DOCUMENT RESUME

ED 065 277 SE 012 767

TITLE	[Technical School Science Syllabus: Grades 7-10].
INSTITUTION	Victoria Education Dept. (Australia).
PUB DATE	[72]
NOTE	137p.
EDRS PRICE	MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Course Descriptions; *Curriculum; *General Science; International Education; Science Courses; Secondary School Science; Technical Education
IDENTIFIERS	*Australia

ABSTRACT

The syllabi included in this package outline the science courses to be taught in the Technical Schools of the Education Department of Victoria (Australia) in grades seven through ten. There is a separate syllabus for each grade, with two parts for grade ten. Each syllabus contains a statement of aims, a list of the topics to be taught (including an indication of the scope and depth of treatment), suitable textbooks and references for the teacher and student, and suggested demonstrations and student laboratory work. All syllabi suggest that physical, earth and life sciences be included in the year's course. For students taking additional science in grade ten, Part II of the syllabus for that year contains subject matter intended to provide a rigorous grounding in physics and chemistry in addition to the general science contained in Part I. [Not available in hard copy due to marginal legibility of original document.] (AL)

EDUCATION DEPARTMENT - VICTORIA

TECHNICAL SCHOOLS SYLLABUSES

JUN 711, 712, 713

SCIENCE

FORMS I, II AND III

APPENDIX B

1969 REVISION

CURRICULUM AND RESEARCH BRANCH

EDUCATION DEPARTMENT - VICTORIA

TECHNICAL SCHOOLS SCIENCE SYLLABUSES

FORMS I - III

APPENDIX B

AIMS OF THE SYLLABUSES

This document should be filed with Syllabuses JUN 711, 712 and 713

I. AIMS OF SCIENCE TEACHING IN THE JUNIOR FORMS

A. The Forms I, II and III Science Syllabuses (JUN 711, 712 and 713: 1969 Revision) should be regarded by teachers as a complete unit. The following aims are intended to encompass the complete science contribution to the school curriculum in these first three years.

B. The aims of teaching science in the first three years are:-

1. To develop an understanding of a series of basic scientific concepts (as distinct from isolated facts). This understanding should promote in the student:-

(a) a growing understanding of the environment;
(b) an appreciation of the role of science in the contemporary world;
(c) enjoyment from mastery of these concepts;
(d) a growing interest in science and a concern for the future role of science in our civilization;
(e) the capacity for critical evaluation which will be useful whether or not the student pursues future scientific studies.

2. To develop the ability to plan, conduct and evaluate experiments or researches. This implies that the student will be able to:-

(a) select, assemble and manipulate appropriate apparatus;
(b) make accurate and objective observations and measurements;
(c) record and systematise experimental results;
(d) draw logical conclusions and evaluate them;
(e) communicate experimental procedures to others both orally and in a written form.

II. IMPLICATIONS OF THE AIMS

A. At no stage do the aims of the course imply that the teacher or student is restricted by the detail of each topic, by the sequence of topics, or by the division of the topics into yearly syllabuses. Teachers should feel free to develop syllabuses which are suitable for their requirements.

B. It should be noted that the aims stated above explicitly involve the student in an active role in the learning situation. Teacher demonstrations will be required, and are desirable in certain situations. However, the bulk of the time spent by the student in the science classroom should be in individual or group activity.

C. The aims make certain assumptions about organisation of science departments. These assumptions are:-

1. A time-table in which science (a practical subject) is taught in single sections.

2. Adequate physical conditions.

   (a) free movement throughout the science department should be made feasible;
   (b) handy storage of equipment is essential so that the student can locate apparatus for an experiment;
   (c) ample library reference materials are required to be accessible at all times. For this reason the science department should develop a reference library of its own.

3. The classroom environment should be a stimulating one. A constant turnover of thoughtful displays should be a feature of all science rooms.

III. TESTING

Testing is an intrinsic part of the educative process. Even accepting or rejecting a student's answer to an oral question is a form of testing. Testing must be continuous. It is used basically to monitor a student's progress or a lesson's effectiveness.

Within the aims of the course, testing must check on understanding rather than memorisation, and it can be used as an incentive to the individual student to better his past performances.

IV. ACTIVITIES

The science learning situation could well involve all of the following points:-

A. Communication

1. Students should be encouraged to make reports orally and in writing. The student could report on:-

   (a) observations made;
   (b) science in the news;
   (c) discoveries in reading;
   (d) problems of interest to the student.

2. Students should be expected to develop skill in presenting his ideas informally in the classroom situation. Answers to questions asked by the teacher should be expressed at length by the student.

B. Learning aids

1. A class museum could be assembled. A constant turnover should be maintained to avoid the accumulation of too-familiar exhibits.

2. Students or a class could keep a record book containing systematically arranged reports and news cuttings of scientific interest. This could become a supplementary reference.

3. Films, film strips and T.V. programs should be used to enrich the student's experience in regions which are difficult or impossible to directly encounter in the classroom.

4. Appropriate excursions should be a normal part of the learning situation. Careful preparation is required for success.

5. Displays and models can enrich the classroom environment.

6. Continual discussion by all members of the class on the items above should be encouraged.

C. Library

The use of the library should be regarded by the student as a normal adjunct to science.

D. Home Assignments

These should be set with great care and with an eye to the amount of work involved, and the resources which students could be expected to possess. An assignment should preferably involve an activity that students cannot do at school, e.g. collecting specimens.

E. Science Clubs

Well organised Science Clubs could be restricted to specific areas such as meteorology, astronomy, etc.

F. Formal Lessons

Whilst it is hoped that formal lessons will be at a minimum, there are situations where the formal lesson is necessary:-

1. Teacher demonstration.
2. Application problems involving calculations or explanations.
3. Development of theory.

G. Practical Work

1. As practical work is the main technique for science teaching, it should be designed with the following principles in mind:-

   (a) the encouraging of true, often simple experimentation rather than repetition of established routines and the "proving" of established laws;

   (b) practical work should lead from question to discovery;

   (c) should be performed by small groups or individually;

   (d) should involve a mimimum of teacher direction;

   (e) the acquisition of information is incidental;

   (f) the responsibility for practical work should be thrown onto the students;

   (g) an understanding of the limitations of the method and equipment should be developed.

   (h) the ability to generalise from a sufficient basis.

2. The teacher will retain for himself only those experiments which are necessarily arduous, dangerous or requiring special skills and equipment.

3. Recording - Training in the making of accurate, concise records should commence from the most junior forms and be developed continuously.

(a) Initially, a single sentence or a simple sketch would be an adequate record of practical work. It is suggested that a conclusion should be written however, at the conclusion of a series of practical exercises.

(b) With increased experience and as more demanding experiments are undertaken, it is suggested that the student should develop the ability to write more detailed reports. In the first three years a record of practical work could consist of answers to the questions:

1. What was done? (i.e. method)
2. What was observed? (i.e. results and observations)
3. What was discovered? (i.e. conclusions)

- together with

4. Review (i.e. evaluation of techniques and conclusions, limitations of the experiment, further possible experiments, and generalisations where possible).

(c) Where actual experimentation is involved, it is suggested that the students publish their record of the experiment for distribution within the school.

4. Identification of equipment should be part of the student's practical training.

5. Practical skills - Naturally, the student will receive training in correct and safe techniques in the use of apparatus. Some practical skills which probably would be needed by the student by the time he has completed Form III are:-

(a) Turning on laboratory taps.
(b) Pouring from liquid reagent bottles.
(c) Transferring solid chemical from one container to another.
(d) Using a bunsen burner.
(e) Boiling liquids in a test tube.
(f) Heating solids in ignition tubes and crucibles.
(g) The correct use of retort stands and filter stands.
(h) The use of crucible tongs.
(i) Preparation of a solution of a solid in a liquid.
(j) Testing a substance for solubility.
(k) Heating and bending glass tubing and making an eye-dropper.
(l) Testing for the presence of carbon dioxide, oxygen and hydrogen.
(m) Smelling a gas.
(n) Identifying a magnetic material.
(o) Using and maintaining a microscope.
(p) Preparing a microscope slide.
(q) Taking readings from measuring instruments e.g. rule, thermometer, voltmeter, ammeter, barometer.
(r) The hardness test for minerals.
(s) Heating in an evaporating basin and the use of a water bath.

6. Safety

Emphasis must continually be placed on the safe techniques in all experimental work. Accident procedures e.g. in the case of fire; cuts; burns; splashes; swallowing reagents should be inculcated.

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EDUCATION DEPARTMENT, VICTORIA

TECHNICAL SCHOOLS DIVISION

INTERMEDIATE TECHNICAL SYLLABUS

INT 722

SCIENCE II

FORM IV

1971

6

CURRICULUM & RESEARCH BRANCH

A.71/16 (C & R)

TABLE OF CONTENTS

SCIENCE PART II (1971)

FORM IV

1. FOREWORD

1.1. This syllabus replaces syllabus "Science Part II - Form IV (1966).

1.2. The structure of the former syllabus has been retained, but changes have been made so that:

(a) some topics considered to be too difficult or not properly developed have been deleted;

(b) additional material has been added to compensate for deletions from Science I in a revision carried out at the same time;

(c) the overall reductions in both Physics and Chemistry relates the syllabus content more realistically to the time normally available;

(d) opportunity for practical work has been significantly increased, and many topics can now be developed from a practical point of view.

2. AIMS OF THE COURSE

The course is intended to provide students with a rigorous introductory course in Chemistry and Physics as a preparation for more advanced studies in these subjects at the Leaving Technical level.

3. GENERAL COMMENTS

3.1. Format

Each section of this syllabus has been presented as follows:

(a) Brief introduction to the section

(b) The course itself

(c) Explanatory notes

(d) References

(i) Student References

(ii) Teacher References

Content

Method

3.2. Integration

Teachers are advised to integrate the teaching of the Science II syllabus with Science I for students taking both parts. The opportunity to relate the science course to other subjects should also be taken.

3.3 Practical Work

(a) Some practical work has been suggested but these experiments should not be considered to be mandatory. Teachers are urged to develop practical work which they consider appropriate for their students.

(b) It is considered that opportunity for practical work has been significantly increased. Many topics can be developed from a practical point of view.

(c) It is strongly suggested that practical work should be an integral part of the course and should not be treated as a separate entity.

(d) The opportunity to integrate practical work in Science II with that undertaken for Science I should not be missed.

(e) Safety in the laboratory is a vital part of any practical work. Teachers are advised to refer to Appendix "B" ("Safety in the Laboratory") of syllabus LEA 741 Chemistry (1971): Part II - Practical Course.

4. STRUCTURE OF THE COURSE

4.1 The syllabus is presented in two sections:-

A. Chemistry

B. Physics

4.2 All topics in both sections should be studied.

4.3 Four periods per week should be allotted to the subject.

5. ASSESSMENT

Assessment will be by one externally set and internally marked paper of two hours duration excepting for candidates in schools where an approved moderating procedure is conducted.

6. REFERENCES

6.1 Each section of the course has recommended references appended. It is not suggested that all the references are needed, and teachers would be wise to select from these the ones they consider most appropriate for their needs. They should also consider other references as well as those that have been cited.

Attention is drawn to:

(a) References considered suitable for students.

(b) References considered to be useful in devising methods of teaching certain topics. Only a few of this type of reference are included. Teachers are urged to search for and use other teaching method references.

6.2 Teachers may find the following of general use for the course:

Henderson, J.H. A Dictionary of Scientific Terms
Oliver and Boyd, Edinburgh, 1953

Williams, T.J. A Biographical Dictionary of Scientists
Adams and Charles Black, London, 1969

7. THE SYLLABUS

A CHEMISTRY

		Notes
I.	**Matter**	1.
	A. Properties of matter.	2.
	B. Composition of matter.	
	Elements. Compounds. Mixtures.	3.
	C. Physical and chemical change and associated energy.	
II.	**Basic Atomic Theory**	
	A. The structure of matter	
	The atom. The molecule.	4, 5.
	B. The composition of the atom.	
	The election, proton and neutron.	6.
	C. A simple Bohr-Rutherford picture of the atom.	
	1. Atomic number.	7.
	2. Mass number.	
	3. Isotopes.	8.
III.	**Symbols, Formulae and Equations**	
	A. Chemical symbols and formulae.	9, 10.
	B. Atomic weight. The quantitative nature of the chemical formula.	
	C. 1. Stable electron configuration.	12.
	2. The valency of common elements and radicles.	13.
	D. 1. Conservation of mass in chemical reactions.	14.
	2. Conservation of energy in chemical reactions.	14.
	E. 1. Simple chemical equations.	15.
	2. The stoichiometry of chemical reactions.	16.
IV.	**Physical States of Matter**	
	A. Gases.	17.
	1. Measurable properties of a gas.	18.
	2. Effect of pressure variation on the volume of a constant mass of gas at constant temperature.	
	3. (a) Effect of temperature variation on the volume of a constant mass of gas at constant pressure.	
	(b) The absolute temperature scale.	
	4. The general gas equation: $\frac{PV}{T}$ = constant.	19.
	5. The kinetic molecular theory model of an ideal gas.	20.
	B. Liquids.	
	1. The effect of temperature variation on the density of liquids.	
	2. (a) Evaporation of liquids.	
	(b) Vapour pressure. The variation of vapour pressure of a liquid with temperature change.	21.
	3. Boiling of liquids. The variation of boiling point of liquids with pressure change.	22.
	4. Condensation.	
	5. The kinotic molecular theory model of liquids.	20.
	C. Solids.	17.
	1. The melting of solids and freezing of liquids.	23.
	2. The kinetic molecular theory model of solids.	20.

V. Nucleonics

A. Radioactivity. 25.
B. Alpha and beta particles and gamma radiation and their distinguishing properties. 26.

VI. Practical Work

The following practical work is suggested for consideration but these experiments should not be considered to be mandatory. Teachers are urged to develop practical work which they consider appropriate for their students.

1. Conservation of mass in chemical reactions.
   e.g. (i) magnesium in flashbulb.
   (ii) precipitation of silver chloride (AgCl) in a sealed tube.
2. Percentage composition:
   e.g. (i) Oxygen and magnesium in magnesium oxide (MgO) by direct combination.
   (ii) Oxygen in copper oxide (CuO) by reduction.
   (iii) Sulphur in iron sulphide (FeS) or copper sulphide (CuS) by direct combination.
   (The experimental results can be used to confirm Atomic Weight values obtained from reference texts.)
   (iv) Water in hydrated magnesium sulphate ($Mg\ SO_4.7\ H_2O$) or hydrated copper sulphate ($Cu\ SO_4.5H_2O$).
3. Gas Laws.
4. Variation of saturated vapour pressure with temperature change.
5. Variation of boiling point with pressure change.
6. Cooling curve of naphthalene.
7. Simple stoichiometry
   e.g. (i) decomposition of lead carbonate.
   (ii) combination of magnesium and oxygen.

CHEMISTRY NOTES

1. Throughout this entire course it should be stressed that the chemist is concerned with study of the properties, the composition and the structure of matter, the changes that occur in matter, and the energy released or absorbed during these changes.

2. Teachers may find a classification of properties into EXTENSIVE and INTENSIVE properties is useful.

3. Treat the distinguishing properties simply at this stage.

4. The atom as the smallest particle of an element taking part in a chemical reaction is an explanation of the atom which has been modified in the light of evidence involving the transfer of electrons to produce a more stable configuration.

5. The molecule is the smallest particle of an element OR a compound existing under normal conditions that can retain the chemical properties of the element or compound.

   Most elements are considered to have monatomic molecules, i.e. the molecule consists of one atom. The molecules of many gaseous elements are diatomic e.g. hydrogen, oxygen, chlorine.

6. The relative size, charge, location and mobility should be covered. Reference to sub-shells is not required, but teachers may find it worthwhile to deal with the $2n^2$ rule.

7. Use the atomic number to build up the idea of the periodic classification.

8. Restrict to a few appropriate isotopes e.g. those of carbon and hydrogen. It should be pointed out that some isotopes are stable and others are radioactive.

9. Most elements have a symbol derived from their name in English. The most common elements have been known for much longer and their symbols are derived from the Greek or Latin name e.g. Na (from L. natrium) for sodium.

The student should know the following symbols:
Ag, Al, Ba, Ca, C, Cl, Cu, H, Fe, K, Pb, Mg, Hg, N, O, P, Si, Na, S, Sn, Zn. (See also Note 13, below).

Stress at this stage that the symbol represents one ATOM of the element. A quantitative significance will be given to the symbol later in this course.

10. Thus the student should be able to determine both the element and the number of atoms of each element present in a molecule from a formula. Ensure that the student is able to distinguish between the use of say 2 in 2Fe (2 atoms of Fe) and its use in H_2 (one molecule of hydrogen which consists of 2 atoms).

11. Use the definition based on Carbon 12 and stress that atomic weights are ratios. Problem work should be given. The term formula weight should be used for problems. Students should understand that each symbol represents the atomic weight of each element and that the sum of the weights is the formula weight of a substance.

12. The distinction between a complete and a stable electron configuration should be made. Use the inert gases in the periodic classification to show that chemical stability is usually achieved with outer electron shell stability.

13. The idea of valency can be built up using electron dot formulae. A coverage in simple terms of electro valency and co-valency is intended. The student should be familiar with the valencies of the following: aluminium, barium, calcium, copper, carbon, hydrogen, magnesium, potassium, silver, sodium, zinc, ammonium, carbonate, hydroxide, nitrate, sulphate, sulphide, sulphite, chloride, oxide.

14. These concepts are considered to be vital.

15. Chemical equations should not be used for predictive purposes. Problems involving equation writing should be given. It is suggested that the following procedure be used for equation writing:
(a) The equation is written in words.
(b) The correct molecular formulae are written.
(c) The equation is then balanced.

16. Limit problems to mass relationships only. Multiples or sub-multiples of formula weights only need be treated.

17. Explain in terms of the Kinetic Molecular Theory model of matter.

18. The measurable properties of a gas - mass, volume, pressure and temperature, could well be measured during the course of practical work.

19. For problem work use $\frac{P_1 V_1}{T_1} = \frac{P_2 V2}{T_2}$

20. This should be understood as a powerful theory which can be invoked to explain a wide range of phenomena. However the theory assumes ideality. The theory should be presented as a good model to account for the observations made in the preceeding sections.

21. Saturated vapour pressure may be treated but this will not be examinable.

22. Boiling can be explained as taking place when the vapour pressure of the liquid equals the pressure on the surface of the liquid.

23. A simple treatment only is required.

24. Relate to section II.

25. Students should be aware that radioactivity is due to instability of atomic nuclei. The radioactive atoms may occure naturally or be synthesized artificially.

26. The properties are: relative mass, penetration, deflection in magnetic, electric and gravitational fields.

CHEMISTRY REFERENCES

STUDENT

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Time-Life International, Netherlands, 1963.

2. Parson, Cyril and Dover, Clare. Foundations of Science The Elements and Their Order Sampson Low Marston, London, 1966.

