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)
Syllabus:

Integrated Science

Pusat Perkembangan Pelajaran
March, 1973

Revised Version
Contents

1. Introductory notes.
2. List of topics.
3. Objectives.
4. Syllabus sections.
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.
Time Allocation

The course is intended to be covered in three years with a weekly time allocation of 300 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.

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.

<table>
<thead>
<tr>
<th>Question Category *</th>
<th>Proportion (roughly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50 %</td>
</tr>
<tr>
<td>B</td>
<td>30 %</td>
</tr>
<tr>
<td>C</td>
<td>15 %</td>
</tr>
<tr>
<td>D</td>
<td>5 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of Complexity</th>
<th>Proportion (roughly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple (S)</td>
<td>40 %</td>
</tr>
<tr>
<td>Medium hard (M)</td>
<td>40 %</td>
</tr>
<tr>
<td>Hard (H)</td>
<td>20 %</td>
</tr>
</tbody>
</table>

*Key to Symbols

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

B (Comprehension) ...... including ability to extend a principle to a known 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.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabus</td>
<td>Teachers should study the syllabus carefully, paying special attention to the specific objectives for each section of the syllabus.</td>
</tr>
<tr>
<td></td>
<td>The syllabus, and not the worksheets, will form the basis for the Lower Certificate Examination.</td>
</tr>
<tr>
<td>Worksheets</td>
<td>At present, the teaching method should be geared to the use of specially prepared worksheets. Teachers are encouraged to supplement these work-</td>
</tr>
<tr>
<td></td>
<td>sheets by writing appropriate ones wherever possible to suit the needs of their pupils. However, the general principles of worksheet construction should be adhered to.</td>
</tr>
<tr>
<td>Textbooks</td>
<td>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.</td>
</tr>
<tr>
<td>Teachers' Guide</td>
<td>Teachers should consult these as frequently as desirable.</td>
</tr>
<tr>
<td>Curriculum Paper No. 7</td>
<td>This paper on Science for General Education (UNISO) is a very useful teacher guide to the philosophy, rationale and method to the teaching of this course and should be consulted wherever possible.</td>
</tr>
<tr>
<td>Apparatus and Equipment</td>
<td>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.</td>
</tr>
<tr>
<td>Audio-visual Aids</td>
<td>Judicious use should be made of these, if available, to achieve desirable lesson objectives.</td>
</tr>
</tbody>
</table>
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
Section 1:
Methods of Heat Transfer
Some Problems Situations

Section 2:
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 3:
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 4:
Detecting the Environment
10.1 Rectilinear propagation 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 5:
Solutes and solvents
11.1 The water cycle
11.2 Solubility in aqueous solvents
11.3 Non-aqueous solvents
11.4 Emulsions and colloids

Section 6:
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.
Section 12: 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 occurring elements
16.3 Naturally occurring 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 con-
clusions.

(5) 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 in-
formation 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 interconvertible.

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

knowledge of the need for oxygen in combustion.

knowledge of the approximate composition of air.

some information about the noble gases.

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

knowledge of some facts about respiration and rusting of iron.

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

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

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

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

awareness of the industrial importance of the gases of the air.

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

In Section 6: Cells and Reproduction

knowledge of the cell as a unit of structure in organisms.

knowledge of the cell as a unit of reproduction in organisms.

knowledge of the reproduction of cells and the replication of living material.

some information on the methods of achieving fertilisation.

on understanding of the concept of fertilisation.

knowledge of the facts of mammalian reproduction.

some information on cellular growth and the development of multicellular organisms.

some information on methods of caring for young organisms.

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

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

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

an objective attitude to the facts of reproduction.

an awareness of the continuity of living tissues from generation to generation.

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 of 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.
the knowledge that $pH$ is a measure of the degree of acidity of a solution.

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

the knowledge that acids neutralise alkalis.

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

awareness of the processes involved in identifying a chemical substance.

awareness of the use of standard scales for comparison purposes.

skills in handling simple chemicals and glassware.

awareness of the dangers of handling hydrogen in large quantities.

In Section 10: Detecting the Environment

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

knowledge of some facts about the human eye.

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

knowledge of some facts about a lens camera.

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

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

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

awareness of our reliance on binocular vision for many judgements.

some skill in the use of simple dissecting instruments.

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

knowledge of the operation of the bones of the inner ear.

the knowledge that the production of sound requires a vibration.

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

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

the knowledge that the ear has a limited band of reception.

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

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

awareness of the receptors of communication and man's dependence upon them.
knowledge of some facts about taste and smell.

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

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

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

ability to design experiments to investigate stated hypotheses

awareness of the limitations of taste, smell and touch.

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

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

knowledge of some facts about evaporation and cloud formation.

knowledge of some facts about water purification.

knowledge of some facts about solubility.

knowledge of some facts about crystals.

some information about solvents and extractions.

some information about colloids.

ability to form hypotheses concerning solubility and to test these experimentally.

ability to design experiments concerning solubility

ability to work with multiple variables in these experiments

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

awareness of need to conserve water and of the importance of water to man.

skills in using some scientific techniques e.g. crystallising, chromatography, emulsifyine.

In Section 12: Food and the Transport Systems

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

knowledge of some facts about teeth.

some information about feeding in animals other than man.

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

knowledge of the use of control experiments in enzyme.

knowledge of some facts about various transport systems in plants and animals.
knowledge of some facts about elimination and excretion in plant and animals.

ability to apply knowledge to form classifications

ability to relate structure to function

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

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

an interest in maintaining healthy teeth.

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

further skill in simple biological techniques

In Section 13: Electricity and Magnetism (II)

some information about the relationship between electrical units.

some information about costing electrical energy.

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

knowledge of some facts about electromagnetism

knowledge of some facts about discharge tubes

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

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

the knowledge that there is a.c. as well as d.c.

ability to apply knowledge of electrical circuitry to domestic wiring.

ability to analyse current relationships in parallel circuits.

ability to calculate fuse values for given situations

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

awareness of and an interest in leisure pursuits in electronics

further skill in wiring techniques.

In Section 14: Support and Movement

knowledge of what a force does

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

the knowledge that friction is always a resisting force

knowledge of certain facts about gravity

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
knowledge of some facts about micro-organisms.

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

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

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).

further ability to use a key in identifying unknown creatures

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

interest in the need for conservation of fuel resources

awareness of the importance of the sea as a source of mineral

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

various chemical and biological skills

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.

<table>
<thead>
<tr>
<th>Syllabus Topic</th>
<th>Notes</th>
<th>Suggested Practical Work</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1. Basic laboratory techniques</strong></td>
<td></td>
<td><strong>and use of units.</strong></td>
</tr>
<tr>
<td>(a) Measurement of length, mass, time</td>
<td>-</td>
<td>Use of the ruler, balance, stopwatch/stopclock and thermometer. (S.I. units to be used throughout)</td>
</tr>
<tr>
<td>and temperature</td>
<td></td>
<td>(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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Aids to measurement including strings, dividers, calipers (not vernier) map measurer etc. may be used.</td>
</tr>
<tr>
<td>(b) Measurement of area</td>
<td>-</td>
<td>Method to include the counting of squares (Besides m², cm² may also be used).</td>
</tr>
<tr>
<td>(c) Measurement of volumes</td>
<td>-</td>
<td>Volumes of solids (regular and irregular), liquids and gases.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The use of graduated cylinders, plastic syringers and droppers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Besides m³, cm³ may also be used).</td>
</tr>
</tbody>
</table>


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.

(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.

(c) Variations among living organisms

- Simple experiments leading to first ideas of variations common to all living organisms.

Notes

- The use of the formula

\[ \text{Density} = \frac{\text{Mass}}{\text{Volume}} \]

is not required.

- Safety precautions in using the burner.

- To include the filter funnel retort stand and clamps, tripod stand, etc.

- These should be discussed in connection with practical work.

Suggested 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.

(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.

(P) Activities leading to the awareness of variations within one kind of
Density = \frac{Mass}{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.

- Simple experiments based on magnets etc.

- Simple experiment based on the burning of a candle in air.

- 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.

(c) Variations among living organisms
- Simple experiments leading to first ideas of variations common to all living organisms.

- 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.

