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ABSTRACT

As a revised version of the Scottish Integrated Science, an outline of the Malaysian science course is presented in this volume for use as a guideline for science teaching at the secondary level. A total of 16 sections is included in three forms which are intended to be covered in three years. The topics include: lab techniques, unit systems, scientific methods, living things, energy, particles, gasses, cells, reproduction, heat flow, electricity, bases, acids, detecting mechanisms, solutes, solvents, transport systems, mechanics, conservation, and natural resources. Notes for instruction, suggested practical work, and behavioral objectives are prepared for each topic. Recommendations are made on class-paced instruction, use of teaching aids and laboratory equipment, small group activities, and evaluation techniques. (CC)

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KEMENTERIAN PELAJARAN MALAYSIA

Syllabus:

Integrated Science

Pusat Perkembangan Pelajaran
March, 1973.

Revised Version.

Contents

Integrated Science

Form I - III

Introductory Notes to Syllabus

I Background

The Integrated Science Syllabus has been adapted from the Scottish Integrated Science as set out in Science for General Education Curriculum Papers No. 7, Scottish Education Department (HMSO)

The original syllabus was tried out in about 400 pilot schools in Malaysia between 1969 and 1972. The present Malaysian Integrated Science Syllabus has undergone a few changes, mainly in the order of presentation, taking away unsuitable and adding new content material to suit local conditions.

II General Objectives and Emphasis

The general statement of aims and the specific objectives in the pages following should be referred to. They also should form the guideline to possible teacher - pupil performance and achievement and also teaching style, approach and methods in general. at the end of the course, pupils should be expected to have acquired an appropriate degree and extent of knowledge and understanding of science and some of its basic principles, favourable attitudes and practical skills.

III General Approach

The teaching approach should be consonant with the aims and objectives of the course. It is suggested that the 'didactic' method be minimised and the 'heuristic' method utilised wherever possible. Generally, class-paced instruction has been recommended.

The organisation of practical activities is left to the teacher but the follow pattern is a useful guide :-

(1) Individual or small group activity
(2) 'Station' method
(3) Teacher demonstrations
(4) Individual assignments.

IV Syllabus Allocation

The suggested allocation of topics is as follows:-

Form 1	:	Sections 1 - 6
Form 2	:	Sections 7 - 12
Form 3	:	Sections 13 - 16

The order of the topics to be taught should generally be that recommended, especially Sections 1 - 4, as certain basic scientific principles and concepts should be acquired before the rest of the material can be fully appreciated. However, the order within one year may not be very rigid.

V Time Allocation

The course is intended to be covered in three years with a weekly time allocation of 200 minutes (i.e. 5 periods).

It is suggested, wherever possible, at least three periods should be practical work done in the science laboratory or in the classroom

VI Testing and Assessment

Testing should be done only to assess whether the stated specific objectives have been achieved. The most appropriate time, if testing is desirable, is after a whole section of the syllabus has been taught and not at a pre-allocated time.

Testing can be done in various ways including written 'objective type' test items and station-type practical test.

If an objective - type test paper is to be given the teacher should ensure that the proportion of questions of various categories and complexities should be appropriate.

It is suggested that the following should be a guide in test - construction.

Question Category *	Proportion (roughly)
A	50 %
B	30 %
C	15 %
D	5 %

Degree of Complexity	Proportion (roughly)
Simple (S)	40 %
Medium hard (M)	40 %
Hard (H)	20 %

*Key to Symbols

A (Knowledge) ..... recall of useful information not inert or inoperative ideas.

B (Comprehension) ..... including ability to extend a principle to a krown classroom or textbook situation where it is obvious to the pupil which principle should be used.

C (Application) ..... ability to apply a principle to a new situation where the pupil must first select the appropriate principle.

D (Highest abilities) ..... including analysis, synthesis and evaluation.

VII Use of Instructional Materials.

Syllabus - Teachers should study the syllabus carefully, paying special attention to the specific objectives for each section of the syllabus.

The syllabus, and not the worksheets, will form the basis for the Lower Certificate Examination.

Worksheets - At present, the teaching method should be geared to the use of specially prepared worksheets. Teachers are encourage to supplement these worksheets by writing appropriate ones wherever possible to suit the needs of their pupils. However, the general principles of worksheet construction should be adhered to.

Textbooks - The role of 'textbook' has changed according to the philosophy and aims of education. In this case, it should be, at best, a pupil reference book suitable for self-paced background reading and encouraging pupils to seek answers to their problems and finding ways of doing so.

Teachers' Guide - Teachers should consult these as frequently as desirable.

Curriculum Paper No.7 - This paper on Science for General Education (MISO) is a very useful teacher guide to the philosophy, rationale and method to the teaching of this course and should be consulted wherever possible.

Apparatus and Equipment - Improvisation of science apparatus is encouraged. Where improvisation is not possible, standard - type apparatus, if available, should be made use of as frequently as possible, if desired, by the pupils.

Audio-visual Aids - Judicious use should be made of these, if available, to achieve desirable lesson objectives.

INTEGRATED SCIENCE FOR MALAYSIA

Syllabus Topics

Forms 1 - 111

FORM 1

Section 1: Introducing Science

1.1 Introduction to some lab techniques and use of units
1.2 Introducing to the Scientific Method

Section 2: Looking At Living Things

2.1 Investigation of some living things
2.2 Diversity of form
2.3 The idea of classification

Section 3: Energy

3.1 Forms of energy
3.2 Energy interconversion
3.3 Energy converters in action
3.4 Energy and living things

Section 4: Particles of Matter

4.1 Evidence of particles?
4.2 The kinetic theory
4.3 Structure of solids, liquids and gases
4.4 Some applications of kinetic theory

(a) Relative weight of solids, liquids, gases.
(b) Expansion of heating
(c) Gas 'pressure'

Section 5: Some Common Gases

5.1 Preparation and properties of some common gases
5.2 Composition of air
5.3 Unbreathed and breathed air
5.4 Solubility of air in water
5.5 Release of energy - respiration
5.6 Respiratory system
5.7 Energy intake and photo synthesis
5.8 Rusting

Section 6: Cells and reproduction

6.1 Units of life - cells
6.2 Cells in reproduction
6.3 Achieving fertilisation
6.4 The growing embryo

Form II

Section 7:	Heat Flow
7.1	Methods of Heat Transfer
7.2	Some Problems Situations
Section 8:	About Electricity
8.1	Electricity at rest
8.2	What is electricity ?
8.3	Electricity in motion - current
8.4	Opposing the current - resistance
8.5	Heating by current
8.6	Driving the current - voltage.
Section 9:	Hydrogen, Acids and Bases
9.1	Preparation and properties of hydrogen
9.2	Burning hydrogen - synthesis of water
9.3	'Electrolysis of water'
9.4	Action of metals on cold water
9.5	Action of metals on dilute acids
9.6	Common properties of acids and alkalis
9.7	'Salt Formation'
Section 10:	Detecting the Environment
10.1	Rectalineal propogation of light
10.2	Reflection of light
10.3	Ray-tracing
10.4	The eye and light
10.5	Vision: some limitations
10.6	Vision: some defects
10.7	Ear and Sound
10.8	Hearing: Some limitations and defects
10.9	Balance
10.10.	The Nervous system
Section 11:	Solutes and solvents
11.1	The water cycle
11.2	Solubility inaqueous solvents
11.3	Non-aqueous solvents
11.4	Emulsions and colloids
Section 12:	Transport Systems
12.1	Types of food balanced diet
12.2	Teeth and feeding
12.3	Other methods of feeding
12.4	Digestive system
12.5	Digestive process
12.6	Need for a transport system
12.7	Types of transport systems
12.8	Excretion and Elimination.

Form III

Section 13: More About Electricity

13.1 Electricity in the home
13.2 Introduction to Electronics
13.3 Introduction to electromagnetism
13.4 Electric Supply

Section 14: Support and Movement

14.1 The idea of force
14.2 Work and energy
14.3 Support in plants
14.4 Support in animals
14.5 Muscles and movement

Section 15: The Earth

16.1 Origin and structure of Earth
16.2 Naturally occuring elements
16.3 Naturally occuring sulphides, oxides and carbonates
16.4 Silica and silicates
16.5 Petroleum as fuel
16.6 Salts from the sea
16.7 The Soil environment

Section 16: Population and Propagation

(To be developed)

INTEGRATED SCIENCE COURSE

STATEMENT OF OBJECTIVES

(Summative)

Pupils should acquire:

(A) in knowledge and understanding

1. knowledge of some facts and concepts concerning the environment
2. knowledge of the use of appropriate instruments in scientific experiment
3. an adequate scientific vocabulary
4. an ability to communicate using this vocabulary
5. comprehension of some basic concepts in science so that they can be used in familiar situations
6. ability to select relevant knowledge and apply it in new situations
7. ability to analyse data and draw conclusions
8. ability to think and act creatively
9. ability to evaluate in terms of internal and external criteria.

(B) in attitudes

10. awareness of the inter-relationship of the different disciplines of science
11. awareness of the inter-relationship of the various fundamental concepts in science
12. awareness of the relationship of science to other aspects of the curriculum
13. awareness of the contribution of science to the economic and social life of the community.
14. INTEREST AND ENJOYMENT IN SCIENCE.
15. an objectivity in observation and in assessing observations.

(C) in practical skills

16. some simple scientific skills
17. some experimental techniques involving several skills.

Note:

Within each of these three groups the items are in hierarchical order of complexity.

Specific Objectives for the Various Sections of the Integrated Science Syllabus.

(The final outcome of these formatives, as specified for each Section, should be the overall objectives for the whole Syllabus. More specific objectives are also found in the Teachers' Guide to Worksheets.)

Pupils should acquire:

In Section 1: Introducing Science

(1) knowledge of the use of measurement devices and units frequently employed in the sciences.

(2) the knowledge that there is considerable variation within any one kind of organism.

(3) ability to observe and record results

(4) some ability to analyse certain data and draw tentative conclusions.

(5)a awareness that human senses are limited and unreliable.

(6) awareness that some variables have distributions which are random and some which are non-random.

(7) awareness of the incompleteness of much scientific knowledge (Blackbox).

(8) INTEREST IN AND ENTHUSIASM FOR SCIENCE.

(9) confidence in handling simple apparatus.

(10) certain simple experimental techniques and skills in the laboratory.

In Section 2 : Looking at Living Things.

(1) the knowledge that animals react to external stimuli.

(2) the knowledge that there is a very large variety of living things.

(3) the knowledge that living things can be classified as animals and plants and that these can be further divided into sub-sets.

(4) some familiarity with the methods of constructing a simple key.

(5) some ability to observe objectively, this time in changing situations over longer periods of time.

(6) some familiarity with the formation of hypotheses concerning animals and to test these hypotheses experimentally.

(7) some familiarity with ways of analysing a complex set of information to identify common elements (preparation and use of keys)

(8) a sense of wonder at the wide variety of living things

(9) some simple biological experimental skills

In Section 3: Energy

(1) the knowledge that energy exists in many different forms.

(2) the knowledge that the different forms of energy are inter-convertible.

(3) the knowledge that foods provide the energy for growth, reproduction and movement in living things.

(4) the knowledge that food is essentially complex material always contain carbon.

(5) awareness that energy can only be defined operationally.

(6) awareness of the infinite quantity of energy available to mankind.

(7) awareness of the need for control and efficient use of energy resources.

(8) motivation for subsequent studies in syllabus all of which is concerned with the inter-relationship of energy and matter.

(9) creative ability in model-making.

In Section 4: Matter as Particles

(1) the knowledge that there are three states of matter: solid, liquid and gas.

(2) the knowledge that matter is made up of discrete particles.

(3) the knowledge that the particles are in a state of motion.

(4) knowledge of a model of the states of matter using kinetic theory.

(5) knowledge of certain facts about some properties of matter .

(6) information about some instruments.

(7) knowledge of the use of words ELEMENT, ATOM, COMPOUND, MOLECULE.

(8) some elementary information about the periodic table of elements.

(9) some familiarity with the process of reasoning inductively in constructing a kinetic model and of testing the predictions experimentally.

(10) ability to predict behaviour of matter using a kinetic model and to test the predictions experimentally.

(11) awareness of involvement of energy in making and breaking compounds.

(12) some simple experimental techniques.

In Section 5: Some Common Gases

(1) knowledge of identification tests for oxygen, nitrogen and carbon dioxide and their lab. preparation.

(2) knowledge of some basic facts about photosynthesis.

(3) the knowledge that carbon dioxide increases in exhaled breath after exercise.

(4) knowledge of acts about the carbon dioxide/oxygen balance in plants and animals.

(5) knowledge of the need for oxygen in combustion.

(6) knowledge of the approximate composition of air.

(7) some information about the noble gases.

(8) some information about the industrial processes for isolating oxygen and nitrogen.

(9) knowledge of some facts about respiration and rusting of iron.

(10) ability to apply the above knowledge in new and problem situations.

(11) ability to draw conclusions from a mass of data (Section 8.1).

(12) awareness of the need for a control experiment in assessing results of many experiments.

(13) awareness of the importance of place/animal inter-relationship in the world.

(14) awareness of the industrial importance of the gases of the air.

(15) some simple techniques in biology and chemistry. e.g. use of microscope, use of indicator etc.

In Section 6: Cells and Reproduction

(1) knowledge of the cell as a unit of structure in organisms.

(2) knowledge of the cell as a unit of reproduction in organisms.