3. Understanding Science (eds.) Students' Book of Basic Chemistry
Sampson Low, London, 1962.

TEACHER

CONTENT

1. Benfey, O.T. et al. Chemical Systems CBA McGraw-Hill, St.Louis, 1969.

2. Miall, L. (ed.) A New Dictionary of Chemistry 3rd Ed.
Longmans, London, 1961.

3. McClellan, A.L. (ed.) Chemistry: An Experimental Science
Teacher's Guide Freeman, San Francisco, 1963.

4. Stove, J.D. and Phillips, K.A. A Modern Approach to Chemistry
2nd Ed. Heineman, Melbourne, 1970.

5. Stove, J.D. and Phillips, K.A. Practical Manual Heineman, Melbourne, 1970.

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2. Newnham, R.E. Chemasta Teachers Valency A.S.T.J., Vol.12 No.1, May 1966.

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4. Norman, P. Overhead Projection Demonstrations of Kinetic Theory
A.S.T.J., Vol.15 No.2, August, 1969.

5. Reimann, A.L. Charles' Law A.S.T.J., Vol.13 No.2, August, 1967.

6. Walker, Noojin Balancing Chemical Equations Sci. Ed., Vol.53, No.4 Oct. 1969.

7. Withers, Graham Chemistry Demonstrations Using the Overhead Projector
A.S.T.J., Vol.16 No.1, May 1967.

B PHYSICS

In any introductory course in Physics, stress must be placed on the importance of quantities, their units and their measurement. Emphasis in this course is on the S.I. system of units, abbreviations and symbols.

All quantities mentioned in the course must be defined as they are introduced.

Physics is a mathematical science, and problem solving must be used to develop an understanding of the principles involved.

	NOTES
I. MEASUREMENT	
A. The S.I. basic units.	1
B. The S.I. derived units.	2
II. VECTORS	
A. Addition of two vectors.	3
B. Subtraction of vectors.	4
C. Resolution of a vector into two components at right angles to each other.	5
III. KINEMATICS	
A. Displacement. Velocity, Acceleration.	6
B. Velocity-time graphs for a particle moving:	7
1. at constant velocity;	
2. at variable velocity under uniform acceleration.	
C. Equations for uniformly accelerated motion in a straight line.	8

$$v = v_0 + at$$

$$s = v_0 t + \frac{1}{2}at^2$$

$$v^2 = v_0^2 + 2as$$

IV. DYNAMICS	
A. 1. Relationship between resultant force and acceleration.	9
2. Units of force.	10
B. 1. Motion of a mass on:	
(a) a smooth horizontal surface under a constant horizontal force;	
(b) a smooth horizontal surface under a constant force inclined to the horizontal;	
(c) a smooth inclined plane under gravity.	11
2. The effect of frictional force on these motions.	12

VII. PRACTICAL WORK

The following practical work is suggested and teachers should understand that these are not mandatory. Many topics can be developed from a practical point of view. Teachers are urged to develop practical work they consider appropriate for their students.

1. Parallelogram of forces.
2. Velocity time graphs for:
   (a) uniform velocity;
   (b) uniform acceleration.
3. Relationship between resultant force and acceleration (constant mass).
4. Voltmeter - ammeter measurement of resistance.
5. Resistances in series and parallel.
6. Power rating of the element of an incandescent lamp.
7. Specific heat of water using an immersion element.
8. Conservation of momentum, using one stationary mass before collision on the air track.
9. Temperature - time curve for heating ice.
10. Latent heat of fusion of ice using wide mouth Dewar flask.
11. Acceleration due to gravity using linear air track.

PHYSICS NOTES

1. Units must be introduced throughout the course where relevant. Teachers may find it necessary to introduce their students to the F.P.S. and/or the F.S.S. (British Engineering) systems of units.
2. This system is to be taught as a coherent system of units, symbols and abbreviations based on the S.I. basic units.

   Throughout the course students should be encouraged to develop the S.I. derived units from the basic S.I. units.
3. Include velocities and forces. Numerical methods should be employed when the vectors are at right angles. All other cases should be treated graphically.
4. Restrict to changes of velocity in a straight line.
5. Restrict to the following cases:
   (i) resolution of single forces and single velocities,
   (ii) resolution (parallel and perpendicular to the plane) of the gravitational weight force of a mass on an inclined plane,
   (iii) resolution of a single force acting on a mass on a horizontal plane into vertical and horizontal components.

6. The vector nature of these quantities must be emphasized. The distinction between distance and displacement and also between speed and velocity must be stressed.

7. Where applicable the properties of the straight line graph (i.e. the gradient and intercepts) should be stressed and related to the motion under consideration. For non-linear graphs the significance of the gradient at any point could be inferred from knowledge of the gradient of the straight line graph, i.e. the tangent to the curve at that point.

   Data for graphs should be gained from actual experiments (see P.S.S.C. Laboratory Manual and Air Track Manual).

8. The derivations of these equations will not be examinable. Demonstrate that $v = at$, and $v = v_o + at$ are mathematical expressions that fit the graphs obtained previously from actual physical measurements.

   Whilst it is realized that the notation Δs and Δt would more properly be used in the equations, this has not been done in the interest of simplicity.

9. The acceleration produced by a resultant force should be investigated experimentally from two aspects:

   (i) the direction of the acceleration compared to the direction of the resultant force,

   (ii) the magnitude of the acceleration compared with the magnitude of the resultant force. The concept of action and reaction forces should be introduced in this section.

10. The newton and poundal must be defined as forces which produce unit acceleration in the direction of the force, when acting on unit mass.

11. For problems involving gravitational forces, it is necessary to develop the relationship:

    Weight force = mass x acceleration due to gravity

    i.e. $F = mg$

12. The relationship between friction and the normal reaction to a surface is <u>not</u> required.

13. Work is defined as the products of force and displacement. It must be stressed that the force and displacement have the same direction.

14. Use S.I. units only.

15. $K.E. = \frac{1}{2} mv^2$ is <u>not</u> required.

16. Restrict to two masses with velocities in the same straight line locking together after collision.

17. The joule is the S.I. unit for energy. (Other heat energy units such as the calorie and the B. Th. U. could be expressed in terms of the joule.)

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16. Restrict to two masses with velocities in the same straight line locking together after collision.

17. The joule is the S.I. unit for energy. (Other heat energy units such as the calorie and the B. Th. U. could be expressed in terms of the joule.)

18. Include problems on change in temperature (specific heat) and change in state (latent heat). This section should be taught after the qualitative introduction given in the Chemistry section. Use the equations:

$$E = mc\Delta T$$

$$E = mL_v$$

$$E = mL_f$$

Examination problems will be restricted to heat exchanges between two masses or the heat required to produce a change of state or a certain temperature change in a given mass of material.

19. (a) The student must appreciate that charge is conserved at all times.

    (b) The colomb as either the quantity of electricity represented by a current of one ampere flowing for one second or as the charge carried by a fixed number of electrons flowing past a point in a circuit in a second.

    (c) The ampere as a fixed number of electrons flowing past a point in a circuit in one second.

20. (a) Define potential difference in terms of work done in joule in moving unit charge between two points. Stress that potential difference is an energy difference.

    (b) Stress that the unit of potential difference (the volt) is joule/coulomb i.e. the volt is defined in terms of work done in moving a fixed amount of charge.

21. For a given conductor at constant temperature the potential difference divided by the current is a constant. As resistance depends on type of material, cross sectional area, length and temperature of the conductor, the significance of the words "given" and "constant" should be discussed.

22. Derivation of the equations are not examinable. Current problems should be restricted to series, parallel (limit to two resistances in parallel) and combinations of both.

    Demonstrations using ammeters and voltmeters in a circuit should show:

    (a) for two resistances in series:

        (i) potential difference across separate resistances equals total potential difference across the combinations;

        (ii) total resistance equals sum of separate resistances.

    (b) for two resistances in parallel:

        (i) potential difference across the combination is the same as across each resistance;

        (ii) total circuit current equals sum of the current in the separate resistances.

23. This application should serve as a useful integrating unit with the heat section. Problems should be given on immersion elements being used to heat water.

24. A qualitative treatment only is intended.

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EDUCATION DEPARTMENT, VICTORIA

TECHNICAL SCHOOLS DIVISION

INTERMEDIATE TECHNICAL SYLLABUS

INT 721

SCIENCE I

FORM IV

1971

CURRICULUM & RESEARCH BRANCH

TABLE OF CONTENTS

INT 721

SCIENCE PART 1 (1971)

FORM IV

1. FOREWORD

1.1 This syllabus replaces syllabus "Science Part I - Form IV (1966)"

1.2 The science syllabuses for Technical Schools Form IV (Parts I and II) have been revised. The existing structure of the syllabuses has been retained, but changes have been made so that:

(a) some redundant topics have been deleted and others have been introduced to make the syllabus a more coherent whole in itself and in relation to syllabuses for the earlier stages of science education;

(b) the requirements for the areas of the syllabus are less demanding so that appropriate practical work can now be attempted in all areas.

1.3 Although the syllabuses are not new, they are revisions made in the light of experience gained over the six years since their introduction.

1.4 It is intended that these syllabuses should have a life of a few years, during which time a major syllabus revision will take place.

2. AIMS OF THE COURSE

2.1 To present Science primarily as an inherent part of man's culture.

2.2 To present all students with a wide range of scientific knowledge which, it is hoped, will assist them to behave rationally in their environment.

2.3 To show that the disciplines of science can be applied to everyday problems.

3. GENERAL COMMENTS

3.1 Each unit of this syllabus has been presented in a new format as follows:

(a) Brief introduction to the unit

(b) The course itself

(c) Explanatory notes

(d) References

(I) Student References

(II) Teacher References

Content

Method

3.2 This syllabus represents a science course which will occupy at least four periods per week.

3.3 (a) A course consists of seven syllabus units of which at least four must be taken from Section A - Pure Sciences.

(b) Teachers are advised to select syllabus units to suit the needs and interests of their students.

(c) Although up to three units may be taken from Section B, the Technical Schools Sciences Standing Committee would prefer that Section A, the Pure Sciences, should be taught in its entirety so that students would benefit from a broad coverage of the sciences. The Committee also considers Conservation as a most important unit. However it recognizes that some students may require a more specialized program.

3.4 Practical Work

No specific practical work has been suggested. However practical work should be regarded as an intrinsic part of the course, and it should not be treated as a separate entity. Complete sections of the course can be taught from a practical approach.

3.5 Integration

Teachers are advised to integrate the teaching of the Science I syllabus with Science II for students taking both parts. The opportunity to relate the science course to other subject areas should also be taken.

A. STRUCTURE OF THE COURSE AND STUDENT PROGRAMS

The syllabus is in two sections.

A.1 Section A Pure Sciences

(a) The Pure Sciences included in the syllabus are:

A1 Astronomy

A2 Chemistry

A3 Biology

A4 Geology

A5 Physics

(b) At least four of these units are to be taught.

4.2 Section B Applied Sciences

(a) The Applied Sciences presented as detailed syllabus units are:

B1 Conservation

B2 Food science

B3 Textile Science

B4 Material in the Home

B5 Industrial Processes

B6 Computers

B7 Soil Science

B8 Trade Mechanics

B9 Trade Electricity and Magnetism.

(b) The foregoing topics do not comprise a comprehensive list of topics considered suitable for students at Form IV level, and teachers may prefer to develop additional units such as:

General Biology

Genetics

Evolution

Learning

Instrumentation

Geological History of Australia

Geological History of Victoria

Anthropology

Quality Control

Evolution of Man

Oceanography

Space Physics

Space Biology

Human Relationships

Science Fiction (e.g. pseudo-science)

History of a Scientific Idea

History of a Scientist

Science and Religion

(c) Up to three units of applied Science may be taken. Unless there are exceptional circumstances which demand otherwise, "Conservation" should be regarded as a compulsory unit.

4.3 Time allocation

(a) Depending on the proportion of Pure Science and Applied Science units taken, the following time allocation is suggested:

(i) Pure Sciences: half to two thirds of the time available. Each of the four sciences taken should be given approximately equal class time with the possible exception of Astronomy where practical work will necessarily be held outside school hours.

(ii) Applied Sciences one third to a half of the time available. It is suggested that the time allocated to the Applied Science be spread throughout the year, rather than one term a half year.

(b) It is strongly recommended that Pure and Applied Sciences be treated concurrently rather than as separate blocks.

5. ASSESSMENT

5.1 Assessment of Section A (Pure Sciences) will be by one externally set (and internally marked) paper of two hours duration, excepting for candidates in schools where an approved moderating procedure is conducted. 50% of the marks will be allocated to this paper.

5.2 Assessment of Section B (Applied Sciences) will be by cumulative assessment and testing or by an internally set and marked examination of not more than two hours duration. 50% of the marks will be allocated to this section.

5.3 The final mark for Science I will be a percentage.

6. REFERENCES

6.1 Each section of the course has recommended references appended. It is NOT suggested that all the references are needed, and teachers would be wise to select from these the ones they consider most appropriate for their needs. They should also consider other references as well as those that have been cited.

Attention is drawn to:

(a) References considered suitable for students.

(b) References considered to be useful in devising methods of teaching certain topics. Only a few of this type of reference are included. Teachers are urged to search for and use other teaching method references.

6.2 Teachers may find the following of general use for the course:

Henderson, J. H. A Dictionary of Scientific Terms
Oliver and Boyd, Edinburgh, 1953.

Williams, T. J. A Biographical Dictionary of Scientists
Adams and Charles Black, London, 1969.

7. THE SYLLABUS

A. PURE SCIENCES

A.1 ASTRONOMY

This course has been designed as a practical course (1). The student is therefore required to conduct his own practical work, and this will necessarily be in his or her own time.

	NOTES
I. Methods of Observation.	2, 3, 4, 17.
A. Optical telescopes	5, 6.
1. Refracting.	
2. Reflecting.	
B. Radio telescopes.	7.
C. Spectroscopes.	8.
II. Stars and Constellations.	9, 10, 17.
A. Magnitude and colour of stars.	11, 12.
B. Variable Stars.	13.
1. Cepheid variables.	14.
2. Novae.	15.
3. Super novae.	15.
C. Multiple stars.	16.
Binary stars including eclipsing binaries.	17.
D. Galactic and globular clusters.	
III. Galaxies	18.
A. Main types of galaxies.	19, 21.
B. The local system of galaxies.	
C. The Milky Way.	
1. Dimensions.	
2. The Sun's position.	
3. Dust and gas.	20.

ASTRONOMY

NOTES

1. (a) It is suggested that schools purchase small refracting telescopes to be lent overnight to students.

(b) Measurements can be made with simple instruments designed and constructed by the students themselves.

(c) It is suggested that the class meets as a group for observation of stars a few times per year.

(d) Most of the observation done by the students should be in their own time, perhaps in "syndicates". The teacher should set a fairly specific assignment to guide the students initially. Less direction should be necessary as they become more competent in observation.

(e) Class time will be spent more on planning observations to be made and discussing results. The student is expected to spend some of his or her time in reading, and on practical work guided by the teacher.

2. This section should be treated more as a preparation for later sections than an end in itself. There is an obvious possible integration with the Physics unit.

3. The importance of photographic records in Astronomy should be covered, as well as the reason for this.

4. The history of the technology of astronomical observation could be investigated by the student.

5. The operation of the telescope should be explained perhaps by using ray diagrams, but this will not be required for examination purposes.

6. The advantages and disadvantages of various types of optical telescopes should be discussed. It is suggested that only the equatorial mounting needed be discussed at this level.

7. Radiations other than visible light reach the earth from other parts of the universe. The radio telescope can detect part of these radiations. Australia's contribution to Radio-Astronomy should be mentioned.

8. An elementary treatment only is envisaged.

9. Students are expected to become familiar at least with the following constellations:

CRUX (Southern Cross)

ORION

CANIS MAJOR

SCORPIO

GEMINI

All of the astronomical objects referred to are found in, or associated with these constellations.

10. Explain the meaning of the terms "star" and "constellation".

11. The magnitude scale should be discussed, but dealing with apparent magnitude only.

12. The dependence of colour on surface temporature for Main Sequence stars should be explained.

13. See also eclipsing binary stars.

14. An elementary treatment only. The use of cepheid variables in distance determination could be discussed.

15. The relative rarity of novae and supernovae should be covered.

16. Multiple stars can be explained as relatively close knit groups of stars, few in number, which are revolving around a common centre of gravity.

17. Distinguish binary stars from optical double stars.

18. Where appropriate, the following units of distance should be used:

1. astronomical unit (au)
2. light year (ly)
3. parsec (pc)

19. Restrict to spiral, elliptical and irregular galaries.

20. Theories of the origin and evolution of the universe could be discussed.

21. Mention should be made of the difficulty for visual observations due to interventining dust and gas. The "Coal Sack" and the Great Nebula in Orion are good examples, respectively. The origin and evolution of stars could be treated.

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2. Immaculate, M. Sister — Helping pupils find the constellations

   A.S.T.J., Vol. 11, No. 3, November, 1965.
3. Wilkinson Gretta — Handy hints for practical astronomy

   Lab-Talk, Vol. 13, No. 7, Aug. 1969.

A 2 CHEMISTRY

This course has been designed as a practical course. The student is therefore required to conduct his own practical work.

NOTES

I. How do we Obtain Pure Substances from Mixtures?

A. Elements: - metals, non-metals, inert. 1.

B. Compounds. 2.

C. Mixtures. 3.

D. Separation techniques for mixtures. 4.

II. What Type of Compounds Are There?

A. Inorganic compounds.

1. Oxides. Acidic, basic and neutral oxides. 5.

2. Acids and their properties.

3. Alkalis and their properties.

4. Salts. 6.

B. Organic compounds.

1. Historical background. 7.

2. The diversity of organic compounds. 8.

3. The reason for the diversity. 9.

4. The structure of some organic compounds. 10.

III. How Can we Identify Compounds?

A. Physical properties. 12.

B. Flame tests. 13.

C. Ignition tube tests. 14.

Notes.

1. This involves a revision of the concept of elements initiated in previous years and should be related to the appropriate section in Physics.

2. The following should be emphasized:-

(a) In a compound the elements are bonded. Teachers could well develop this topic by means of an introductory discussion of ionic and covalent bonds.

(b) In a compound the elements show none of their own characteristics.

(c) The elements are present in a compound in definite proportions by weight.

3. Consider many examples to show that:

(a) The constituents of a mixture are relatively easily separated.

(b) The constituents of a mixture may be present in almost any proportion.

(c) The constituents of a mixture may often show their individual properties.

Therefore there is evidence to conclude that:
Bonds are absent between the constituents of a mixture.

4. Some methods are:

mechanical means; filtration; distillation; fractional distillation; evaporation; magnetic separation; paper chromatography.

For any method of separation considered an outline of the scientific principles involved should be discussed as well as several industrial applications.

An approach to this topic would be to require the student to devise a means of separating a mixture such as water-alcohol or pigments.

5. (a) Acidic oxides should be defined as being capable of neutralizing an alkali to produce a salt and water.

(b) Basic oxides should be defined as being capable of neutralizing an acid to produce a salt and water.

(c) Water should be given as one example of a neutral oxide i.e. neither acidic nor basic.

6. Salts other than sodium chloride should be prepared by acid/alkali, acid/basic oxide and acid/metal.

7. Briefly outline that:

(a) Until recently most organic compounds were produced naturally from biological processes.

(b) Many natural organic compounds have been analyzed and synthesised.

(c) Many naturally occurring organic compounds have been modified to improve their properties.