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<tr>
<th>Syllabus Topic</th>
<th>Notes</th>
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<tbody>
<tr>
<td>2.1. An investigation of some living things</td>
<td>- The intention here is to carry out some simple investigations into some common organisms.</td>
<td>(P) Investigation and observation on some common organisms such as the earthworm, cockroach, grasshopper, garden snail, fish, bird, mouse etc.</td>
</tr>
<tr>
<td></td>
<td>(a) external structure (b) movement (c) habitat (d) general habits such as reactions to stimuli, food choice etc.</td>
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<td>- The investigations should continue for several weeks if necessary.</td>
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<td>- Observations are to be recorded systematically in order to formulate hypotheses.</td>
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<tr>
<td></td>
<td>- Groups of pupils can work on different organisms, discuss differences in results etc.</td>
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</tr>
<tr>
<td>2.2. Diversity of form</td>
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<td></td>
</tr>
<tr>
<td>(a) There is a great variety of animals and plants.</td>
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<td></td>
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<tr>
<td>(b) External features to indicate diversity of form.</td>
<td></td>
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<tr>
<td></td>
<td>- Introduce a variety of plants and animals.</td>
<td>(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.</td>
</tr>
<tr>
<td></td>
<td>- The emphasis should be entirely on things which can be seen with the naked eye.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Establish the fact that this is only a minute sample of the immense number of different plants and animals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Wherever possible specimens should be living and common in the locality of the school.</td>
<td>mushroom, bread mould, fern, mass, alga etc.</td>
</tr>
<tr>
<td></td>
<td>- Collecting of such living things should be permitted.</td>
<td>Hydra earthworm, roundworm, grasshopper, cockroach, butterfly, garden snail, cockershell,</td>
</tr>
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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.

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<td>(b) movement</td>
<td>- Observations are to be recorded systematically in order to formulate hypotheses.</td>
<td>Practical work should include</td>
</tr>
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<td>(c) habitat</td>
<td></td>
<td>(a) looking at the external structure of the organism.</td>
</tr>
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<td>(d) general habits such as reactions to stimuli, food choice etc.</td>
<td>- Groups of pupils can work on different organisms, discuss differences in results etc.</td>
<td>(b) finding out how it moves.</td>
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<td></td>
<td>(c) setting up a suitable habitat in the laboratory.</td>
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<td>(d) finding out about its habits including reactions to stimuli and food choice.</td>
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<td>- Collecting of such living things should be maintained as far as possible through the course.</td>
<td>hydra earthworm, round worm, grasshopper, cockroach, butterfly, garden snail, cockershell, prawn, crab etc.</td>
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<td></td>
<td></td>
<td>fish, frog, toad, lizard, bird, mouse, etc.</td>
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</table>
2.3. An idea of Classification

(a) The need for classification as a natural consequence of Section 2.2 is evident.

(b) (i) Living things and non-living things. Very simple treatment at this stage should be made - no mention of words such as phyla, genera, etc.

(ii) plants and animals.

(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.

(c) Construction of simple keys. Introduction to the construction of simple keys as a means for classification and identification.

(P) Visit to school library use of stamps albums etc. to familiarise the pupils with the idea of classification.

(P) Sorting specimens into large groups e.g.

- plants into flowering and non-flowering
- animals into those with backbones and without backbones.
- Vertebrates into mammal, birds, fish, amphibian and reptiles.

(P) Construction of simple keys for any simple group of plants, 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.

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<tr>
<td><strong>3.1. Forms of energy</strong></td>
<td>- The pupils should be introduced to the various forms of energy using everyday examples.</td>
<td>(D) - A few introductory demonstration experiments on the forms of energy.</td>
</tr>
<tr>
<td></td>
<td>- Energy forms (a) - (h) should be mentioned at this stage; not necessarily in that order.</td>
<td>- The 'energy kit' or energy converters like electric fan, toy motors, bicycle dynamo etc. may be used.</td>
</tr>
<tr>
<td>(a) kinetic (or motion) energy.</td>
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<tr>
<td>(b) heat energy</td>
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<td>(c) light energy</td>
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<tr>
<td>(d) sound energy</td>
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<tr>
<td>(e) potential or stored) energy.</td>
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<tr>
<td>(f) chemical energy</td>
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<tr>
<td>(g) electrical energy</td>
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<tr>
<td>(h) atomic or nuclear energy.</td>
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<td><strong>3.2. Energy interconversion</strong></td>
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</tr>
<tr>
<td>Energy can be converted from one form to another.</td>
<td>- A wide range of simple energy changes is provided for the pupils to look at and classify.</td>
<td>(S) A wide variety of simple examples is set up at stations in the laboratory for pupil activity.</td>
</tr>
<tr>
<td></td>
<td>- At this stage it is only necessary for pupils to indicate the main energy changes e.g.</td>
<td>Some examples of main energy changes should include the following.</td>
</tr>
<tr>
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<td>(a) kinetic energy → heat energy</td>
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<td></td>
<td>(b) electrical energy → heat energy and sound energy etc.</td>
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</tr>
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<td></td>
<td>kinematic to heat; sound; potential; electrical &amp; light.</td>
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<tr>
<td></td>
<td>electrical to heat; light; potential; sound; kinetic.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>heat to light; kinetic; sound;</td>
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<td></td>
<td>Chemical to heat; sound; light;</td>
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<tr>
<td></td>
<td>potential to heat; kinetic.</td>
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</table>
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.

Suggested Practical Work

(S/D) Experiments to illustrate the working of energy conversion such as (a) - (e)

(P) Hero's engine, water wheel, model telegraph etc.

(P) Compare effects of heating of various foods in air or in oxygen.

(D/P) Compare the ratio of liberation of heat energy by living things and non-living things.

(P) Class Project

Using the results from class experiments make a large chart of 'energy chains'.

Notes

- Energy_and_living_things

(a) Foods are necessary for warmth, movement, respiration, growth and reproduction of living things.

(b) The stored (chemical) energy of foods can be released under suitable conditions.

(c) The food of animals is mainly 'organic' coming from other animals or from plants; all are complex substances containing carbon.

(d) Source of energy in living things.

A more detailed study of foods and energy will be done in Section 5 and 14.

There is opportunity here to trace the source back to the sun.
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<td>(d) storage batteries</td>
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<td>(e) electric lifts</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>There is also opportunity here for model construction by pupils; encouragement for choice of hobbies etc.</td>
<td>(P) Hero's engine, water wheel, model telescope etc.</td>
</tr>
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</table>

| 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' with the sun as the ultimate source of energy for mankind. |

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

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Syllabus Topic

4.1 Evidence for the fine division of matter

(a) States of matter: solid, liquid, gas.

(b) Matter is made up of discrete, tiny particles

(c) Particles in solids are relatively closely packed; they are less so in liquids; and least so in gases.

Notes

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.

The pupils should NOT be provided with an atomic theory and then be asked to use the experimental evidence to verify it.

Teachers should encourage pupils at every stage to formulate simple theories based on experimental evidence obtained.

The difference between theory and fact should be emphasised.

Suggested Practical Work

(F) Examples of solids, liquids and gases (revision)

(P) Diffusion of gases from balloons.

(R) Diffusion of perfume or other gases from one part of room to another.

(B) Diffusion of nitrogen dioxide or bromine (great care) in air and vacuum.

(F) Diffusion of copper sulphate in water or iodine in dilute potassium iodine solution.

(P/D) Diffusion of copper sulphate potassium permanganate or other coloured salts in gels.

(P) Dilution experiments.

(C) Oil film experiment (no calculation required)

(?) Volume change on addition of 50cm³ water to 50cm³ alcohol (used methylated spirit).

(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 with ink etc.)
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<tr>
<td><strong>4.2 Kinetic theory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Solids, liquids and gases.</td>
<td>The difference between solids, liquids, and gases is pictured as moving particles and owing to the nature of movement of the particles.</td>
<td>(D) Solid carbon dioxide ('dry ice') changing into gas in a balloon.</td>
</tr>
<tr>
<td>(b) Particles are always in a state of motion</td>
<td>There is no need to discuss movement by rotation of particles.</td>
<td>(D) Sublimation of solid iodine.</td>
</tr>
<tr>
<td>(c) Energy changes particles during change of state</td>
<td></td>
<td>(D) Kinetic theory illustrated by the use of mechanised models.</td>
</tr>
<tr>
<td><strong>4.3 Structure of matter</strong></td>
<td></td>
<td></td>
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<tr>
<td>(a) Metals and non-metals</td>
<td>Simple physical properties of metals and non-metals to be investigated.</td>
<td>(P) Physical properties of metals and non-metals.</td>
</tr>
<tr>
<td>(b) Elements and compounds</td>
<td>Naming of elements. However use of chemical symbols is not required.</td>
<td>(P) Experiments on iron filings and sulphur.</td>
</tr>
<tr>
<td>(c) Making and breaking compounds</td>
<td>For example, by combining of copper directly with chlorine and electrolyzing copper (II) chloride solution. There is no need to distinguish between physical and chemical changes but show that the formation and decomposition of compounds involve energy changes.</td>
<td>(D) Direct combination of copper foil or Dash metal and chlorine.</td>
</tr>
<tr>
<td></td>
<td>The use of the terms 'atoms' and 'molecules' but there is no need at this stage to mention 'ions'</td>
<td>(P) Electrolysis of copper (II) chloride solution (Pencil 'lead' or carbon rods used as electrodes).</td>
</tr>
<tr>
<td>(d) Atoms and molecules</td>
<td></td>
<td>(P/D) Make or show similar molecules using polystyrene spheres or other material.</td>
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<tr>
<td><strong>4.4 Applications of kinetic theory</strong></td>
<td></td>
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</tr>
<tr>
<td>(a) Relative weights of solids, liquids and gases.</td>
<td>The usual long series of experiments on density or relative density is avoided.</td>
<td>(P) A volume of ir (gas) weights less than an equal volume of water (liquid).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(P) A volume of water (liquid) weighs less than an equal volume of sand (solid).</td>
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<tr>
<td>(b) Expansion of solids, liquids and gases</td>
<td>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.</td>
<td>(D) Formation of layers according to density in liquids.</td>
</tr>
<tr>
<td>(c) Gas pressure</td>
<td>The applications are on some modern everyday examples such as, thermometer, fire alarms, compensation in watches, thermostats etc.</td>
<td>(F) Expansion of solids and gases</td>
</tr>
<tr>
<td>(S/D) Heating of compound bar (bimetallic strip)</td>
<td>(S/D) Bar-and-gauge experiment</td>
<td></td>
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<tr>
<td>(S/D) Ball-and-ring experiment</td>
<td>(S/D) Force of contraction, breaking iron pin.</td>
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<td>(D) Partially inflated balloon in a bell jar.</td>
<td>(D) Collapsing can (or plastic bottle) – may be connected to a vacuum pump.</td>
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<tr>
<td>(D) Aneroid barometer</td>
<td>(S) Simple pressure experiments using:</td>
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<tr>
<td></td>
<td>(a) syringes</td>
<td></td>
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<td></td>
<td>(b) Bourdon gauge</td>
<td></td>
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<tr>
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<td>(c) Magde burg, hemispheres. (or plumbers cups)</td>
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<td>(d) Manometre, etc.</td>
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The kinetic theory and structure of 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.

