2$ to CuO.

19. The degree of hydration of a suitable hydrated salt, e.g. barium chloride or magnesium sulphate.

20. Various gas preparation from the theory syllabus. 7.

21. Structure and properties. 8.

22. Conductometric titration- acid/alkali. 9.

23. The density of air at S.T.P.

24. Investigations

The following list indicates the type of investigations considered to be suitable practical experience for the Leaving Chemistry student, but teachers are urged to devise other investigations which they consider appropriate for their students in particular areas of the state.

Specific safety factors for these investigations have not been indicated because the precautions necessary will depend on the methods adopted. Teachers should consider safety when devising their own investigations.

(a) The water and ash content of brown coal.

(b) The chemical properties of a water supply.

(c) The determination of limestone present in rock samples using Schröter's apparatus.

(d) The determination of salts present in bone.

(e) The sulphur dioxide concentration in city air.

(f) Variations in salt concentration of sea water from different localities.

(g) Identification of the mineral content of ore samples.

(h) The chemical problems of dyeing fabrics.

5.2 Course Notes

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(h) The chemical problems of dyeing fabrics.

5.2 Course Notes

Date Experiment Details

1. Expt. 3: It is suggested that a simple conductivity cell be constructed with platinum or carbon electrodes, and that this be used in series with a suitable globe and a 10-20V A.C. power supply, A.C. will minimize polarization.

Solutions to be tested should all be 2M wherever possible and would include the strong acids and bases, some weak acids and bases and a varied selection of salts. Some non-electrolytes might well be included.

2. Expt. 4: This experiment will provide an opportunity to graduate the pipette against the burette.

Suggested salts to prepare are the two sodium sulphates or the three sodium orthophosphates.

3. Expt. 9: It is suggested that nichrome wire be used instead of platinum wire. Sets of reference spectra should be available. Mixtures containing two cations might be used. Teachers may wish to mention the historical significance of spectrometry and its present day applications.

4. Expt. 10: This would follow experiments 1, 2, 9 and 10. The students should be encouraged to attempt as many confirmatory tests as possible, (e.g. spot tests) and to this end suitable reference texts should be available, (e.g Vogel, "Qualitative Inorganic Analysis"), together with a wide selection of specialized reagents.

5. Expt. 14: The reactants may be placed in separate reacting vessels connected by a "salt bridge", (e.g filter paper soaked in potassium sulphate solution) and the electrodes connected to a galvanometer which demonstrates electron flow and also determine the polarity of the electrodes.

Colour changes may also show reaction(s).

(NOTE! A solution of chlorine in water may be readily prepared by cautiously acidifying sodium hypochlorite solution with 2 M hydrochloric acid.)

6. Expt. 17: Natural samples of hard water are more "realistic" than artificially prepared samples: failing this, students should attempt to prepare artificially hard samples. A standard soap solution may be prepared by dissolving 10g. of Castile Soap in 1 litre of equal parts of distilled water and industrial methylated spirits. Other than the usual softening processes of boiling and adding soda ash, the removal of hardness by ion exchange resins should be attempted.

7. Expt. 20: The Important characteristics of O_2, CO_2, SO_2, H_2S, HCl, Cl_2, NO_2, and NH_3 should be established using "small-scale" techniques.

This would be an excellent experiment to perform early in the year & should provide firm foundations for experiments 2,9, and 16.

8. Expt. 21: Students are asked to devise means of "qualitatively" determining a wide range of physical properties for some selected solids, (such as two or three from sodium chloride, lead,

suggested salts to prepare are the two sodium sulphates or the three sodium orthophosphates.

3. Expt. 9: It is suggested that nichrome wire be used instead of platinum wire. Sets of reference spectra should be available. Mixtures containing two cations might be used. Teachers may wish to mention the historical significance of spectrometry and its present day applications.

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This would be an excellent experiment to perform early in the year & should provide firm foundations for experiments 2,9, and 16.

8. Expt. 21: Students are asked to devise means of "qualitatively" determining a wide range of physical properties for some selected solids, (such as two or three from sodium chloride, lead, tin, copper, naphthalene, anhydrous ferric chloride etc.)

The physical properties might include m.p., b.p., colour, density, hardness, lustre, malleability, conductivities of solid, fused solid and dissolved solid, solubilities in a range of solvents.