(d) Many of the organic materials which we use today do not occur naturally but have been synthesized.

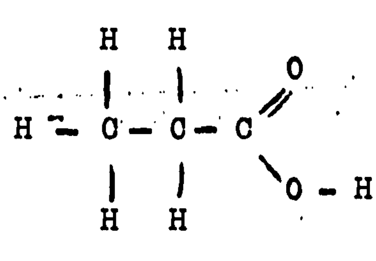
8. Students could compile their own list of types of organic compounds.

9. The ability of carbon atoms to bond with:

(a) each other to form chains, rings or branched chains or rings;

(b) other no-metallic atoms such as H, O, S, Cl and N.

10. Students should be shown the structure of some organic compounds using molecular models and should be able to deduce the molecular formula of a simple compound from its structural formula.



as $C_3H_6O_2$

11. It is important to emphasize that the tests used here are simple tests and are not usually definitive in themselves. Other more sophisticated tests are in common use.

12. The state, colour, odour and solubility of some compounds could be examined. The opportunity to identify salts prepared (see Note 6 above) should be taken.

13. Use the cations Li^+, Na^+, K^+, Ca^{++}, Ba^{++}, and possibly Sr^{++}. The use of cobalt blue glass to remove the colour due to sodium compounds as impurities should be shown. Flame colours are not required to be memorized.

14. Restrict to compounds containing the cations NH_4^+ and Zn^{++}; anions CO_3^{--}, NO_3^-, S^{--}, SO_3^{--}; and some organic compounds.

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A3. ECOLOGY

Whilst this course cannot be treated in the same manner as other sections as far as practical work is concerned, there still exists ample opportunity for practical work. Some of this will necessarily be conducted outside the classroom over an extended period and possibly in the student's own time. It is strongly suggested that the Ecology and Conservation sections be integrated together.

	NOTES
I. Basic Concepts.	
A. Ecosystems and Their Interdependent Parts.	1.
1. Non-living.	
2. Producers.	2, 3.
3. Consumers.	3.
4. Decomposers.	3.
B. Natural Cycling of Elements and Compounds.	
Water, carbon, oxygen, nitrogen and phosphorus.	4.
C. Transmission of Energy in Ecosystems.	
1. The sun as the primary energy source.	2.
2. Conservation and transformation of energy.	5, 6.
3. The pyramid of numbers related to the energy available.	
II. The Environment.	
A. Limiting Factors.	7, 8.
B. Populations.	8.
1. Interspecie interactions.	9.
(a) Positive interactions:	
(i) of benefit to both organisms;	
(ii) of benefit to one but not detrimental to the other.	
(b) Negative interactions.	
(i) Parasitism.	
(ii) Predation.	
2. Intraspecie interaction.	9, 10.
(a) Natural selection.	
(b) Adaptation.	
C. Ecological Communities.	11.
1. Dominance.	
2. Successions.	
3. Climax.	

NOTES.

1. The ecosystem concept provides a suitable starting point. However, it should be understood that the boundaries between ecosystems are commonly hard to define.

2. A practical investigation of photosynthesis is required.

3. A practical investigation of respiration is required. (The opporunity to relate these topics to the Chemistry section should be taken)

4. The details of these cycles are not to be memorized, but "perfect" and "imperfect" cycles should be considered.

5. Consideration of food chains could later be extended to food webs.

6. The importance of the loss of energy at each step in a food chains should be discussed.

7. A consideration of some limiting factors that are relevant to examples being studied is advised. These could include:

1. Temperature.
2. Water supply.
3. Soil.
4. Salts.
5. Radiations.

Seasonal and long term variations should be investigated.

8. Polymorphism and natural selection leading to adaptation should be treated here.

9. The selection of a few appropriate examples is recommended.

10. A brief consideration of natural selection and adaptation is envisaged.

11. Although dominance, succession and climax are best demonstrated with plant populations, the associated animal life should not be neglected.

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3. Weaver, A. Miles The forgotten majority: Science Curriculum Science Education Vol. 54, No. 1, March 1970.

A4. GEOLOGY

This course deals mainly with Geomorphology, but as most other facets of Geology can be incorporated to explain the observable landforms, it is therefore a revision in part and extension of previous work and is hoped to be a stimulus for further learning.

Most areas of the State exhibit varied aspects of Geology and these should be investigated by means of excursions and assignments as much as possible. Students should be encouraged to study areas of their own choice and to present their ideas on the structure and formation of the landscape.

Obviously more time will be spent on items of local interest in Part II, but it is hoped that over the whole course a broad understanding of Geology will be developed.

	NOTES
I. Constructive and Destructive Processes of the Crust.	
A. Sedimentation.	
(a) General.	1.
(b) Bedding.	2.
(c) Order of Deposition.	3.
B. Structural Geology.	
(a) Dip and strike of a bed.	4.
(b) Folding.	5, 7.
(c) Faulting.	6, 7.
(d) Jointing.	8.
C. Erosional Processes.	
(a) Weathering and soil formation	9.
(b) Mass wasting.	10.
(c) Action of:	
(i) Running water.	11.
(ii) Waves and currents.	3.
(iii) Wind and ice.	11.
II. Land forms (Caused by process in A, B, and C.)	
A. Due to rivers.	12.
B. Due to waves and currents.	3, 13.
C. Due to diastrophism.	14, 18.
D. Due to wind.	15.
E. Due to ice.	17, 18.

NOTES.

1. Include primary controlling factors e.g. source (ie. sedimentary, igneous and metamorphic rocks), transport, and depositional agencies.

2. Include horizontal and inclined beds (strata). Graded bedding could be included. It will be necessary to deal with bedding planes.

3. It would be valuable to include top and bottom indicators of a sedimentary rock succession e.g. ripple marks and swash marks - observable on any beach.

4. Discuss the difference between true dip and apparent dip.

5. Discuss anticlines and synclines. Assymetrical folding could be included.

6. Normal (tension or gravity) faults and reverse (thrust or compression) faults.

7. Include the possible relationship between faults and monoclines..

8. Discuss the simple distinctions between joints and faults.

9. Include soil profiles to show A, B, and C horizons. Discuss the mechanical and chemical aspects including the contribution of plants and animals.

10. Include landslides and hillside creep.

11. Relate to the landforms due to rivers.

12. Include: meanders, slip-off slopes, under-cut slopes, rapids, deltas, ox-bow lakes, - or other examples of prior streams. Where locally applicable deal with levees alluvial fans and river terraces.

13. Include wave cut notches and platforms, cliffs, bars and beaches.

14. This should be linked closely with Structural Geology and should include horsts and grabens. Local examples should be the guide for more detailed observation and study. e.g. dip slopes, excarpments, fault scarps and strike ridges.

15. A treatment of sand dunes is intended. This could be related to cross-bedding due to change in prevailing wind direction.

16. Glaciated valleys as distinct from normal river valleys; glacial moraines.

17. Include: types of cones, remnants of volcanoes, craters, and lava plains. More detail would be necessary in areas where vulcaricity has been active. Revision of igneous processes and metamorphism could be made here.

18. Zones of crystal weaknesses in the Earth, such as the "Ring of Fire" could be related to landforms due to earthquakes and volcanoes.

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2. Tebbutt, F. H. S.

Demonstrations in sedimentary Geology

Aust. Sci. Teacher's Journal, Vol. 15, No. 2, August 1969.

A5. PHYSICS

This course has been designed as a practical course. The student is therefore required to conduct his own practical work.

I. Atomic Particles and Structure. NOTES

A. 1. The electron, proton and neutron. Their discovery and properties.

2. The Rutherford-Bohr concept of the atom. Atomic number and mass number. 1.

B. 1. Structure of atoms from H to Ca in the Periodic Classification. 2.

2. The importance of the outer shell to include:

(a) discussion of inert gases having an outer doublet or octet (i.e. a stable section configuration);

(b) investigation of the influence on activity. 3.

II. Electric Current.

A. Flow of charge constitutes an electric current.

1. Current flow in vacuum tubes, gass, electrolytes and solids. 4.

2. (a) Metallic conductors. 5.

(b) Intrinsic semiconductors. 6.

(c) Non-conductors.

B. Effects associated with flow of charge . 7, 8.

1. Magnetic.

2. Heating.

3. Chemical.

C. Sources of electric current. 8, 9.

1. Chemical.

2. Thermal.

3. Electromagnetic.

III. Radiation.

A. The electro magnetic spectrum. 10, 11.

B. 1. The visible spectrum. 12.

(a) Continuous spectra.

(b) Line spectra.

2. Visible radiations.

(a) Reflection from plane and concave surfaces.

(b) Refraction in parallel slabs, prisms and lenses.

(c) Absorption during relection from coloured surfaces and during transmission through coloured filters.

NOTES

1. Actual values need not be memorized.

2. The most common isotopes only (where appropriate).

3. Particular reference should be given to the elements Na, K, Cl, and F. The relative ability of Na, K, Ca and Mg metals to form ions when reacted with cold water could be demonstrated. Students could well compare the reactivity of Ca, Mg and Al with water of various temperatures as an introduction to this section.

Explain the production of ions in terms of loss of electrons and the energy required for this.

4. Emphasis should be placed on:

(a) The particles which move and carry the charge;

(b) The reasons why the particles are able to move.

5. Some classification of metallic conductors should be attempted.

6. Ge, Si and Se should be treated as typical examples. The construction of simple radio sets incorporating transistors could be attempted.

7. Some applications of these effects should be studied e.g.

1. Magnetic: solenoid switch, electric bell, speaker's transformer electromagnet, electric motor.

2. Heating: heaters, stoves, arc welding.

3. Chemical: electrolysis, electroplating.

8. Students should be encouraged to construct their own working models.

9. Examples and applications could include:

lead acid accumulator, dry cell, thermocouple, simple generator.

10. This section should be integrated with the appropriate parts of Astronomy.

11. A descriptive, practical treatment of this section is envisaged.

12. Revise the Form III treatment.

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B. APPLIED SCIENCES

B1. CONSERVATION

INTRODUCTION

Of all the creatures on this planet, man has demonstrated a special ability to alter his environment to satisfy his needs. With a small, diffusely distributed population this did not constitute a threat. The degree of environmental manipulation which man induced was minor in degree and extent.

However, because of the tremendous population explosion, together with rapid technological advances in modern times, man is now threatening his own extermination.

Increasing demand for resources is tending to denude the earth of much of its natural wealth at a rate faster than these resources can be replaced. Some resources are simply irreplacable.

Man is now influencing not only specific ecosystems, but the global environment itself.

The trend toward extinction of wildlife continues in our own time. The most stable biological system, and hence the one with the greatest production potential, is known to be the most versatile, the most complete. Any alteration to such a system may have results which are not easily predicted, nor easy to reverse.

In order for man to persist on this planet, it is essential that his activities are consistent with long-term ecological stability. This does not mean that environmental manipulation should cease, but rather that the requirement for ecological stability should be a primary consideration and not an afterthought.

Unless the concept of conservation is widely understood, accepted and practiced, our future is bleak. It should be clearly appreciated that conservation does not aim just to preserve. Conservation is concerned with production - involving the wise use of resources today so that they are not destroyed for future generations, rather than ignorant mis-use.

In developing an informed understanding of conservation two main themes must be constantly referred to:

1. Some of our resources are virtually non-replaceable. (For example, coal and oil reserved are the product of millions of years of natural processes.) Other resources are more easily replaced, provided that adequate time is available for the replacement (- for example, the regeneration of forests).

2. Ecosystems tend to maintain a stable dynamic state. Any change in the system will cause it to adjust until a new equilibrium is attained. If too dramatic a change is brought about in an ecosystem, however, it may be unable to obtain a new equilibrium, and be destroyed.

The effects of man's manipulation of the environment may be apparent by alteration in:

1. Ecological Indices. e.g. (i) Pyramid of numbers
   (ii) Breeding habits
   (iii) Survival of species.
   (iv) Migrations, population distributions.

2. Aesthetic and Social Indices. e.g.
   (i) Air and water pollution.
   (ii) Traffic congestion.
   (iii) Loss of open spaces near cities.
   (iv) Litter.

These points should be used when consideration of the effects of specific activities of man on the environment is attempted.

I. Man, the Most Powerful Ecological Factor.

A. Population.

Theory of Malthus. Modification of natural selection in human species. Increase of world population. Food problems of man.

B. Man's capacity to modify his environment drastically in a short time.

II. Where is Conservation Needed?

An examination of the way man alters the environment by considering in some detail a few of the following, together with conservation measures undertaken to reduce harmful effects.

1. Farming. Some aspects are: clearing, grazing, cultivation, drainage, pesticides.

2. Mining. Clearing, erosion disposal of wastes, explosives.

3. Road and railway construction. Clearing, erosion.

4. Fires. Loss of forest, erosion, loss of wild life.

5. Dam construction. Water level, temperatures, flow characteristics, siltation.

6. Manufacturing. Pollution (air and water).

7. Urbanization. Sewage and garbage disposal, litter, clearing, motor car.

8. Pest control. Biological and biochemical.

9. Atomic explosions. Fallout, defoliation, erosion.

10. Logging. Clearing, erosion.

11. Introduction of foreign species.

(The list above is not intended to be a comprehensive one. Teachers may well develop topics not mentioned.)

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1. White, D. and Elliott, C. (eds.)

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2. Calder, Nigel The Environment Game Penguin, Middlesex, 1969.

3. Carson, R. Silent Spring Penguin Books, Middlesex 1966.

4. Marshall, J. The Great Extermination. Heineman, Melbourne, 1968.

5. N.R.C.L.V. Victoria's Resources. (Quarterly)

6. Udall, S. The Quiet Crisis. Holt, Rinehart and Winston, N.Y., 1962.

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Science Education Vol. 53, No. 3, April 1969.

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D. FOOD SCIENCE

I. Food Constituents:

A. Carbohydrates - elements present.

Sources and properties of :-

(a) Monosaccharides (glucose, fructose).

(b) Disaccharides (sucrose, maltose, lactose).

(c) Polysaccharides (starch, dextrin, cellulose, pectin, glycogen).

Sucrose - common forms. Hydrolysis. Changes on boiling with water to about 200°C. Applications in cookery. Starch - microscopic appearance of varieties. Hydrolsis to glycogen in digestion. Commercial production of glucose from starch. Effects of moist and dry heat. Application in cookery. Experiments on solubility, effect of acids, iodine. Fehling's test. Fermentation of sugar.

B. Fats and Oils - glycerides of fatty acids. Elements present. Animal and vegetable fats and oils. Sources, functions, uses. Tests for presence of fat in food. Experiments on solubility, effect of heat, effect of alkalis. Saponification. Application of emulsification in digestion. Action of lipase in digestion. Rancidity. Declouration. Prevention of light reactions - foil wrapping to protect vitamins A & D from ultra violet light.

C. Proteins:

Elements present. Complex molecule which can be hydrolysed into simpler units - amino acids. Application in digestion. Function in the body. First and second class proteins. Sources. Experiments on: solubility, effect of heat, acids, enzymes; and their applications in cooking.

D. Water:

Elements present. Functions. Sources in food and beverages. Daily requirements. Factors affecting thirst. Percentage in common foods. Experiments to find percentage of water in a food.

E. Mineral Matter:

Sources of Ca, P, Fe, and I. Functions of each. Variety of other inorganic materials found in human body. Estimation of percentage of mineral matter in a food.

F. Vitamins - A, B, C, D:

Discovery and investigation. Sources, functions, properties stability.

II. Importance of Nutrition:

A. Malnutrition:

Failure to supply body with one or more of the essential food constituents. This may result in diseases known as 'deficiency diseases', e.g. scurvy, beri-beri, pellagra, rickets, night-blindness, simple goitre, nutritional anaemia.

B. Diets

Essentials of a basic diet to provide adequate nutrition. Diabetes, hepatitis, allergies. Weight reduction.

REFERENCES

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Whitcombe and Tombs, Melbourne.

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Science activity Topics. <u>Food Science</u> Nelson, Melbourne. 1968.

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8. Martin, E. A. <u>Nutrition in Action</u> (2nd ed.)
Holt Rinehart and Winston, N.Y. 1965.

B3. TEXTILE SCIENCE

I. Introduction: NOTES

Examination of textiles to note the overall pattern - viz.

(A) Fibres - which are spun into yarn or directly felted into fabric.

(B) Yarns - which are woven, knitted, etc. into fabric.

(C) Fabrics - which are modified by various finishing processes to become saleable goods.

II. Fibres

(A) Fibre Types:

1. Classification covering main fibres marketed here. 1.

2. Simple test for identification - microscopic appearance (including transverse section and burning test). 2.

(B) Fibre Structure:

1. All fibres as polymers - long chains of chemical units.

2. Synthetic and cellulose fibres as examples of simple polymers with all units identical.

3. Silk as a more complex polymer - the protein fibroin - with 4 main amino acid units arranged somewhat irregularly in long (polypeptide) chains.

4. Wool as a still more complex polymer - the protein keratin - with chains formed from 18 amine acid units. Chains spiral, and are cross linked. Cystine (an amino acid not present in silk) providing special cross linkages which are very important in permanent waving of hair and permanent pleating of wool (34).

5. Macrostructure and microstructure of wood as underlying its distinctive properties. 3.

(C) Fibre Quality:

1. Fibre damage - mechanical and chemical. Slipe. Shoddy.

2. Tender wool.

III. Yarns

(A) Mono and multi filament yarns.

(B) Twist - S and Z.

(C) High bulk yarns.

(D) Ply yarns.

(E) Ropes.

(F) Elements of yarn manufacture - carding, combing, drawing, spinning. 4.

IV. Fabrics NOTES

(A) Woven - Inspection and analysis of simple plain and twill weaves.

(B) Knitted - Comparison of weft knitted and warp knitted fabrics.

(C) Minor constructions - main characteristics of felting, braiding, knitting.

V. Textiles

(A) Preparatory viz. - scouring, carbonising, bleaching, drying.

(B) Functional e.g. - milling, decatising, raising, cropping, pressing, calendering, starching, controlled shrinking (sanforising etc.), mothproffing, shrinkproofing, permanent creasing, permanent set.

VI. Properties of Textiles

Dependent on finish, fabric construction, yarn construction and type of fibre. 6.

VII. Use of Textiles

Fabric use as dependent both on cost and degree to which required properties are exhibited.

NOTES

1. Classification of fibres according to origin:

1. Naturally occurring

(a) Animal e.g. wool, silk, hair (alpaca, cashmere etc.)

(b) Vegetable (i) Stem e.g. flax (linen), hemp, juice cramie.
(ii) Leaf e.g. sisal, manila.
(iii) Seed e.g. cotton, kapok.
(iv) Fruit e.g. coconut fibre (coir).

(c) Mineral e.g. asbestos.

2. Man-made (a) Mineral e.g. fibreglass, lame.
(b) Regenerated cellulose e.g. viscose.
(c) Modified cellulose e.g. acetate.
(d) True synthetics e.g. nylon, Orlon, Terylene etc.

OR

Classification based on chemical composition:

Cellulose e.g. cotton, linen, jute, sisal, nscose etc.

Cellulose esters e.g. acetate.

Protein e.g. wool, silk, cashmere etc.