(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.

(c) Gas pressure

This sub-section allows the use of simple kinetic theory to predict and explain the properties of gases

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.

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.

To ascertain the depth of treatment of these topics reference should be made to the specific objectives of this section.

(F) 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.

(D) Partially inflated balloon in a bell jar.

(D) Collapsing can (or plastic bottle) - may be connected to a vacuum pump.

(D) Aneroid barometer

(S) Simple pressure experiments using:

(a) syringes
(b) Bourdon gauge
(c) Magdeburg, hemispheres, (or plumbers cups)
(d) Manometre, etc.
Section 5:

**COMM 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.

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<td>5.1 (a) Simple laboratory preparation of oxygen and carbon dioxide</td>
<td>The pupils need not know the method of preparation of nitrogen.</td>
<td>(P/D) Preparation of oxygen from hydrogen peroxide.</td>
</tr>
<tr>
<td>(b) Simple properties of oxygen, carbon dioxide and nitrogen</td>
<td>It is intended that pupils should discover distinguishing tests for these gases.</td>
<td>(P/D) Preparation of carbon dioxide from limestone and hydrochloric acid.</td>
</tr>
<tr>
<td>(c) Carbon dioxide as a compound of carbon and oxygen.</td>
<td>Give the pupils an opportunity to make hypothesis as to the nature of carbon dioxide.</td>
<td>(F) Solubility in water.</td>
</tr>
<tr>
<td>5.2 Composition of air</td>
<td>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.</td>
<td>(P/D) Solubility in sodium hydroxide and alkaline pyragallol.</td>
</tr>
<tr>
<td>(a) Oxygen</td>
<td></td>
<td>(F) Burning splint and glowing splint tests.</td>
</tr>
<tr>
<td>(b) Carbon dioxide</td>
<td></td>
<td>(F) Effect of moist pH paper (or universal indicator).</td>
</tr>
<tr>
<td>(c) Nitrogen</td>
<td>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.</td>
<td>(F) Effect on lime-water and bicarbonate indicator.</td>
</tr>
<tr>
<td>(d) Noble gases</td>
<td></td>
<td>(P/D) Burning magnesium in carbon dioxide.</td>
</tr>
<tr>
<td>(e) Water vapor</td>
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<td>(a) Oxygen</td>
<td></td>
<td>(P) Effect of moist pH paper (or universal indicator).</td>
</tr>
<tr>
<td>(b) Carbon dioxide</td>
<td></td>
<td>(P) Effect on lime-water and bicarbonate indicator.</td>
</tr>
<tr>
<td>(c) Nitrogen</td>
<td>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.</td>
<td>(P/D) Burning magnesium in carbon dioxide.</td>
</tr>
<tr>
<td>(d) Noble gases</td>
<td></td>
<td>(P) Air is necessary for things to burn (Revision)</td>
</tr>
<tr>
<td>(e) Water vapour</td>
<td></td>
<td>(P) Is all the air used up in combustion? (Revision)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(P) What is the nature of the gas remaining? (Revision)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(P) Increase in mass on burning e.g. magnesium in air.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(P/D) Simple 'synthesis' of air by mixing nitrogen and oxygen in various proportions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(D) Where possible simple demonstration of the properties of liquid air and solid carbon dioxide ('dry ice') should be carried out.</td>
</tr>
</tbody>
</table>

Reference may be made to the pressure of water vapour, dust particles and bacteria etc. in the atmosphere.
### 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. |

| (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. |

### 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. |

### 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 |

| (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. |

| (c) Energy is used for body warmth, movement, growth and reproduction etc. |

### Suggested Practical Work

- **However, great care should be taken in handling these substances.**
- **(D) Films, visits to factories etc.**
- **(F) 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.
- **(F) Burn carbon, bread/rice and sugar etc in air or oxygen to show products giving 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**
- **(P/D) Boil out air from river or pond water and test for oxygen.**
- **(P/D) Release of energy from living things**
  - Let pupils breathe on thermometer
  - germinating seeds etc. in vacuum flasks.
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<tbody>
<tr>
<td><strong>5. Respiratory system</strong></td>
<td><strong>Provide diagrams of lungs, ribcage, diaphragm etc.</strong></td>
<td>(p) Face mask showing lungs or goats lungs.</td>
</tr>
<tr>
<td>(a) Respiratory organs</td>
<td><strong>Brief reference to artificial respiration and pressure difference in the lungs during breathing.</strong></td>
<td>(q) Apparatus to show action of diaphragm in breathing.</td>
</tr>
<tr>
<td>(b) Gas exchange in the lungs - diffusion of gases</td>
<td><strong>Pupils can trace source of common foods back to plants</strong></td>
<td>(d) Apparatus to show action of diaphragm in breathing.</td>
</tr>
<tr>
<td>(c) Mechanism of breathing</td>
<td></td>
<td>(d) Model showing action of rib muscles.</td>
</tr>
<tr>
<td><strong>5.7 Energy intake and photosynthesis.</strong></td>
<td></td>
<td>(d) Films on respiration.</td>
</tr>
<tr>
<td>(a) Energy in food (revision) photosynthesis:</td>
<td><strong>Plants take in energy from the sun. They are producers of organic substances.</strong></td>
<td>(b) Charts or films on food chains, food webs, etc.</td>
</tr>
<tr>
<td>(b) Plants as intermediate source of energy for animals (producers and consumers)</td>
<td><strong>Animals are consumers</strong></td>
<td>(e) Removal of carbon dioxide from air by leaf using bromthymol blue indicator.</td>
</tr>
<tr>
<td></td>
<td><strong>Carbon dioxide 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</strong></td>
<td>(p) Starch test in green leaves.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Building of starch from glucose in leaf discs of squares floating glucose solution.</td>
</tr>
<tr>
<td></td>
<td><strong>Importance of photosynthesis to all life should be made clear.</strong></td>
<td>(p) Chlorophyll is necessary in photosynthesis - test variegated leaf.</td>
</tr>
<tr>
<td><strong>5.6 Rusting</strong></td>
<td></td>
<td>(p) Examine pond weed under microscope (M.P.) Show that chlorophyll is in chloroplasts.</td>
</tr>
<tr>
<td><strong>5.9 Industrial uses of common gases - oxygen nitrogen, carbon dioxide, noble gases</strong></td>
<td><strong>Simple conditions for rusting and common methods of preventing rusting should be discussed.</strong></td>
<td>(F) Slide or photomicrograph of T.S of leaf to show stomata and air space.</td>
</tr>
<tr>
<td></td>
<td><strong>Industrial uses and importance to be discussed briefly.</strong></td>
<td>(p/D) Liberation of oxygen from water plants</td>
</tr>
<tr>
<td></td>
<td><strong>Air pollution problems in towns and cities may be touched upon here.</strong></td>
<td>(F) Experiments to show that water, air (oxygen) are necessary for rusting.</td>
</tr>
</tbody>
</table>
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.