(3) knowledge of the reproduction of cells and the replication of living material.

(4) some information on the methods of achieving fertilisation.

(5) on understanding of the concept of fertilisation.

(6) knowledge of the facts of mammalian reproduction.

(7) some information on cellular growth and the development of multi-cellular organisms.

(8) some information on methods of caring for young organisms.

(9) some information on the distribution of species, within a population e.g. dispersal experiments.

(10) ability to classify from observable characteristics e.g. living and dead tissue, from observation on a series of preparations of cells.

(11) ability to compare and interpret differences in similar structures e.g. in floral development of chick embryo.

(12) an objective attitude to the facts of reproduction.

(13) an awareness of the continuity of living tissues from generation to generation.

(14) an understanding of the technique of the microscope in the study of cells.

In Section 7: Heat Flow

(1) the knowledge that heat energy is transferred in three ways, by conduction, convection and radiation

(2) further knowledge of the concept of energy

(3) ability to apply this knowledge to new and problem situations.

(4) ability to analyse data and draw conclusions (factors affecting heat loss and gain by one of these processes)

(5) ability to analyse complex situations to identify the elements (identifying individual methods of heat transfer within a complex)

(6) awareness of the phenomena of conduction, convection and radiation, defined in operational terms.

(7) awareness of the importance of heat to mankind

(8) awareness of the need for conservation of sources of heat energy.

(9) skill in the use measuring instruments and simple apparatus.

In Section 8: Electricity (I)

(1) the knowledge that there are only two types of electric charge called positive and negative.

(2) the knowledge that electric current is a flow of electrons.

(3) knowledge of certain basic facts about current, voltage and resistance in simple d.c. circuits.

(4) ability to apply the above knowledge in new problem situations.

(5) ability to work with multiple variables in these experiments.

(6) ability to generalise from particular observations in simple electrical circuits.

(7) ability to form a theory relating current to voltage using observed phenomena

(8) awareness of danger in using mains electricity.

(9) skills in simple wiring techniques.

In Section 9: Hydrogen, Acids and Alkalis

(1) knowledge of a test for the identification of hydrogen.

(2) the knowledge that water is formed when hydrogen is burned,

(3) the knowledge that certain metals react with water at room temperature (sodium, calcium, magnesium)

(4) the knowledge that certain metals displace hydrogen from dilute acid (magnesium, aluminium, iron, tin)

(5) the knowledge that other metals do not displace hydrogen from dilute acid (lead, copper, silver, mercury)

(6) the knowledge that there is a gradation of reactivity among the common metals.

(7) the knowledge that pH is a measure of the degree of acidity of a solution.

(8) the knowledge that acid and alkali are names given to solutions at opposite ends of the pH scale.

(9) the knowledge that acids neutralise alkalis.

(10) the knowledge that there is a simple quantitative relationship in neutralising acids with alkalis.

(11) awareness of the processes involved in identifying a chemical substance.

(12) awareness of the use of standard scales for comparison purposes

(13) skills in handling simple chemicals and glassware.

(14) awareness of the dangers of handling hydrogen in large quantities.

In Section 10; Detecting the Environment

(1) knowledge of some facts about rectilineal propagation and reflection of light and the pin hole camera.

(2) knowledge of some facts about the human eye.

(3) the knowledge that the focal distance of a lens is related to its curvature.

(4) knowledge of some facts about a lens camera.

(5) the knowledge that the brain does not always interpret the signal from the eye correctly.

(6) ability to make comparisons between related entities (eye and camera).

(7) awareness of the importance of knowing that the brain may not interpret the signal from the eye reliably.

(8) awareness of our reliance on binocular vision for many judgements.

(9) some skill in the use of simple dissecting instruments.

(10) knowledge of the major parts of the ear (drum, bones, inner ear)

(11) knowledge of the operation of the bones of the inner ear

(12) the knowledge that the production of sound requires a vibration

(13) the knowledge that pitch is related to frequency, which is related to length of vibrator and tension in vibrator.

(14) the knowledge that a medium is needed for transmission of sound.

(15) the knowledge that the ear has a limited band of reception.

(16) ability to use inductive processes of thought to build the hypothesis that vibrations are necessary for sound to be produced.

(17) ability to drawing conclusions from a variety of data obtained in finding threshold frequencies for the ear.

(18) awareness of the receptors of communication and man's dependence upon them.

(19) knowledge of some facts about taste and smell.

(20) the knowledge that touch nerve endings vary in concentration in different parts of the body.

(21) knowledge of reflex action in muscle/nerve systems and the fact that this reflex takes time to act.

(22) ability to deal with problems with several variables using the effects of smell and feel on taste.

(23) ability to design experiments to investigate stated hypotheses

(24) awareness of the limitations of taste, smell and touch.

(25) awareness of the different levels of control man has over his own musculature.

(26) awareness of the need for instruments to overcome man's limitations and the inevitable limitations of instruments as well.

In Section 11: Solvents and Solutions

(1) knowledge of some facts about evaporation and cloud formation.

(2) knowledge of some facts about water purification.

(3) knowledge of some facts about solubility.

(4) knowledge of some facts about crystals.

(5) some information about solvents and extractions.

(6) some information about colloids.

(7) ability to form hypotheses concerning solubility and to test these experimentally.

(8) ability to design experiments concerning solubility

(9) ability to work with multiple variables in these experiments

(10) awareness of the need for patience in a long-term project (e.g. crystal-growing.)

(11) awareness of need to conserve water and of the importance of water to man.

(12) skills in using some scientific techniques e.g. crystallising, chromatography, emulsifying.

In Section 12: Food and the Transport Systems

(1) knowledge of some facts about foods and the means of classifying them.

(2) knowledge of some facts about teeth.

(3) some information about feeding in animals other than man.

(4) knowledge of some facts about the digestive system of mammalia and digestion of food.

(5) knowledge of the use of control experiments in enzyme.

(6) knowledge of some facts about various transport systems in plants and animals.

(7) knowledge of some facts about elimination and excretion in plant and animals.

(8) ability to apply knowledge to form classifications

(9) ability to relate structure to function

(10) ability to design experiments to obtain information from which to generalise, by investigating sweat secretion

(11) an interest in balancing food intake to ensure good health and proper body functioning.

(12) an interest in maintaining healthy teeth.

(13) awareness of the need for water balance in maintaining healthy animals and plants.

(14) further skill in simple biological techniques

In Section 13: Electricity and Magnetism (II)

(1) some information about the relationship between electrical units.

(2) some information about costing electrical energy.

(3) knowledge of the use of beam deflection in a C.R.T.

(4) knowledge of some facts about electromagnetism

(5) knowledge of some facts about discharge tubes

(6) knowledge of some facts about the motor effect and its applications.

(7) the knowledge that a current can be generated by relative motion of a closed coil and a magnetic field.

(8) the knowledge that there is a.c. as well as d.c.

(9) ability to apply knowledge of electrical circuitry to domestic wiring.

(10) ability to analyse current relationships in parallel circuits.

(11) ability to calculate fuse values for given situations

(12) awareness of the important technological revolutions resulting from the development of electromagnetics and, the later development of electronics.

(13) awareness of and an interest in leisure pursuits in electronics

(14) further skill in wiring techniques.

In Section 14: Support and Movement

(1) knowledge of what a force does

(2) the knowledge that change of motion only comes about because of an unbalanced force.

(3) the knowledge that friction is always a resisting force

(4) knowledge of certain facts about gravity

(5) the knowledge that the newton (N) is a unit of force and can be measured by a spring balance

(6) the knowledge that the lever is 'force multiplier'

(7) the knowledge that forces occur in pairs

(8) knowledge of the joule as a unit of work (1 joule, J = 1 newton - meter (Nm))

(9) knowledge of the ideas of motion energy and stored energy.

(10) knowledge that a machine is an energy transformer but not an energy multiplier

(11) knowledge of some facts about support in plants and animals

(12) knowledge of some facts about muscular effort and the forearm as a lever

(13) ability to build the concept of force from a set of related facts

(14) ability to formulate the 'law of the lever' from a set of observations

(15) ability to develop a theory to explain observed phenomena, (stability and leg arrangement in animals)

(16) ability to apply the above knowledge to a new problem situation

(17) awareness of the need to postulate ideal conditions in order to formulate satisfactory physical concepts (e.g. movement without friction and ideal machines)

(18) awareness that in the absence of external forces, uniform motion in a straight line is as probable as a state of rest

(19) awareness of the anomalous posture of man in relation to his structure

(20) awareness of the fact that any machine must waste some of the energy input

In Section 15: The Earth

(1) knowledge of some facts about the origin and structure of the earth

(2) knowledge of some facts about naturally occurring elements and ores

(3) knowledge of the reasons for the presence of these elements and ores in the earth

(4) further knowledge of the idea of order of activity in elements

(5) knowledge of some facts about calcium carbonate and some common calcium compounds and also hard and soft waters.

(6) knowledge of some facts about silica and silicates

(7) knowledge of possible means of forming metamorphic rocks

(8) some information about colours in minerals and glazes

(9) some information about the fossil fuels (coals, oil, and natural gas)

(10) some information about the salts of the sea

(11) knowledge of some facts about the soil

(12) knowledge of some facts about micro-organisms

(13) ability to form hypotheses from experimental observations using data derived from experiments on oxides, sulphides and carbonates

(14) ability to retrieve information about earth, fossil fuel, rock types etc.

(15) ability to use acquired knowledge and skills in solving a problem of identification of an unknown substance, malachite. (This involves both analysis of material to obtain information and a syntheses of the findings to provide a reasonable solution).

(16) further ability to use a key in identifying unknown creatures

(17) awareness of the importance of certain properties of minerals, in the earth, which allow them to be used for building materials

(18) interest in the need for conservation of fuel resources

(19) awareness of the importance of the sea as a source of mineral

(20) awareness of the place of micro-organisms in the life of man, both useful and harmful

(21) various chemical and biological skills

(22) some simple micro-biological techniques

Section 1: INTRODUCING SCIENCE

This Section introduces pupils to some basic techniques, skills and apparatus used in the school science laboratory.

In Section 1.2 a variety of simple pupil experiments taken from Physics, Chemistry and Biology is set up for pupil activity in small groups.

This Section also introduces the pupil to the scientific method and technique and includes a series of experiments designed to arouse interest and instil the spirit of inquiry in the learning of science.

Practical work is classified under the following categories:

(P) = Small group or individual pupil experiment.
(S) = "Stations" Method
(D) = Demonstration experiment.

Syllabus Topic	Notes	Suggested Practical Work
1.1. Basic laboratory techniques and use of units.		
(a) Measurement of length mass time and temperature	- Use of the ruler, balance, stopwatch/ stopclock and thermometer. (S.I. units to be used throughout) - Aids to measurement including strings, dividers, calipers (not vernier) map measurer etc. may be used.	(P) Practical work using apparatus and methods as suggested in 1.1. (a)-(f) including precautions in using the bunsen burner and observing general safety precautions.
(b) Measurement of area	- Method to include the counting of squares (m^2, cm^2 may also be rised).	
(c) Measurement of volumes	- Volumes of solids (regular and irregular), liquids and gases. - The use of graduated cylinders, plastic syringers and droppers (m^3, cm^3 may also be used).	

Syllabus Topic	Notes	Suggested Practical Work
(d) Comparison of mass per unit volume of solids and liquids leading to simple ideas of density	- The use of the formula $\text{Density} = \frac{\text{Mass}}{\text{volume}}$ is not required.	
(e) Use of the bunsen burner	- Safety precautions in using the burner.	
(f) Use of other common laboratory apparatus	- To include the filter funnel retort stand and clamps, tripod stand, etc.	
(g) General laboratory procedures and safety precautions	- These should be discussed in connection with practical work.	(i) Common methods of using and handling laboratory apparatus and chemicals. (ii) Good habits in handling apparatus and chemicals. (iii) Use of fire - extinguishers, first-aid boxes etc.
1.2. Introducing the Scientific method.		
(a) Making Observations and drawing conclusions	- Introduce some interesting experiments requiring the making of some simple observations and the drawing of some conclusions or inferences. - The drawing of conclusions/ inferences should be based on the observations made by pupils and should be appropriate to the level of experience and mental development of the pupils.	(P) Simple experiments based on magnets etc. (P) Simple experiment based on the burning of a candle in air. (P) Simple experiment based on the bunsen flame. (P) Other interesting experiments requiring observations and drawing of simple conclusions or inferences.
(b) The 'black-box'	- This is an experiment to illustrate that some observations may not necessarily lead to definite conclusions/ inferences and that scientific knowledge may be incomplete.	(P) The 'black box' experiment.
(c) Variations among living organisms	- Simple experiments leading to first ideas of variations common to all living organisms.	(P) Activities leading to the awareness of variations within one kind of

(d) Comparison of mass per unit volume of solids and liquids leading to simple ideas of density	Density = $\frac{\text{Mass}}{\text{volume}}$ is not required.	
(e) Use of the bunsen burner	- Safety precautions in using the burner.	
(f) Use of other common laboratory apparatus	- To include the filter funnel retort stand and clamps, tripod stand, etc.	
(g) General laboratory procedures and safety precautions	- These should be discussed in connection with practical work.	(i) Common methods of using and handling laboratory apparatus and chemicals. (ii) Good habits in handling apparatus and chemicals. (iii) Use of fire - extinguishers, first-aid boxes etc.