Polyamide e.g. nylon.
Polyester e.g. Terylene, Dacron, Tetoron.
Acrylic e.g. Orlon.

2. The burning test which forms the basis of this systematic scheme is one of the simplest yet most informative if carefully carried out. At least the following points should be noted - ease of ignition, whether self extinguishing, odour, ash or bead formed, colour of flame or smoke.

Fibre DOES NOT BURN - Glass (melts to bead), asbestos.

Fibre BURNS

(a) No bead formed, burnt paper smell - cotton, viscose, linen. Ink bolt test will distinguish linen. Shirlastain A (obtainable from I.C.I.) will distinguish viscose from cotton.
Alternativel viscose can be distinguished, with practice, by its low wet strength - about 50% of dry strength c.f. cotton 120% of dry strength.

(b) Bead forms

(i) Round fawnish bead cannot be crushed between fingers. Fibre shrinks from flame. Celery smell. Self extinguishing. White smoke - NYLON.

(ii) Black bead. Ignites readily. Not self extinguishing - ORLON.

(iii) Irregular crisp black mass. Burnt hair smell. Ignites readily. Self extinguishing - SILK, WOOL. (Silk dissolves in conc. HCl.)

(iv) Black bead. Vinegar smell. Shrinks from flame, but ignites readily. Not self extinguishing - ACETATE. **

(v) Round fawnish bead when melts, hard irregular black brittle bead when burns. Difficult to ignite. Shrinks from flame. Self extinguishing. Aromatic odour. Heavy black smoke - TERYLENE (DACRON).

** Confirm by dissolving in acetone.

3. Two reprints (both available free from C.S.I.R.O. and titles "The Structure of Wool Fibre" - one by D.J. Rigby and the other by R. Frazer and F. Lennox) will give a very adequate background for teacher reference.

4. Note that wool, worsted and cotton systems differ in their detail.

5. Aims and basic outlines only.

6. The type of fibre especially controls the chemical properties, while all contribute to the physical properties. Attempt to relate the various types of finish, cloth and yarn construction, and fibre to the overall properties of the fabric.

REFERENCE

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1. Cooper, E. K. Silkworms & Science. Lutterworth Press. 1963.
2. Page, C.E. Textiles. Mullen. 1964.

Fibre DOES NOT BURN - Glass (melts to bead), asbestos.

Fibre BURNS

(a) No bead formed, burnt paper smell - cotton, viscose, linen. Ink bolt test will distinguish linen. Shirlastain A (obtainable from I.C.I.) will distinguish viscose from cotton.
Alternativel viscose can be distinguished, with practice, by its low wet strength - about 30% of dry strength c.f. cotton 120% of dry strength.

(b) Bead forms

(i) Round fawnish bead cannot be crushed between fingers. Fibre shrinks from flame. Celery smell. Self extinguishing. White smoke - NYLON.

(ii) Black bead. Ignites readily. Not self extinguishing - ORLON.

(iii) Irregular crisp black mass. Burnt hair smell. Ignites readily. Self extinguishing - SILK, WOOL. (Silk dissolves in conc. HCl.)

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4. Note that wool, worsted and cotton systems differ in their detail.

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4. Potter, M. D. & Corbman, B.P. Fibre to Fabric. McGraw-Hill 3rd edition 1962.

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Walsh, Noel This is how I do it Lab-Talk, Vol. 14 No. 6, July 1970.

B4. MATERIALS IN THE HOME

This section incorporates the applied and the sociological aspects of science.

Regarding the former, the following criteria could be applied when discussing the use of a material:

(a) What are the particular properties that favour the use of a material? Why are other materials with like properties not used? (e.g. for economic reasons).

(b) The ideas of critical purchasing could be taught. The students should develop a rationale for purchasing materials based on scientific reasoning rather than cute or inaccurate advertising.

This section lends itself very well to the scientific method and experimental approach.

Teachers can use some of the areas following or others that they consider more important.

1. Plumbing. Why are certain metals preferred?
2. Building (Why is a particular material used for a specific purpose? Research by students and teacher on the future use of new materials in the home).
3. Paints, lacquers and other surfacing agents.
4. Surfaces and utensils in the kitchen.
5. Lighting in the home.
6. Toilet accessories. What is the role of soap, toothpaste? Is it better because of packaging and additives? What is the role of these additives? Can one product be "better" than the other?

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STUDENT

Choice. (Australian Consumers Association).

TEACHER

Huff, D. How to Lie with Statistics Gollancz, London, 1967.

B5. COMPUTERS.

The computer is playing an increasing role in industry, commerce and public adminstration. It would be virtually impossible to avoid being affected by the operations of computers nowadays, - whether it be computerized accounts or the distribution of natural gas.

This unit is intended to acquaint the student with the computer to the extent that some understanding of its role in our industralized society can be achieved.

	NOTES
I. Calculating Machines.	1.
A. Development of mechanical calculating machines	2.
B. Electronic calculating machines.	3.
II. The Computer.	4.
A. Flow diagrams.	
B. Elementary programming.	
C. Roles of computers in our society.	

NOTES.

1. The opportunity to integrate this unit with mathematics should be taken. Practice with various types of machines should be given.

2. The history of calculating machines from fingers and abacus to modern machines could be developed.

3. The increased efficiency of these machines should be mentioned.

4. (a) Stress could be laid on the fact that the computer is an elegant aid to man, but altimately it must be directed by man as well as designed and produced by him.

   (b) Students could be given instruction in simple computer languages such as "Minitran" or "Fortran". Jobs can be processed on a school basis at the Monash University Computer Centre. Regional Institutes of Technology may be prepared to offer their computer facilities to schools.

   (c) It is suggested the versatility of a computer be explored by means of a project involving co-operative effort of a group e.g. processing weather information, examination results; school census results.

   (d) Some students may be interested to make the circuitry required for a simple "computer".

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2. Whitehouse, L. G. Minitran - Monash University Student Fortran
Monash Uni. Computer Centre.

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1. Cronley, T.H. Understanding Computers McGraw Hill, N.Y., 1967.

2. Fink, Donald G. Computers and the Human Mind Heineman, London, 1966.

3. Hollingdale, S.H. and Tootill, G.C.
Electronic Computers Penguin, Middlesex, 1965.

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5. Vorwald, A & Clark, F. Computers Lutterworth Press, London, 1963.

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2. Delaney, Arthur A. A Computer activity for the classroom
Sch. Sci. and Maths Vol. LXVI, No. 3, March 1966.

3. Winthrop, H. Communication with a Computer
Science Education Vol. 51, No. 4,
October 1970.

B6. SOIL SCIENCE

It is saddening to find how ignorant young city people are of primary industry in general and of the work of the farmer in particular.

This introductory course in Soil Science is an attempt to bring the farmer, his farm, his work and the scientific work of the Department of Agriculture, into the classroom. It is hoped that the attempt is particularly successful in city schools. A day excursion to a farm would be desirable.

I. Classification of Soils.

These major properties are looked for when classifying soils.

(A) Presence or absence of calcium carbonate, either as white streaks or large round concretions.

(B) Colour.

(C) Degree of contrast in texture of successive horizons and sharpness of transition.

(D) Degree of acidity or alkalinity.

(E) Depth to parent rock.

(F) Presence or absence of ironstone gravel.

(G) Size and shape of natural aggregates and the pattern of cracks between them.

II. Soil Groups.

(A) Mineral soils: (i) no calcium carbonate in profile;
(ii) calcium carbonate in profile.

(B) Peaty soils.

(C) Skeletal soils.

(D) Miscellaneous.

III. Main Factors in Soil Formation.

(A) Leaching.

(B) Waterlogging.

(C) Vertical movement of clay.

(D) Erosion.

(E) Deposition of mud.

(F) Restoration of elements from subsoil to surface by the action of plants.

(G) Weathering of parent rock and of minerals in the soil especially by warm water.

The importance of the relation between soil and climate must be stressed.

IV. Australian Soils.

(A) Water and water reserves.

(B) Aeration and drainage.

(C) Acidity and alkalinity.

(D) Phosphorus.

(E) Nitrogen.

(F) Other elements including trace elements.

V. Soil Improvement.

(A) Farming Method:

1. Irrigation - limits, dangers, necessity, possibility of the conversion of sea water. eg. nuclear reactors.

2. Reclamation.

3. Conservation of soils - effects of over production and over stocking. Necessity for fallow, rotation etc.

4. Preservation of soils and plant growth - effects of bush fires, erosion, burning off, movement of stock, movement of cow-sheds, clearing of trees and scrub, etc.

5. Conservation of water resources - subsoil and surface.

(B) Treatment of Soils:

eg. Use of trace elements, superphosphate, other fertilizers, legumes like subterranean clover to improve structure and increase the available nitrogen supply.

VI. Problems of the Farmer.

(A) Some obvious problems which the farmer may recognize and overcome.

1. Drainage.

2. Erosion.

3. Conservation of water.

4. Shade for stock.

5. Stocking land in an intelligent manner.

6. Conservation of feed and pasture.

7. Destruction of vermin.

(B) Other problems (not so obvious) the farmer overcomes by:

1. Experience - success and failure of crops, appreciation of the climate of his district, stock suitable to his district, avoidance of ov. rstocking, intelligent and experienced farm management;

2. Advice of the Department of Agriculture - soil analysis, experimentation in the field, etc;

3. His subsequent action on the result of an investigation using this experience and advice.

NOTES:

1. The substance of Sections I - IV may be found in Leeper "An Introduction to Soil Science".

The points made in Sections 5 and 6, are somewhat self-evident. Leeper raises and answers many queries mentioned in these sections. Recourse to material from the Department of Agriculture in this state would also be essential; while the aid of an experienced farmer would be invaluable in any survey attempted in these sections.

The soil profiles for study should include PODZOL, RED LOAM, MALLEE and CHERNOZEM which all occur in Group (a) above. These profiles could be permanently mounted where field study allows this. The other groups rate only a mention in such a course at this and discussion should point to their existence and location in Victoria.

REFERENCES

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Perry, G.A. Investigator's Book of Soils. Rural Studies Series, Blandford Press.

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1. Leeper, G. An Introduction to Soil Science M.U.P., Melbourne, 1954.

2. Stephens, C. G. A Manual of Australian Soils. C.S.I.R.O., Melbourne 1953.

3. Strahler, Arthur N. The Earth Sciences. Harper and Row, N.Y. 1963.

4. Uren, Earth Studies Harper International Student Reprint 1965.

B7. TRADE MECHANICS

I. Solids, Liquids and Gases.

Properties:

(a) Expansion. Coefficient of linear expansion for solids. Coefficient of cubical expansion for liquids and gases.

(b) Density. Simple determinations of densities of various metals. Principle of flotation. Relative density determination using the principle of flotation. Hydrometer.

(c) Change of state. Latent heat (qualitative only).

(d) Transmission of heat.

In addition the following topics should be covered in:

(i) GASES: Pressure. Atmospheric pressure. Boyle's Law. Charle's Law. Discussion of the effect of temperature and pressure on the volume of a gas in terms of the Kinetic Molecular Therry.

(ii) LIQUIDS: Pressure. Pressure increase with depth.

II. Force.

Representation of force. Types of force - tensile, compressive and shear. Gravitational units of force. Moment of a force. Principle of moments. Equilibrium - taking moments about any point for:

(i) lever under the action of two forces ;

(ii) lever under the action of three forces;

(iii) rigid body under the action of more than two forces.

III. Work, Energy and Power.

Definitions. Transformation of potential energy to kinetic energy for masses under the action of gravity. Problems on work, potential energy and horse-power (gravitational units only).

IV. Simple Machines.

Principle of work. Mechanical Advantage. Velocity Ratio.

$$\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} = \frac{\text{M.A.}}{\text{V.R.}}$$

Applications to: (i) lever;

(ii) pulley systems;

(iii) wheel and axle ;

(iv) inclined plane.

B8. TRADE ELECTRICITY AND MAGNETISM

I. Structure of Matter.

The electron, proton and neutron. Description of conductors, insulators and resistors in terms of atomic and molecular structure.

II. Electric Current.

Electron flow constitutes an electric current. Sources of electricity: chemical, thermal and electromagnetic.

III. Electrical Units.

Definition of ampere and volt (S.I. system)

IV. Electrical Resistance.

Resistance: a physical property of a circuit. The ohm. The effect on resistance of length, cross sectional area and type of material. Resistivity units: ohm inch, ohm per circular mil. foot. Comparison of resistivities of common materials used in an electrical installation i.e. conductors, insulators and resistors. Effect of temperature on resistance. Temperature coefficient of resistance.

V. Electric Circuits.

Ohm's law. Resistors in series, parallel connection. Mechanical analogy to electric power (watts), energy (watt-hours). Watts per horse-power.

$$\text{Power} = VI = \frac{V^2}{R} = I^2R.$$ Simple tariff problems.

VI. Electric Cells.

The Le-Clanche cell. Its advantages over a simple cell. The dry cell. Internal resistance. Uses of both types of cell. Cells in series and parallel connection.

VII. Permanent Magnets.

Laws of magnets. Types of magnetic fields. Methods of detecting and plotting fields. Types of materials used in modern permanent magnets.

VIII Electro-magnets.

The magnetic field around a straight conductor and coiled conductor carrying a direct current. The effect on the field on inserting an iron core in the coil. Applications of electromagnetism: solenoids, bells, field systems of D.C. machines, lifting magnets.

IX. Electric Measuring Instruments.

Basic moving coil movement and its conversion to read voltage and current related to Ohm's law. Shunts and multipliers.

TRADE MECHANICS TRADE ELECTRICITY AND MAGNETISM

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Weber, Robert L. et al *Physics for Science and Engineering*
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EDUCATION-DEPARTMENT - VICTORIA

TECHNICAL SCHOOLS SYLLABUS

JUN. 711.

SCIENCE

FORM I

1969 REVISION.

CURRICULUM AND RESEARCH BRANCH

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TECHNICAL SCHOOLS SCIENCE SYLLABUSES

FORMS I - III

I. FOREWORD.

During 1968 the science syllabuses for Technical Schools Forms I, II and III were reviewed. The existing structure of "Principles" has been retained, but changes have been introduced so that:

1. the syllabus for each year has become more directly related to the time available;

2. some "Principles" have been changed to make them more tenable scientifically;

3. new "Principles" have been introduced and others moved from one year to another to provide a more coherent sequence for the first three years;

4. the syllabus proper is now virtually a list of "Principles", providing increased scope for teacher initiative.

The revised syllabuses are not new in the sense that they were when the "Principle" approach was first introduced in 1958, but they represent revisions in the light of experience with them over this period. It is intended that these syllabuses should have a life of a few years, during which time a major syllabus revision will take place.

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JUN 711 - SCIENCE - FORM I (1969 Revision)

II A. GENERAL COMMENTS

1. This syllabus replaces syllabus "Form I - Science (1962)".

2. The revised syllabus is in the form of a list of "Principles" supplemented by brief notes on the areas to be covered.

3. It should be noted that -

   (a) the "Principle" itself is still meant to be

III Appendix.

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3. It should be noted that -

(a) the "Principle" itself is still meant to be the conclusion reached, and not the heading or the introduction:

(b) the courses should be taught in the spirit of general science, with full scope for individual student enquiry and experiment.

* *

B. OUTLINE SYLLABUS

1. OBSERVATION AND CLASSIFICATION ARE IMPORTANT TOOLS OF SCIENTISTS.

(a) Observation.
Teachers are advised to select demonstrations which will provide opportunity for a range of observations. After performing experiments, the students could well compare their observations. The differences will help to stress the need for care and accuracy.

It would be well worth while selecting a procedure for which the student will observe that "nothing happens" because the change involved is too small. The student will benefit from an experience with a problem for which no immediate solution can be found, and for the moment at least, the problem remains open-ended.

(b) Classification
A diverse range of materials should be available for classification. Students should be encouraged to develop their own criteria, and become aware of other, equally valid criteria. They should learn to discriminate between criteria on the basis of usefulness.

Teachers should not neglect the concept of sets being concurrently developed in mathematics.

After devising a scheme of classification students should be confronted with an object which does not fit into the established scheme. In this case a new set of criteria may be needed, or the object may have to be treated as a special case.

2. ALL MATTER CONSISTS OF CONSTANTLY MOVING PARTICLES.

Teachers are urged to point out that models and analogies are used to help in grasping the point being developed.

Care should be taken to distinguish between the motion of a particle because of its own kinetic energy, and that due to the movement of the medium in which it is suspended.

The student should come to have some appreciation of the minute size of molecules.

3. PARTICLES OF ONE SUBSTANCE DIFFER FROM PARTICLES OF OTHER SUBSTANCES.

4. MATTER MAY EXIST IN THE SOLID, LIQUID, OR GASEOUS STATE.

As wide a range of substances should be used. Liquids other than water can be used, and gases other than air.

5. SOUND IS CAUSED BY VIBRATION.

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As wide a range of substances should be used. Liquids other than water can be used, and gases other than air.

5. SOUND IS CAUSED BY VIBRATION.

Experience with a wide range of materials capable of vibration as well as instruments could be arranged.

6. SOUND TRAVELS ONLY THROUGH MATTER.

7. ALL MATTER IS MADE UP FROM ONE OR MORE SIMPLE SUBSTANCES CALLED ELEMENTS.

The formal definition of a chemical element is unnecessary. An explanation in terms of a simple substance the particles of which are identical would be satisfactory.

8. ELEMENTS CAN EXIST ALONE

The student should come to appreciate that some elements exist free in nature, but others have to be specially prepared.

9. ELEMENTS CAN BOND TOGETHER TO FORM NEW SUBSTANCES CALLED COMPOUNDS

The properties of particular elements alone should be investigated and the properties of the product formed after they have been combined.

There is an opportunity here to develop the ability to write WORD equation to represent chemical reactions.

The systematic naming of compounds could be introduced simply. Most compounds are named with a metal element first. The meaning of the prefixes - 'di', 'tri' and the suffixes - 'ide', 'ite' and 'ate' could be explained when appropriate.

10. MIXTURES CAN BE SEPARATED BECAUSE OF DIFFERENCES IN THE PROPERTIES OF THE PARTICLES.

The properties of each constituent of a mixture should be investigated before separation is attempted so that an appropriate method is chosen.

11. MINERALS ARE NATURALLY OCCURRING COMPOUNDS OR ELEMENTS

At this level the emphasis will probably be placed on the concept of naturally occurring substances with a definite composition, or definite range of composition. Students will doubtless try to make some collection and may desire a basis for classification. A simple one would be -

(a) ore minerals
(b) rock forming minerals.

However, they may note differing form or habit and make a classification thus. They could be lead to look at other properties such as hardness, and classify as hard - medium - soft. Cleavage, S. G. and colour are other physical properties that could lead to simple classification. Note here that colour, which is often the most striking property, can be influenced by traces of certain impurities. Streak on an unglazed tile is usually a safer basis for identification or classification. Students could be expected to distinguish between 2 or 3 minerals, given the properties of each. At no stage should students be expected to memorize the properties of minerals, but to make intelligent use of references for identification. Visits to the National Museum, the museum of the Mines Department, field excursions, and liaison with lapidary societies are strongly recommended.