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<tbody>
<tr>
<td>5.1 Cells and living things</td>
<td></td>
<td>(P) Examination of cells from various tissues e.g. onions scale epidermal peel, macerated balsam stem, crinum lily, pollen and cheek cells.</td>
</tr>
<tr>
<td>(a) Simple structure of plant and animal cells</td>
<td>The structure of plant and animal cells as revealed by light microscopy is introduced very simply.</td>
<td></td>
</tr>
<tr>
<td>(b) Unicellular organisms</td>
<td>Living things also exist which are composed of single cells but all at the microscopic level.</td>
<td>(D) Observation of slides or photomicrographs of animal sperm and egg.</td>
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<td></td>
<td>(P/D) Observation of one or two unicellular organisms e.g. Paramoecium and pond organisms (Hay infusion may be used here).</td>
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<tr>
<td>5.2 Cells in reproduction</td>
<td></td>
<td>(P) Observation of simple reproductive structure of a flower.</td>
</tr>
<tr>
<td>(a) Simple fission</td>
<td>The role of cells in reproduction is briefly studied.</td>
<td>(D) Viewing of 8 mm film cassettes on fission in micro organisms such as Paramoecium.</td>
</tr>
<tr>
<td>(b) More complex reproduction</td>
<td>Simple fission of single cell micro-organisms is a form of reproduction.</td>
<td>Also photomicrographs of mammalian sperm and egg to show difference in size and shape.</td>
</tr>
<tr>
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<td>With complex multicellular plants and animals simple fission is not possible. Special male and female cells are required.</td>
<td>(P) Examination of pollen grains and section of unfertilised carpel.</td>
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<td>(P) Examination of various different flowers stamens; pollen grains on a microscope slide.</td>
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<td></td>
<td>(P) Examination of fish roes.</td>
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<td>The role of cells in reproduction is briefly studied.</td>
<td>(D) Viewing of 8 mm film cassettes on fission in micro-organisms such as Paramococium. Also photomicrographs of mammalian sperm and egg to show difference in size and shape.</td>
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<td>(P) Examination of fish roe.</td>
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</tr>
<tr>
<td></td>
<td>(D) Dissection of mammal to show goneral position of ovaries and testes.</td>
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</tbody>
</table>
### Syllabus Topic

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<tbody>
<tr>
<td>6.3 Methods of achieving fertilisation</td>
<td>(a) Pollination and fertilisation in plants</td>
<td>(D) Films</td>
</tr>
<tr>
<td></td>
<td>Flowers use insects, wide etc. to transport pollen. Discuss briefly self-pollination and cross-pollination. Also cross-breeding in plants</td>
<td>(C) Films (P) Examination of flowers to find out how this is done. (F) Grow pollen tubes. (D) Film or slides of pollen tube entering an embryo sac.</td>
</tr>
<tr>
<td></td>
<td>(b) Fertilisation in animals</td>
<td>(D) Use of potato ceras technique, if possible; otherwise use film cassettes or slides. (D) Films on 'mating' etc.</td>
</tr>
<tr>
<td></td>
<td>Establish that fertilisation is an essential process in sexual reproduction in both plants and animals. 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.</td>
<td></td>
</tr>
<tr>
<td>6.4 The growing embryo</td>
<td>(a) The chick embryo</td>
<td>(D) Dissection (or examination of preserved specimen of pregnant rabbit, rat or guinea pig to show the reproductive system. (Reference should be made to the presence and arrangement of other organs)</td>
</tr>
<tr>
<td></td>
<td>Establish the need for food.</td>
<td>Opening of hen's eggs at 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.</td>
</tr>
<tr>
<td></td>
<td>Start with the developmental stages of fertilised hen's eggs. Then go on to the development of animal embryo within the uterus.</td>
<td></td>
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</tbody>
</table>

(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.

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</thead>
<tbody>
<tr>
<td>7.1 Methods of Heat Flow</td>
<td>- Pupils are first of all introduced to the three methods of heat flow by simple experiments.</td>
<td>(P) Heat waxed rod with pins, nails, etc. or with heat sensitive paper.</td>
</tr>
<tr>
<td>(a) conduction of heat energy</td>
<td>- A simple explanation in terms of particles should be forthcoming from pupils.</td>
<td>(P) Currents, shown by (a) potassium permanganate or dye etc. in water. (b) smoke in air</td>
</tr>
<tr>
<td>(b) convection of heat energy</td>
<td>- A simple picture is possible in terms of hot expanded fluid rising and cold fluid sinking (See Section 4.4)</td>
<td>(P/S) A series of experiments involving lagged, polished, dull surface etc.</td>
</tr>
<tr>
<td>(c) radiation of heat energy</td>
<td>- A simple idea that particles are not required for heat flow by radiation</td>
<td>(P) Thermometer in evacuated flask etc.</td>
</tr>
</tbody>
</table>

1.2 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. |

(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.

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<tbody>
<tr>
<td>8.1 Electricity at rest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Charging by friction</td>
<td>- The success of these activities depends on the humidity of the room. Humidity can be kept lower by ventilation.</td>
<td>(P) Charging balloons to show presence of charges.</td>
</tr>
<tr>
<td>(b) Two types of charges:</td>
<td></td>
<td></td>
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<tr>
<td>positive and negative</td>
<td></td>
<td>(P) Charged plastic strips of different kinds placed on inverted watch glass or attached to strings, etc.</td>
</tr>
<tr>
<td>(c) Like charges repel each</td>
<td></td>
<td>(D) Metallised spheres attracted and repelled.</td>
</tr>
<tr>
<td>other. Unlikes charges attract each other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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'.

(b) Conductors and insulators - Continuity tester may be improvised.

- Also identify which parts of an electric bulb are conductors and which are insulators.

(c) Switches - Examine various types including household switches. (toggle, tumbler, pendant etc.).

(d) Current in a series circuit - Show that the current around a series circuit is the same at various points on the circuit.

- Use water analogy for current only, not potential difference (p.d.)

(e) Unit of electric current - 'Ampere' is introduced symbol for ampere is A. There is no need to define ampere at this stage.

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.

(b) Conductors and insulators - Continuity tester may be improvised.

- Also identify which parts of an electric bulb are conductors and which are insulators.

(c) Switches - Examine various types including household switches. (toggle, tumbler, pendant etc.).

(d) Current in a series circuit - Show that the current around a series circuit is the same at various points on the circuit.

- Use water analogy for current only, not potential difference (p.d.)

(e) Unit of electric current - 'Ampere' is introduced symbol for ampere is A. There is no need to define ampere at this stage.

(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.
(f) cells in series - There is no need to mention 'volts' yet at this stage.

- The motorcar or motor-cycle battery is an example of cells in series. There is no need at all to discuss the theory.

(g) current in parallel branches - At this stage only simple treatment. More can be done in subsequent sections.

(h) use of continuity tester - This can be improvised from cells and a bulb with two leads.

8.4 Opposing the current - resistance

(a) Effect of change of length and gauge of wire - The intention here is to 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.

(b) Variable resistor - Application from 'volume control' to lamp dimmer

- The ohm as a unit of electrical resistance need not be mentioned at this stage.

(P) On circuit board, two cells
- connected + to +
- connected + to -
- with one bulb
- with two bulbs

(D) Examine car or motor-cycle battery.

(P) Bulbs in parallel branches. (Why should the bulbs light?)

(P) Comparing current in different parts of circuit using ammeters at various points.

(P) To test for faulty circuits.

(P) Change in effective length of wire using a crocodile clip as contact at various points on wire.

(P) Effect on brightness of bulb and ammeter reading

(P) Repeat the experiment using wires of different gauge.

(P) Radio-type resistor ammeter and bulb, or circuit board.
2.5 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 the electrical resistance or p.d. at this stage.

(b) Fuses

- This is an application of the heating effect of current.

- 1/4-A fuses are suitable for this experiment. Or use a very thin strand of wire.

2.6 Driving the current - voltage

(a) Voltage

- 'Voltage' is now introduced. The symbol for 'voltage' is \( V \). The symbol for 'current' is \( I \)

(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.

(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.

(P) Equal lengths of resistance wire (e.g. nichrome, of different gauges) in series on circuit board.

(P) Set up circuit with one bulb and one cell. Short circuit the bulb. Wire becomes hot.

(P) Wire a fuse link to three cells, ammeter, and resistor. Gradually increase current until fuse melts.

(P) Three bulbs in series with three cells.

- Voltmeter across bulbs in turn, across two bulbs and then all three.

(S) Various sources tested for voltage - all low voltage e.g. the accumulator, dry cell etc.

(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

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</table>
| 9.1 Hydrogen - properties and preparations | - This gas is introduced as another gas (P) Solubility of hydrogen
- Allow pupils to test and become familiar with identification test (P) Hydrogen is less dense than air
- The use of hydrogen cylinders is not recommended (P) Hydrogen burns in air but does not support combustion.
- Hydrogen may be identified by the following:
  (a) Burrs explosively in a mixture of hydrogen and air (P) Identification test (small test tube only)
  (b) Burns in air or oxygen to form water only (see Section 9.2)
| 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.) (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.
- Discuss why water is a compound (hydrogen oxide) and not a mixture of hydrogen and oxygen. |
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 tonic theory is required here, for explanation.