1.2. Introducing the Scientific method.

(a) Making Observations and drawing conclusions	- Introduce some interesting experiments requiring the making of some simple observations and the drawing of some conclusions or inferences.	(P) Simple experiments based on magnets etc. (P) Simple experiments based on the burning of a candle in air.
	- The drawing of conclusions/ inferences should be based on the observations made by pupils and should be appropriate to the level of experience and mental development of the pupils.	(P) Simple experiment based on the bunsen flame. (P) Other interesting experiments requiring observations and drawing of simple conclusions or inferences.
(b) The 'black-box'	- This is an experiment to illustrate that some observations may not necessarily lead to definite conclusions/ inferences and that scientific knowledge may be incomplete.	(P) The 'black box' experiment.
(c) Variations among living organisms	- Simple experiments leading to first ideas of variations common to all living organisms.	(P) Activities leading to the awareness of variations within one kind of organism.
(d) Need for Classification	- This is a natural consequence of (c)	(P) Simple activities in classification

(Note: To ascertain the depth of treatment of these topics reference should be made to the specific objectives of this Section)

Section 2. LOOKING AT LIVING THINGS

This short section continues the biological work begun in Section 1. It allows the pupils to see what is involved in longer-term investigations the variety of living things and the need for classifying them.

Nothing is complicated is envisaged at this stage. Detailed structure of the organisms studied is not required. Pupils should be given every opportunity to observe how certain living organisms behave either in their natural environment or in vivaria etc.

Syllabus Topic	Notes	Suggested Practical Work
2.1. An investigation of some living things (a) external structure (b) movement (c) habitat (d) general habits such as reactions to stimali, food choice etc.	- The intention here is to carry out some simple investigations into some common organisms. - The investigations should continue for several weeks if necessary. - Observations are to be recorded systematically in order to formulate bypotheses. - Groups of pupils can work on different organisms, discuss differences in results etc.	(P) Investigation and observation on some common organisms such as the earthworm, cochroache, grasshopper, garden snail, fish, bird, mouse etc. Practical work should include (a) looking at the external structure of the organism. (b) finding out how it moves. (c) setting up a suitable habitat in the laboratory. (d) finding out about its habits including reactions to stimali and food choice.
2.2. Diversity of form (a) There is a great variety of animals and plants. (b) External features to indicate diversity of form.	- Introduce a variety of plants and animals. - The emphasis should be entirely on things which can be seen with the naked eye. - Establish the fact that this is only a minute sample of the immense number of different plants and animals. - Wherever possible specimens should be living and common in the locality of the school. - Collecting of such	(P) Observations of flowering and non-flowering plants, animals with and without back bones, living on land and in water e.g. onion, lallang, hibiscus, allamanda, mimosa, pudica, tapioca etc. mushroom, bread mould, fern, mass, alga etc. Hydra earthworm, round worm, grasshopper, cockroach, butterfly, garden snail, cockershell,

This short section continues the biological work begun in Section 1. It allows the pupils to see what is involved in longer-term investigations the variety of living things and the need for classifying them.

Nothing is complicated is envisaged at this stage. Detailed structure of the organisms studied is not required. Pupils should be given every opportunity to observe how certain living organisms behave either in their natural environment or in vivaria etc.

Syllabus Topic	Notes	Suggested Practical Work
2.1. <u>An investigation of some living things</u> (a) external structure (b) movement (c) habitat (d) general habits such as reactions to stimali, food choice etc.	- The intention here is to carry out some simple investigations into some common organisms. - The investigations should continue for several weeks if necessary. - Observations are to be recorded systematically in order to formulate bypotheses. - Groups of pupils can work on different organisms, discuss differences in results etc.	(P) Investigation and observation on some common organisms such as the earthworm, cochroache, grasshopper, garden snail, fish, bird, mouse etc. Practical work should include (a) looking at the external structure of the organism. (b) finding out how it moves. (c) setting up a suitable habitat in the laboratory. (d) finding out about its habits including reactions to stimali and food choice.
2.2. <u>Diversity of form</u> (a) There is a great variety of animals and plants. (b) External features to indicate diversity of form.	- Introduce a variety of plants and animals. - The emphasis should be entirely on things which can be seen with the naked eye. - Establish the fact that this is only a minute sample of the immense number of different plants and animals. - Wherever possible specimens should be living and common in the locality of the school. - Collecting of such living things should be maintained as far as possible through the course.	(P) Observations of flowering and non-flowering plants, animals with and without back bones, living on land and in water e.g. onion, lallang, hibiscus, allamanda, mimosa, pudica, tapioca etc. mushroom, bread mould, fern, mass, alga etc. hydra earthworm, round worm, grasshopper, cockroach, butterfly, garden snail, cockershell, prawn, crab, etc. fish, frog, toad, lizard, bird, mouse, man, etc.

Syllabus Topic	Notes	Suggested Practical Work
	- Meuseums and zoos should be visited whenever possible. - School gardens, animal house, ponds, aviary etc. should also be made use of.	
2.3. An idea of Classification		
(a) The need for classification	- The need for classification as a natural consequence of Section 2.2 is evident.	(P) Visit to school library use of stamps albums etc. to familiarise the pupils with the idea of classification.
(b) (i) Living things and non-living things. (ii) plants and animals.	Very simple treatment at this stage should be made - no mention of words such as phyla, genera, etc.	(P) Sorting specimens into large groups e.g. - plants into flowering and non-flowering
(iii) flowering and non flowering plants.	Animals with backbones are most familiar to pupils at this stage and can be used to show, simply, how on large group with common features can be divided into smaller groups each with its own distinctive characteristics.	- animals into those with backbones and without backbones. - Vertebrates into mammal, birds, fish, amphibian and reptiles.
(c) Construction of simple keys	Introduction to the construction of simple keys as a means for classification and identification.	(P) Construction of simple keys for any simple group of pants, animals leaves, flowers, buttons etc.
	(This topic is developed further in Section 16 - THE SOIL ENVIRONMENT - The ecological approach to teaching Biology is also introduced in Section 16 - THE EARTH).	(This work can be extended to using simple keys in connection with certain soil and leaf litter on inhabitants of rock pools, or freshwater habitants in Section 16).

(Note: To ascertain the depth of treatment of these topics, reference should be made to the specific objectives of this Section).

Section 3: ENERGY

The concept of energy is basic to any science course and is therefore introduced early. The term 'energy' is used operationally and no attempt is to be made to define it.

Syllabus Topic	Notes	Suggested Practical Work
3.1. Forms of energy (a) kinetic (or motion) energy. (b) heat energy (c) light energy (d) sound energy (e) potential or stored) energy. (f) chemical energy (g) electrical energy (h) atomic or nuclear energy.	- The pupils should be introduced to the various forms of energy using everyday examples. - Energy forms (a) - (h) should be mentioned at this stage; not necessarily in that order. - No discussion on atomic energy is expected.	(D) - A few introductory demonstration experiments on the forms of energy. - The 'energy kit' or energy converters like electric fan, toy motors, bicycle dynamo etc. may be used.
3.2. Energy interconversion Energy can be converted from one form to another.	- A wide range of simple energy changes is provided for the pupils to look at and classify. - At his stage it is only necessary for pupils to indicate the main energy changes e.g. (a) kinetic energy → heat energy (b) electrical energy → heat energy and sound energy etc.	(S) A wide variety of simple examples is set up at stations in the laboratory for pupil activity. - Some examples of main energy changes should include the following. kinetic to heat; sound; potential; electrical & light. electrical to heat; light; potential; sound; kinetic. heat to light; kinetic; sound; Chemical to heat; sound; light; potential to heat; kinetic.

Syllabus Topic	Notes	Suggested Practical Work
3.3. Energy Converters in action		
(a) hydro-electric scheme (b) pile driver (c) electric scheme using steam engine. (d) storage batteries (e) electric lifts	- Important energy converters are studied using models and other aids. - Energy conversion kit if available, can be profitably used. - Everyday examples such as the electric fan, electric light, bulb, hair drier, telephone, radio television, model telegraph, clock, toy cars, model airplanes etc. can be used to emphasise the application of energy conversion. - There is also opportunity here for model construction by pupils; encouragement for choice of hobbies etc.	(S/D) Experiments to illustrate the working of energy conversion such as (a) - (e) (P) Hero's engine, water wheel, model teleg... etc.
3.4. Energy and living things		
(a) Foods are necessary for warmth, movement, respiration, growth and reproduction of living things.		(P) Compare effects of heating of various foods in air or in oxygen.
(b) The stored (chemical) energy of foods can be released under suitable conditions.		(D/P) Compare the rate of liberation of heat energy by living things and non-living things.
(c) The food of animals is mainly 'organic' coming from other animals or from plants; all are complex substances containing carbon.	A more detailed study of foods and energy will be done in Section 5 and 14.	
(d) Source of energy in living things.	There is opportunity here to trace the source back to the sun.	(P) Class Project Using the results from class experiments make a large chart of 'energy chains'

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(d) Source of energy in living things.	There is opportunity here to trace the source back to the sun.	(P) Class Project Using the results from class experiments make a large chart of 'energy chains' with the sun as the ultimate source of energy for mankind.
		(D) Films on 'energy'

(Note: To ascertain the depth of treatment of these topics, reference should be made to the specific objectives of this section).

Section 4: MATTER AS PARTICLES

At this stage the knowledge which pupils have gained about materials and energy is used to introduce some basic ideas about the nature and structure of matter.

The classification of materials according to state (solid, liquid, gas) and complexity (element and compound) is mentioned but no attempt is made to define these rigorously.

The kinetic-particle theory is built gradually and illustrated by analogy. It is then used to explain factors and to predict the behaviour of matter. These forecasts are then tested by experimentation.

'Atom' and 'molecule' should be introduced but no formal definitions are required. No discussion need be made of 'ion'.

Syllabus Topic	Notes	Suggested Practical Work
4.1 Evidence for the fine division of matter	The purpose of this sub-section is to provide the pupils with experiments which will lead them to the observation of matter as being made up of fine particles.	(P) Examples of solids liquids and gases (revision)
(a) States of matter: solid, liquid, gas.		(P) Diffusion of gases from ballons.
		(P) Diffusion of perfume or other gases from one part of room to another.
(b) Matter id made up of discrete, tiny particles	The pupils should NOT be provided with an atomic theory and then be asked to use the experimental evidence to verify it.	(D) Diffusion of nitrogen dioxide or bromine (great care) in air and vacuum.
		(P) Diffusion of copper sulphate in water or iodine in dilute potassium iodine solution.
(c) Particles in solids are relatively closely packed; they are less so in liquids; and least so in gases.		(P/D) Diffusion of copper sulphate potassium permanganate or other coloured salts in gels.
	Teachers should encourage pupils at every stage to formulate simple theories based on experimental evidence obtained.	(P) Dilution experiments.
		(P) Oil-film experiment (no calculation required)
		(P) Volume change on addition of 50cm^3 water to 50cm^3 alcohol (used methylated spirit).
	The difference between theory and fact should be emphasised.	(P) Volume change on addition of common salt to water.
		(D) Transparency of gold leaf (or Mylar sheet)
		(P/D) Brownian movement (smoke cells diluted indian ink etc.)

Syllabus Topics	Notes	Suggested Practical Work
4.2 Kinetic theory		
(a) Solids, liquids and gases.	The difference between solids, liquids, and gases is pictured as moving particles and owing to the nature of movement of the particles.	(D) Solid carbondioxide ('dry ice') changing into gas in a balloon.
(b) Particles are always in a state of motion		(D) Sublimation of solid iodine.
	There is no need to discuss movement by rotation of particles.	(D) Kinetic theory illustrated by the use of mechanised models.
(c) Energy changes particles during change of state		
4.3 Structure of matter		
(a) Metals and non-metals	Simple physical properties of metals and non-metals to be investigated.	(P) Physical properties of metals and non-metals.
(b) Elements and compounds	Naming of elements. However use of chemical symbols is not required.	(P) Experiments on iron filings and sulphur.
(c) Making and breaking compounds	For example, by combining of copper directly with chlorine and electrolysing copper (II) chloride solution.	(D) Direct combination of copper foil or Dash metal and chlorine.
	There is no need to distinguish between physical and chemical changes but show that the formation and decomposition of compounds involve energy changes.	(P) Electrolysis of copper (II) chloride solution (Pencil 'lead' or carbon rods used as electrodes).
(d) Atoms and molecules	The use of the terms 'atoms' and 'molecules' but there is no need at this stage to mention 'ions'	(P/D) Make or show similar molecules using polystyrene sphores or other material.
4.4. Applications of kinetic theory		
(a) Relative weights of solids, liquids and gases.	The usual long series of experiments on density or relative density is avoided.	(P) A volume of ir (gas) weights less than an equal volume of water (liquid).
		(P) A volume of water (liquid) weighs less than an equal volume of sand (solid).