Reference is then made to a text of physical data in order to "quantitatively" check their observations.

Finally, and most importantly, the students attempt to correlate the observed properties with the structure of the solid.

9. Expt. 22: The conductivity (i.e. reciprocal of resistance) is determined and plotted against the volume of reactant added.

A conductivity cell consisting of "platinized" platinum electrodes of 1 cm^2. area, 1 - 2cm. apart is used with a H.F. A.C. supply (e.g an induction coil.) A wheatstone bridge circuit is employed with a telephone ear-piece in place of the usual galvanometer.

It is suggested that a suitable volume of 0.01 M HC1 be titrated with 0.1 M Na OH solution, (Reference (Reference: Vogel, "Quantitative Inorganic Analysis" 2nd edition Chap. 7 P. 718 et. seq.)

5.3 References

The books listed below are considered suitable but not necessarily essential.

Student References.

1. STOVE, J.D. and PHILLIPS, K.A.
A Modern Approach to Chemistry
(2nd Ed.) Heineman, Melb., 1970.

2. STOVE, J.D. and PHILLIPS, K.A.
Practical Manual Heineman, Melb., 1970

Teacher References.

1. GABB, M.H. and LATCHEM, W.E.
A Handbook of Laboratory Solutions
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A Handbook of Laboratory Solutions
Andrew Deutch, London, 1967

2. VOGEL, A Textbook of Macro and Semi-micro
Qualitative Inorganic Analysis
Longmans, London, 1966

3. VOGEL, ARTHUR I. A text book of
Quantitative Inorganic Analysis
Longmans', London, 1966.

APPENDIX "A"

LEA 741 CHEMISTRY - PART II - PRACTICAL COURSE (1971)

SUGGESTED LIST OF APPARATUS FOR PRACTICAL COURSE

The minimum number of pieces of apparatus are listed for one practical class consisting of a maxumim of fifteen (15) students.

ITEM.	MINIMUM NUMBER
BASINS, EVAPORATING	15
BURNER, BUNSEN & TUBING	15
BURNER, MEKER	2
BEAKERS, PYREX	
100 ml, squat	15
250 ml, squat	15
400 ml, squat	15
600 ml, squat	15
BEAKERS, POLYTHENE	
1 litre	3
2 litre	3
BURETTES, BLUE LINE WITH P.T.F.E. stopcocks	15
BRUSHES, BURETTE	15
BRUSHES, TEST TUBE	30
BLOWPIPES	15
BLOCKS, CHARCOAL	15
BAROMETER, FORTIN	1
BOTTLES, REAGENT, WIDE NECKED & LIDS	
BOTTLES, REAGENT, NARROW NECK, STOPPED	
BALANCES, TOP LOADING MONOPAN	1
BALANCES OHAUS DIAL-O-GRAM	2
CASSEROLES, WITH HANDLE	15
CRUCIBLES, PORCELAIN WITH LIDS	30
CRUCIBLES, SILICA WITH LIDS	15
CYLINDERS, MEASURING	
10 ml	15
100 ml	15
500 ml	3
2 litre	3
CORK BORER SET & SHARPENER	1
CLIPS, HOFFMAN	15
CENTRIFUGES	2
DESSICATORS, 6"	8
DEIONISER * (alternative) (for production of deionized water.)	1
FUNNELS, THISTLE	8
FUNNELS, GLASS OR PLASTIC	15
FUNNELS, BUCHNER & PAPER TO FIT	8
FILTER PAPER, NO. 1	
FLASKS, CONICAL, 250 or 200 ml	30
FLASKS, VACUUM, 500 ml with pressure tubing	15