9.4 Action of metals on water

(a) Sodium - Great care must be taken with sodium. Avoid using potassium here.

(b) Calcium

(c) Magnesium - Use sodium, calcium and magnesium to establish order of activity.

No attempt should be made to collect the gas produced.

9.5 Action of metals on dilute acids

(a) magnesium - Various metals should be tried. Only one acid need be used. Dilute hydrochloric or sulfuric acid is suitable.

(b) aluminium,

(c) iron

(d) lead

(e) tin

(f) copper - The acid is introduced at this stage merely as a hydrogen-containing substance.

- Here a further gradation of reactivity is obtained.

9.6 Acids and alkalis - Definitions of 'acid' and 'alkali' are not required and reference 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 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 'neutralising' alkali.

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).

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 ionic theory is required here.

(P) Preparations of 2 or 3 salts using dilute hydrochloric, sulphuric and nitric acids with sodium, potassium 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.

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

- Resemblence of eye to camera; lens, blackened interior, light-sensitive surface etc. Difference in method of focussing in the eye and the camera.

Vision: some limitations

(a) Colour blindness
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.

(P) Colour vision test cards.

(b) Blind spot

(S) Experiments to demonstrate other limitations of vision. e.g. (b) to (e)

(c) Single-eye and stereo-vision

(d) Optical illusions in shapes and colours
Colour is seen only in the centre of the retina.

10.6 Vision: some defects

Further work with prisms leading to the understanding of the behaviour of diverging (concave) lenses.

(a) Short 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.

(b) Long sight

(c) Correction of shortsight and longsight
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.
Sources of sound

The structure of the ear is studied in relation to the detection of sound.

- Discuss to bring out the function of the bones in the middle ear.

Varieties of sound sources studied to show that sound is caused by vibration.

- Energy changes involved may be discussed.

Transmission

- The need for material medium for the transmission of sound is demonstrated.

10.5 Hearing: some limitations and defects

Frequency and pitch

- Variation of pitch with number of vibrations per second i.e. frequency.

  The unit of frequency is Hertz (Hz).

- Use of simple objects, rules, elastic bands, etc.

  Vary tension and length to increase frequency.

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 detected.

- 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.)
10.9 Balance

- The importance of stereo-audio properties of ears
- The need for a combination of signals e.g. eye pressure, muscle tension, sound.

Discuss briefly the role of the semi-circular canals in the ear.

(P) Detection by pupil (blindfolded) of the direction of sound source.
(P) Blindfold pupil and push gently. (Note difficulty experienced by the pupil to balance himself.
(P) Spin pupil on chair, etc. Ask him to note direction of movement of room immediately on stopping.

10.10 The Nervous system

(i) The central nervous system

- Discussion on functions and importance of the brain and the spinal cord.
- Relate to the sense of hearing, balance and sight to certain nerve centres of the brain.

(D) Models and films, if available, on the central nervous system.

(ii) The surface nervous system

(i) centre of taste
- Indicate the narrow region of the mouth sensitive to taste and the range of this region.

(F) 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) Test knee or Achilles.
10.10 The Nervous System

(a) The central nervous system

- Discuss briefly the role of the semi-circular canals in the ear.

(b) The surface nervous system

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- Indicate the narrow region of the mouth sensitive to taste and the range of this region.

(ii) centre of smell

- Note the great increase in range and variety compared with taste.

(iii) areas sensitive to 'touch' and pain

- Note the wide areas on the body, sensitive to 'touch' and also the relative sensitivity.

(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) Blindfold pupil and push gently. (Note difficulty experienced by the pupil to balance himself)

(P) Spin pupil on chair, etc. Ask him to note direction of movement of room immediately on stopping.

(D) Models and films, if available, on the central nervous system.

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(P) Eliminate sight and taste. Then ask for the description of smells.

(P) Plot 'touch' (pain) nerve endings.

(P) Tap knee or Achilles heel reflex. Ask for resistance, then tap again.

(F) Discuss on functions and in importance of the brain and the spinal cord.

- Relate to the sense of hearing, balance and sight to certain nerve centres of the brain.

Indicate the narrow region of the mouth sensitive to taste and the range of this region.
Section 11: SOLVENTS AND SOLUTES

Changes of state are revised to introduce the water cycle. This leads to the consideration of various methods of water purification. Colloids and emulsions are included because of their practical significance.

### 11.1 THE WATER CYCLE

**Suggested Practical Work**

1. **Notes**

<table>
<thead>
<tr>
<th>Syllabus Topics</th>
<th>Notes</th>
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<tr>
<td><strong>D</strong></td>
<td><strong>P</strong></td>
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</table>

**Section 11:** SOLVENTS AND SOLUTES

- Experimentation
- Experiments and investigations
- Conditions
- Efforts of alcohol on animals like mice, hamster, web-spinning spider, etc.
- Films on this topic.

**Revision**

- L'mitatons of the human senses (a) (d)

**Revision**

- Human sense of the (experimentation (a))

**Revision**

- Human sense of the (experimentation (a))

**Revision**

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**Revision**

- Human sense of the (experimentation (a))

**Revision**

- Human sense of the (experimentation (a))
- It should be noted that the area of paper, cloth etc or volume of liquid drops exposed are variables.

(c) Cloud and mist formation

- Emphasise that clouds and mist are not in the gaseous state.

(d) Drinking water and its purification

- 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.

(e) Organisms in water

- Also show that these organisms can be killed by boiling the water.

(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.

11.2 Solubility in aqueous solvents

(a) Saturated solutions

- Limits to solubility of any one substance.
Variation of solubility

Factors affecting rate of solution
(i) particle size
(ii) stirring
(iii) temperature

Factors affecting solubility of a substance

Energy changes on solutions.

11.3 Non-aqueous solvents

Solvents to be used may be as follows, alcohol, acetone, petrol, kerosene, carbon tetrachloride.

(a) Solubility

(b) Extraction

Experiments with suitable 'controls'

Experiments on separating soluble from insoluble substances

PAPER CHROMATOGRAPHY AS A METHOD OF SEPARATION AND IDENTIFICATION

11.4 Emulsions and colloids

Make simple emulsions e.g. oil and soap, 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 test to identify a colloid and to distinguish it from a true solution.

- Iron (III) chloride hydrolyses in water to form iron (III) hydroxide colloid.

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.

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<td>12.1</td>
<td></td>
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<tr>
<td>(a) Types of food</td>
<td></td>
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</table>
| (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 | |
(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.

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<td>These are for energy (b) foods brought by pupils using</td>
<td></td>
</tr>
<tr>
<td>(iii) proteins</td>
<td>These are for growth and repair of body tissues and also for energy (i) iodine solution (starch)</td>
<td></td>
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</table>
12.2 Teeth and feeding

(a) Structure of a tooth Provide simple diagram of a tooth in longitudinal section to show enamel dentine, pulp, crown and root.

(b) types of teeth Discuss their relation to diet and method of feeding

(c) core of teeth Mention the importance of minerals including fluorides in the building of strong teeth.

12.3 Other method of feeding

A brief look at feeding methods of some invertebrates

12.4 Digestive system of a mammal Provide simple diagram of digestive system of human being for discussion following demonstrations.

12.4 Digestive system of small pond animals

(ii) Benedict's solution (sugar)

(iii) Millon's reagent or Biuret test (proteins)

(iv) filter paper or ethanol extract emulsion (fats)
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.

(b) Action of enzymes in

(i) the mouth

Enzymes are regarded here merely as agents in hydrolysis

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)

(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

12.6 The need for a transport system

(a) absorption

Absorption of food in the small intestine

(D) Visking 'sausage' with starch and glucose inside demonstration diffusion of smaller molecules.

(P) Saliva and starch or diastase and starch with a control.

(P) Digestion process in the stomach. Hydrochloric acid, rennin, pepsin or milk, etc.

(P) Starch and diastase in visking tubing

(D) Visking tubing experiments and diffusion experiments (Brownian movement) -- revision
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 (transverse 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.

(i) Circulation in: human beings

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 liver, kidneys, skin

Distinguish between excretion and elimination as follows:

(a) Excretion: extracting wastes from a circulatory medium and passing them to a temporary depot before elimination.

(b) Elimination: getting rid of wastes more or less mechanically

(b) Importance of skin

One function is regulating body temperature

(c) Routes by which waste materials leave the body

Animals: definite excretory system faeces and urine

Plants: 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

(D) Latex injection of fresh goat's kidney, if possible.

(P) Breath out into lime water / bicarbonate indicator.

(P) Weight of sweat produced per square metre on different parts of the body.