Syllabus Topic	Notes	Suggested Practical Work
	The kinetic theory and structure matter are here related to the 'relative weights' of substances by observing that (i) a gas rides through liquids the gas being less dense than the liquids. (ii) immiscible liquids form layers the less dense layer floating on the denser layers.	(D) Formation of layers according to density in liquids.
(b) Expansion of solids, liquids and gases	The applications are on some modern everyday examples such as, thermometer, fire alarms, compensation in watches, thermostats etc.	(P) Expansion of solids and gases (S/D) Heating of compound bar (bimetallic strip) (S/D) Bar-and-gauge experiment (S/D) Ball-and-ring experiment (S/D) Force of contraction, breaking iron pin.
(c) Gas pressure	This sub-section allows the use of simple kinetic theory to predict and explain the properties of gases	(D) Partially inflated balloon in a bell jar. (D) Collapsing can (or plastic bottle) - may be connected to a vacuum pump. (D) Aneriod barometer
	Since the relative weight of a gas is much smaller than that of a solid or liquid, the particle spacing must be larger, in which case the gas must be more compressible.	(S) Simple pressure experiements using: (a) syringes (b) Bourdon gauge (c) Magde burg, hemispheres. (or plumbers cups) (d) Manometre, etc.
	Also, since the particles are moving in all direc-	

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	Since the relative weight of a gas is much smaller than that of a solid or liquid, the particle spacing must be larger, in which case the gas must be more compressible.	(S) Simple pressure experiements using: (a) syringes (b) Bourdon gauge (c) Magde burg, hemispheres. (or plumbers cups) (d) Manometre, etc.
	Also, since the particles are moving in all directions, there should be a 'pressure' exerted on the walls of the container. At this stage there is no need to define what 'pressure' is. No mathematical problems on pressure and density should be set.	

e: To ascertain the depth of treatment of these topics referenoe should be made to the ifio objectives of this section).

Section 5: SOME COMMON GASES

We live in an ocean of air. In this section the pupil is introduced to some common properties and some constituent gases of air. Air is then examined to discover its composition.

The uses of air in chemical and biological processes are also examined. Conditions for rusting are briefly studied.

Syllabus Topic	Notes	Suggested Practical Work
5.1 (a) Simple laboratory preparation of oxygen and carbon dioxide	The pupils need not know the method of preparation of nitrogen.	(P/D) Preparation of oxygen from hydrogen peroxide.
		(P/D) Preparation of carbon dioxide from limestone and hydrochloric acid.
(b) Simple properties of oxygen, carbon dioxide and nitrogen	It is intended that pupils should discover distinguishing tests for these gases.	(P) Solubility in water.
		(P/D) Solubility in sodium hydroxide and alkaline pyragallol.
		(P) Burning splint and glowing splint tests.
		(P) Effect of moist pH paper (or universal indicator).
		(P) Effect on lime-water and bicarbonate indicator.
(c) Carbon dioxide as a compound of carbon and oxygen.	Give the pupils an opportunity to make hypothesis as to the nature of carbon dioxide.	(P/D) Burning magnesium in carbon dioxide.
5.2 Composition of air	By consideration of the role of air in burning and the identification of the gas remaining the qualitative composition of the atmosphere can be arrived at.	(P) Air is necessary for things to burn (Revision)
(a) Oxygen		
(b) Carbon dioxide		(P) Is all the air used up in combustion? (Revision)
(c) Nitrogen	There is no need for exact quantitative work but it should be shown that the gas used up in combustion constitutes approximately one-fifth by volume.	(P) What is the nature of the gas remaining? (Revision)
(d) Noble gases		
(e) Water vapour		(P) Increase in mass on burning e.g. magnesium in air.
		(P/D) Simple 'synthesis' of air by mixing nitrogen and oxygen in various proportions.
	Reference may be made	(D) Where possible simple

to some common properties and some constituent gases of air. Air is then examined to discover its composition.

The uses of air in chemical and biological processes are also examined. Conditions for rusting are briefly studied.

Syllabus Topic	Notes	Suggested Practical Work
5.1 (a) Simple laboratory preparation of oxygen and carbon dioxide	The pupils need not know the method of preparation of nitrogen.	(P/D) Preparation of oxygen from hydrogen peroxide.
		(P/D) Preparation of carbon dioxide from limestone and hydrochloric acid.
(b) Simple properties of oxygen, carbon dioxide and nitrogen	It is intended that pupils should discover distinguishing tests for these gases.	(P) Solubility in water.
		(P/D) Solubility in sodium hydroxide and alkaline pyragallol.
		(P) Burning splint and glowing splint tests.
		(P) Effect of moist pH paper (or universal indicator).
		(P) Effect on lime-water and bicarbonate indicator.
(c) Carbon dioxide as a compound of carbon and oxygen.	Give the pupils an opportunity to make hypothesis as to the nature of carbon dioxide.	(P/D) Burning magnesium in carbon dioxide.
5.2 Composition of air	By consideration of the role of air in burning and the identification of the gas remaining the qualitative composition of the atmosphere can be arrived at.	(P) Air is necessary for things to burn (Revision)
(a) Oxygen		
(b) Carbon dioxide		(P) Is all the air used up in combustion? (Revision)
(c) Nitrogen	There is no need for exact quantitative work but it should be shown that the gas used up in combustion constitutes approximately one-fifth by volume.	(P) What is the nature of the gas remaining? (Revision)
(d) Noble gases		(P) Increase in mass on burning e.g. magnesium in air.
(e) Water vapour		(P/D) Simple 'synthesis' of air by mixing nitrogen and oxygen in various proportions.
	Reference may be made to the pressure of water vapour, dust particles and bacteria etc. in the atmosphere.	(D) Where possible simple demonstration of the properties of liquid air and solid carbon dioxide ('dry ice') should be carried out.

Syllabus Topic	Notes	Suggested Practical Work
	The importance uses of oxygen, carbon dioxide, the noble gases and nitrogen may be discussed (See also Section 5.10)	However, great care should be taken in handling these substances
	Outline of industrial manufacture of oxygen and nitrogen from air by fractional distillation.	(D) Films, visits to factories etc.
5.3 Unbreathed and breathed air		
(a) Difference in composition between breathed and unbreathed air.	Comparison to show the increased amount of carbon dioxide and water vapour content. Discuss with pupils how to collect equal volumes of unbreathed air and breathed air and how a comparison can be made.	(P) Collect and compare properties e.g. - appearance, - smell, - taste, - solubility in water and sodium hydroxide - effect on pH paper - burning splint and growing splint tests - limewater/bicarbonate indicator.
(b) All animals breathe in some oxygen and breathe out some carbon dioxide	Emphasis that unbreathed air contains, besides oxygen, carbon dioxide and nitrogen. Also breathed air may also contain some oxygen, more carbon dioxide and more water vapour than unbreathed air. Discuss why this should be so.	(P) Burn carbon, bread/rice and sugar etc in air or oxygen to show products gives positive tests for carbon dioxide. (P/D) Removal of some oxygen from air by small invertebrates (such as cockroaches and grasshoppers) and giving out of carbon dioxide
5.4 Solubility of air in water	This is to emphasise the importance of dissolved air to aquatic life. Water pollution may be discussed briefly here.	(P/D) Boil out air from river or pond water and test for oxygen.
5.5. Respiration - release of energy		
(a) Food contains energy (revision)	(Refer back to the release of energy from food in Section 3.4 and Section 5.3)	(P/D) Release of energy from living things - Let pupils breathe on thermometer
(b) The energy in foods can be released in living things	The release of energy in living organisms is much slower and more controlled than in burning.	- germinating seeds etc. in vacuum flasks.
(c) Energy is used for body warmth, movement, growth and reproduction etc.		

Syllabus Topics	Notes	Suggested Practical Work
5.6 Respiratory system		
(a) Respiratory organs	Provide diagrams of lungs, ribcage, diaphragm etc.	(D) Examine sheep's lungs or goats lungs.
(b) Gas exchange in the lungs - diffusion of gases	Simple account of air sacs moist thin walls, good blood supply in small blood vessels allowing diffusion of gases.	(D) Apparatus to show action of diaphragm in breathing.
(c) Mechanism of breathing	Brief reference to artificial respiration and pressure difference in the lungs during breathing.	(D) Apparatus to show action of diaphragm in breathing. (D) Model showing action of rib muscles. (D) Films on respiration.
5.7 Energy intake and photosynthesis		
(a) Energy in foods (revision) photosynthesis:	Pupils can trace source of common foods back to plants	(D) Charts or films on food chains, food webs, etc.
(b) plants as intermediate source of energy for animals (producers and consumers)	Plants take in energy from the sun. They are producers of organic substances.	(P) Removal of carbon dioxide from air by leaf using bicarbonate indicator.
	Animals are consumers	(P) Starch test in green leaves. (D) Building of starch from glucose in leaf discs of squares floating glucose solution.
	Carbondioxide is removed from air, built up into sugars and starches. In most leaves sugar is converted to starch too quickly - iris leaves show sugar well	(P) Chlorphyll is necessary in photosynthesis - test variegated leaf. (P) Examine pond weed under microscope (H.P.) Show that chlorphyll is in chloroplasts.
	Importance of photosynethesis to all life should be made clear.	(P) Slide or photomicrograph of T.S of leaf to show stomata and air space. (P/D) Liberation of oxygen from water plants
5.8 Rusting	Simple conditions for rusting and common methods of preventing rusting should be discussed.	(P) Experiments to show that water, air (oxygen) are necessary for rusting.
5.9. Industrial uses of common gases - oxygen nitrogen, carbon dioxide, noble gases	Industrial uses and importance to be discussed briefly. Air pollution problems in towns and cities may be touched upon here.	(D) Films

Section 6: THE UNIT OF LIVING THINGS

The purpose of this section is to investigate the unit structure of living things, and the brief study of male and female cells as specialised units leads naturally into sexual reproduction.

The compound microscope is introduced for looking closely at the structure of living things at a higher magnification than can be obtained with a hard lens. Micro-organisms are used now, as they were deliberately excluded in the earlier work (Section 2).

The work at the end of this section on the development of embryos after fertilisation needs careful planning to ensure that the material is available. Ideally, further observations on various animal and plant life should be made.

Syllabus Topic	Notes	Suggested Practical Work
6.1 Cells and living things		
(a) Simple structure of plant and animal cells	The structure of plant and animal cells as revealed by light microscopy is introduced very simply.	(P) Examination of cells from various tissues e.g. onions scale epidermal peel, macerated begonia, balsam stem, crinum lily, pollen and cheek cells.
(b) Unicellular organisms	Living things also exist which are composed of single cells but all at the microscopic level.	(D) Observation of slides or photomicrographs of animal sperm and egg.
		(P/D) Observation of one or two unicellular organisms e.g. Paramoecium and pond organisms (Hay infusion may be used here).
6.2 Cells in reproduction	The role of cells in reproduction is briefly studied.	(D) Viewing of 8 mm film cassettes on fission in micro organisms such as Paramoecium.
(a) Simple fission	Simple fission of single cell micro-organisms is a form of reproduction.	Also photomicrographs of mammalian sperm and egg to show difference in size and shape.
(b) More complex reproduction	With complex multi-cellular plants and animals simple fission is not possible. Special male and female cells are required.	(P) Observation of simple reproductive structure of a flower.
		(P) Examination of pollen grains and sections of unfertilised carpel.
		(P) Examination of various different flowers stamens; pollen grains on a microscope slide.
		(P) Examination of fish roes.

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(b) More complex reproduction	With complex multi-cellular plants and animals simple fission is not possible. Special male and female cells are required.	(P) Observation of simple reproductive structure of a flower.
		(P) Examination of pollen grains and sections of unfertilised carpel.
		(P) Examination of various different flowers stamens; pollen grains on a microscope slide.
		(P) Examination of fish roes.
		(D) Dissection of mammal to show general position of ovaries and testes.

Syllabus Topic	Notes	Suggested Practical Work
6.3 Methods of achieving fertilisation		
(a) Pollination and fertilisation in plants	Flowers use insects, wide etc. to transport pollen.	(D) Films
	Discuss briefly self-pollination and cross-pollination. Also cross-breeding in plants	(D) Films (P) Examination of flowers to find out how this is done. (P) Grow pollen tubes. (D) Film or slides of pollen tube entering an embryo sac.
(b) Fertilisation in animals	Establish that fertilisation is an essential process in sexual reproduction in both plants and animals	(D) Use of pomato ceras technique, if possible; otherwise use film cassettes or slides.
	A factual account of how sperm and egg meet in the process of fertilisation. Terms use to include: Ovary fallopian tube. (oviduct) uterus, vagina, Testes, penis, sperm duct.	(D) Films on 'mating' etc.
6.4 The growing embryo		
(a) The chick embryo	Establish the need for food e.g. the significance of yolk in egg.	(D) Opening of hen's eggs at 3,5,7,10,15 and 21 day stages of incubation.
	Start with the developmental stages of fertilised hen's eggs. Then go on to the development of animal embryo within the uterus.	(D) Dissection (or examination of preserved specimens of pregant rabbit, rat or guinea pig to show the reproductive system. (Reference should be made to the presence and arrangement of other organs)

(Note; To ascertain the depth of treatment of these topics, reference should be made to the specific objectives of this Section).

Section 7: HEAT FLOW

The transfer of heat energy is necessary to the understanding of many everyday phenomena. Since matter and energy are intimately related opportunity is taken to introduce the basic concept of energy through the experimental approach.