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BURETTES, BLUE LINE WITH P.T.F.E. stopcocks	15
BRUSHES, BURETTE	15
BRUSHES, TEST TUBE	30
BLOWPIPES	15
BLOCKS, CHARCOAL	15
BAROMETER, FORTIN	1
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BALANCES, TOP LOADING MONOPAN	1
BALANCES OHAUS DIAL-O-GRAM	2
CASSEROLES, WITH HANDLE	15
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CRUCIBLES, SILICA WITH LIDS	15
CYLINDERS, MEASURING	
10 ml	15
100 ml	15
500 ml	3
2 litre	3
CORK BORER SET & SHARPENER	1
CLIPS, HOFFMAN	15
CENTRIFUGES	2
DESSICATORS, 6"	8
DEIONISER * (alternative) (for production of deionized water.)	1
FUNNELS, THISTLE	8
FUNNELS, GLASS OR PLASTIC	15
FUNNELS, BUCHNER & PAPER TO FIT	8
FILTER PAPER, NO. 1	
FLASKS, CONICAL, 250 or 200 ml	30
FLASKS, VACUUM, 500 ml with pressure tubing	
FLASKS, FLORENCE, 500 ml	15
FIRE EXTINGUISHER, CARBON DIOXIDE	1
FIRST AID KIT (including eye irrigator)	1
FIRST AID LABORATORY CHART, B.D.H.	1
GOGGLES, SAFETY ** (alternative)	16
GLASSWARE SET, QUICK FIT	1
HOLDERS, TEST TUBE, METAL	15
JERRYCAN, PLASTIC, 5 gallon	8

ITEM.	MINIMUM NUMBER
LABELS, PLASTIC SELF ADHESIVE (STA - PUT NO. R1705)	
MATS, WIRE GAUZE	15
MATS, ASBESTOS 12" square	15
MASKS, FACE ** (alternative)	16
PIPETTES,	
20 ml or 25 ml.	15
10 ml graduated	15
RACKS, DRAING	
STANDS,	
TRIPOD	15
TEST TUBE, PLASTIC	30
BURETTE WITH PLASTIC CLAMPS	15
SHELVES, BEEHIVE	6
STOPPERS, RUBBER	
STOPPERS, RUBBER 1 hole	
STOPPERS, RUBBER 2 hole	
SPECTROMETER, DIRECT VISION	(OPTIONAL) 1
SPATULAS STAINLESS STEEL 4"	15
SEMI-MICRO KIT	16
TRIANGLES, PIPECLAY	30
THERMOMETERS, $-10^{\circ}C-110^{\circ}C$	15
TUBES, BOILING PYREX 6"x1" and stand	45
TUBES, SAMPLE & STOPPERS	
TUBES, IGNITION	5 gross
TUBING, GLASS SODA GLASS	
(also ROD - SODA GLASS)	
TROUGHS, PNEUMATIC	6
TONGS, CRUCIBLE	15
TUBES, IGNITION	5 gross
WASH BOTTLE, POLYTHENE SQUEEZE TYPE	15
WIRE PLATINUM OR NICHROME	
WATCH GLASSES, 3"	60

APPENDIX "B"

LEA 741 CHEMISTRY : PART II - PRACTICAL COURSE (1971)

SAFETY IN THE LABORATORY.

1. Introduction:

(a) To ensure reasonable safety in the laboratory NO practical class should contain more than FIFTEEN students.

(b) Safe procedures must be taught, and continually stressed.

(c) The dangers associated with common chemicals, and in particular those handled in the course, should be made known to each student.

The common hazards to be anticipated are:

(i) Cuts from broken glasswe
(ii) Dry burns from hot objects
(iii) Burns from chemicals
(iv) Fire
(V) Explosion
(Vi) Poisoning: be particularly careful of CUMULATIVE POISONS, i.e. mercurials, lead compounds, benzene, to name the more common; and POISONS that are specific for some individuals i.e. carbon tetrachloride and hydrogen sulphide.

2. General Recommendations:

(a) FACE MASKS should be worn where warranted in the best interests of safety. This applies especially in situations where corrosisive liquids are being handled or materials are being heated in test tubes or ignition tubes.

(b) PROTECTIVE CLOTHING, (laboratory dust coats,) MUST be worn at all times. It is suggested that this item be included on the student's book list.

(c) A FULLY STOCKED FIRST AID CABINET should be in each laboratory and should be readily accessible. It is also recommended that a first aid chart be prominently displayed.

(d) A COMPRESSED CARBON DIOXIDE FIRE EXTINGUISHER should be in each laboratory.

(e) Instructors should ensure that all CHEMICALS ARE STORED SAFELY, that all bottles are CLEARLY AND CORRECTLY LABELLED, and that chemicals are stored in the CORRECT CONTAINER OR VESSEL.

(f) Students should NOT have access to store-rooms, NOR should they be required to handle CORROSIVE CHEMICALS IN LARGE CONTAINERS, e.g. winchesters of conc. H_2SO_4.