(P) Acetone or alcohol (methylated spirit) on back of hand.

(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.

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<td>(a) Conductors and insulators. A revision on work began in Section 8.</td>
<td>(p) Circuit boards with bulbs show also that electrolytes can conduct electricity.</td>
</tr>
<tr>
<td></td>
<td>(b) Methods of wiring No mains supply to be used; but establish the idea of household circuits.</td>
<td>(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.</td>
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<tr>
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<td>(c) Wiring plugs Connecting plugs to leads. Both international colour codes and 'old' colour codes should be introduced.</td>
<td>(p) Circuit boards with parallel branches. Total current related to number of branches added.</td>
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<td>(p) Use 5A, 3-pin plugs, car head lamp bulb and S.B.C. lampholder.</td>
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<td>'Old' code Earth: Green Live: Red Neutral: Black</td>
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<td>(d) Main's voltage Do's and dont's at mains voltage voltages. Discuss Lembaga Letrik Negara pamphlet on &quot;Safety&quot;.</td>
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<td>(e) Earthing Use of earth-wire and lightning conductor</td>
<td>(T) Van de Graaf generator discharge at points.</td>
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<td>(f) Fuse-rating The use of fuses of correct rating to be discussed.</td>
<td>(D) Household appliances connected to kilowatt-hour meter or</td>
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<td>(g) Power-rating Power-rating of various household appliances. Simple numerical problems may be given</td>
<td>(P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)</td>
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<td>Power supply information that 1 KW-h = 1 unit of electrical</td>
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<td>Power supply information that 1 KW-h = 1 unit of electrical energy.</td>
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<td>Current (A) = ( \frac{\text{Power (W)}}{\text{Voltage (V)}} )</td>
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</tbody>
</table>
13.2 Introduction to electronics

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<tr>
<th>(a) Conductors and insulators.</th>
<th>Revise - electrostatics and electrons (see Section 8)</th>
</tr>
</thead>
</table>

(b) One-way conduction

- Mention the use of divides and transistors in radios, rectifiers, and battery chargers etc.
- Use of one-way conduction in cathode - ray oscilloscope (C.R.O.)
- Deflect spot. Idea of scanning and persistence of vision

(c) Ionisation in discharge tubes

- No theory on ionisation to be discussed.
- Contrasts with filament lamp bulbs. Advantages - low wattage, higher efficiency etc.

13.3 Introduction to electromagnetism

<table>
<thead>
<tr>
<th>(a) Electromagnetic effects.</th>
<th>There is opportunity here to improvise apparatus.</th>
</tr>
</thead>
</table>

(b) Electromagnets

(c) Force on a conductor

(d) Electric bell

(e) Electric meter

(f) Electric motor

13.4 Electric Supply

<table>
<thead>
<tr>
<th>Generation of current.</th>
<th>Mechanical energy $\rightarrow$ electrical energy.</th>
</tr>
</thead>
</table>

| Simple electroscope used to identify charges. |
| Discharge of electroscope by conductors |
| Discharge electrostatic machine by path including microammeter. |
| Divide with milliammeter in series. |
| Maltese - cross tube on E.H.T. |
| Deflect beam by magnet. |
| C.R.O. experiments |
| Evacuate discharge tube to show glow. (Use E.H.T. power pack not induction coil) |
| Fluorescent lamp tubes, pilot bulbs etc. |
| Magnetic effect of a straight wire |
| a coil carrying a current. Behaviour of coil carrying a current. |
| Make electromagnets using U-shaped and bar soft iron. |
| Force on a wire carrying a current across a magnetic field 'catapult force' |
| Aluminium tape between poles of U-magnets. |
| Construction and working of an electric bell. |
| Construction of moving coil meter. |
| Construction of a model motor. |
| Dynamo using motor in reverse. |
(b) Idea of alternating current (A.C)

No theory - only simple idea that current is flowing in either direction.

(c) Change of current direction and strength.

(D/P) Connect coil to a centre-zero galvanometer and move bar magnet in coil.

(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.

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<td>14.1 Idea of force</td>
<td>A force is introduced as lifting, pulling, pushing, stretching, compressing or turning.</td>
<td>(P) Plasticene, springs, elastic bands, latex foam etc.</td>
</tr>
<tr>
<td>(a) Some examples.</td>
<td>Push-pull effect on shape. Effection motion.</td>
<td>(F) Change of speed and for direction.</td>
</tr>
<tr>
<td>(b) Idea of 'friction'</td>
<td>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.</td>
<td>(D) 'Frictionless' motion using air-pucks (balloon-type preferable) or object on polystyrene beads.</td>
</tr>
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<td>(c) Force due to gravity</td>
<td>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.</td>
<td>(N) 'Guinea and feather' experiment.</td>
</tr>
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<td>(d) 'Measuring force'</td>
<td>Investigation of springs. Spring balance. Introduction to the unit of force - the 'newton' (N).</td>
<td>(P) Making and providing a scale for a spring (or elastic band) balance.</td>
</tr>
<tr>
<td>(e) Turning effect of forces</td>
<td>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'.</td>
<td>(F) The law of lever experiment.</td>
</tr>
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<td>(f) Pairs of forces</td>
<td>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.</td>
<td>(D) Turning effect of forces.</td>
</tr>
<tr>
<td>(N/S) Water rocket, sausage balloon, exploding trolleys</td>
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<td>14.2 Work and energy</td>
<td>In section 3 various forms of energy and their interconversions were investigated.</td>
<td>(N) Transfer of energy in lifting load.</td>
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<td>(a) Idea of work</td>
<td>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)</td>
<td>(P) Energy transferred in climbing stairs.</td>
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<tr>
<td>Work done = Force x distance moved</td>
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<td>(b) Idea of 'friction'</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Force due to gravity</td>
<td>Investigation of springs. Spring balance. Introduction to the unit of force - the 'newton' (N)</td>
<td></td>
</tr>
<tr>
<td>(d) Measuring force</td>
<td>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'.</td>
<td></td>
</tr>
<tr>
<td>(e) Turning effect of forces</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Pairs of forces</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

14.2 Work and energy

In section 3 various forms of energy and their interconversions were investigated.

(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

(F) Plasticene, springs, elastic bands, latex foam etc.

(F) Change of speed and for direction.

(F) 'Frictionless' motion using air-pucks (balloon-type preferable) or object on polystyrene beads.

(C) 'Guinea and feather' experiment.

(F) Making and providing a scale for a spring (or elastic band) balance.

(F) The law of lever experiment.

(D) Turning effect of forces.

(S) Water rocket, sausage balloon, exploding trolleys

(T) Transfer of energy in lifting load.

(D) Energy transferred in climbing stairs.
Revision of the idea of kinetic energy $\rightarrow$ potential energy.

Lever and block and tackle as machines.
Can a machine multiply energy?
Machines are only energy transformers. Mechanical advantage or velocity ratio may be mentioned only qualitatively.

14.3 Support in plants

Simple observations on the structure of the stem of a
(a) herbaceous
(b) woody
(c) aquatic plant.

14.4 Support in animals

(a) Land invertebrates. Investigate the methods of support in
(a) the earthworm
(b) an insect
Compare this with the above.

(b) Land vertebrates

Discuss the need for large girdles in land animals with backbone.

(c) Aquatic vertebrates

May be defined, only in operational terms.

(d) 'Centre of gravity' of animals

May be discussed briefly.

(e) Stability in animals.

14.5 Muscles and Movement

Relate lever to forearm. Use model with spring as biceps.

(p) Transfer of kinetic to potential energy.

(p) Lever and pulley system.

(p) Examine pond weed or seaweed in water. Compare with herbaceous and woody stems.

(P) Turgidity in seedlings.

(P) Sausage balloon covered with paper mache.

(P) Skeleton with spine. Examine longitudinal section of long bone of animal and compare with that of a bird.

(P) Compare the dimensions of skeletons of a fish and a land animal, in particular the size of the hip-girdle and shoulder girdle.

(P) Find the C.G. of animal silhouettes, objects.

(P) Stability of shapes of animals and objects.

(P) 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'.