12. ROCKS ARE ASSEMBLAGES OF MINERALS.

The word assemblage is used advisedly, having connotations of mixture, grouping, arrangement etc. Whilst most rocks could rightly be termed mixtures of minerals, some e.g. sandstone whilst essentially all quartz, nevertheless may have individual grains cemented together by other minerals e.g. limonite. Even when this is not so, it is still an aggregate of mineral particles. Most schools will want to set up a museum or display of their rock collections. Specimens should show a fresh surface rather than a weathered surface.

If it is envisaged to hold an excursion to collect rocks or see a variety in situ, an excursion to the Bulla-Sydenham district would be one of the most

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If it is envisaged to hold an excursion to collect rocks or see a variety in situ, an excursion to the Bulla-Sydenham district would be one of the most fruitful. Within a small area may be seen sandstones, shales, hornfels, basalt, granodiorite and aplite, as well as the famous columnar jointing of the "Organ Pipes". Although on public property this area must be approached by crossing private property, and permission from the owner must be obtained. (See Education Gazette, June 1966, p.377.)

13. ROCKS MAY BE CLASSIFIED ACCORDING TO ORIGIN

Students should be encouraged to contribute to a rock collection and to suggest how the rocks could have been formed, rather than fit them into the accepted classification from the start.

14. ORGANISMS FEED, BREATHE, GROW AND REPRODUCE.

The term 'breathe' is taken to mean an exchange with the environment of oxygen and carbon dioxide. It should not be taken to mean only the external breathing which occurs in many animals. The term respiration would probably be too complex to be fully understood at this stage.

15. ORGANISMS ARE MADE UP OF CELLS.

This is a reasonable generalization for the experience of the student in Form I. Some organisms are unicellular, whilst others have nuclei which are not separated by a definite cell wall.

The student must appreciate that the cell itself feeds, breathes, grows, and reproduces.

16. CELLS DIFFER IN TYPE

An attempt to relate the structure of cells to their function should be made.

Cells in microscopic section may appear flat, - two dimensional. Several sections are needed before a realistic concept of the structure of a cell is possible.

17. OBJECTS CAN BE SEEN BECAUSE THEY EMIT OR REFLECT LIGHT.

The student should understand that light must pass from an object and enter the eye before it can be seen.

18. LIGHT APPEARS TO TRAVEL IN STRAIGHT LINES AND AT VERY HIGH SPEED

For the remaining 6 topics considerable class project activity is envisaged. It is suggested that instead of directing students to memorize a large amount of factual material, the emphasis should be placed on -

(a) Individual or group observations outside class time. Class time would be spent in discussion, preparation of duplicated reports and delivering verbal reports.

(b) Student research and the efficient use of reference facilities.

The use of appropriate films, T.V. programs, radio broadcasts, visits to the Museum of Applied Science, the Planetarium, the Observatory are strongly recommended.

19. OUR SUN IS THE NEAREST OF A VAST NUMBER OF STARS

20. ASTRONOMY USES A SPECIAL SET OF UNITS BECAUSE OF VAST DISTANCES INVOLVED.

Formal definitions are not required. Limit the units to the Astronomical Unit, the light year, and the parsec.

21. SOLAR SYSTEMS CONSIST OF A STAR (SUN) AND ORBITING PLANETS.

22. SOME PLANETS HAVE NATURAL SATELLITES CALLED MOONS

23. MAN'S IDEAS CHANGE AS HE DISCOVERS NEW FACTS

The student should appreciate that science is not a static body of knowledge and theory, but is constantly in a state of flux.

24. DEVELOPMENTS AND USE OF NEW SCIENTIFIC INSTRUMENTS HAS INCREASED MAN'S KNOWLEDGE

C. REFERENCES

CLASS SETS

Clark, J. et al.,	Earth and Universe	Science on the Mark Series, Longmans.
Child, J.	Australian Rocks and Minerals	Periwinkle
How and Why Series,	Sound Light and Colour The Microscope	Wonder Books, New York
I.C.I.	Elements of Industry	
Orr, M.A.	An Easy Guide to Southern Stars	Gall & Inglis, Edinburgh
Parker, B.M.	What Things are Made Of,	Basic Science Series, Peterson & Co.
	OR	
Reuben,	What is Sound	Pageant of Knowledge Series, Collins

TEACHER REFERENCE

Newell, W.F.	The Australian Sky	Jacaranda, 1967.

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III. APPENDIX

PRACTICAL WORK

NOTES

(a) TEACHERS ARE STRONGLY ADVISED TO PREVIEW ALL PRACTICAL WORK BEFORE THEY ATTEMPT IT IN CLASS, OR BEFORE THEY ALLOW STUDENTS TO ATTEMPT IT.

(b) The following student experiments and teacher demonstrations are suggestions only. It is not implied that all or any of the experiments listed for each topic should be done. Teachers may well develop other, and possibly better illustrations.

SUGGESTIONS FOR PRACTICAL WORK

1. OBSERVATION AND CLASSIFICATION ARE IMPORTANT TOOLS OF SCIENTISTS

Possible approaches, -

(a) Observation

- (i) Heat zinc oxide. Cool.
- (ii) Heat cobalt chloride. Cool. Add water.
- (iii) Time pendula of various lengths.
- (iv) Describe the fluorescence of various materials.
- (v) Dissolve potassium nitrate in water.
- (vi) Describe prepared microscope slides.
- (vii) Heat sodium thiosulphate till liquid. Cool. Add a crystal or simply shake.

(b) Classification

Students devise classifications for:

paper shapes; bottle tops; cards; shells; leaves; students; rocks; animals; living things; matter.

It is suggested that the student starts with simple materials and then extends the experience to more abstract items later.

2. ALL MATTER CONSISTS OF CONSTANTLY MOVING PARTICLES.

Some ideas:

(a) Particles.

- (i) Examine newspaper photographs.
- (ii) Halve a piece of paper. Continue to halve until the piece is extremely small. Examine the piece under a microscope.
- (iii) Examine prepared microscope slides under progressively higher magnifications.
- (iv) Examine electron micrographs.
- (v) Discuss a beam of light in a theatre picking out specks of dust in the air.
- (vi) Serially dilute a strongly coloured solution like potassium permanganate.

(b) Energetic nature of particles.

(i) Demonstrate with a vibrator attached to a perspex cell containing ball-bearings. The cell can be placed on an overhead projector. (A windscreen wiper motor works well and the demonstration is improved if the ball-bearings are weakly magnetized.)

(ii) The vapours from volatile liquids like acetone and gases with odours can be released to spread.

(iii) Separate two gas jars mouth to mouth with filter paper. A few drops of concentrated hydrochloric acid is placed in one and concentrated ammonia in the other. The white fumes of ammonium chloride can be observed streaming into the jar containing the acid.

(iv) Place a small crystal of a coloured solute at the bottom of a container of water. Gradual solution takes place over an extended period.

(v) Demonstrate Brownian movement. Place a drop of homogenized milk on a clean microscope slide and cover with a cover slip. Set the microscope at low power, with low illumination, the stage horizontal. The rapid dancelike motion of the fat droplets can be seen.

(vi) Release a coloured gas to completely occupy a container.

3. PARTICLES OF ONE SUBSTANCE DIFFER FROM PARTICLES OF OTHER SUBSTANCES.

The following project could be developed, -

Tabulate the properties of groups of metals, gases, liquids, etc. (Colour, lustre, density, odour, solubility, and crystal shape could be considered.)

The student could be posed with the problem -

"Why are there differences between substances?"

4. MATTER MAY EXIST IN SOLID, LIQUID, OR GASEOUS STATE

(a) Classification of matter. (See p.1.)

(b) Use vibrator model. (See p.2.)

(c) Demonstrate the change of state when heating and cooling matter.

(i) Make lead sinkers.
(ii) Gently heat sulphur, and cool in water.
(iii) Make seals from sealing wax.
(iv) Demonstrate distillation.
(v) Demonstrate the release of carbon dioxide from a fire extinguisher. The solid form of this compound appears as a snow-like substance, which sublimes.
(vi) A good demonstration would be the freezing of mercury. Liquid air can be used as the refrigerant. (CAUTION)
(vii) Discuss the changes of state of common substances such as butter, ice-cream.

(d) The importance of the various states of water to life on this planet should not be missed. The solid form of water represents a store of water which is released in the liquid form gradually. Similarly, water vapour is a store which can be widely distributed before it is converted into the form needed by living things. It is not surprising, therefore, that life has adapted to a temperature range in which water is in the liquid state.

5. SOUND IS CAUSED BY VIBRATION

(a) The students could produce sounds with objects, touching them to feel vibrations, and investigating how a sound can be made louder. Some things to use are:

tuning fork; violin; guitar;
hand bell; electric bell;
human throat; stretched objects
such as wires, rubber bands;
rules; bottles, - tapping and
also blowing across the top;
wobble boards.

(b) Discuss the shattering of glass vessels by pure, intense sounds.

(c) Place a vibrating tuning fork in a bowl of water on an overhead projector.

(d) Investigate the construction of a loudspeaker and telephone.

(e) Attach a stiff bristle to the end of a prong of a tuning fork. Draw this over smoked piece of glass. If smoked paper can be wrapped around a drum which is steadily rotated, a permanent record can be kept. The paper can be sealed with shellac.

(f) Construct a monochord with a movable bridge.

(g) Make a set of chimes with pipes of various lengths.

6. SOUND TRAVELS ONLY THROUGH MATTER

(a) Demonstrate that sound travels through matter.

(i) Construct a "wire" telephone.
(ii) Tap water or gas pipes in adjacent rooms.
(iii) Discuss sounds heard underwater; the Indian trick of listening on the ground for the approach of buffalo; that the sound of a train can be heard through the rails (CAUTION).
(iv) Place a tuning fork at one end of a metre rule and listen at the other end.

(b) Demonstrate that sound does not travel through a vacuum.

Suspend an electric bell in a bell jar and evacuate. Compare the intensity of the sound as the vacuum increases with the original.

Discuss communications on space flights.

7. ALL MATTER IS MADE FROM ONE OR MORE SIMPLE SUBSTANCES CALLED ELEMENTS.

The practical work involves decomposition of or reactions between substances to produce elements. Students should be encouraged to suggest what the element formed could be and its origin. (It should be made clear that all chemical reactions do not release elements as products.)

(a) Compile a list of the elements. Students could indicate the elements they are familiar with.

(b) Hold a piece of sheetmetal in a luminous bunsen burner flame. The black deposit of carbon appears on the metal.

(c) Place an iron nail in copper sulphate solution. The nail becomes copper coated.

(d) Heat mercuric oxide in an ignition tube. The oxygen produced can be identified. The silvery residue is mercury.

(e) Decompose water by electrolysis. A student experiment using platinum electrodes, test tubes, and a shallow basin is preferred to the use of Hoffman's voltameter.

(f) Add a small quantity of concentrated nitric acid to sodium thiosulphate solution in a test tube. Elemental sulphur is precipitated, and may be filtered out. (The brown gas evolved is noxious.)

(g) Carefully add the minimum amount of concentrated sulphuric acid to a beaker containing about 1" sugar, so that the sugar is moistened. The elements of water are extracted from the sugar by the acid, leaving the black spongy carbon.

8. ELEMENTS CAN EXIST ALONE.

(a) The opportunity to prepare common elements like oxygen, hydrogen, chlorine should be taken.

(b) Fill balloons with helium.

(c) Discuss the mining of the noble metals. A session on gold panning would be valuable.

(d) A project on the elements on a class basis is suggested.

Some ideas, -

(i) List the 90 elements which exist in nature.
(ii) Name the man-made elements.
(iii) What are the most common elements?
(iv) How are elements named?
(v) Which elements are the most abundant?
(vi) For a selected element -
(a) Discovery. Name of discoverer; date of discovery; symbol; how the element was named, experiments leading to discovery.
(b) Source of element. Raw materials; abundance; distribution; treatment of raw materials.
(c) Properties of element.
(d) Uses of element.
(e) Samples of element.

A master chart to record the findings of groups would be used. Verbal reports could be made, and written reports circulated.

It is advisable for the students to see as many samples of elements as possible.

9. ELEMENTS CAN BOND TOGETHER TO FORM NEW SUBSTANCES CALLED COMPOUNDS.

(a) Burn magnesium in oxygen (air).
(b) Burn phosphorus in oxygen (air).
(c) Burn zinc in chlorine. (Teacher demonstration.)
(d) Heat sulphur and iron filings in a crucible.
(e) Ignite small test tubes of hydrogen.

10. MIXTURES CAN BE SEPARATED BECAUSE OF DIFFERENCES IN THE PROPERTIES OF THE PARTICLES.

(a) Separate salt from water by evaporation.
(b) Filter mud from dirty water.
(c) Use a centrifuge to separate cream from milk.
(d) Separation of iron-salt-sulphur mixture.
  (i) Magnetic action to retrieve iron.
  (ii) Mix with water and recover sulphur by filtration.
  (iii) Separate salt by evaporation.
(e) Discuss filters for purifying water, air, petrol.

11. MINERALS ARE NATURALLY OCCURRING COMPOUNDS OR ELEMENTS.

(a) Examine a wide variety of minerals for their physical properties - (hardness, specific gravity, colour, cleavage, streak).
(b) Minerals can be classified into, -
  (a) elements. (small group) e.g. gold, native copper, sulphur, silver.
  (b) Compounds. e.g. galena, haematite.
    (i) ore minerals - e.g. cassiterite.
    (ii) rock-forming minerals. e.g. feldspar.

  (c) The properties of gold, (a native mineral element) and "fool's gold" (a compound of iron - FeS_2) would be of interest. Fool's gold is hard, brittle, and dissolves in nitric acid.

12. ROCKS ARE ASSEMBLAGES OF MINERALS.

(a) Examine a sample of granite carefully. The minerals quartz (colourless), feldspar (pink, white or off-white), and mica (black) can be distinguished with the naked eye. A hand magnifier could be used with this activity.

(b) Crush samples of granite and separate the minerals. The shape of the minerals could be described.

(c) Study a variety of other rocks using a hand lens and stereoscopic microscope to illustrate that in general rocks are not homogeneous, but consist of discrete mineral particles. Basalt should be one studied

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(b) Crush samples of granite and separate the minerals. The shape of the minerals could be described.

(c) Study a variety of other rocks using a hand lens and stereoscopic microscope to illustrate that in general rocks are not homogeneous, but consist of discrete mineral particles. Basalt should be one studied because of its free availability, and the apparent homogeneity to the unaided eye. Distinction of minerals will require the microscope. (Some rocks are so fine grained that a study in thin section under the petrological microscope would be required - outside the scope of the course).

(d) Cool a hot saturated solution of a salt such as an alum or copper sulphate rapidly in ice water, and compare the crystals formed with those in a solution cooled gradually overnight.
Basalt, a volcanic rock, has cooled at the surface (i.e. rapidly) and the crystals are small. Basalt is apparently homogeneous to the naked eye. Granite, a plutonic rock, cooled slowly beneath the surface so that the crystals are large.

13. ROCKS MAY BE CLASSIFIED ACCORDING TO ORIGIN.

(a) Study samples of rocks and attempt answers to the following questions.

(i) Where was the rock found?
(ii) Do any of the rocks have properties in common?
(iii) Has this rock any prominent features distinguishing it from other rocks?
(iv) What is the shape and arrangement of the particles within this rock?
(v) What conditions could account for these characteristics i.e. under what conditions could it have been formed?

Students should note such characteristics as:

1. Rounding and size of pebbles in conglomerate.
2. Particles size in sandstones, mudstones.
3. Size and inter-relationship of crystals in granite, basalt.
4. Vesicles in basalt (pressure release at surface c.f. opening of soft drinks).
5. Bedding of mudstones, shales, slates.
6. Foliation of schists and cleavage of slates. (Cleavage may cut across bedding planes.)
7. Relative hardness of various rocks.

(b) Develop theories of formation of the various rocks, supported where possible by laboratory experiments.

(i) Settling rates (show dependence on particle size, stream flow); distribution with regard to conglomerate, sandstone, mudstone (refer again to stream flow.)
(ii) Behaviour of molten material and effect of rate of cooling on particle size (note glass and furnace slags) can be related to characteristics of granite, basalt, pumice, obsidian.
(iii) Duplication of natural phenomena to provide supporting evidence for the action of heat and pressure in the formation of metamorphic rocks is difficult, and may well have to be limited to baking of clays.

(c) The accepted classification of rocks into igneous, sedimentary and metamorphic can now be made, - the meaning of the terms should be explained. In doing this, opportunity should be taken to revise the limitations of classification. Students should be aware:

(i) That the rock samples used are relatively easy to classify, but others display "in-between" characteristics, and -

(ii) That the classification is extended to sub-groups as study is continued.

A suggested minimum rock list is:
conglomerate, sandstone, mudstone, shale, limestone, granite, basalt, slate, quartzite, marble, schist.

14. ORGANISMS FEED, BREATHE, GROW AND REPRODUCE.

Teachers should be prepared to conduct experiments which cannot be completed in one session. Experiments in this section could well extend over many weeks.

(a) Plant bean seeds. Carry out a weight and height record over some months.
(b) Classify food requirements of living things. The source, amount, food types, form most palatable could be considered.

(c) Perform a starch test on leaves obtained from a plant exposed to sunlight. Repeat this test on leaves from a similar plant kept in the dark for some days.
Why has the plant in the dark lost its starch (food)?
(The most suitable leaves to use are round, soft-leaved dicotyledons such as hibiscus, marshmellow, or geranium. The leaves should be exposed to sunlight for some hours.
Boil the leaves in water to soften them and to destroy the enzyme systems quickly. It is necessary to remove the chlorophyll before performing the test. This can be done by boiling in meths. in a water bath.)
(d) Measure the volume of air which can be displaced from the lungs by forced expiration into a bell jar of water in a trough. Test this gas for oxygen and carbon dioxide and compare with air.
As a test for oxygen the time a candle will remain alight in inspired air could be compared with this time in an equal volume of room air. The lime water test for carbon dioxide could be carried out on expired air and room air.
An interesting technique to study the oxygen consumption of bacteria contaminating milk may be found in - "B.S.C.S.: An Enquiry into Life, Student Laboratory Guide", pages 93 and 94.
(e) Breed mice, or other small animals
(f) Set up and maintain an aquarium as a permanent feature of the Science room.

(g) Obtain some water from a stagnant pool. Examine samples of the water microscopically, and record the nature of the inhabitants. Add some breadcrumbs, rotting leaves. Examine the population over an extended period.
(An alternative source of micro-organisms can be obtained from 500 ml. of water in a flask the bottom of which is covered with hay or dry grass and which is left in a warm place for some days.)

15. ORGANISMS ARE MADE UP OF CELLS.

(a) It would probably be better to use prepared, stained microscope slides at first. Examine slides of amoebae, paramecia, bacteria, spirogyra, hydra, as well as slides of tissues from more complex organisms.
(b) Students should be taught to prepare their own slides and stain them by simple procedures. Banana cells, onion epidermis cells, cells from the lining of the mouth, blood cells could be used. (Tissues should always be mounted in a medium as similar as possible to their natural environment. If a small drop of aqueous iodine solution or methylene blue is placed beside the coverslip, the solution can be drawn across the tissue to be stained by a piece of blotting paper held on the opposite side of the coverslip.)