3. Laboratory conduct and behaviour..

(a) It is assumed that an important part of any assessment of laboratory work would include an assessment of a student's ability to conduct himself or herself in an orderly manner in the laboratory and to have a practising knowledge of safe working procedures.

(b) The most common causes of accidents due to the "human factor" are:

(i) Inattention to the task in hand: leads to injury to others or self.

Recommendation: An experiment should be inspended if anything untoward occurs to avoid attention being divided. The cultivation of a responsible attitude in practical sessions is of paramount importance.

(ii) Boisterous behaviour: leads to injury to others or self, or breakage or damage of equipment, or distraction of others causing inattention.
Recommend: Restraint at ALL TIMES; curb exuberance. Persistent offenders be suspended from the laboratory, or, as a last resort, expelled from the practical sessions.

(iii) Absence of the instructor: leads to 1. or 2. above.
Recommend: Continuous presence of and supervision by an instructor. Temporary suspension of practical work in cases where instructor must be absent.

4. Specific Detail:
(a) To obtain MAXIMUM STUDENT CO-OPERATION in laboratory safety procedures, it is strongly recommended that this safety appendix be copied and distributed to each students for inclusion in his or her practical book.
(b) HAZARDS SHOULD BE INDENTIFIED AND PRECAUTIONS INDICATED
In general, all hazards should be assumed present in any experiment. The table which follows lists, for each experiment, the common hazards and the necessary safety precautions.

A. Some Potentially Dangerous Substances.

Experiment Number.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. All Chemicals in the laboratory. RECOMMENDATION. Avoid contact at all times	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2. Gas supply: danger of explosion. RECOMMENDATION. Constantly check for leaks.	+	+		+	+		+	+	+	+	+	+	+	+	+
3. Hydrogen sulphide: poisonous. RECOMMENDATION. Use $(NH_4)_2S$ solution	*									*					
4. Conc. sulphuric acid: highly corrosive and violent reaction with water. RECOMMENDATION. 1. Avoid student use! 2. Face shield when diluting or using, and protective gloves.		*								*					
5. Mercurials and Pb compounds: Poisonous and may be absorbed through the skin; cumulative. RECOMMENDATION. Avoid at all times.	*	*			*					*					
6. Conc. nitric acid: highly corrosive. RRECOMMENDATION. Face masks and protective gloves					*										
7. Chlorine gas: small does - injurious; large doses - fatal. RECOMMENDATION. Micro scale preparations.		*								*				*	
8. Potassium chlorate: explosion! RECOMMENDATION. Use 10 vol. H_2O_2 for O_2 preparation															

tentially Dangerous Substances.

	EXPERIMENT NUMBER																						
Experiment Number.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
emicals in the laboratory. ENDATION. Avoid contact at all times	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
pply: danger of explosion. ENDATION. Constantly check for leaks.	+	+		+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
en sulphide: poisonous. ENDATION. Use $(NH_4)_2S$ solution	*									*													
sulphuric acid: highly corrosive olent reaction with water. ENDATION. 1. Avoid student use! 2. Face shield when diluting or using, and protective gloves.		*								*										*			
ials and Pb compounds: ous and may be absorbed through in; cumulative. ENDATION. Avoid at all times.	*	*			*					*													
nitric acid: highly corrosive. ENDATION. Face masks and protective gloves					*													*					
ine gas: small does - injurious; doses - fatal. ENDATION. Micro scale preparations.		*								*				*		*				*			
sium chlorate: explosion! ENDATION. Use 10 vol. H_2O_2 for O_2 ration																				*			