Syllabus Topic	Notes	Suggested Practical Work
7.1 Methods of Heat Flow	- Pupils are first of all introduced to the three methods of heat flow by simple experiments.	
(a) conduction of heat energy	- A simple explanation in terms of particles should be forthcoming from pupils.	(P) Heat waxed rod with pins, nails, etc. or with heat sensitive paper.
(b) convection of heat energy	- A simple picture is possible in terms of hot expanded fluid rising and cold fluid sinking (See Section 4.4)	(P) Currents shown by (a) potassium permanganate or dye etc. in water. (b) smoke in air
(c) radiation of heat energy	- A simple idea that particles are not required for heat flow by radiation	(P) Thermometer in evacuated flask etc.
7.2 Problem situations involving heat flow		
(a) conduction occurs best in solids, particularly in metals	- The pupils can now conduct a series of problem experiments, either arranged around the laboratory for 'station' or individual experiments.	(P/S) A series of experiments involving lagged, polished, dull surface etc.
(b) liquids and gases are relatively poor conductors of heat	- In these, the knowledge gained in 7.1 is applied and extended.	
(c) convection occurs in fluids only		

(d) hot fluids are less dense than cooler fluids and usually rise

(e) radiation does not require particles of matter

(f) dull surfaces are good radiators and good absorbers of heat while bright, shiny surfaces are relatively poor

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Section 8: ELECTRICITY (I)

In modern living an elementary knowledge of electricity is essential to everyone. This is one of the two Sections on Electricity in this syllabus. The first part is mainly on basic concepts of electricity and circuitry. The second part deals with applications of electricity in the home and in industry.

Syllabus Topics	Notes	Suggested Practical Work
8.1 Electricity atrest		
(a) Charging by friction	- The success of these activities depends on the humidity of the room. Humidity can be kept lower by ventilation.	(P) Charging balloons to show presence of charges.
(b) Two types of charges: positive and negative		(P) Charged plastic strips of different kinds placed on inverted watch glass or attached to strings, etc.
(c) Like charges repel each other. Unlike charges attract each other	- The 'electrostic' kit or Van de Graaf generator may be useful here.	(D) Metallised spheres attracted and repelled.

8.2 What is electricity?

(a)	Identity of static and current electricity	- A billiard ball model of the atom is now not sufficient and the electron should introduced as a necessary particle to suggest that an electric current is a 'flow of electrons'	(D) High voltage static electrical experiments e.g. with lighting a neon bulb. (D) Battery and ammeter to show current (D) High voltage static electrical machine discharged through micro ammeter.

8.3 Electricity in motion - current

(a)	Sources and complete circuit required	- Circuit boards are advantageous in this section since they encourage the pupils to further investigation. Owing to the speed and ease of connection of components.	(P) Circuit boards with e.g. torch-light cells and bulb (2.5 V. 0.2A) to show that. - a complete circuit is necessary for electrons to flow - in a one-cell, one-bulb circuit, current will flow even if the polarity of cell is reversed.
(b)	Conductors and insulators	- Continuity tester may be improvised - Also identify which parts of an electric bulb are conductors and which are insulators.	(P) Use of continuity tester, torchlight bulb as current indicators.
(c)	Switches	- Examine various types including household switches. (toggle, tumbler, pendant etc.)	(P) Examinations of the construction of various types of switches.
(d)	Current in a series circuit	- Show that the current around a series circuit is the same at various points on the circuit.	(P) More bulb to various points in series circuit (same brightness) and later use ammeter to replace bulb.
		- Use water analogy for current only, not potential difference (p.d.)	(P) Set up a series circuit with three bulbs in different positions in the circuit (same brightness); inter-change bulbs.
(e)	Unit of electric current - ampere	- 'Ampere' is introduced symbol for ampere is A. There is no need to define ampere at this stage.	

(f)	cells in series	- There is no need to mention 'volts' yet at this stage.	(P) On circuit board, two cells - connected + to + - connected + to - - with one bulb - with two bulbs
		- The motorcar or motorcycle battery is an example of cells in series. There is no need at all to discuss the theory	(D) Examine car or motor-cycle battery.
(g)	current in parallel branches	- At this stage only simple treatment. More can be done in subsequent sections.	(P) Bulbs in parallel brances. (Why should the bulbs light?) (P) Comparing current in different parts of circuit using ammeters at various points.
(h)	use of continuity tester	- This can be improvised from cells and a bulb with two leads.	(P) To test for faulty circuits.
8.4	<u>Opposing the current</u> - <u>resistance</u>		
(a)	Effect of change of length and gauge of wire	- The intention here is to (a) lead up to the use of a rheostat, or 'volume control' (b) introduce an investigation which involves two variables (length and gauge) with respect to resistance.	(P) Change in effective length of wire using a crocodile clip as contact at various points on wire. - Effecton brightness of bulb and ammeter reading (P) Repeat the experiment using wires of different gauge.
(b)	Variable resistor	- Application from 'volume control' to lamp dimmer - The <u>ohm</u> as a unit of electrical resistance need not be mentioned at this stage.	(P) Radio-type resistor ammeter and bulb, or circuit board.

8.5 Heating by current

(a)	Conversion of electrical to heat energy	- The Joule as a unit of energy need not be mentioned at this stage. - The heat energy produced is related only to the size of current (i.e. the larger the current the larger the heat energy produced) and not to electrical resistance or p.d. at this stage.	(P) Equal lengths of resistance wire (e.g. nichrome, of different gauges) in series on circuit board.
(b)	Fuses	- This is an application of the heating effect of current.	(P) Set up circuit with one bulb and one cell. Short circuit the bulb. Wire becomes hot.
		- $\frac{1}{4}$-A fuses are suitable for this experiment. Or use a very thin strand of wire.	(P) Wire a fuse link to three cells, ammeter, and resistor. Gradually increase current until fuse melts.

8.6 Driving the current - voltage

(a)	Voltage	- 'Voltage' is now introduced. The symbol for 'voltage' is **V** . The symbol for 'current' is **I**	(P) Three bulbs in series with three cells. - Voltmeter across bulbs in turn, across two bulbs and then all three.
(b)	Relationship between voltage and current.	- Not as OHM's Law, but as 'the larger the voltage, the larger the current' - Voltage of unknown sources to be measured.	(S) Various sources tested for voltage - all low voltage e.g. the accumulator, dry cell etc.
(c)	Main's voltage	- It is important to warn pupils on the danger on the main's voltage - More about electricity and magnetism particularly about household applications, will be done in Section 13.	(D) Refer to Lembaga Letrik Negara Safety booklet.

Section 9: HYDROGEN, ACIDS AND ALKALIS

This Section looks informally at some common acids and alkalis and establishes pH as an indication of relative acidity. The displacement of hydrogen by metals in acids is used to form first ideas of an activity series.

Salt formation is treated very qualitatively but the idea of reacting weights of solutes is introduced using syringes and rough titrations.

Word equations (not chemical symbols) may be used wherever relevant

Syllabus Topics		Notes	Suggested Practical Work
9.1	Hydrogen - properties and preparations	- This gas is introduced as another gas - Allow pupils to test and become familiar with identification test - The use of hydrogen cylinders is not recommended - Hydrogen may be identified by the following: (a) Burns explosively in a mixture of hydrogen and air (b) Burns in air or oxygen to form water only (see Section 9.2)	(P) Solubility of hydrogen (P) Hydrogen is less dense than air (P) Hydrogen burns in air but does not support combustion. (P) Identification test (small test tubes only)
9.2	'Synthesis of water'	- The formation of water by burning hydrogen in air should be shown qualitatively only (This experiment is dangerous and should be undertaken only by the teacher. Adequate safety precautions must be taken.) - Discuss why water is a compound (hydrogen oxide) and not a mixture of hydrogen and oxygen.	(D) Burning of hydrogen in air (precautions to be taken) - identify product formed by boiling and freezing point. - Also by chemical test for presence of water.

9.3	'Electrolysis of water'	- A little acid is added to make it conduct electricity - Discuss energy changes involved in both synthesis and electrolysis of water. - No ionic theory is required here, for explanation.	(P/D) Electrolysis of water and test for products.
9.4	Action of metals on water		
	(a) Sodium (b) Calcium (c) Magnesium	- Great care must be taken with sodium. Avoid using potassium here. - Use sodium, calcium and magnesiam to establish order of activity No attempt should be be made to collect the gas produced.	(D) Action of sodium on water (use only a small piece about the size of match-head)
9.5	Action of metals on dilute acids		
	(a) magnesium (b) aluminium, (c) iron (d) lead (e) tin (f) copper	- Various metals should be tried. Only one acid need be used. Dilute hydrochloric or sulphuric acid is suitable. - The acid is introduced at this stage merely as a hydrogen - containing substance - Here a further gradation of reactivity is obtained.	(P) Actions of metals on dilute acid.
9.6	Acids and alkalis	- Definitions of 'acid' and 'alkali' are not required and referance to acidic and basic oxides need not be made.	(P) Common (household etc) acids and alkalis tested with pH paper

(a)	pH as degree of acidity and alkalinity	- pH paper (universal indicator) rolls is is used, to show degree of acidity or alkalinity of common household acids and alkalis such as lemon juice, vinegar, soap powders, indigestion remedies, etc.		
(b)	neutralisation	- This should be treated very simply as acid 'cancelling out' alkali.	(P)	Neutralisation experiments.
		- Quantitative ideas should however, be established using graduated plastic syringes, burettes etc. This is to bring home the idea that a fixed mass of acid (solute) will neutralise a fixed mass of given alkali (solute).	(P)	Simple quantitative experiments on neutralisation.
9.7	Salt formation	- Only the method by acid-alkali neutralisation is required here. - Help pupils to draw the conclusion that: an acid + an alkali ⟶ a salt + water - Avoid the use of the word 'strength' in discussing acids and alkalis. However, the word 'concentration' may be used. - No tonic theory is required here.	(P)	Preparation of 2 or 3 salts using dilute hydrochloric, sulphuric and nitric acids with sodium, potasium or ammonium hydroxides.

Section 10: DETECTING THE ENVIRONMENT

The sensory nerves and their limitations are considered here. Subjective anomalies are pointed out. The physics of light and sound is treated observationally. No attempt is made to interpret them in terms of photons or waves.

Syllabus Topics		Notes	Suggested Practical Work
10.1	Rectalineal (propagation of light)	- Light rays are observed to travel in straight lines in a uniform medium.	(P/D) Simple experiment with candle and cardboard or with rubber tubing.
10.2	Reflection of light on plane surfaces		
(a)	Angle of incidence equals angle of reflection	- Simple light boxes or bright torchlight as source of light	(P) Experiments with plane mirrors and light rays.
(b)	Characteristics of images formed in plane mirrors		
10.3	Ray-tracing	- Rays can be traced through prisms, and then convex lenses of different curvatures. - Relate position of focus to curvature qualitatively.	(P) Using ray boxes and prisms trace rays through prisms base to base, then through converging lenses
10.4	The eye and light		
(a)	Structure of the eye in relation to sight	- Observe parts of eye: eye lens, iris, choroid coat, optic nerve, aqueous humour, vitreous humour, etc.	(P) Dissection of goat's eye
(b)	Relative curvature of lens to muscles of eye	- Establish how the eye muscles can change the shape of the lens.	(P) Squeeze eye lens to show shape can be altered.

(c) The pin-hole camera and the eye	- Starting with the pin-hole camera study the role of converging (convex) in focussing light on a photographic film. This work can then be applied to both a camera and the eye.	(P) Making of pin-hole camera etc. (P) Examinations of the structure and functions of parts of a lens camera
	- Resemblence of eye to camera; lens, blackened interior, light-sensitive surface etc. Difference in method of focussing in the eye and the camera.	(P) Model of eye using large flask or a variable-focus eye model.
10.5 Vision: some limitations		
(a) colour blindness (b) blind spot (c) single-eye and stereo-vision (d) optical illusions in shapes and colours (e) persistence of vision	- These limitations are to be discussed briefly to bring out the fact that sometimes accepted signals breakdown and the eye gives the wrong message to the brain - Colour is seen only in the centre of the retina.	(P) Colour vision test cards. (S) Experiments to demonstrate other limitations of vision. e.g. (b) to (e)
10.6 Vision: some defects	- Further work with prisms leading to the understanding of the behaviour of diverging (concave) lenses.	
(a) short sight (b) long sight	- A brief treatment of these sub-topics and how these defects are corrected by using suitable lenses (only qualitative treatment is expected).	(P) Ray tracing through prisms, apex to apex, then through diverging lenses, using ray boxes.
(c) correction of shortsight and longsight		(D) Model of eye using large flask with appropriate lenses to show clearly the cause of short-sight and long-sight. Then use lenses to correct defects.

Ear and sound

	Structure of ear	- The structure of the ear is studied in relation to the detection of sound.	(D) Examine model of ear, etc.
		- Discuss to bring out the function of the bones in the middle ear.	
(b)	Sources of sound	- Various sound sources studied to show that sound is caused by vibration.	(P/S) Sources of sound - vibration
		- Energy changes involved may be discussed.	(D) Electric bell or clapper in vacuum
(c)	Transmission of sound	- The need for material medium for the transmission of sound is demonstrated	

10.3 Hearing: some limitations and defects

(a)	Frequency and pitch	- Variation of pitch with number of vibrations per second i.e. frequency. The unit of frequency is Hertz (Hz).	(D/S) Use of simple objects, rules, elastic bands, etc. Vary tension and length to increase frequency.
(b)	Loss of sensitivity to higher frequencies	- The human ear can detect sound of only a certain range of frequencies. As a person grows older the higher frequency range cannot be defected.	
		- Discuss the causes of this including possible ones for deafness.	
		- A large-scale demonstration can be given at the upper threshold of hearing using the group plot of distribution curve. (Note that this experiment is also limited by the apparatus especially by the loudspeaker used.)	(D) Using a signal generator, a loudspeaker and a CRO.