16. CELLS DIFFER IN TYPE.

Continue the microscopic examination of cells. It would probably be best to use stained slides for this topic. Note that the students will probably make their observation of the differences between cells when the previous topic is under consideration.

(a) Examine a section of a leaf. Describe as many different types of cells as possible. Low power would be best to use, although high power will be needed on occasions to check on classification. Where are these types of cells found in the leaf? What function would you expect them to perform?
(b) Compare a L.S. and T.S. of plant leaf, stem and root. The same cells appear to be different simply because they are viewed in different section.
(c) Examine complex tissues and classify the cells. Connective tissue, blood, muscle, nerve, bone slides would be appropriate. Why are most blood cells round? What function could a very long, thin cell have?

17. OBJECTS CAN BEEN SEEN BECAUSE THEY EMIT OR REFLECT LIGHT.

(a) Use a rheostat to increase the illumination provided by a lamp. Can the lamp be seen in the dark? When is the globe easiest to see?
(b) List the objects in the classroom which are emitting light of their own.
(c) Which object produces the greatest light in a darkroom? Match, flints, candle, electronic flash?
(d) Discuss: phosphorescence, stars, fires, lamps, light houses.
(e) Construct a periscope with plane mirrors and cardboard tubes to demonstrate reflection. Which objects reflect light well? Why is the glare greater at the beach or in snowfields than in usual surroundings?
(f) Construct a "hall of mirrors".
(g) Gradually darken a room by closing blinds, drawing curtains etc. Which objects disappear first? Which objects are easy to see?
(h) Discuss: spotlights in theatres; search lights; car head lamps (c.f. tail lights); moonshine, earthshine; greasepaint; why the planets are visible; darkened faces for commando raids; etc.
(i) Discuss eclipses at the appropriate time in terms of this principle.

18. LIGHT APPEARS TO TRAVEL IN STRAIGHT LINES AND AT VERY HIGH SPEED.

(a) Demonstrate a beam of light from a projector in a darkened room. Chalk dust can be used to outline the beam.
Why can the beam be seen?
(b) Arrange cards with holes punched in the centre of each so that a light can be seen.
How must the cards be arranged so that the light is visible through the holes?
(c) Study eclipses at the appropriate time. (A solar eclipse should be viewed indirectly as a safety precaution.) taken.
(d) Calculate the time taken for light to reach the earth from the sun, and from the nearest stars.
(e) Discuss the history of the measurement of the speed of light.
(f) Investigate the production of shadows.
(g) Make and use a pin-hole camera.
(h) Use a Nicholson light box to produce a ray of light. Demonstrate reflection by plane mirrors, curved mirrors, and the effect of various lenses on the beam. The beam could be "traced" on a paper background.
(i) Discuss the operation of the microscope, the telescope.
(j) Demonstrate total internal reflection in "light tubes" which can be obtained commercially.

19. OUR SUN IS THE NEAREST OF A VAST NUMBER OF STARS.

Some assignments -

(a) Students should become familiar with some of the more obvious constellations in the Southern Hemisphere.
e.g. Crux, Orion, Scorpio, Canus Major, Centaurus, Taurus, Argo, Musca, Southern Triangle.
(b) Record the position of a constellation during the night at hourly intervals.
The measurement of angles can be done with a simple protractor attached to a sighting tube, or by estimating the angle using "handspans".
(c) Record the position of a constellation at the same time of night during the year. The use of star maps can be explained after this experience.
(d) After some experience with observing constellations students should be able to recognize prominent stars in each. The names of these prominent stars could be recorded.
e.g. In Orion, - Betelguese, Bellatrix, Rigel.
(e) The student will probably discriminate differences between stars after some time. Stars could be classified according to brightness, (using their own reference standards) or according to colour.

(f) Observe a particular constellation such as Crux with binoculars or telescope. The number of stars visible by these means is impressive.
(g) A permanent record of stars can be obtained using a fast film in a camera exposed for a short time on a moonless night. Enlargements are better.

(h) Expose a photographic film for some hours with the camera pointed to the South Celestial Pole.
Why are there "tracks"?
Why are they arcs of a circle?

(i) Investigate the sun as an energy source. Use Crooke's radiometer to demonstrate energy.
What is the origin of this energy?

(j) Direct observation of the Sun should be discouraged. Demonstrate the method of observing the Sun indirectly.

(k) The twinkling of stars can be explained by means of a demonstration. Cast the image of a small, intense light source on a screen (use a projector).
Place a bunsen burner near but below the lens.
The image shimmers because light rays are passing through air layers of different temperatures and are refracted to a varying degree.

20. <u>ASTRONOMY USES A SPECIAL SET OF UNITS BECAUSE OF THE VAST DISTANCES INVOLVED.</u>

(a) Tabulate the distances of some stars from the Earth in miles. (e.g. the Sun, Proxima Centauri). It should be noted that the distance of most stars from the Earth is not known.

(b) Express these distances in Astronomical Units, light years, parsecs. The convenience of these should become apparent.

(c) Calculate the time taken for light to reach the Earth from these sources.

<u>NOTE.</u>

It should be understood by the student that stars in a constellation may be tremendous distances from each other.

(i) Even though they are considered to be moving at great speeds they are so faraway from Earth that their position relative to each other does not appear to change over hundreds of years.

(ii) They appear in relation to each other in fairly discrete units called constellations because the line of sight to each of the stars is similar.

21. <u>SOLAR SYSTEMS CONSIST OF A STAR AND ORBITING PLANETS.</u>

(a) The distinction between a star and a planet should be made.

(b) Observe the planets, (see daily press for details of rising and setting times).

(c) Record the position of the planets at the same time of night over a period of weeks.
The path of the planet can be plotted against the background of stars. The student should be encouraged to account for the movement of the planets from his own observations.

(d) Demonstrate planetary motion with models.

(e) Construct a model ...

(i) [illegible] Use Crooke's radiometer to demonstrate energy.
What is the origin of this energy?
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(d) Demonstrate planetary motion with models.
(e) Construct a model solar system to scale.
Some projects:
(i) Tabulate information on the planets. Size, surface, temperature, satellite, etc. could be recorded.
(ii) Investigate the discovery of Neptune, Uranus, and Pluto.
(iii) What evidence is there of solar systems other than our own?

22. SOME PLANETS HAVE NATURAL SATELLITES CALLED MOONS.

(a) The Moon is best viewed when now so that the field is not flooded with light. The craters of the Moon can be well viewed with binoculars. Students may be interested to construct their own Moon map. In doing this they will be confronted with the problems solved in map making on Earth, such as designation of North and South, references points.
(b) Observe the moons of Jupiter. Careful observation will reveal them orbiting the planet.
(c) Some projects:

(i) Why can we see only one face of the Moon?
(ii) How does the Moon affect the Earth? e.g. calendars, moonlight, tides, eclipses.
(iii) Can the Moon be seen during the day?
(iv) Why can we see faintly the surface of the Moon on the dark side of the terminator?
(v) Investigate moon exploration.
(vi) Tabulate the information known about satellites of planets in our solar system.

23. MAN'S IDEAS CHANGE AS HE DISCOVERS NEW FACTS

Ideas for group or individual investigation:

(i) The shape of the Earth.
(ii) Combustion.
(iii) The Helio-centric solar system.
(iv) The nature of the atom.
(v) History of infectious diseases.
(vi) Drifting continents.

24. DEVELOPMENT AND THE USE OF NEW SCIENTIFIC INSTRUMENTS HAS INCREASED MAN'S KNOWLEDGE..

Some topics to consider:

(i) The microscope and the electron microscope.
(ii) The telescope and the radio telescope.
(iii) X-rays.
(iv) Transistors.
(v) Space vehicles.
(vi) Cyclotrons and linear accelerators.

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EDUCATION DEPARTMENT - VICTORIA

TECHNICAL SCHOOLS SYLLABUS

JUN. 712

SCIENCE

FORM II

1969 REVISION

CURRICULUM AND RESEARCH BRANCH

TABLE OF CONTENTS

TECHNICAL SCHOOLS SCIENCE SYLLABUSES

FORMS I - III

I. FOREWORD.

During 1968 the science syllabuses for Technical Schools Forms I, II and III were reviewed. The existing structure of "Principles" has been retained, but changes have been introduced so that:

1. the syllabus for each year has become more directly related to the time available;
2. some "Principles" have been changed to make them more tenable scientifically;
3. new "Principles" have been introduced and others moved from one year to another to provide a more coherent sequence for the first three years;
4. the syllabus proper is now virtually a list of "Principles", providing increased scope for teacher initiative.

The revised syllabuses are not new in the sense that they were when the "Principle" approach was first introduced in 1958, but they represent revisions in the light of experience with them over this period. It is intended that these syllabuses should have a life of a few years, during which time a major syllabus revision will take place.

JUN 712 - SCIENCE - FORM II (1969 REVISION)

II. A. GENERAL COMMENTS.

1. This syllabus replaces syllabus "Form II - Science (1965)".
2. The revised syllabus is in the form of a list of "Principles" supplemented by brief notes on the areas to be covered.
3. It should be noted that -
   (a) the "Principle" itself is still meant to be the conclusion reached, and not the heading or the introduction;
   (b) the courses should be taught in the spirit of general science, with full scope for individual student enquiry and experiment.

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B. OUTLINE SYLLABUS

1. ENERGY OCCURS IN MANY FORMS.

Without rigorous definition the student should understand that energy is capable of causing motion and therefore capable of doing work.

2. ENERGY CAN BE CHANGED FROM ONE FORM TO ANOTHER.

The student should have experience with energy changes from one form to many other forms.

3. SOME COMMON SUBSTANCES CAN BE IDENTIFIED BY SIMPLE TESTS.

The student should be encouraged to develop experience in practical chemistry.

4. MOST COMMON FUELS CONTAIN COMPOUNDS OF CARBON AND HYDROGEN.

It would be advisable to revise Principles 7 and 9 from Form I.

5. FUELS MUST BE AT IGNITION TEMPERATURE AND IN THE PRESENCE OF OXYGEN FOR COMBUSTION.

6. FIRES MAY BE EXTINGUISHED BY REDUCING THE TEMPERATURE, REMOVING THE FUEL, OR CUTTING OFF THE SUPPLY OF OXYGEN.

Relate this topic as closely as possible to fire fighting particularly in the various types of fire in the home.

7. HEATING MAY CAUSE CHANGES IN TEMPERATURE, VOLUME, AND STATE.

Note that the temperature of matter may not change when it is being heated. Some substances do not expand uniformly when heated over an extended temperature range.

8. HEAT ENERGY IS TRANSFERRED BY CONDUCTION, CONVECTION, AND RADIATION.

Heat energy is transferred from a region at higher temperature to one at lower temperature until energy is more evenly distributed. The medium separating the two regions determines the method by which heat is transferred.

9. ALL LIFE DEPENDS ULTIMATELY ON PHOTOSYNTHESIS FOR FOOD.

Photosynthesis is a complex series of biochemical reactions by which compounds are synthesized from carbon dioxide and water. Energy is needed for this synthesis, and later the degradation of these compounds releases this energy.

A fairly detailed investigation of photosynthesis is advised.

10. MANY LIVING THINGS REQUIRE OXYGEN TO RELEASE ENERGY FROM FOOD.

Some organisms are specially adapted to obtaining energy under anaerobic conditions (i.e. in the absence of free oxygen). It would be advisable to consider a diverse range of living things.

11. LIVING THINGS EXIST IN A STATE OF BALANCE WITH THEIR TOTAL ENVIRONMENT.

It is intended to emphasize the fact that living things are affected not only by food supply, predators, etc., but also by other living and non-living things, i.e. the complete environment. It is implicit in the statement that if a living thing survives, then it and its environment have established a balance.

12. LIVING THINGS HAVE SURVIVED BECAUSE OF ADAPTATION TO THEIR ENVIRONMENT.

The vicissitudes of the environment select those of a species which are well equipped for a survival and procreation. Generally this has not been observed by man because the "weeding-out" process is thought to require many generations, perhaps over a period of thousands of years, before a detectable change is produced. Some suspected examples of adaptation have been recorded.

Living things exhibit minute to minute changes in response to environmental stimuli. The ability to change in this way would be an adaptation whichis acquired by the selection process. The actual change itself (e.g. pupillary constriction in light) is not an adaptation to the environment in the sense used above.

An examination of the theory of natural selection and the theory of evolution is intended here at an elementary level.

13. THE EARTH'S CRUST IS CHANGING NOW IN THE SAME WAY AS IT HAS IN THE PAST.

Stress should be laid on this or another statement of uniformitarianism, as this is absolutely basic to our study of geology.

14. NEARLY ALL CHANGED IN THE EARTH'S CRUST TAKE PLACE OVER LARGE PERIODS OF TIME.

Allude to the Geological Time Scale.

15. ROCK AGE IS CALCULATED FROM THE RELATIVE POSITION OF BEDS AND FOSSIL EVIDENCE.

It should be noted that these are only two of the techniques used to determine rock age. These can be used to construct a relative time scale.

16. A LIMITED RANGE OF VIBRATIONS CAN BE DETECTED BY THE EAR.

The perception of sound in species other than man should be alluded to.

17. THE PITCH OF A NOTE DEPENDS ON THE FREQUENCY OF THE VIBRATION.

18. THE LOUDNESS OF A SOUND DEPENDS ON THE ENERGY OF THE VIBRATION.

19. LIGHT CAN BE REFRACTED OR REFLECTED.

The nature of light as a wave propagation should be investigated in this topic.

20. WHITE LIGHT CAN BE SEPARATED INTO DIFFERENT COLOURS.

21. THE EARTH IS ALMOST SPHERICAL IN SHAPE AND BY CONVENTION POINTS ON ITS SURFACE ARE LOCATED IN TERMS OF LONGITUDE AND LATITUDE.

22. THE PRINCIPAL MOTIONS OF THE EARTH ARE:

1. ROTATION ON ITS AXIS.
2. REVOLUTION AROUND THE SUN.

23. RELATIVE POSITIONS OF THE SUN, EARTH AND MOON ARE RESPONSIBLE FOR ECLIPSES, PHASES AND TIDES.

C. REFERENCES

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III. APPENDIX

PRACTICAL WORK.

NOTES.

(a) TEACHERS ARE STRONGLY ADVISED TO PREVIEW ALL PRACTICAL WORK BEFORE THEY ATTEMPT IT IN CLASS, OR BEFORE THEY ALLOW STUDENTS TO ATTEMPT IT.

(b) The following student experiments and teacher demonstrations are suggestions only. It is not implied that all or any of the experiments listed for each topic should be done. Teachers may well develop other, and possibly better illustrations.

SUGGESTIONS FOR PRACTICAL WORK.

1. ENERGY OCCURS IN MANY FORMS.

(a) Stored energy. (This name is used to avoid the confusion which may result when chemical and nuclear energy are included in potential energy in later years).

(i) Use a water wheel to demonstrate energy of water in an elevated container. Relate this to the distribution of water in a reticulated water supply, farm tank supply, the use of water wheels and turbines.

(ii) Release an inflated balloon. Relate this to jet motors and rockets.

(iii) Use a rubber band to drive model planes and cars.

(iv) Examine spring operated toys, watches and motors.

(v) Use an air gun to fire a pellet at a movable target.

(b) Chemical energy.

(i) Demonstrate the "exploding tin". Discuss precautions in lighting gas appliances.

(ii) Place a small piece of potassium or sodium in a bowl of water (CAUTION!).

(iii). Demonstrate a model fire extinguisher. The gas released can be used to drive a wheel.

(iv) Discuss the operation of the internal combustion engine and rocket motors.

(c) Kinetic energy.

(i) Use a moving billiard ball to move objects such as toy cars.

(ii) Use a toy cannon or gun to fire a projectile at a movable target.

(iii) Use a carpet bowls set.

(d) Electrical energy.

(i) Plastic rules and combs rubbed on clothing can be shown to be able to pick up small objects like hair, paper and chaff. The use of electrostatic filters could be discussed.

(ii) Make a model electric motor, electric bell, electromagnet. (Details of simple models can be found in Hopwood, "Science Model Making").

(iii) Discuss electric motors and appliances.

(e) Sound energy. This is difficult to demonstrate convincingly.

(i) Bring a vibrating tuning fork near a suspended pith ball in a perfectly still atmosphere.

(ii) Sound a gong loudly near a sensitive flame. (Draw a long, fine jet from glass tubing.) The flame will fluctuate. The surroundings must be free from draughts and noise for this demonstration to be convincing.

(iii) Dismantle microphones and telephones to explain the operation of the diaphragm.

(iv) Use a model to explain the function of the ear with particular reference to the ear drum.

(f) Heat energy.

A Crooke's radiometer can be used to illustrate this. From the student's point of view, light energy may well be the energy producing motion. The effect on the speed of rotation at constant illumination but different temperature could be investigated.

(g) Light energy.

The exposure meter of a camera could be used to demonstrate movement caused by light energy.

(h) Nuclear energy.

(i) A class project on the use of nuclear energy for electricity production could be attempted.

(ii) A film of atomic or nuclear bomb blasts could be shown to illustrate the tremendous energy available from the nucleus of the atom.

2. ENERGY CAN BE CHANGED FROM ONE FORM TO ANOTHER.

(a) Bend steel wire (e.g. fencing wire) back and forth rapidly.

(b) Pass an electric current through a resistance wire.

(c) Hammer a lump of lead.

(d) Ignite a piece of magnesium.

(e) Construct a steam turbine. This could be used to drive a generator.

(f) Investigate a series of energy changes, e.g. producing electricity in a hydro-electric power station; a thermal power station; a motor car; the laying down of energy resources such as oil, coal, and gas.

(g) Discuss energy changes in plants and animals.

3. SOME COMMON SUBSTANCES CAN BE IDENTIFIED BY SIMPLE TESTS.

Ask the students to compile a list of chemicals with which they come in contact.

The list may include:

oxygen, hydrogen, nitrogen, carbon dioxide, chlorine, rotten egg gas (hydrogen sulphide), baking soda, washing soda, iron, aluminium, copper, common salt, cane sugar, vinegar (acetic acid), starch, alcohol, fruit saline, peanut oil, ammonia, lemon juice (citric acid), kerosene, methylated spirits.

Samples of these substances could be obtained or prepared and revelant tests could be conducted by the students. (Emphasize safety!)

Tests for a gas, for example, could be:

(i) Colour, odour, density.

(ii) Does the gas burn?

(iii) Does the gas help burning?

(iv) Does it dissolve in water?

(v) Does the gas affect moist litmus?

(vi) Are there any special reactions?

(vii) IN WHAT WAY ARE THESE PROPERTIES DIFFERENT FROM OTHER SIMILAR SUBSTANCES?

CAN SOME OF THESE PROPERTIES BE USED TO IDENTIFY THE SUBSTANCE?

It would be expected that the student becomes familar with the tests for oxygen, hydrogen and carbon dioxide (at least).

4. MOST COMMON FUELS CONTAIN COMPOUNDS OF CARBON AND HYDROGEN.

(a) Burn a variety of fuels such as wood, paper, wax, fats, oils, kerosene, methylated spirits, town gas. Hold a clean, dry gas jar over the flame. The water vapour produced condenses on the cold glass. After some time a black deposit may form on the glass. Where did this black deposit come from?