B. Some Potentially Dangerous Procedures.

	EXPERIMENT NUMBER														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1
1. Using pipette: Burns to mouth. RECOMMENDATION. 1. Practise with water. 2. Use 0. 1 M solutions or less				*											
2. Evacuation of flaxks: implosion. RECOMMENDATION. 1. Avoid normal flasks 2. Use R.B. bolt head flasks.						*									
3. Inserting glassware into stoppers. Breakage and penetration of hand. RECOMMENDATION. 1. Lubricate with water, etc. 2. Protect hands with cloth.	*	*			*	*				*	*		*		
4. Heating Ig'n or test tubes: Burns from ejected contents. RECOMMENDATION. 1. Face mask. 2. Practise correct procedures. 3. Use small quantities in ig'n tubes. 4. T.T. no more than 1/3 full.	+	+						+		+					+
5. Handling hot objects: burns RECOMMENDATION. 1. Tongs for crucibles & lids 2. Test tube holders 3. Ig' tube holders, e.g. peg. 4. Tripods - grasp by lowest part of leg; quench top. 5. Bunsens - check for burning back.	*	*		*	*			*	*	*	*	*	*		*
6. Storage of hot charcoal blocks: fire. RECOMMENDATION. Storage under teacher supervision.	*									*					
7. Testing a gas for odour: distress or injury. RECOMMENDATION. 1. Correct Safety procedure. 2. Micro preparation.	*									*					+
8. Use of acid and alkalies: chemical burns. RECOMMENDATION. 1. Correct Safety procedures. 2. Use of 2M solutions or less wherever possible.	*	*	*	*	*	*	*		*	*				*	
9. Use of bunsen burner; burns to person, clothing RECOMMENDATION. 1.[illegible] plan when not in use. 2.TURN of gas when not in use.	*	*								*					*

entially Dangerous Procedures.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
ipette: Burns to mouth. DATION. 1. Practise with water. 2. Use 0. 1 M solutions or less				*												*						*	
ion of flaxks: implosion. DATION. 1. Avoid normal flasks 2. Use R.B. bolt head flasks.						*																	*
g glassware into stoppers. and penetration of hand. DATION. 1. Lubricate with water, etc. 2. Protect hands with cloth.	*	*			*	*				*	*		*							*		*	*
Ig'n or test tubes: om ejected contents. DATION. 1. Face mask. 2. Practise correct procedures. 3. Use small quantities in ig'n tubes. 4. T.T. no more than 1/3 full.	+	+						+		+					+			+		+	+		
hot objects: burns DATION. 1. Tongs for crucibles & lids 2. Test tube holders 3. Ig' tube holders, e.g. peg. 4. Tripods - grasp by lowest part of leg; quench top. 5. Bunsens - check for burning back.	*	*		*	*			*	*	*	*	*	*		*	*	*	*	*	*	*		
of hot charcoal blocks: fire. DATION. Storage under teacher supervision.	*									*													
gas for odour: distress or injury. DATION. 1. Correct Safety procedure. 2. Micro preparation.	*									*					+	*				*			
cid and alkalies: chemical burns. DATION. 1. Correct Safety procedures. 2. Use of 2M solutions or less wherever possible.	*	*	*	*	*	*	*		*	*				*		*		*		*		*	
nsen burner; burns to person, clothing ATION. 1.[illegible] plan when not in use. 2.TURN of gas when not in use.	*	*								*					*			*		*	*		

A.63/1372.
Tech.Sch.Br.

EDUCATION DEPARTMENT, VICTORIA

LEAVING TECHNICAL SYLLABUS.

LEA.731 BIOLOGY 1964

1 GENERAL

1. THE AIMS OF THIS SUBJECT ARE:-

   (a) To develop an understanding (rather than a memorising) of the fundamental facts, laws, and principles of biology.

   (b) To develop problem-solving skills based on these facts, laws, and principles, so that they can be applied to new or novel situations.

   (c) To develop an understanding and appreciation of the contribution of biology to culture.

   (d) To develop basic practical skills of experimentation, and of observation and recording of biological phenomena.

2. The written part of this subject will be examined externally and the practical part internally. A pass in this subject will not be granted unless a satisfactory year's practical work has been completed.

3. The detailed syllabus for this subject is set out below.

II DETAILED SYLLABUS

A-WRITTEN PART

PHYSICAL BASIS OF LIFE.

(a) Living material (or 'protoplasm') consists of chemical substances - carbohydrates, fats, proteins, mineral salts, water, vitamins.

(b) Protoplasm is distinguished from non-living material in several respects - metabolism, growth, response to stimuli, movement, but especially the ability to reproduce itself.

(c) Protoplasm occurs in units called cells. Features of a typical plant cell and a typical animal cell.

(d) Relationship between cells, tissues, organs and systems. Examples occur throughout the course.

2. CLASSIFICATION.

(a) There are millions of different kinds, or species, of living things. These are classified into two large groups - the plant kingdom and the animal kingdom - with a few other groups.