<table>
<thead>
<tr>
<th>Syllabus Topic</th>
<th>Notes</th>
<th>Suggested Practical Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1 Origin and Structure of the Earth...</td>
<td>A brief mention of the origin sufficient to allow discussion of the formation of igneous rocks.</td>
<td>(P) Illustrate with charts and specimen of rocks obtained from Pejabat Kajihumi, Ipoh.</td>
</tr>
<tr>
<td></td>
<td>Mention of sedimentary and metamorphic rocks.</td>
<td>(D) Models showing how these rocks were formed.</td>
</tr>
<tr>
<td></td>
<td>Layers in the earth's crust—the cone and mantle (brief mention)</td>
<td></td>
</tr>
<tr>
<td>15.2 Naturally Occuring Elements</td>
<td>Scarcity of these and the explanation on basis of reactivity.</td>
<td>(P) Action of metals on oxygen and sulphur</td>
</tr>
<tr>
<td></td>
<td>Establish this by examining the action of metals on oxygen and sulphur.</td>
<td>(A selection from Mg, Al, Fe, Zn, Sn, Cu)</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>Use the 'Arculus' method.</td>
</tr>
<tr>
<td>15.3 Naturally Occuring sulphates, oxides and carbonates</td>
<td>These are the three types of minerals in the earth's crust from which metals are obtained.</td>
<td>(P) Specimens of naturally occurring 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.</td>
</tr>
<tr>
<td>(a) Physical Characteristics</td>
<td>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. 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, is it is a basic carbonate. It is perhaps wise to avoid these complications by using 'magnesite' or 'dolomite'.</td>
<td>(P) Heat iron pyrites in air. Examine products. Sulphur dioxide detected by smell, etc.</td>
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<tr>
<td>(b) Action of heat</td>
<td></td>
<td></td>
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<tr>
<td>(c) Heating with carbon</td>
<td></td>
<td>(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.</td>
</tr>
<tr>
<td>16.4 Silica and silicates</td>
<td>(d) Calcium carbonate and some calcium compounds.</td>
<td>(P) Chemical nature of limestones, quicklime and slaked lime.</td>
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<td>--------------------------</td>
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<td>--------------------------------------------------</td>
</tr>
<tr>
<td>(e) 'malachite' experiment</td>
<td>Limestone, quicklime, slake-lime - their chemical nature and used are briefly treated.</td>
<td>(P) Experiments with soft and hard waters.</td>
</tr>
<tr>
<td></td>
<td>Soft and hard waters are briefly studied.</td>
<td>(P) Experiments to elucidate the nature of 'malachite' etc.</td>
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<tr>
<td></td>
<td>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)</td>
<td></td>
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<tr>
<td></td>
<td>This sub-section is included because of their great abundance in the earth's crust and their importance as building materials, crockery etc.</td>
<td>(P) Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)</td>
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<td></td>
<td>Points to make clear are their relative stability towards heat and to chemical reagents.</td>
<td>(P) Action of heat on the above.</td>
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<td></td>
<td>Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage)</td>
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<tr>
<td></td>
<td>Pottery and glazes. Glass.</td>
<td>(P/D) Formation of 'pottery tiles' from clay.</td>
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<tr>
<td></td>
<td>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).</td>
<td>(P/D) Formation of glazes and glass.</td>
</tr>
<tr>
<td>16.5 Petroleum 'Crude Oil'</td>
<td>(b) Some uses</td>
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<td>Points to make clear are their relative stability towards heat and to chemical reagents.</td>
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<td>Natural gas as fuel</td>
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<td></td>
<td>The main intention is to explain the existence of common salt in the sea and hence the importance of</td>
<td>(P) Evaporation of sea water to obtain salts.</td>
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<td></td>
<td>16.6 Salts from the sea.</td>
<td>(P) Identification of sodium.</td>
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<tr>
<td></td>
<td>Limestone, quicklime, slake-lime - their chemical nature and used are briefly treated.</td>
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(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)

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Points to make clear are their relative stability towards heat and to chemical reagents.

Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage).

Pottery and glazes. Glass.

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) Action of heat on the above.

16.5 Petroleum - 'Crude Oil'

(a) Origin of petroleum

Occurrence in Malaysia

(b) Petroleum refining.

Reframing as a process of fractional distillation. (Visit to Port Dickson/Lutong refineries, if possible. Otherwise use films)

(P/D) Formation of 'pottery tiles' from clay.

16.6 Salts from the sea.

Natural gas as fuel

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.

Sedimentary rocks

Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)

(P/D) Formation of glazes and glass.

(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).

(P) Evaporation of sea water to obtain salts.

(P) Identification of sodium salts by flame tests.

(P) Identification of chloride by electrolysis.

(P) Purification of rock salt or crude salt.
### 16.7 The soil Environment.

(a) **Formation of soil**

Simple treatment at this stage

Investigation of some of the physical and chemical properties of soil, including some quantitative work on humus, water and air content.

(b) **Properties of soil**

Visible animals of the soil. Establish that there are many different kinds and an enormous population.

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).

These organisms may be harmful, may cause disease or may act as parasites.

Useful application of such life.

Contamination of food and steps to reduce or prevent this.

Man's interference with soil by common agricultural practices needed to maintain crop growth.

The need for conservation

(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).

(P) Setting of soil samples in water.

(P) Microscopic examination of soil.

(P) Bleaching of top soil, and sub-soil samples with hydrogen peroxide.

(P) Composition of soil samples.

(P) Sort out leaf-litter and top soil in shallow plastic trays Use simple pictorial keys for identification.

(P) Extract with Tallgren and Bearman funnels.

(N) Extraction of earthworms with dilute formaldehyde solution.

(P) Respiration produces carbon dioxide, use sieved soil from which visible animals have been removed.

(P) Agar plates and soil water, tap water, pond water, milk etc.

(P) Culture Pythium (damping off) on seedlings. (Use of film material suggested where possible).

(P) Different groups make bread or alcohol.

(P/D) Culture solutions experiments. Emphasise the need for nitrogen, phosphorus and sulphur.

(N) Visual aids, including films.
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.

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<tr>
<td>13.1 Electricity in the home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Conductors and insulators</td>
<td>A revision on work began in Section 9</td>
<td>(p) Circuit boards with bulbs show also that electrolytes can conduct electricity.</td>
</tr>
<tr>
<td>(b) Methods of wiring</td>
<td>No mains supply to be used, but establish the idea of household circuits</td>
<td>(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.</td>
</tr>
<tr>
<td>(c) Wiring plugs</td>
<td>Connecting plugs to leads. Both international colour codes and 'old' colour codes should be introduced.</td>
<td>(p) Circuit boards with parallel branches. Total current related to number of branches added.</td>
</tr>
<tr>
<td></td>
<td><strong>International Code:</strong></td>
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<tr>
<td></td>
<td>Earth: Yellow/green stripes</td>
<td></td>
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<tr>
<td></td>
<td>Live: Brown</td>
<td></td>
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<tr>
<td></td>
<td>Neutral: Red</td>
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<tr>
<td></td>
<td><strong>'Old' code:</strong></td>
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<td>Earth: Green</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Neutral: Black</td>
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<tr>
<td>(d) Main’s voltage</td>
<td>Do's and don'ts at mains voltage voltages. Discuss Lembaga Letrik Negara pamphlet on &quot;Safety&quot;.</td>
<td></td>
</tr>
<tr>
<td>(e) Earthing</td>
<td>Use of earth-wire and lightning conductor</td>
<td>(n) Van de Croaf generator discharge at points.</td>
</tr>
<tr>
<td>(f) Fuse - rating</td>
<td>The use of fuses of correct rating to be discussed.</td>
<td></td>
</tr>
<tr>
<td>(g) Power - rating</td>
<td>Power-rating of various household appliances. Simple numeral problems may be given</td>
<td>(D) Household appliances connected to kilowatt-hour meter or (P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)</td>
</tr>
<tr>
<td></td>
<td>Power supply information that 1 KW-h = 1 unit of electrical energy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current (A) = [\frac{\text{Power (W)}}{\text{Voltage (V)}}]</td>
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Knowledge gained is applied to practical situations. In addition, some electromagnetism is added in order to touch upon the motor, dynamo and alternating current.

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<tr>
<td>(b) Methods of wiring</td>
<td>No mains supply to be used, but establish the idea of household circuits</td>
<td>(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.</td>
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<td>Connecting plugs to leads. Both international colour codes and 'old' colour codes should be introduced.</td>
<td>(p) Circuit boards with parallel branches. Total current related to number of branches added.</td>
</tr>
<tr>
<td>(d) Main's voltage</td>
<td></td>
<td>(p) Use 5A, 3-pin plugs, car head lamp bulb and S.B.C. lampholder.</td>
</tr>
<tr>
<td>(e) Earthing</td>
<td>Use of earth-wire and lightning conductor</td>
<td>(p) Van de Croaf generator discharge at points.</td>
</tr>
<tr>
<td>(f) Fuse rating</td>
<td>The use of fuses of correct rating to be discussed.</td>
<td>(D) Household appliances connected to kilowatt - hour meter or</td>
</tr>
<tr>
<td>(g) Power rating</td>
<td>Power-rating of various household appliances. Simple numerical problems may be given</td>
<td>(P/D) 48W and 6W bulb with joules meter (12 volt D.C. input)</td>
</tr>
</tbody>
</table>

International Code:
- Earth: Yellow/green stripes
- Live: Brown
- Neutral: Red
- 'Old' code
- Earth: Green
- Live: Red
- Neutral: Black

Do's and don'ts at mains voltage voltages. Discuss Lembaga Letrik Negara pamphlet on "Safety".