Test the collected gas in an endeavour to identify it. Carbon dioxide is present in the gas. Where did the carbon dioxide come from? (Test air to demonstrate the low concentration of carbon dioxide in air).

Where did the carbon of the carbon dioxide come from? Where did the oxygen of the carbon dioxide come from?

(b) Discuss pollution by furnaces, cars, fires and burning fuels.

5. FUELS MUST BE AT IGNITION TEMPERATURE AND IN THE PRESENCE OF OXYGEN FOR COMBUSTION.

(a) Place a glowing splint in a gas jar of oxygen and compare the burning with that in air.

(b) Cover two identical burning candles, one with a small gas jar and the other a bell jar.

(c) Boil water in a paper cup on a gauze mat.

(d) (i) Place various substances at the perimeter of a metal plate heated in the centre with a bunsen burner. It would be best to conduct several trials first with identical pieces of different woods (e.g. red gum, pine, balsa) to avoid the confusion which can occur if contact with the heating surface varies.

(ii) Try to ignite a small volume of kerosene in a crucible with a match. Repeat when the crucible is heated on an electric hot plate. This could be repeated with meths. and petrol provided adequate care is taken.

(e) Demonstrate how burning can be improved by:

(i) Maintenance of a high temperature;

(ii) The good supply of fuel;

(iii) Increasing the supply of oxygen.

Relate these to combustion in furnaces, coal-mine explosions, flour-mill explosions, jet engines, rockets.

(f) What is the best way to start a fire? What fuel is used first? Why? What form is the fuel in? Why?

It should be clearly understood by the student that heating a fuel generally raises its temperature. The ignition temperature does not change with heating.

6. FIRES MAY BE EXTINGUISHED BY REDUCING THE TEMPERATURE, REMOVING FUEL OR CUTTING OFF THE SUPPLY OF OXYGEN.

(a) Ignite some oil in a metal bottle top and lower the top into a beaker of ice water. The flame will go out.

(b) (i) Pour carbon dioxide onto a burning fuel. This works best if the fuel is in a container. An interesting demonstration can be made by pouring carbon dioxide into a vessel containing burning candles of different heights. The lowest flame is extinguished first.

(ii) Do not neglect one of the simplest methods of cutting off the oxygen supply to a fire, that is, by sealing the fire in an enclosed space, e.g., covering a pan of burning fat with a newspaper. Small fires can be quickly controlled without fire extinguishers provided that prompt, appropriate action is taken.

(c) (i) Extinguish a small wood fire with water. Water both cools this fuel and cuts off the oxygen supply.

(ii) Pour water on a small quantity of burning oil in a metal tray. Although the water cools the fuel it promotes the spread of the fire because the oil floats on the water. Stress the danger of the use of water on oil and electrical fires.

(d) Use a model fire extinguisher to put out a fire (the "soda-acid" type would be best). Here the fuel is cooled by the liquid and the oxygen supply is interrupted by the liquid and the carbon dioxide.

(e) Investigate the various types of fire extinguishers and why they are used. Soda-acid, carbon dioxide, and foam extinguishers should be included.

(f) Discuss fire control in specific situations with particular regard to the home, e.g.,

(i) "Sealing" of a fire by closing doors and windows.

(ii) Protecting the home and family in bush fires.

(iii) Fire breaks and "burning back".

(iv) Precautions for car drivers trapped by fire.

(v) Burning fat, curtains, clothing.

7. HEATING MAY CAUSE CHANGES IN TEMPERATURE, VOLUME AND STATE.

(a) Heat small identical sized objects of different materials (e.g. lead, glass, plastic, wood, rubber, copper) in a water bath. Record the temperature of the boiling water. Quickly dry them and place them on a block of paraffin or dry ice.

Although initially and finally at the same temperatures, the blocks melt different amounts of the solid paraffin. Heat and temperature are not the same.

(b) Heat water at a constant rate and monitor the temperature. Repeat but heating at different rates. A temperature-time graph could be constructed.

(c) Heat naphthalene (or water containing ice). Record the temperature at regular time intervals. Continue till the liquid formed has been boiling for some time. Construct a temperature-time graph.

(d) Allow a block of dry ice to sublime. Attempt to measure the temperature.

(e) Make lead sinkers or use sealing wax to form a seal. (A signet ring can be used to make an impression.)

(f) Place equal amounts of methylated spirits, water, kerosene, and oil in identical small beakers in a water-bath heated with an immersion heater. The water should be constantly stirred. Record the temperature of each substance over a period. Construct a temperature-time graph to show that the change in temperature varies with the substance heated.

(g) Demonstrate the change in volume with a change in temperature using the following apparatus:

ball and ring; bar and gauge; breaking pin; linear expansion; a flask filled with coloured water and fitted with a narrow glass tube overflow; and a balloon fitted over the mouth of a flask and heated.

(h) The students could use an ice-salt mixture to freeze water to demonstrate a change of state. The increase in volume of some substances on solidification could be investigated.

(i) Construct a thermostat with a bimetallic strip.

(j) Demonstrate the variation in boiling point and freezing point of water with dissolved impurities and changed pressure. Discuss the use of antifreeze. Demonstrate regelation. Change of state may occur when heating or cooling take place. Other conditions apart from temperature are important.

(k) Discuss applications of expansion and contraction of matter with temperature variation, e.g., the draining of a car radiator in cold "snaps".

(l) The change in the kinetic energy of the particles of matter with change in heat content would be the desirable model to develop. The student should understand that cooling is the loss of heat energy. What is the temperature of absolute vacuum?

8. HEAT ENERGY IS TRANSFERRED BY CONDUCTION, CONVECTION AND RADIATION.

(a) Solids.

(i) Attach tacks to metal bars with petroleum jelly and heat at one end.

(ii) Hold identical bars of different metals in a bunsen burner flame until they are too hot to hold.

(iii) Heat similar sized samples of different materials, e.g., glass, wood, rock, concrete. A spot of petroleum jelly could be placed at equal distances from the heat source for each sample.

(iv) Which substances conduct heat well? Where are they used? Which substances conduct heat poorly? Where are these used? Construct an "ice-box" from foam plastic to show the insulating properties of the material. This can be done by drilling holes in the plastic to snugly take test tubes which can be filled with boiling water or ice water. Compare with similar tubes in the open.

(b) Fluids. (i.e. gases and liquids.)

(i) Demonstrate convection in gases.

(ii) Place a small crystal of potassium permanganate (or fluorescein or fine sawdust) at the bottom of a beaker of water to one side. Heat directly underneath.

(iii) A suspension of aluminium paint in ether in a petri dish on a microprojector can be used to show convection in liquids. Heat from the hands is sufficient. (CARE. Ether is explosive!)

(iv) Fill a balloon with hot air (or helium) and release in air, or use foam plastic or cork in water to show that these substances rise in the medium because of the difference in density.

(v) Construct a model hot water service.

(vi) Discuss room heating and cooling and refrigeration.

(vii) The origin of land and sea breezes, trade winds and the doldrums could be mentioned.

(c) Vacuum.

(i) Evacuate a bell jar containing a small heating element and two thermometers. Connect the element to a power source and read the thermometers, one of which is shielded. Repeat with the bulb of one thermometer coated black and also with air in the bell jar. (This experiment could be performed in air using a radiator).

(ii) Attach tacks to sheets of metal with a small amount of petroleum jelly. Place the sheets equidistant from a radiator. The surface of one sheet facing the radiator is coated black, the other is left shiny.

(iii) Make a solar hot water service. The pipes are generally blackened to facilitate absorption.

(iv) Discuss the many applications of radiation of heat, e.g. the melting of snow by hikers for water, the use of light coloured clothes in summer, mirages over asphalt roads in summer, etc.

(v) How does the earth come to be heated by the sun? The inability to explain certain phenomena in terms of conduction and convection should be used to imply another form of heat transfer, that is, radiation.

Indicate the close relationship between light energy and heat energy. Heat energy may be transferred in the form of rays, as in the case of light energy.

(d) Applications.

The transfer of heat by one of these methods alone is rarely encountered. Examine everyday applications such as:

the vacuum flask; insulating houses; the function of clothing; ice boxes and refrigerators (including open display units).

9. ALL LIFE DEPENDS ULTIMATELY ON PHOTOSYNTHESIS FOR FOOD.

(a) Extract the chlorophyll from some leaves by boiling the leaves in meths. in a water bath.

The green pigment could be separated into components by means of chromatography.

(b) Separate the light and green parts of a variegated leaf and extract the pigments as above.

(c) Grow plants in the dark for several days to demonstrate the loss of pigment.

(d) Establish the iodine test for starch, (see Form I, Appendix P 14). Test a leaf for starch after it has been exposed to sunlight for many hours. Compare with a similar leaf kept in a dark place.

(e) Perform the starch test for a variegated leaf.

(f) Conduct an experiment designed to show some of the factors affecting photosynthesis. Adequate control should be included. For example many samples of the same species of plant could be obtained. Grow half in sunlight and the other half in the dark. In each group have plants growing in an atmosphere of air, oxygen, carbon dioxide, oxygen - carbon dioxide mixtures.

Other variables to investigate are:

leaf area (cover part of leaf with foil);

humidity (use calcium chloride to dry the atmosphere);

water supply (cut "veins" supplying certain leaves);

site of photosynthesis (isolate part of the stem and part of the leaf by cutting the vascular supply).

Test for the presence of starch after some days.

(g) (i) Examine prepared slides of a leaf for stoma. (Rhubarb leaves are good).

(ii) Prepare slivers of leaves for microscopic examination. (This can be done by folding a leaf backwards and forward until it splits. If the two edges are carefully pulled apart, a section of the undersurface epidermis can be separated off and mounted in water).

Place a drop of concentrated salt solution at the side of the coverslip while examining the stomata. They can be seen to close. If the salt solution is replaced with water they open again.

(h) Repeat experiment 6 and test for carbon dioxide removed from the atmosphere and oxygen added. Control is necessary.

(i) Students could prepare a detailed list of their diet for one day. The origin of the food should be stated beside each item.

(j) Classify foods into sources high in content of fats, protein and carbohydrate. The simple sugars are the precursors for these chemicals.

10. MANY LIVING THINGS REQUIRE OXYGEN TO RELEASE ENERGY FROM FOOD.

(a) Oxygen Uptake.

(i) Analyse inspired and expired air to show a decrease in the oxygen content (and an increase in the carbon dioxide content). See Principle 14, Form I. Compare with the burning of fuels.

(ii) Examine the structure of the lungs, bronchi and thorax of a rat, rabbit or other suitable animal. (By law the animal must be killed before it is presented in the classroom). If recently dead the lungs may be inflated with a tube placed in the mouth.

(iii) Discuss external breathing in animals.

1. Changes in gas concentrations.
2. Use a model of lungs to show breathing.
3. Discuss poison gases.
4. Investigate artificial breathing: as treatment for drowning, electric shock, poison; iron lungs; airmen, and space travellers.
5. Study the water spider (Argyroneta aquatica).
6. How do insects breathe?
7. Investigate hypothermy in major surgery. Here the temperature is lowered so the rate of metabolism decreases and therefore the oxygen requirement is lowered.

(iv) Demonstrate the oxygen uptake by bacteria in milk using methylene blue as an indicator. (See B.B.C.S. "Student Laboratory Guide: An Enquiry into life", Harcourt Brace and World, 1963, pp93, 94).

(v) Investigate breathing in unicellular organisms such as the amoeba.

(b) Release of Energy.

(i) Burn magnesium in an atmosphere of oxygen, and again in carbon dioxide. The magnesium burns fitfully in carbon dioxide, but the energy release is more pronounced in oxygen.

(ii) Where does the energy released by living things come from?

1. Burn a fuel in oxygen and note the production of energy, heat in particular.

2. Measure body temperature. This could be measured over a period of hours and also under varying ambient temperatures. (An attempt at control could be provided by measuring the temperature of a container of water, initially at room temperature).

3. Discuss the calorific value of foods. What are the calorific requirements for people engaged in various types fo work and in different climates?

4. Measure the breathing rate of a person at rest and immediately after graded exercise. The exercise can be arranged by stepping up on a box a set number of times per minute.

The mechanism of the increase in respiratory rate is well beyond the the student. However, the breathing rate (and probably the oxygen uptake) generally rises as external work is done.

11. LIVING THINGS EXIST IN A STATE OF BALANCE WITH THEIR TOTAL ENVIRONMENT.

(a) Study communities in a selected area. This could be an aquarium, a marked area of the school yard, a rock pool, a tree, or a paddock in the country. Record the population of all species over an extended period (of weeks). The population does not change significantly if the conditions remain relatively constant.

(b) Tabulate the average number of offspring for a variety of living things and the time required for reproduction. Calculate the total expected population in one year. (Rabbits, mice, rats, fish, protozoans).

Obviously these numbers do not exist in nature. What reasons can be advanced for the relatively constant level of a population?

Suggestions will probably include:

food and water supply, predation, parasitism.

(c) Investigate plagues, (human disease, insects, the "red" tide). (For an account of the "red" tide see Time Life International "The Sea".) Why should a sudden increase in a population occur?

(d) With a hay infusion, or a sample of stagnant water carry out a population census over some weeks. Why should there be a rise and fall in population?

(e) Study a barren region like a fallow field, a newly formed cutting, etc., and compare with a similarly situated one which is much older. Why should there be the difference in population of the areas?

(f) Predation will inevitably be introduced in the previous discussions. Construct food chains to show how balance can be maintained.

(g) Discuss the treatment of infectious disease by drugs. Here the environment of the pathogenic organism (i.e. the body) is made hostile to the organism by a chemical injected into the blood stream. The environment is deliberately manipulated to destroy any "balance" between the organism and the body so that the organism dies out.

(h) Discuss the rise and fall of species by:

(i) "Natural" processes. The fall of the reptiles and the rise of the mammals is an example. The environment probably changed so that a new balance had to be established.

(ii) Man-made changes, e.g. the dodo, the use of insecticides, the mallee fowl, the rabbit and the prickly pear.

12. LIVING THINGS HAVE SURVIVED BECAUSE OF ADAPTATION TO THEIR ENVIRONMENT.

(a) (i) Select a dry, sunny part of a garden and mark out a certain area. (A square yard would suffice.)

(ii) Make an inventory of the inhabitants of this area, both plant and animal. Repeat this for a shady, cool spot.

(iii) List the differences between the two regions: average day and night temperatures; water supply; hours of sunlight; moisture content of soil; chemical composition of soil and type of soil.

(iv) Why are some living things found in one area but not the other? Is it possible for living things to reach both areas?

(b) Hypotheses advanced in Part I above may be put to the test. Various environmental factors can be systematically varied.

For example, a study could be made of a fast growing plant like oats planted in identical containers, at constant temperature, under constant illumination. The water supply or the salt concentration of the nutrient fluid can be varied.

(c) Why are slaters found in cool, dark places but rarely in bright, dry areas? Make a single alley "maze" with home boxes at either end. The roof of the alley could be transparent and a white background painted on the floor with a grid of black lines. A temperature gradient can be established by placing ice in one box and heated water in the other. A humidity gradient can be established over some hours if calcium chloride is placed in one box and moistened paper in the other. Variation in illumination is easily produced. Slaters can be placed midway in the alley and their position charted. Alternatively, the slaters could be placed in either box. This must be done on sufficiently large a scale in order to take individual differences into account.

Student should realize that some slaters will die in a hostile environment. Others are able to move away and are therefore more likely to reach satisfactory conditions. Thus the environment has selected some individuals to survive on the basis of their characteristics.

(d) Discuss the development of antibiotic resistant strains of bacteria and insecticide resistant strains of insects. The environment for these organisms has been changed by the introduction of the chemical and only certain individuals survive to reproduce.

(e) Excursions to carefully chosen areas would be of benefit.

(i) A seashore. Make an inventory of the inhabitants of the various zones of the beach.

(ii) A swamp.

(iii) A mountainside.

(iv) Rock pools.

What factors would be expected to determine where these living things prefer to live?

(f) Assignments.

(i) Camouflage in living things.

(ii) Special adaptations for defence such as fangs, teeth, poison glands, shells and odours.

(iii) Adaptations for food gathering, e.g. cacti, the venus fly trap, spiders' webs, ant eaters' and birds' beaks.

(iv) Special adaptations for reproduction, e.g. sea-horse, crabs, lobster and stickle back.

(v) Adaptations for locomotion.

Seeing the living things involved is to be preferred, and visits to the National Museum and the Museum of Applied Science may be possible.

(g) Discuss the suspected adaptation of the peppered moth in industrial England.

(h) Discuss the theory of evolution of living things and refer to specific examples.

e.g., Galapagos finches, the modern horse, whales, humans, cacti, conifers and eucalypts.

Refer to the selective breeding of domestic animals, stock animals and crops and plants.

(i) Investigate the disappearance of certain species of animals since prehistoric times, e.g., the sabre-toothed tiger and the woolly mammoth.

Why have some ancient forms of life survived in certain areas, e.g. the tuatua of New Zealand?

Why is the survival of some species of animals threatened at the moment?

13. <u>THE EARTH'S CRUST IS CHANGING NOW IN THE SAME WAY IT HAS IN THE PAST.</u>

Wherever possible relate the processes discussed with local landforms.

(a) Gradation.

(i) Degradation (erosion).

1. Weathering.

(A) Physical Weathering. (Disintegration). Observe the expansion of freezing water. A can of soft drink can be safely frozen in a refrigerator, (there is danger of damage or injury with a sealed bottle of water.) Discuss the results of water freezing in rock crevices.

Heat a rock strongly in a bunsen burner flame and then immerse it in water. Compare the structure of the surface with an unheated rock. Discuss the effect of heat and cold on rock in desert areas.

(B) Chemical Weathering. (Decomposition) Demonstrate the solution of limestone by a dilute acid solution. Show that carbon dioxide forms a weak acidic solution in water, using litmus. Hydrogen sulphide forms an acidic solution. Where are acid forming substances found in nature? Discuss the formation of limestone caves.

If rocks containing a large proportion of iron are broken open the effect of oxidation can be seen in the zones of iron oxides forming in the rock. Illustrate by allowing a nail to rust in a moist atmosphere. Discuss the prevalence of iron oxides in rocks and soils.

(C) Mass Movement. The presence of water in the ground is an important contributory factor in the movement of landslides. Discuss notable landslides.

2. Stream Action. (Corrasion and transport).

(A) Collect water pebbles and break them open to contrast the irregular interior with the smooth exterior. What factors contribute to the corrosive action of a stream?

(B) Examine a river valley. Why is there a "V" shaped valley where the river is fast flowing, whereas the valley is flat and wide when the water flows slowly? Investigate on a quantitive basis the transport capacity of flowing water. Where is the material carried by moving water deposited?

3. The Effect of Living Things.

Investigate the degrading effect of plants, roots and burrowing animals.

(ii) Deposition. (Deposition from water.)

1. Mix sand, garden soil and clay in a gas jar of water and allow to settle. Layers can be observed.

2. Examine rocks and quarries, cuttings and mines for layers.

3. What is needed to convert the deposits from rivers and oceans into rocks?

4. Obtain the cores from drilling operations to demonstrate layers.

(b) Diastrophism. (Movements of solids parts of earth.)