(b) Characteristics of animals and plants. Contrasts.

(c) Each group is sub-divided into smaller groups called 'phyla' or 'divisions'.

3. ANIMAL KINGDOM.

The following phyla with a sufficient description of a typical example of each to indicate the characteristics of the group. (Other examples should be mentioned.)

(a) Protozoa
(b) Porifera
(c) Coelenterate
(d) Platyhelminthes
(e) Annelida
(f) Nematoda
(g) Arthropoda
(h) Mollusca
(i) Echinodermata
(j) Chordata (vertebrate only)

4. MORPHOLOGY, ANATOMY, HISTOLOGY OF THE MAMMAL (This section should be integrated with section 5 as far as possible)

(The rabbit or rat will be suitable for practical work, but there should be frequent reference to man.)

Definition of mammal; external features; general arrangement and function of endoskeleton; outline of - alimentary tract and associated organs; respiratory system; excretory system; reproductive systems (exclude accessory glands); circulatory system (heart, course of circulation, main blood vessels mentioned in practical syllabus); simple idea of lymphatic system; brief survey of central nervous system; the eye as a sense organ (omit microscopic details of retina).

Sufficient histology of kidney, lung, blood and the arrangement of layers and glands in the intestine to give better understanding of the above and following sections.

5. PHYSIOLOGY OF MAN.

The Inter-relation of the systems of the body should be emphasised.

(a) Chemistry of digestive system.

(b) Chemistry of respiratory system.

(c) Nature and formation of excretory products, their disposal by kidney and lung.

(d) Nervous system - as a means of co-ordinating body processes.

(e) Hormone-producing glands as a chemical means of co-ordinating body processes - pituitary, thyroid, islet cells of pancreas only.

(f) Control of body temperature.

6. PLANT KINGDOM

The following divisions with sufficient description of the examples mentioned to indicate the characteristics of the group

(a) Thallophyta (Unicellular plant, spirogyra, seaweed)
(b) Bryophyta (liverwart, moss)
(c) Tracheophyta (a fern, a gymhosperm, an angiosperm).

7. MORPHOLOGY, ANATOMY, HISTOLOGY OF FLOWERING PLANT.

The external morphology of a typical dicotyledon (bean) and monocotyledon (maize); the internal anatomy of a primary dictotyledonous stem and root as seen under L.P. magnification; sufficient of the internal structure of a monocotyledonous stem to show the arrangement of the vascular bundles; microscopic structure of a dorsi-ventral leaf; inflorescence; parts of a typical flower and their function.

8. PLANT PHYSIOLOGY.

(a) Photosynthesis - raw materials, methods of intake, elementary chemistry of process, dependence of all life on photosynthesis, mineral nutrition, manufacture of other substances, effects of deficiencies in mineral nutrition.

(b) Respiration - why a plant needs energy, raw materials, elementary chemistry, diffusion in leaf.

(c) Reproduction and Growth - simple account of ovule and pollen production, pollination, fertilization, seed formation, seed germination including conditions necessary, structural changes and food reserves.

(d) Plant behaviour - movement and response to stimuli. Geotropism, phototropism (refer to plant growth hormone).

(e) Transpiration - intake, transport and loss of water.

9. MICRO-ORGANISMS.

Simpler organisms which cannot be classified as either plant or animal.

(a) BACTERIA.

(i) Simple account of bacterial cells and their characteristics - viability, distribution, reproductive powers, size, mobility, nutrition.

(ii) Pathogenic bacteria, toxin production, brief reference to some common diseases. Defence mechanisms of body - white blood corpuscles; antigen - antibody reaction and its application in immunization.

(iii) Saprophytic bacteria in relation to: soil fertility (decay, nitrification); butter and cheese manufacture; flax retting; vinegar production; tanning; food and water supply.

(iv) Symbiotic bacteria (in legumes); nitrogen fixation, its importance to the plant and to agriculture.

(b) VIRUS

A brief reference to the nature and characteristics of viruses and to important virus diseases, e.g. influenza, myxomatosis, tobacco mosaic.

10. REPRODUCTION.

(a) Origin of individual from a single cell; simple account of growth by cell division (mitosis) and cell enlargement (compare with early belief that the original cell was a tiny, but complete, plant or animal).