10.9	Balance	- The importance of	(P) Detection by pupil (blindfolded) of the direction of sound source.
		(a) stereo-audio properties of ears	
		(b) the need for a combination of signals e.g. eye pressure, muscle tension, sound.	(P) Blindfold pupil and push gently. (Note difficulty experienced by the pupil to balance himself.
		- Discuss briefly the role of the semi-circular canals in the ear	(P) Spin pupil on chair, etc. Ask him to note direction of movement of room immediately on stopping.
10.10	The Nervous system		
	(a) The central nervous system	- Discussion on functions and in importance of the brain and the spinal cord.	(D) Models and films, if available, on the central nervous system.
		- Relate to the sense of hearing, balance and sight to certain nerve centres of the brain.	
	(b) The surface nervous system		
	(i) centre of taste	- Indicate the narrow region of the mouth sensitive to taste and and the range of this region.	(P) Map the regions of taste on the tongue using sweet, bitter, bitter and sour substances.
			(P) Eliminate sight and smell and then ask for the description of taste of a variety of foods and drinks.
	(ii) centre of smell	- Note the great increase in range and variety compared with taste	(P) Eliminate sight and taste. Then ask for the description of smells.
	(iii) areas sensitive to 'touch' and pain	- Note the wide areas on the body, sensitive to 'touch' and also the relative sensitivity.	(P) Plot 'touch' (pain) nerve endings.
	(iv) reflex	- Discuss also the	(P) Tap knee or Archilles

		source.	
	(b) the need for a combination of signals e.g. eye pressure, muscle tension, sound.	(P)	Blindfold pupil and push gently. (Note difficulty experienced by the pupil to balance himself.
	- Discuss briefly the role of the semi-circular canals in the ear	(P)	Spin pupil on chair, etc. Ask him to note direction of movement of room immediately on stopping.
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	(i) centre of taste	- Indicate the narrow region of the mouth sensitive to taste and and the range of this region.	(P) Map the regions of taste on the tongue using sweet, bitter, bitter and sour substances.
			(P) Eliminate sight and smell and then ask for the description of taste of a variety of foods and drinks.
	(ii) centre of smell	- Note the great increase in range and variety compared with taste	(P) Eliminate sight and taste. Then ask for the description of smells.
	(iii) areas sensitive to 'touch' and pain	- Note the wide areas on the body, sensitive to 'touch' and also the relative sensitivity.	(P) Plot 'touch' (pain) nerve endings.
	(iv) reflex action, voluntary and involuntary reactions	- Discuss also the various levels of control that the human has over his nervous system i.e. breathing, bladder and sphincter control etc.	(P) Tap knee or Archilles heel reflex. Ask for resistance, then tap again.

		(P/D) Shine light on iris; note reaction
		(P) Reaction times.
	- Discuss briefly also the effects of alcohols and drugs on body control etc.	(D) Films on effects of drugs etc.
		(D) Effort of alcohol on animals like mice, hamster, web-spinning spider, etc. Films on this topic.
(v) limitation to the working of nerve endings	-	(P) (Revision) Limitations of the human senses

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Section 11: SOLVENTS AND SOLUTES

Changes of state are revised to introduce the water cycle. This leads to the consideration of 'impurities' of various kinds (including living organisms in water supplies) and the various methods of water purification. This leads in turn to the study of solutions in water and other solvents and to brief mention of colloids and emulsions. Colloids and emulsions are included because of their practical significance.

Syllabus Topics	Notes	Suggested Practical Work
11.1 The 'water cycle'		
(a) Change of state of water	- Only a brief discussion is necessary here - Temperatures at which these changes of state occur should be noted. - Energy changes involved may be discussed.	(P) Heat: ice → water → steam Cool: steam → water → ice.
(b) Conditions for evaporation	- These conditions are investigated experimentally. - Explanation for evaporation in terms of molecules and energy changes	(P) Place moist blotting paper, cloth, coloured liquids on glass blides in different conditions and measure time for evaporation

		- It should be noted that the area of paper, cloth etc or volume of liquid drops exposed are variables.	
(c)	Cloud and mist formation. Rainfall	- Emphasise that clouds and mist are not in the gaseous state	(D) Sudden expansion of moist air into evacuated bell jar or winchester bottle under pressure. (P/D) Place thermometer bulb at mouth of bicycle valve outlet of syringe etc.
(d)	Drinking water and its purification	- Sources of drinking water: river pond well - Discuss the purification of water for drinking purposes. The fact that drinking water need not be chemically pure should be stressed. - Visits to reservoir and water works is useful or use film material as aids.	(P) Pour pond water down filter column set up as section of soil to act as filter bed. Evaporate part of f filtrate to dryness.
(e)	Organisms in water	- Also show that these organisms can be killed by boiling the water	(P) Examine remainder of filtrate under microscope or with microprojection. Chloride water sample and reexamine.
(f)	Sea water	- The nature of sea water can be dealt with here or in Section 16. - Relate to water supply. Distillation as a method of purification.	(P) Distillation experiments.
11.2	Solubility in aqueous solvents		
(a)	Saturated solutions	- Limits to solubility of any one subtance	(P) Repeated addition of e.g. 1 of sample to 20 cm^3 water until saturation.

(b)	Variation of solubility	- There is no need heer to define 'solubility'	(P) Variety of salts treated as in the above.
(c)	Factors affecting rate of solution	- This is intended as a piece of work in which pupils can design experiments to test their own predictions.	(P) Experiments with suitable 'controls'
(i)	particle size		
(ii)	stirring	- Explanation can be given in kinetic terms.	
(iii)	temperature		
(d)	Factors affecting solubility of a substance	- In this case only temperature need be considered.	(P) Same as above
		- Crystal growing may form a longer-term project here, if desired.	
(e)	Energy changes on solutions.	- Exothermic and endothermic changes introduced as heat releasing and heat absorbing reactions.	(P) Dissolve e.g. calcium chloride, ammonium nitrate, sodium hydroxide and take temperature.
11.3	Non-agneous solvents	- Solvents to be used may be as follows, alcohol, acetone, petrol, kerosene, carbon tetrachloride.	(P) Dissolving iodine, tar, grease, shellac, nail varnish, etc.
			(P) Remove of stains on fabric etc.
(a)	Solubility	- Relate to dry cleaning and household cleaning.	
(b)	Extraction	- As a process of separating soluble from insoluble substances.	(P) Experiments on separating soluble from insoluble substances
		- Paper chromatography as a method of separation and identification	(P) Separation of a dye mixture (e.g. screened methyl orange, fountain pen ink, etc.) using strips of paper, blackboard chalk, etc.
11.4	Emulsions and colloids		
(a)	simple emulsions.	- Only a brief study is intended here, e.g. to show that apparent solutions are not necessarily so.	(P) Make simple emulsions e.g. oil and soap with water, oil and vinegar. with mustard, hair cream, hand cream.

(b)	emulsifying agents	- The idea of an emulsifying agent is introduced e.g. soap in oil and water (haircream); dry mustard in oil and vinegar (salad dressing)	
(c)	Tyndall effect	- This is a simple water to identify a colloid and to distinguish it from a true solution. - Iron (III) chloride hydrolyses in water to form iron (III) hydroxide colloid.	(P) Tyndall test. Use starch 'solution' or iron (III) chloride 'solution'. Compare with copper (II) sulphate or other salt solution.
11.5	The process of digestion and absorption	- This requires a brief study of the importance of water and solutions in a living system and is treated integrally with 'The Transport Systems' in the next section.	

Section 12: FOOD AND THE TRANSPORT SYSTEMS

This section looks at various types of food, methods of feeding and the ways of getting the food to the proper state and locations for digestion to occur. It therefore looks at ways in which material taken in (absorbed) as food is transported throughout the body and any waste material produced is removed.

The transport systems in some plants is also briefly treated in this section.

Syllabus Topic		Notes	Suggested Practical Work
12.1			
(a)	Types of food		
(i)	Carbohydrates	These include the sugars and starches - for energy	(P) Food tests on (a) starch, glucose, fats and proteins (b) foods brought by pupils using
(ii)	fats	These are for energy	

	(b) Emulsifying agents		emulsifying agent is introduced e.g. soap in oil and water (haircream); dry mustard in oil and vinegar (salad dressing)	
	(c) Tyndall effect	- This is a simple water to identify a colloid and to distinguish it from a true solution. - Iron (III) chloride hydrolyses in water to form iron (III) hydroxide colloid.	(P)	Tyndall test. Use starch 'solution' or iron (III) chloride 'solution'. Compare with copper (II) sulphate or other salt solution.
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Syllabus Topic		Notes	Suggested Practical Work
12.1			
(a)	Types of food		
(i)	Carbohydrates	These include the sugars and starches - for energy	(P) Food tests on (a) starch, glucose, fats and proteins (b) foods brought by pupils using (i) iodine solution (starch)
(ii)	fats	These are for energy	
(iii)	proteins	These are for growth and repair of body tissues and also for energy	

(iv)	minerals	Brief reference is to	(ii) Benedict's solution (sugar)
(iv)	minerals, vitamins roughage, water	Brief reference is to be made to their importance	(iii) Millon's reagent or Biuret test (proteign)
(b)	Balanced diet	Its importance is to be discussed	(iv) filter paper or ethanol extract emulsion (fats)
12.2	Teeth and feeling		
(a)	Structure of a tooth	Provide simple diagram of a tooth in longitudinal section to show enamel dentine, pulp, crown and root.	(D) Examine single teeth and dentition of a flesh-eater and a plant-eater, including man. Note the action of jaw in each case.
(b)	types of teeth	Discuss their relation to diet and method of feeding	
(c)	care of teeth	Mention the importance of minerals including fluorides in the building of strong teeth.	(P) Examine action of substances that contribute to tooth decay e.g. acids, Action of toothpaste.
12.3	Other method of feeding		
		A brief look at feeding methods of some invertebrates	(P) Observe feeding method and mouthparts of grasshopper, cockroach, housefly, mosquito, fish, frog, leech, etc.
			(P) Ciliary feeding in cockles etc. -- movement of particles or gills observed under binocular microscope, if available.
12.4	Digestive system of	Provide simple diagram of digestive system of human being for discussion following demonstrations.	(D) Examine of a small dissected mammal to show alimentary tract
(a)	a mammal		
(b)	small pond animals		(P) Examine small pond animals under the microscope (low-power) to show the gut and its muscle movement (e.g. Daphnia, Chironomus, Rodifers)

12.5	The process of digestion	Note that most foods are complex and insoluble.	
(a)	Function of the system	This is to break down complex substances to simpler soluble substances which can the diffuse through the walls of the small intestines into the body. (Food in the small intestine is still 'outside' the body.) Breakdown of food is both mechanical and chemical Note: Care must be taken not to confuse the diffusion process with osmotic pressure effects which are also taking place.	(D/P) Visking 'sausage' with starch and glucose inside demonstration diffusion of smaller molecules.
(b)	Action of enzymes in	Enzymes are regarded here merely as agents in hydrolysis	(P) Saliva and starch or diastase and starch with a control.
(i)	the mouth	Since salivary amylase (ptyalin) may be absent from saliva of some pupils two members of a group should contribute	
(ii)	the stomach	Diastase may be extracted from germinating barley (or bought from a chemical supplier)	(P) Digestion process in the stomach. Hydrochloric acid, rennin, pepsin or milk, etc.
(iii)	the small intestine	In the small intestine, products having diffused through the wall are carried to all cells by the blood stream and used for energy and growth	(P) Starch and diastase in visking tubing
12.6	The need for a transport system		
(a)	absorption	Absorption of food in the small intestine	(D) Visking tubing experiments and diffusion experiments (Brownian movement) -- revision

(h)	Assimilation	Discuss how food is assimilated. Also the path taken by the digested food from the small intestine to all parts of the body.	
12.7	Types of transport systems		
(a)	Transport of materials in plants	Problem of water loss and gain applied to a variety of organisms (Avoid details of structure).	(S) Plant materials: dye experiment. Use hard lens to inspect plant materials (tranverse and longitudinal sections)
(b)	Streaming in plants and unicellular organisms	Organisms may be stained (e.g. with Congo Red) for clearer observation	(S) Microscopic examination of streaming in pondweed (Hydrilla) and animal materials. Also Paramoecium and other streaming.
(c)	Circulation in higher animals	Transporting fluid may or may not be enclosed in blood vessels.	(P/D) Blood circulation in tail of goldfish, tadpole or young guppies.
(d)	Circulation in human beings		
(i)	circulatory system	Pump (heart), valves, and vessels	(P) Action of valves in arm veins. (D) Goat's heart: to show structure and one-way action of valves.
(ii)	Function of blood	Function of haemoglobin to be discussed, also double function of a circulatory system i.e. (i) transport (ii) gas exchange	(P) Physical activity and the rate of heart beat (D/P) Blood components also examination of a sample under microscope.
12.8	Excretion and Elimination	Getting rid of body wastes in animals and plants. Teaching can begin either from the fate of digested food or with the function of the lungs in a circulatory system.	