Use of earth-wire and lightning conductor.

The use of fuses of correct rating to be discussed.

Power-rating of various household appliances. Simple numerical problems may be given.

Power supply information that 1 KW-h = 1 unit of electrical energy. 

\[
\text{Current (A) = \frac{\text{Power (W)}}{\text{Voltage (V)}}.}
\]

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

No theory - only simple idea that current is flowing in either direction.

(c) Change of current direction and strength.

(D/F) Connect coil to a centre-zero galvanometer and move bar magnet in coil.

(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.

<table>
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<tr>
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<tr>
<td><strong>14.1 Idea of force</strong></td>
<td>A force is introduced as lifting, pulling, pushing, stretching, compressing or turning. Push-pull effect on shape. Effection motion.</td>
<td>(P) Plasticene, springs, elastic bands, latex foam etc.</td>
</tr>
<tr>
<td>(a) Some examples.</td>
<td></td>
<td>(P) Change of speed and for direction.</td>
</tr>
<tr>
<td>(c) Idea of friction</td>
<td>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.</td>
<td>(P) 'Frictionless' motion using air-pucks (balloon-type preferable) or object on polystyrene beads.</td>
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<tr>
<td>(c) Force due to gravity</td>
<td>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.</td>
<td>(P) 'Guinea and feather' experiment.</td>
</tr>
<tr>
<td>(d) Measuring force</td>
<td>Investigation of springs. Springs balance. Introduction to the unit of force - the 'newton' (N)</td>
<td>(P) Making and providing a scale for a spring (or elastic band) balance.</td>
</tr>
<tr>
<td>(e) Turning effect of forces</td>
<td>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'.</td>
<td>(P) The law of lever experiment.</td>
</tr>
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<td>(f) Pairs of forces</td>
<td>Simple observations and discussion.</td>
<td>(P) Turning effect of forces.</td>
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<tr>
<td>(g) Idea of work</td>
<td>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)</td>
<td>(P) Transfer of energy in lifting load.</td>
</tr>
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14.2 Work and energy

In section 3 various forms of energy and their interconversions were investigated.

(g) Idea of work

The idea of work is now introduced as a measure of energy transferred.

\[
\text{Work done} = \text{Force} \times \text{distance moved}
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<td>14.2 Work and energy</td>
<td>In section 3 various forms of energy and their interconversions were investigated.</td>
<td>(F) Transfer of energy in lifting load.</td>
</tr>
<tr>
<td>(a) Idea of work</td>
<td>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)</td>
<td>(F) Energy transferred in climbing stairs.</td>
</tr>
<tr>
<td></td>
<td>Work done = Force x distance moved in the direction on force</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit of work is the joule. Joule = newton x metre</td>
<td></td>
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</tbody>
</table>
14.3 Support in plants
Simple observations on the structure of the stem of a
(a) herbaceous
(b) woody
(c) aquatic plant.

14.4 Support in animals
(a) Land invertebrates.
Investigate the methods of support in
(a) the earthworm
(b) an insect

(b) Land vertebrates
Compare this with the above

(c) Aquatic vertebrates
Discuss the need for large girdles in land animals with backbone.

(d) 'Centre of gravity' of animals
May be defined, only in operational terms.

(e) Stability in animals.
May be discussed briefly.

14.5 Muscles and Movement
Relate lever to forearm. Use model with spring as biceps.

Revision of the idea of kinetic energy → potential energy.
Lever and block and tackle as machines.
Can a machine multiply energy?
Machines are only energy transformers. Mechanical advantage or velocity ratio may be mentioned only qualitatively.

Transfer of kinetic to potential energy.
Lever and pulley system.
Examine pond weed or seaweed in water.
Compare with herbaceous and woody stems.
Turgidity in seedlings.
Sausage balloon covered with paper mache.
Skeleton with spine. Examine longitudinal section of long bone of animal and compare with that of a bird.
Compare the dimensions of skeletons of a fish and a land animal, in particular the size of the hip-girdle and shoulder girdle.
Find the C.G. of animal silhouettes, objects.
Stability of shapes of animals and objects.
Simple model of forearm to demonstrate the action of muscles in moving the bones of the lower arm.
Determine the greatest load lifted by forearm.
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'.

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<tr>
<td>15.1 Origin and Structure of the Earth.</td>
<td>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)</td>
<td>(P) Illustrate with charts and specimen of rocks obtained from Pejabat Kajihumi, Ipoh.</td>
</tr>
<tr>
<td>15.2 Naturally Occuring Elements</td>
<td>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.</td>
<td>(P) Action of metals on oxygen and sulphur (A selection from Mg, Al, Fe, Zn, Sn, Cu) Use the 'Arculus' method.</td>
</tr>
<tr>
<td>15.3 Naturally Occuring sulphates, oxides and carbonates (a) Physical Characteristics (b) Action of heat (c) Heating with carbon</td>
<td>These are the three types of minerals in the earth's crust from which metals are obtained. 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. 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'</td>
<td>(P) Specimens of naturally occurring 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. (P) Heat iron pyrites in air. Examine products. Sulphur dioxide detected by smell, etc. (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.</td>
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<tr>
<td><strong>16.4 Silica and silicates</strong></td>
<td><strong>16.5 Petroleum - 'Crude Oil'</strong></td>
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<tr>
<td>(a) Some properties.</td>
<td>(a) Origin of petroleum</td>
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<tr>
<td>Limestone, quicklime, slake-lime - their chemical nature and used are briefly treated.</td>
<td>Only brief mention Occurence in Malaysia</td>
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<tr>
<td>Soft and hard waters are briefly studied.</td>
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<tr>
<td>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)</td>
<td></td>
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<tr>
<td>Points to make clear are their relative stability towards heat and to chemical reagents.</td>
<td>(P/D) Fractional distillation of crude oil. Use of fractional distillates etc.</td>
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<tr>
<td>Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage)</td>
<td>(P/D) Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide)</td>
<td></td>
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<tr>
<td>Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid)</td>
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<tr>
<td>Action of heat on the above.</td>
<td>(P/D) Formation of 'pottery tiles' from clay.</td>
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<tr>
<td>(P/D) Formation of glazes and glass.</td>
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</tbody>
</table>
16.4 Silica and silicates

(a) Some properties.

This sub-section is included because of their great abundance in the earth's crust and their importance as building materials, crockery etc.

Points to make clear are their relative stability towards heat and to chemical reagents.

Formation of metamorphic rocks (structures of silicates should not be dealt with at this stage).

(b) Some uses

Pottery and glazes. Glass.

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).

16.5 Petroleum — 'Crude Oil'

(a) Origin of petroleum

Occurrence in Malaysia

(b) Petroleum refining.

Refining as a process of fractional distillation. (Visit to Port Dickson/Lutong refineries, if possible. Otherwise use films).

Natural gas as fuel

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.

Sedimentary rocks

16.6 Salts from the sea.

Experiments to elucidate the nature of 'malachite' etc.

Test solubility in water and dilute hydrochloric acid of sand, clay, mica, felspar etc. (Some impurities may dissolve in dilute hydrochloric acid).

Action of heat on the above.

Formation of 'pottery tiles' from clay.

Formation of glazes and glass.

Fractional distillation of crude oil. Use of fractional distillates etc.

Products of combustion of petrol, petroleum gas etc and their contribution to air pollution (e.g. carbon monoxide and sulphur dioxide).

Evaporation of sea water to obtain salts.

Identification of sodium salts by flame tests.

Identification of chloride by electrolysis.

Purification of rock salt or crude salt.
16.7 The soil Environment.

(a) Formation of soil

Simple treatment at this stage

Investigation of some of the physical and chemical properties of soil, including some quantitative work on humus, water and air content.

(b) Properties of soil

Visible animals of the soil. Establish that there are many different kinds and an enormous population.

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).

These organisms may be harmful, may cause disease or may act as parasites.

Useful application of such life.

Contamination of food and steps to reduce or prevent this.

(d) Conservation

Man's interference with soil by common agricultural practices needed to maintain crop growth

The need for conservation

(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).

(P) Setting of soil samples in water.

(P) Microscopic examination of soil.

(P) Bleaching of top soil, and sub-soil samples with hydrogen peroxide.

(P) Composition of soil samples.

(P) Sort out leaf-litter and top soil in shallow plastic trays. Use simple pictorial keys for identification.

(P/P) Extract with Tallgren and Bearman funnels.

(P) Extraction of earthworms with dilute formaldehyde solution.

(P) Respiration produces carbon dioxide, use sieved soil from which visible animals have been removed.

(P) Agar plates and soil water, tap water, pond water, milk etc.

(P) Culture Pythium (damping off) on seedlings. (Use of film material suggested where possible).

(P) Different groups make bread or alcohol.

(P/D) Culture solutions experiments. Emphasise the need for nitrogen, phosphorus and sulphur.

(N) Visual aids, including films.