(b) Simple account of meiosis - cell division to produce cells, each with half the number of chromosomes of a complete cell.

(c) Formation of gametes in the reproductive organs of plants and animals.

(d) Combination of gametes to form a complete zygote. The zygote as a blue print, containing all the information necessary for the new plant or animal - contained in the chromosomes of the nucleus.

(e) Asexual reproduction; definition and examples.

11. HEREDITY.

(a) Elementary genetics - inheritance experiment on Andalusian fowls (to 2nd generation only), existence of genes. Mendel's experiments with tall and dwarf peas; dominance; simple examples of Mendelian inheritance (red hair, colour of eyes).

(b) The chromosomes as bearers of genes.

(c) Simple account of control of characteristics by more than one gene.

(d) Inter-relation between genes and environment in the development of the individual.

12. EVOLUTION.

(a) Simple account of fossil evidence of evolution.

(b) Darwinian theory of evolutionary mechanism.

13. FIELD BIOLOGY.

Simple introduction to ecology in order to study the relationships or organisms to one another and to their physical environment.

A brief study could be made of the effects of a few of the external influences on a particular plant and animal community, e.g. the influence of seasonal changes on life in a pond, garden plot or strip of pasture.

Reference to annuals, biennials, perennials, deciduous and evergreen plants; pupation of insects, etc.

Simple food chains; "balance of nature"; effects of upsetting equilibrium by introduced animals and plants, etc.

B. PRACTICAL PART

14. Practical work must be carried out to cover aspects of the theory. Complete records of drawings and description should be entered in note books. The following is to be regarded as a guide -

(a) CELLS -

(i) Animal cells showing diversity of shape, nucleus, cytoplasm, cell membrane, e.g. amoeba, nerve cell, fat cell, epithelial cell from cheek.

(ii) Plant cells showing cell walls, nucleus, cytoplasm, chloroplasts, starch grains, e.g. banana, onion skin, unicellular alga.

(b) HISTOLOGY -

(i) Plants T.S. monocotyledon stem, dictotyledon primary stem and primary root under L.P. showing tissue arrangement.

Xylem and phloem in T.S. and L.S. under H.P. L.S. root showing meristem, mature cells with vacuoles, differentiated tissues, mitosis (no details).

T.S. dorsiventral leaf, epidermis with stomata.

(ii) Animals T.S.wall of intestine showing villi, absorptive and glandular areas, muscle coats.

Lung (L.P.)
Kidney (L.S. with hand lens)
Malpighian corpuscle (H.P.)
Blood (fresh and stained).

(c) PLANT AND ANIMAL TYPES (Personal observations on living organisms should be made where possible)

Drawing showing external features of examples chosen in Section 3 and Section 6.

(d) MACROSCOPIC STRUCTURE

(i) Bacterium from root nodule.

(ii) Life history of an insect.

(iii) Mammalian dissection demonstrating general arrangement of organs - alimentary canal and associated organs; urinogenital system; circulatory system, heart pulmonary artery, aorta, innominate, carotid, sub-clavian, coeliac, anterior mesenteric, renal and iliac arteries, superior and inferior venae cavae, iliac, renal, portal, hepatic and pulmonary veins.

(iv) Personal dissection of heart and eye.

14. PRACTICAL WORK (CONTINUED)

(v) Flowering Plants - external features of stem and root of typical monocotyledon and dicotyledon: parts of the flower and pollination mechanism for a legume, a composite and a grass; stages in the germination of typical monocotyledon and dicotyledon.

(vi) Simple food tests for proteins, sugar, starch, fats from storage organs in plants.

(f) EXPERIMENTS. At least one experiment from each section below should be performed and recorded by students themselves-

(i) Photosynthesis
(ii) Respiration
(iii) Hydrolysis by enzyme.
(iv) Transpiration
(v) Tropisms
(vi) Mineral nutrition

(g) FIELD BIOLOGY The observations made in connection with Section 13 (Field Biology) should appear in the practical book.

C. REFERENCES

Teachers: Biology (Villee) 4th Edition - Saunders.

Standard: Biology (Kroeben, Wolff & Weaver) - Heath.

OR

Teacher: General Biology (Beaver) - Mosby.

Standard: Elements of Biology (Dodge) - Allyn and Bacon.