(a)	Functions of colon, liver, kidneys, lungs and skin	Distinguish between <u>excretion</u> and <u>elimination</u> as follows: (a) <u>Excretion</u>: extracting wastes from a circulatory medium and passing them to a temporary depot before elimination. (b) <u>Elimination</u>: getting rid of wastes more or less mechanically	(D) Latex injection of fresh goat's kidney, if possible. (P) Breath out into lime water / bicarbonate indicator.
(b)	Importance of skin	One function is regulating body temperature	(P) Weight of sweat produced per square, metre on different parts of the body. (P) Acetone or alcohol (methylated spirit) on back of hand.
(c)	Routes by which waste materials leave the body	<u>Animals</u>: definite excretory system faeces and urine <u>Plants</u>: No definite excretory system (of respiration) but leaf fall may be considered as an example of elimination Some excretory plant products are: essential oil, gums, resins, pigments, and oxalic acid, e.g. in tomato and rhubarb	(P) Water gain or loss in human body (D) 'Dissection' of owl pellets, if possible (D) Examine samples collected.

Section 13: MORE ABOUT ELECTRICITY

In this section on electricity (and some magnetism) the knowledge gained is applied to everyday situations. In addition some electromagnetism is added in order to touch upon the motor, dynamo and alternating current.

Syllabus Topic	Notes	Suggested Practical Work
13.1 Electricity in the home		
(a) Conductors and insulators.	A revision on work began in Section 8	(p) Circuit boards with bulbs show also that electrolytes can conduct electricity.
(b) Methods of wiring	No mains supply to be used; but establish the idea of household circuits	(p) (a) Join 1, 2 and then 3 bulbs in series and then in parallel with one cell to compare brightness. (b) Include faulty lamp bulb in each of the above circuits. (p) Circuit boards with parallel branches. Total current related to number of branches added.
(c) Wiring plugs	Connecting plugs to leads. Both international colour codes and 'old' colour codes should be introduced. International Code: Earth: Yellow/green stripes Live: Brown Neutral: Red 'Old' code Earth: Green Live: Red Neutral: Black	(p) Use 5A, 3 - pin plugs, car head lamp bulb and S.B.C. lampholder.
(d) Main's voltage	Do's and dont's at mains voltage voltages. Discuss Lembaga Letrik Negara pamphlet on "Safety".	
(e) Earthing	Use of earth-wire and lightning conductor	(D) Van de Groaf generator discharge at points.
(f) Fuse - rating	The use of fuses of correct rating to be discussed.	
(g) Power-rating	Power-rating of various household appliances. Simple numerial problems may be given Power supply information that 1 KW-h = 1 unit of electrical	(D) Household appliances connected to kilowatt - hour meter or (P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)

some electromagnetism is added in order to touch upon the motor, dynamo and alternating current.

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(f) Fuse - rating	The use of fuses of correct rating to be discussed.	
(g) Power-rating	Power-rating of various household appliances. Simple numerial problems may be given Power supply information that 1 KW-h = 1 unit of electrical energy. Current (A) = $\frac{\text{Power (W)}}{\text{voltage (V)}}$ Use this to calculate fuse-values and cost of using electrical appliances.	(D) Household appliances connected to kilowatt - hour meter or (P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)

13.2 Introduction to electronics		
(a) Conductors and insulators.	Revise - electrostatics and electrons (see Section 8)	(P) Simple electroscope used to identify charges. (D) Discharge of electroscope by conductors (D) Discharge electrostatic machine by path including microammeter.
(b) One - way conduction	Mention the use of divides and transistors in radios, rectifiers, and battery chargers etc)	(D) Divide with milliammeter in series.
	Use of one-way conduction in cathode - ray oscillo - scope (C.R.O)	(D) (a) Maltese - cross tube on E.H.T. (b) Deflect beam by magnet.
	Deflect spot. Idea of scanning and persistence of vision	(D) C.R.O. experiments
(c) Ionisation in discharge tubes	No theory on ionisation to be discussed. Contrasts with filament lamp bulbs. Advantages - low wattage, higher efficiency etc.	(D) Evacuate discharge tube to show glow. (Use E.H.T. power pack not induction coil) (D) Fluorescent lamp tubes, pilot bulbs etc.
13.3 Introduction to electromagnetism		
(a) Electromagnetic effects.	There is opportunity here to improvise apparatus.	(P) Magnetic effect of a (a) straight wire (b) a coil carrying a current. Behaviour of coil carrying a current.
(b) Electromagnets		(P) Make electromagnets using U-shaped and bar soft iron.
(c) Force on a conductor		(P) (a) Force on a wire carrying a current across a magnetic field - 'catapult force' (b) Aluminium tape between poles of U-magnets.
(d) Electric bell	There is opportunity here to improvise apparatus.	(P) Construction and working of an electric bell.
(e) Electric meter	Simple toys or lobby kits may be used effectively	(P) Construction of moving coil meter.
(f) Electric motor	This may be used to demonstrate electrical energy ⟶ mechanical energy. Display, if possible, models and pictures of different types of motor etc.	(P) Construction of a model motor.
13.4 Electric Supply		
Generation of current.	Mechanical energy ⟶ electrical energy.	(P) Dynamo using motor in reverse.

(b) Idea of alternating current (A.C)	No theory - only simple idea that current is flowing in either direction.	(D/P) Connect coil to a centre-zero galvanometer and move bar magnet in coil.
(c) Change of current direction and strength.		(D) Bicycle dynamo centre - zero galvanometer and bulb in series.

Section 14: SUPPORT AND MOVEMENT

This section attempts to establish the concepts of force and work by operating them in various situations including the human frame. The suitability of various animals and plants to support the forces which they experience is also considered.

Syllabus Topic	Notes	Suggested Practical Work
14.1 Idea of force		
(a) Some examples.	A force is introduce as lifting, pulling, pushing, stretching, compressing or turning.	(P) Plasticene, springs, elastic bands, latex foam etc.
	Push-put effect on shape . Effection motion.	(P) Change of speed and for direction.
(b) Idea of 'friction'	Idea of 'friction' in passing Pupils may find difficulty in realising that a body can maintain uniform motion without some unbalanced force to keep it moving.	(D) 'Frictionless' motion using air-pucks (balloon-type preferable) or object on polystyrene beads.
(c) Force due to gravity	It may be necessary to establish that tall of a body is not due to the magnetic force or the air pushing it down - both common but erroneous, ideas.	(D) 'Guinea and feather' experiment.
(d) Measuring force	Investigation of springs. Spring balance. Introduction to the unit of force - the 'newton' (N)	(P) Making and providing a scale for a spring (or elastic band) balance.
(e) Turning effect of forces	Turn, twist. Lever as a force multiplier. Pupils can be left to find a simple relationship, which can then be seen to be relevant to everyday experience of 'leverage'.	(P) The law of lever experiment. (D) Turning effect of forces.
(f) Pairs of forces	Simple observations and discussion Remove the mistaken idea, that a rocket needs air to push against (c.f. a jet plane) in order to move forward.	(D/S) Water rocket, sausage balloon, exploding trolleys
14.2 Work and energy	In section 3 various forms of energy and their interconversions were investigated.	(D) Transfer of energy in lifting load.
(a) Idea of work	The idea of work is now introduced as a measure of energy transferred. (For example, in lifting a brick, the energy in the muscles to potential energy of the brick is work done) Work done = Force x distance moved	(P) Energy transferred in climbing stairs.

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(a) Idea of work	The idea of work is now introduced as a measure of energy transferred. (For example, in lifting a brick, the energy in the muscles to potential energy of the brick is work done) Work done = Force x distance moved in the direction on force Unit of work is the joule Joule = newton x metre	(P) Energy transferred in climbing stairs.

	Revision of the idea of kinetic energy ⟶ potential energy.	(D) Transfer of kinetic to potential energy.
(c) Simple machines	Lever and black and tackle as machines. Can a machine multiply energy? Machines are only energy transformers. Mechanical advantage or velocity ratio may be mentioned only qualitatively.	(D) Lever and pulley system.
14.3 Support in plants	Simple observations on the structure of the stem of a (a) herbaceous (b) woody (c) aquatic plant.	(P) Examine pond weed or seaweed in water. Compare with herbaceous and woody stems.
		(P) Turgidity in seedlings.
14.4 Support in animals		
(a) Land invertebrates.	Investigate the methods of support in (a) the earthworm (b) an insect	(D) Sausage balloon covered with paper mache.
(b) Land vertebrates	Compare this with the above	(D) Skeleton with spine. Examine longitudinal section of long bone of animal and compare with that of a bird.
(c) Aquatic vertebrates	Discuss the need for large girdles in land animals with backbone.	(D) Compare the dimensions of skeletons of a fish and a land animal, in particular the size of the hip-girdle and shoulder girdle.
(d) 'Centre of gravity' of animals	May be defined, only in operational terms.	(P) Find the C.G. of animal silhouettes, objects.
(e) Stability in animals.	May be discussed briefly.	(P) Stability of shapes of animals and objects.
14.5 Muscles and Movement	Relate lever to forearm. Use model with spring as biceps.	(D) Simple model of forearm to demonstrate the action of muscles in moving the bones of the lower arm.
		(P) Determine the greatest load lifted by forearm.
		(P) Find force exerted by biceps in lifting load.

Section 15: THE EARTH

Some materials of the earth's crust are examined chemically to give an idea of their formation and their continued existence. The materials which can be extracted from the earth (including fuels) are briefly mentioned. The section ends with a study of soil and simple soil biology in the 'soil environment'.

Syllabus Topic	Notes	Suggested Practical Work
15.1 Origin and Structure of the Earth..	A brief mention of the origin sufficient to allow discussion of the formation of igneous rocks. Mention of sedimentary and metamorphic rocks. Layers in the earth's crust- the cone and mantle (brief mention)	(P) Illustrate with charts and specimen of rocks obtained from Pejabat Kajibumi, Ipoh. (D) Models showing how these rocks were formed.
15.2 Naturally Occuring Elements	Scarcity of these and the explanation on basis of reactivity. Establish this by examining the action of metals on oxygen and sulphur. The Arculus method can be used for preparing oxygen. The 'rocksil' must be dry. The action of heat on potassium permanganate is said to be merely a source of oxygen. No details of decomposition is required.	(P) Action of metals on oxygen and sulphur (A selection from Mg, Al, Fe, Zn, Sn, Cu) Use the 'Arculus' method.
15.3 Naturally occuring sulphates, oxides and carbonates	These are the three types of minerals in the earth's crust from which metals are obtained.	(P) Specimens of naturally occuring oxides, carbonates and sulphides should be examined by the class. Particular attention is to be placed on tin (IV) oxide or tin-ore.
(a) Physical Characteristics		Also note hardness and insolubility.
(b) Action of heat	In general metal sulphites and carbonates are converted into oxides on heating and many metals can be obtained from the oxides by heating with carbon.	(P) Heat iron pyrites in air. Examine products. Sulphur dioxide detected by smell, etc.
(c) Heating with carbon	Some simple explanation of this in terms of readiness of combination with oxygen should be given based on the work done in 15.2. Magnesium carbonate as purchased will give both water and carbon dioxide on heating, as it is a basic carbonate. It is perhaps wise to avoid these complications by using 'magnesite' or 'dolomite'	(P) Isolation of (a) Copper from copper (II) oxide (b) Iron from iron (III) oxide (c) lead from lead (II) oxide by heating with carbon. (d) Calcium or magnesium from their carbonates.

(d)	Calcium Carbonate and some calcium compounds.	Limestone, quicklime, slake-lime - their checical nature and used are briefly treated.	(P) Chemical nature of limestones, quicklime and slaked lime.
		Soft and hard waters are briefly studied.	(P) Experiments with soft and hard waters.
(e)	'Malachite' experiment	The 'malachite experiment' should be presented to pupils as an investigation starting from previous experience of behaviour of metal ores or oxides. (If malachite is not available a suitable compound such as copper (II) carbonate or a mixture of copper and calcium carbonates may be given)	(P) Experiments to elucidate the nature of 'malachite' etc.
16.4	Silica and silicates	This sub-section is included because of their great abundance in the earth's crust and their importance as building materials, crockery etc.	(T) Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)
a)	Some properties.	Points to make clear are their relative stability towards heat and to chemical reagents	(P) Action of heat on the above.
		Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage	
(b)	Some uses	Pottery and glazes. Glass.	(P/D) Formation of 'pottery tiles' from clay.
		Dangers of improperly glazed vessels, as glazes generally contain lead compounds.(If available kilns in the Art and Craft Department of the School be made use of).	(P/D) Formation of glazes and glass.
16.5	Petroleum - 'Crude Oil'		
(a)	Origin of petroleum	Only brief mention Occurence in Malaysia	
(b)	Petroleum refining.	Refining as a process of fractional distillation. (Visit to Port Dickson/Lutong refineries, if possible. Otherwise use films)	(P/D) Fractional distillation of crude oil. Use of fractional distillates etc.
			(P/D) Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide)
		Natural gas as fuel	
16.6	Salts from the sea.	The main intention is to explain the existence of common salt in the sea and hence the importance	(P) Evaporation of sea water to obtain salts.
			(P) Identification of sodium

		studied.	and hard waters.
(e)	'Malachite' experiment	The 'malachite experiment' should be presented to pupils as an investigation starting from previous experience of behaviour of metal ores or oxides. (If malachite is not available a suitable compound such as copper (II) carbonate or a mixture of copper and calcium carbonates may be given)	(P) Experiments to elucidate the nature of 'malachite' etc.
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			(P/D) Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide)
		Natural gas as fuel	
16.6	Salts from the sea.	The main intention is to explain the existence of common salt in the sea and hence the importance of the sea, now or in the past, in the provision of one of the world's most important chemicals.	(P) Evaporation of sea water to obtain salts.
			(P) Identification of sodium salts by flame tests.
			(P) Identification of chloride by electrolysis.
		Sedimentary rocks	(P) Purification of rock salt or crude salt.

16.7 The soil Environment.		
(a) Formation of soil	Simple treatment at this stage	(P) Setting of soil samples in water.
(b) Properties of soil	Investigation of some of the physical and chemical properties of soil, including some quantitative work on humus, water and air content.	(P) Microscopic examination of soil. (P) Bleaching of top soil, and subsoil samples with hydrogen peroxide. (P) Composition of soil samples.
(c) Some living things in the soil	Visible animals of the soil. Establish that there are many different kinds and an enormous population.	(P) Sort out leaf - litter and top soil in shallow plastic trays Use simple pictorial keys for identification. (D/P) Extract with Tallgren and Bearman funnels (D) Extraction of earthworms with dilute formaldehyde solution.
	Presence of living things in the soil which are not visible to the naked eye. (Allow two or three groups to try sources other than soil).	(P) Respiration produces carbon dioxide, use sieved soil from which visible animals have been removed.
	These organisms may be harmful, may cause disease or may act as parasites.	(P) Agar plates and soil water, tap water, pond water, milk etc.
	Useful application of such life.	(P) Culture Pythium (damping off) on seedlings. (Use of film material suggested where possible).
	Contamination of food and steps to reduce or prevent this.	(P) Different groups make bread or alcohol.
(d) Conservation	Man's interference with soil by common agricultural practices needed to maintain crop growth	(P/D) Culture solutions experiments. Emphasise the need for nitrogen, phosphorus and sulphur.
	The need for conservation	(D) Visual aids, including films.
	(This section is an indication of how a brief ecological study of an environment can be carried out. If teachers wish, rock pools, belukar or any other area can be treated this way: This will of course require visits outside school to the area chosen).	

Section 13: MORE ABOUT ELECTRICITY

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13.1 Electricity in the home		
(a) Conductors and insulators.	A revision on work began in Section 8	(p) Circuit boards with bulbs show also that electrolytes can conduct electricity.
(b) Methods of wiring	No mains supply to be used, but establish the idea of household circuits	(p) (a) Join 1, 2 and then 3 bulbs in series and then in parallel with one cell to compare brightness. (b) Include faulty lamp bulb in each of the above circuits. (p) Circuit boards with parallel branches. Total current related to number of branches added.
(c) Wiring plugs	Connecting plugs to leads. Both international colour codes and 'old' colour codes should be introduced. International Code: Earth: Yellow/green stripes Live: Brown Neutral: Red 'Old' code Earth: Green Live: Red Neutral: Black	(p) Use 5A, 3 - pin plugs, car head lamp bulb and S.B.C. lampholder.
(d) Main's voltage	Do's and dont's at mains voltage voltages. Discuss Lembaga Letrik Negara pamphlet on "Safety"	
(e) Earthing	Use of earth-wire and lightning conductor	(P) Van de Croaf generator discharge at points.
(f) Fuse - rating	The use of fuses of correct rating to be discussed.	
(g) Power-rating	Power-rating of various household appliances. Simple numerial problems may be given Power supply information that 1 KW-h = 1 unit of electrical energy. Current (A) = $\frac{\text{Power (W)}}{\text{voltage (V)}}$	(D) Household appliances connected to kilowatt - hour meter or (P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)

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(a) Conductors and insulators.	Revise - electrostatics and electrons (see Section 8)	(P)	Simple electroscope used to identify charges.
		(D)	Discharge of electroscope by conductors
		(D)	Discharge electrostatic machine by path including microammeter.
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	Use of one-way conduction in cathode - ray oscillo - scope (C.R.O)	(D)	(a) Maltese - cross tube on E.H.T. (b) Deflect beam by magnet.
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(b) Idea of alternating current (A.C)	No theory - only simple idea that current is flowing in either direction.	(D/P) Connect coil to a centre-zero galvanometer and move bar magnet in coil.
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(d) Measuring force	Investigation of springs. Spring balance. Introduction to the unit of force - the 'newton' (N)	(P) Making and providing a scale for a spring (or elastic band) balance.
(e) Turning effect of forces	Turn, twist. Lever as a force multiplier. Pupils can be left to find a simple relationship, which can then be seen to be relevant to everyday experience of 'leverage'.	(P) The law of lever experiment. (D) Turning effect of forces.
(f) Pairs of forces	Simple observations and discussion Remove the mistaken idea, that a rocket needs air to push against (c.f. a jet plane) in order to move forward.	(D/S) Water rocket, sausage balloon, exploding trolleys.
14.2 Work and energy	In section 3 various forms of energy and their interconversions were investigated.	(D) Transfer of energy in lifting load.
(a) Idea of work	The idea of work is now introduced as a measure of energy transferred. (For example, in lifting a brick, the energy in the muscles to potential energy of the brick is work done) Work done = Force x distance moved in the direction on force Unit of work is the joule . Joule = newton x metre	(P) Energy transferred in climbing stairs.

		Revision of the idea of kinetic energy ⟶ potential energy.	(D) Transfer of kinetic to potential energy.
(c)	Simple machines	Lever and black and tackle as machines. Can a machine multiply energy? Machines are only energy transformers. Mechanical advantage or velocity ratio may be mentioned only qualitatively.	(D) Lever and pulley system.
14.3	Support in plants	Simple observations on the structure of the stem of a (a) herbaceous (b) woody (c) aquatic plant.	(P) Examine pond weed or seaweed in water. Compare with herbaceous and woody stems. (P) Turgidity in seedlings.
14.4	Support in animals		
(a)	Land invertebrates.	Investigate the methods of support in (a) the earthworm (b) an insect	(D) Sausage balloon covered with paper mache.
(b)	Land vertebrates	Compare this with the above	(D) Skeleton with spine. Examine longitudinal section of long bone of animal and compare with that of a bird.
(c)	Aquatic vertebrates	Discuss the need for large girdles in land animals with backbone.	(D) Compare the dimensions of skeletons of a fish and a land animal, in particular the size of the hip-girdle and shoulder girdle.
(d)	'Centre of gravity' of animals	May be defined, only in operational terms.	(P) Find the C.G. of animal silhouettes, objects.
(e)	Stability in animals.	May be discussed briefly.	(P) Stability of shapes of animals and objects.
14.5	Muscles and Movement	Relate lever to forearm. Use model with spring as biceps.	(D) Simple model of forearm to demonstrate the action of muscles in moving the bones of the lower arm. (P) Determine the greatest load lifted by forearm. (P) Find force exerted by biceps in lifting load.

Section 15: THE EARTH

Some materials of the earth's crust are examined chemically to give an idea of their formation and their continued existence. The materials which can be extracted from the earth (including fuels) are briefly mentioned. The section ends with a study of soil and simple soil biology in the 'soil environment'.

Syllabus Topic	Notes	Suggested Practical Work
15.1 Origin and Structure of the Earth..	A brief mention of the origin sufficient to allow discussion of the formation of igneous rocks. Mention of sedimentary and metamorphic rocks. Layers in the earth's crust- the cone and mantle (brief mention)	(P) Illustrate with charts and specimen of rocks obtained from Pejabat Kajibumi, Ipoh. (D) Models showing how these rocks were formed.
15.2 Naturally Occuring Elements	Scarcity of these and the explanation on basis of reactivity. Establish this by examining the action of metals on oxygen and sulphur. The Arculus method can be used for preparing oxygen. The 'rocksil' must be dry. The action of heat on potassium permanganate is said to be merely a source of oxygen. No details of decomposition is required.	(P) Action of metals on oxygen and sulphur (A selection from Mg, Al, Fe, Zn, Sn, Cu) Use the 'Arculus' method.
15.3 Naturally occuring sulphates, oxides and carbonates (a) Physical Characteristics	These are the three types of minerals in the earth's crust from which metals are obtained.	(P) Specimens of naturally occuring oxides, carbonates and sulphides should be examined by the class. Particular attention is to be placed on tin (IV) oxide or tin-ore. Also note hardness and insolubility.
(b) Action of heat	In general metal sulphites and carbonates are converted into oxides on heating and many metals can be obtained from the oxides by heating with carbon.	(P) Heat iron pyrites in air. Examine products. Sulphur dioxide detected by smell, etc.
(c) Heating with carbon	Some simple explanation of this in terms of readiness of combination with oxygen should be given based on the work done in 15.2 Magnesium carbonate as purchased will give both water and carbon dioxide on heating, as it is a basic carbonate. It is perhaps wise to avoid these complications by using 'magnesite' or 'dolomite'	(P) Isolation of (a) Copper from copper (II) oxide (b) Iron from iron (III) oxide (c) lead from lead (II) oxide by heating with carbon. (d) Calcium or magnesium from their carbonates.

(d)	Calcium Carbonate and some calcium compounds.	Limestone, quicklime, slake lime - their checical nature and used are briefly treated.	(P) Chemical nature of limestones, quicklime and slaked lime.
		Soft and hard waters are briefly studied.	(P) Experiments with soft and hard waters.
(e)	'Malachite' experiment	The 'malachite experiment' should be presented to pupils as an investigation starting from previous experience of behaviour of metal ores or oxides. (If malachite is not available a suitable compound such as copper (II) carbonate or a mixture of copper and calcium carbonates may be given)	(P) Experiments to elucidate the nature of 'malachite' etc.
16.4	Silica and silicates	This sub-section is included because of their great abundance in the earth's crust and their importance as building materials, crockery etc.	(P) Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)
a)	Some properties.	Points to make clear are their relative stability towards heat and to chemical reagents	(P) Action of heat on the above.
		Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage	
(b)	Some uses	Pottery and glazes. Glass.	(P/D) Formation of 'pottery tiles' from clay.
		Dangers of improperly glazed vessels, as glazes generally contain lead compounds.(If available kilns in the Art and Craft Department of the School be made use of).	(P/D) Formation of glazes and glass.
16.5	Petroleum - 'Crude Oil'		
(a)	Origin of petroleum	Only brief mention Occurence in Malaysia	
(b)	Petroleum refining.	Refining as a process of fractional distillation. (Visit to Port Dickson/Lutong refineries, if possible. Otherwise use films)	(P/D) Fractional distillation of crude oil. Use of fractional distillates etc.
			(P/D) Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide)

		studied.	and hard waters.
(e)	'Malachite' experiment	The 'malachite experiment' should be presented to pupils as an investigation starting from previous experience of behaviour of metal ores or oxides. (If malachite is not available a suitable compound such as copper (II) carbonate or a mixture of copper and calcium carbonates may be given)	(P) Experiments to elucidate the nature of 'malachite' etc.
16.4	Silica and silicates	This sub-section is included because of their great abundance in the earth's crust and their importance as building materials, crockery etc.	(P) Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)
a)	Some properties.	Points to make clear are their relative stability towards heat and to chemical reagents	(P) Action of heat on the above.
		Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage	
(b)	Some uses	Pottery and glazes. Glass.	(P/D) Formation of 'pottery tiles' from clay.
		Dangers of improperly glazed vessels, as glazes generally contain lead compounds.(If available kilns in the Art and Craft Department of the School be made use of).	(P/D) Formation of glazes and glass.
16.5	Petroleum - 'Crude Oil'		
(a)	Origin of petroleum	Only brief mention Occurence in Malaysia	
(b)	Petroleum refining.	Refining as a process of fractional distillation. (Visit to Port Dickson/Lutong refineries, if possible. Otherwise use films)	(P/D) Fractional distillation of crude oil. Use of fractional distillates etc.
			(P/D) Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide)
		Natural gas as fuel	
16.6	Salts from the sea.	The main intention is to explain the existence of common salt in the sea and hence the importance of the sea, now or in the past, in the provision of one of the world's most important chemicals.	(P) Evaporation of sea water to obtain salts.
			(P) Identification of sodium salts by flame tests.
			(P) Identification of chloride by electrolysis.
		Sedimentary rocks	(P) Purification of rock salt or crude salt.

16.7 The soil Environment.		
(a) Formation of soil	Simple treatment at this stage	(P) Setting of soil samples in water.
(b) Properties of soil	Investigation of some of the physical and chemical properties of soil, including some quantitative work on humus, water and air content.	(P) Microscopic examination of soil. (P) Bleaching of top soil, and subsoil samples with hydrogen peroxide. (P) Composition of soil samples.
(c) Some living things in the soil	Visible animals of the soil. Establish that there are many different kinds and an enormous population.	(P) Sort out leaf - litter and top soil in shallow plastic trays Use simple pictorial keys for identification. (D/P) Extract with Tallgren and Bearman funnels (D) Extraction of earthworms with dilute formaldehyde solution.
	Presence of living things in the soil which are not visible to the naked eye. (Allow two or three groups to try sources other than soil).	(P) Respiration produces carbon dioxide, use sieved soil from which visible animals have been removed.
	These organisms may be harmful, may cause disease or may act as parasites.	(P) Agar plates and soil water, tap water, pond water, milk etc.
	Useful application of such life.	(P) Culture Pythium (damping off) on seedlings. (Use of film material suggested where possible).
	Contamination of food and steps to reduce or prevent this.	(P) Different groups make bread or alcohol.
(d) Conservation	Man's interference with soil by common agricultural practices needed to maintain crop growth	(P/D) Culture solutions experiments. Emphasise the need for nitrogen, phosphorus and sulphur.
	The need for conservation	(D) Visual aids, including films.
	(This section is an indication of how a brief ecological study of an environment can be carried out. If teachers wish, rock pools, belukar or any other area can be treated this way: This will of course require visits outside school to the area chosen).	