(i) Folding. Make coloured layers of plastic, foam or plasticine and compress from the sides to demonstrate folding.

(ii) Faulting. Paint layers on large blocks of wood, polystyrene or foam. A fault can be cut through the block and movement along the fault line can then be demonstrated.

(iii) Visit quarries and cuttings to observe faulted and folded layers.

(iv) Discuss newscuttings about recent earth movements along faults. (Note the vulnerability of Western Australia to earthquakes.)

(v) Locate the areas of earthquake activity around the world and investigate famous earthquakes.

(c) Vulcanism.

(i) One type of volcanic activity can be simulated by lighting ammonium dichromate. (Take Care!)

(ii) Visit areas of volcanic activity.

(iii) Examine aerial photographs of volcanic areas.

(iv) Make a model of a section through a composite cone.

(v) Examine reports of notable volcanic activity.

(vi) Locate the major areas of volcanic activity in the world.

14. NEARLY ALL CHANGES IN THE EARTH'S CRUST TAKE PLACE OVER LARGE PERIODS OF TIME.

This will become apparent after some consideration of the previous topic.

(a) The time needed to build up substantial layers of silt deposits will be obvious when muddy water from a river is allowed to stand for some weeks.

(b) Discuss the periods required for:

(i) The cutting of a river and a glacial valley.

(ii) The formation of mountains by folding, faulting and vulcanism.

(iii) Turbidity currents forming substantial deposits.

(c) Discuss the Geological Time Scale.

15. ROCK AGE MAY BE CALCULATED FROM THE RELATIVE POSITION OF BEDS AND FOSSIL EVIDENCE.

(a) (i) Examine many different sedimentary rocks in situ.

Which would be the oldest layer?

(ii) Study an unconformity. Which would be the oldest layer here? What would account for the unconformity?

(b) Examine fossils and relate these to the general outline of the theory of evolution given earlier. (Principle 12). Where would one expect the oldest fossils to be found?

(c) Construct a time scale and chart of location of fossils for such notable geological features as the Grand Canyon, U.S.A.

(d) An account of the ageing of geological material by radio-active dating could be given.

16. A LIMITED RANGE OF VIBRATIONS CAN BE DETECTED BY THE EAR.

The higher the frequency of a note the more rapidly the eardrum must vibrate. The upper limit of perception is determined in part by the physical characteristics of the eardrum.

(a) Revise Principle 5, Form I.

(b) Construct a Savart's wheel or a disc siren to demonstrate that at low frequencies (below about 20 hertz), a continuous sound is not perceived. (As the speed of rotation of the wheel increases, a musical note is heard.).

(c) Demonstrate the frequencies of various sounds by connecting a microphone through an amplifier to a CRO. (See the Apparatus Guide Sheet for suggestions.)

(d) Use a dog whistle to "call" a dog. To the human ear there is no sound. Demonstrate with the CRO that a sound is produced.

(e) Examine a model of the human ear and discuss the function of the ear-drum and the ossicles. The 3 ossicles (stapes, malleus and incus) can be dissected out of a sheep's head if care is taken. Relate the function of the ear-drum to the skin of a drum, i.e., a body able to vibrate.

17. THE PITCH OF A NOTE DEPENDS ON THE FREQUENCY OF THE VIBRATION.

(a) Use the microphone-amplifier-CRO arrangement to show the frequency of reasonably pure tones of various pitches (e.g., from a tuning fork).

(b) Construct a compound Savart's wheel. The pitch of each wheel can be compared for the same number of revolutions per unit time. Record the frequency of each note. (The unit to be used is the hertz (Hz)).

(c) Use various musical instruments to produce notes of different pitches. Construct a set of chimes from water pipe. Make a series of flutes from test tubes filled to various depths or use a variable organ pipe tube.

(d) Fill a kettle when blindfolded and use the pitch of the note emitted to decide when it is full.

18. THE LOUDNESS OF A SOUNDS DEPENDS ON THE ENERGY OF THE VIBRATION.

The ear-drum will vibrate more violently the louder the sound becomes. A pain threshold exists for very intense sounds. Damage may result from prolonged exposure to intense sounds.

(a) Make sounds with musical instruments. Feel the instrument when the sound is soft and loud.

(b) Use a small and a large hammer on a piece of water pipe to produce sounds of the same frequency but different energy. When is the sound the loudest? Which hammer has the most energy?

(c) Drop very small weights from equal heights on to a drum. Repeat for the same weight dropped from different heights. When is the sound the loudest? When has the weight the most energy?

(d) Use a CRO to "show" very soft sounds and compare with loud sounds from the same source.

19. LIGHT CAN BE REFRACTED OR REFLECTED.

(a) Reflection.

(i) Use mirrors to reflect light from an intense source on to the ceiling of a room.

(ii) In a dark room shine an intense beam of light on a polished metal surface. Use chalk dust to make the beam visible. The reflected beam can be seen.

(iii) Examine the construction of a reflecting telescope and a microscope. What is the purpose of reflecting light in these instruments?

(iv) Use two mirrors at right angles to produce multiple reflections. Construct a hall of mirrors.

(v) Use a concave mirror to reflect a beam of light and focus on a point.

(vi) Discuss:

1. Reflections in glass, water surfaces and polished surfaces.

2. Moonshine and earthshine.

3. Heliography.

4. Why do some materials appear dull but others shiny?

5. The hall of mirrors in a fun park.

6. Glare when driving.

(vii) Use a ripple tank to demonstrate the reflection of waves. In this respect (i.e., reflection), light shows properties of a wave propagation.

(b) Refraction.

(i) Place a rule in a bowl of water. Why does the stick appear to bend at the surface of the water?

(ii) Place two identical coins at the bottom of similar containers. Fill one with water. Do the coins appear to be the same size when viewed from above?

(iii) In a darkened room pass a beam of light into a tank of water. Vary the angle of incidence and observe the direction of the beam in the water. It may help to make the water murky by adding a small amount of methylated spirit or milk.

This can be done with a block of glass instead of water. Demonstrate total internal reflection.

(iv) Use lenses to bring a beam of light to a focus.

(v) Discuss:

ceiling of a room.

(ii) In a dark room shine an intense beam of light on a polished metal surface. Use chalk dust to make the beam visible. The reflected beam can be seen.

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(iv) Use lenses to bring a beam of light to a focus.

(v) Discuss:

1. Why diamonds glitter.

2. The aiming problem of the arrow fish.

3. The operation of the eye; short and long sightedness; spectacles; the danger of watching solar eclipses directly.

4. The operation of the camera; the refracting telescope; and binoculars.

5. Mirages.

(vi) Use a ripple tank to demonstrate refraction of waves. This property of waves also suggests that light may be considered to be a wave propagation.

20. 'WHITE' LIGHT CAN BE SEPARATED INTO DIFFERENT COLOURS.

(a) Pass an intense beam of light through a glass prism to produce dispersion. Display the emergent light on a screen. Describe the colours produced. An explanation based on the different refraction for light of different wavelengths could be given.

Without moving the light source, prism or screen, repeat the prism experiment with red, green and blue light separately and record the position of each beam after refraction on the screen.

(b) Use two prisms, one to produce the spectral colours, the other to recombine them again into white light on a screen.

(c) Discuss the production of rainbows. Why is it impossible to reach the end of the rainbow?

(d) Why do diamonds produce colour when moved in light?

(e) Discuss the chromatic aberration of cheap cameras, telescopes and microscopes.

21. THE EARTH IS ALMOST SPHERICAL IN SHAPE AND BY CONVENTION POINTS ON ITS SURFACE ARE LOCATED IN TERMS OF LONGITUDE AND LATITUDE.

(a) Discuss the history of the flat-earth theory and the evidence for a spherical shape.

(i) The disappearance of ships over the horizon.

(ii) The circular shadow on the moon during eclipses.

(iii) Circumnavigation.

(iv) The Bedford levels experiment.

(v) Photographs from spacecraft.

(vi) The variation of the declination of stars with latitude. Note the use of the sextant.

(b) Investigate the history of the "prime" meridian. Why should international convention decide on one prime meridian?

(c) Discuss the evidence that the earth is slightly flattened at the poles.

(i) Direct measurement.

(ii) Variation in spacecraft orbits.

(iii) Variation in gravity.

(d) Discuss the significance of:

(i) The International Date Line.

(ii) Time zones of the world.

(iii) The equator.

(iv) The Tropics of Capricorn and Cancer.

(e) Locate various places given the latitude and longitude. Follow routes taken by ships and planes on a map given this information.

Record the longitude and latitude of noteworthy places such as capital cities, oil wells and the antipodes of certain cities.

(f) How is latitude and longitude measured by navigators?

This topic could be introduced by means of a treasure hunt in which the "treasure" can be located on the surface of the school yard, for example, provided the distance from two reference axes is given.

22. THE PRINCIPAL MOTIONS OF THE EARTH ARE -

1. ROTATION ON ITS AXIS.

2. REVOLUTION AROUND THE SUN.

(a) Make discerning use of charts, models and films to cover the following points.

(i) The tilt of the axis of the earth to the ecliptic.

(ii) The reason for alternate day and night.

(iii) The seasons (mention the solstices and equinoxes.)

(iv) The hotter summer in the Southern Hemisphere.

(v) Foucault's pendulum.

(b) Calculate the speed of a point on the surface of the Earth due to rotation. Calculate the speed of the Earth in its annual trip around the Sun.

(c) Discuss generally the concept of Universal Gravitation.

(d) Discuss:

(i) The firing of space craft into orbit with regard to the rotation of the Earth.

(ii) The problems of interplanetary navigation in terms of the revolution of the planets around the Sun.

(iii) Why are certain times more propitious for certain space journeys?

23. THE RELATIVE POSITION OF THE SUN, EARTH AND MOON ARE RESPONSIBLE FOR ECLIPSES, PHASES AND TIDES.

Construct a scale model of the sun-earth-moon and the earth moon system.

(a) Use models to demonstrate solar and lunar eclipses and study them directly whenever possible.

Examine photographs of eclipses.

(b) How can eclipses be predicted?

(c) Use models to demonstrate phases of the moon. Observe the moon through all phases. (A pair of binoculars would be suitable).

(d) Observe the phases of Venus.

(e) Record the rise and set of the moon over a period of one month and record the occurrence of high and low tide at this position. The time could be summarized graphically.

(f) Observe the moons of Jupiter over some hours. The moons can be seen to orbit the planet.

(g) Refer to the Universal Gravitation concept developed previously when discussing:

(i) The motion of planets around the Sun.

(ii) The motion of moons around planets.

(iii) The variation of a spacecraft's orbits when passing over massive features on the surface of the Moon and the Earth.

(iv) Why tides are approximately 12 hours apart.

(v) What are spring tides, neap tides?

(vi) What are tidal bores; why are tidal variations large in some places yet slight in others?

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EDUCATION DEPARTMENT - VICTORIA

TECHNICAL SCHOOLS SYLLABUS

JUN 713

SCIENCE

FORM III

1969 REVISION

100

CURRICULUM AND RESEARCH BRANCH

TABLE OF CONTENTS

TECHNICAL SCHOOLS SCIENCE SYLLABUSES

FORMS I - III

I. FOREWORD

During 1968 the science syllabuses for Technical Schools Forms I, II and III were reviewed. The existing structure of "Principles" has been retained, but changes have been introduced so that:

1. the syllabus for each year has become more directly related to the time available;

2. some "Principles" have been changed to make them more tenable scientifically;

3. new "Principles" have been introduced and others moved from one year to another to provide a more coherent sequence for the first three years;

4. the syllabus proper is now virtually a list of "Principles", providing increased scope for teacher initiative.

The revised syllabuses are not new in the sense that they were when the "Principle" approach was first introduced in 1958, but they represent revisions in the light of experience with them over this period. It is intended that these syllabuses should have a life of a few years, during which time a major syllabus revision will take place.

JUN 713 SCIENCE - FORM III (1969 REVISION)

II. A. GENERAL COMMENTS

1. This syllabus replaces syllabus "Form III - Science (1965)."

2. The revised syllabus is in the form of a list of "Principles" supplemented by brief notes on the areas to be covered.

3. It should be noted that -

   (a) the "Principle" itself is still meant to be the conclusion reached, and not the heading or the introduction;

   (b) the courses should be taught in the spirit of general science, with full scope for individual student enquiry and experiment.

B. OUTLINE SYLLABUS

1. SCIENTISTS MAKE THEORIES OR HYPOTHESES TO HELP EXPLAIN OBSERVATIONS. THEY MAY BE REVISED OR REJECTED AS A RESULT OF NEW DISCOVERIES.

   Although this topic may be dealt with on its own terms, it is recommended to refer to it on the numerous occasions during the year when the opportunity arises in other topics. Other aspects of scientific method should not be neglected at appropriate times e.g. conventions; communication; control; replication.

2. THE TEMPERATURE, PRESSURE, AND WATER VAPOUR CONTENT OF THE ATMOSPHERE PRODUCE A VARIETY OF WEATHER CONDITIONS.

   The student should become familiar with some of the factors known to affect weather and with the more common instruments used in meteorology.

3. MANY WEATHER CHANGES ARE DUE TO THE INTERACTION OF ADJACENT AIR MASSES.

   The intelligent but cautious interpretation of weather maps should be encouraged.

4. PREDICTION OF WEATHER CHANGES REQUIRES WIDESPREAD AND CONSTANT COLLECTION OF ATMOSPHERIC DATA.

   Weather forecasting is the province of experts who must take into account many variables. Teachers are advised to be careful to stress the very tentative nature of predictions based on the superficial understanding of the student at this level.

5. ATOMS CONSIST OF ELECTRONS ORBITING A COMPACT GROUP OF PROTONS AND NEUTRONS.

Students should be aware of a comparison between the diameter of the nucleus and the diameter of the atom, leading to a conclusion that the atom is mostly empty space.

The opportunity to discuss the modification of scientific theory should not be neglected in this topic.

6. ELEMENTS AND COMPOUNDS MAY BE FURTHER SUB-CLASSIFIED.

Many classifications can be profitably extended to produce smaller, more specifically defined groups. It is important in this topic to make use of student devised classifications.

7. THERE ARE SEVERAL "FAMILIES" OF ELEMENTS.

As experience in chemistry is broadened, there is danger that the student will be overawed by the chemistry of ninety odd elements. The classification of elements into families should be appreciated by the student as a useful strategy, but like all simplifications, there are exceptions.

8. THERE IS A VARIETY OF CHEMICAL REACTIONS.

A wide experience of many different types of chemical reactions is intended rather than classification as such. The student should realize that a particular reaction may be classified in more than one way.

9. FOODS CONTAIN CHEMICAL COMPOUNDS WHICH MAY BE CLASSIFIED AS CARBOHYDRATES, PROTEINS, FATS AND OILS, MINERAL SALTS, WATER AND VITAMINS.

Identification of vitamins by chemical tests is beyond the scope of this section.

10. A BALANCED DIET IS NECESSARY TO DEVELOP AND MAINTAIN A HEALTHY BODY.

Students should become aware that not all vital food components contribute to the energy requirements of the individual.

11. CAREFUL PREPARATION CONSERVES FOOD NUTRIENTS.

Food is cooked for three main reasons:

1. To change the structure of the food and degrade the chemicals present so that the food is more digestible.

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Food is cooked for three main reasons:

1. To change the structure of the food and degrade the chemicals present so that the food is more digestible.

2. To make the food more palatable.

3. To destroy organisms and enzymes to assist preservation.

It should be noted that the requirements of one of these may conflict with the others, so that a compromise is reached. In doing so some food value is lost. The aim of good cooking is to reduce losses to a minimum. The method of storage of food and preparation should be chosen to ensure the minimum loss of nutritive value.

12. THERE ARE MANY TECHNIQUES OF FOOD PROCESSING AND PRESERVATION.

The purpose of preservation of food is to destroy micro-organisms present in the food which lead to its putrification; to isolate the food so that it cannot be contaminated, and to destroy enzyme systems present in the food which promote decay. Students should realize that main foods, (even "staple" foods), may have much of their nutrient value removed and may contain additives, some of which are quite harmful.

13. A CHANGE IN A BODY'S MOTION OCCURS IF A RESULTANT FORCE ACTS ON IT.

Do not neglect the reverse of this. If a body does not suffer a change of motion, then there is no resultant force acting on it.

14. SOME FORCES ACT AT A DISTANCE IN REGIONS CALLED FORCE FIELDS.

Students should be made aware of no-contact forces possible in gravitational, magnetic and electric fields; and the properties of a body which produce these fields.

15. THERE ARE MANY KINDS OF RADIATIONS THAT HAVE THE SAME SPEED AS LIGHT.

It is important that the student realizes that light is only one type of an extensive range of radiations.

Any discussion of wavelength would be on an elementary, qualitative basis.

16. RADIATIONS MAY TRANSFER INFORMATION FROM ONE POINT TO ANOTHER.

It is considered that the treatment of this topic should be restricted to radio.

17. AN ELECTRIC CURRENT IS A FLOW OF CHARGE.

Students should be aware that the flow of charge occurs only in an electric field.

18. A MAGNETIC FIELD SURROUNDS A FLOW OF CHARGE.

19. LIVING CELLS CONTAIN A REGULATING CENTRE CALLED THE NUCLEUS.

This topic includes a revision of the cellular theory of living matter commenced in Form I.

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20. DIFFERENT TYPES OF BODY CELLS HAVE DIFFERENT FUNCTIONS.

21. MANY DIFFERENT TYPES OF CELLS ARE NEEDED TO CARRY OUT THE ACTIVITY OF AN ORGAN.

This is intended to serve as an introduction to the following topic.

22. PARTS OF THE BODY ACT TOGETHER TO PERFORM SPECIAL FUNCTIONS.

It is misleading to consider the organism to be made up of discrete functional organ "systems", although the "systems" may be able to be separated physically.

23. SOME MATERIALS NEEDED BY MAN MUST BE EXTRACTED FROM NATURALLY OCCURRING SUBSTANCES.

The opportunity should be taken to relate this branch of applied science to social conditions.

24. MAN IS NOW ABLE TO SYNTHESIZE MANY MATERIALS.

Although materials are generally obtained from naturally occurring substances at first, economic, geographical and political conditions often create a situation where there is a drive to synthesize materials.

III. APPENDIX - PRACTICAL WORK

NOTES:

(a) Teachers are strongly advised to preview all practical work before they attempt it in class, or before they allow students to attempt it.

(b) The following student experiments and teacher demonstrations are suggestions only. It is not implied that all or any of the experiments listed for each topic should be done. Teachers may well develop other, and possibly better illustrations.

SUGGESTIONS FOR PRACTICAL WORK

1. SCIENTISTS MAKE THEORIES OR HYPOTHESES TO HELP EXPLAIN OBSERVATIONS. THEY MAY BE REVISED OR REJECTED AS A RESULT OF NEW DISCOVERIES.

(a) "Black box" situation.

(i) Provide students with sealed boxes containing various objects. Students should be encouraged to suggest what the contents of the box could be, and to record their hypotheses. They could devise methods to test these hypotheses, and then carry them out. As a result of these experiments the original suggestions may have to be modified; may remain unchanged because no evidence has emerged one way or another; or may be confirmed. It is possibly best for the purposes of thi[illegible] be made up of discrete functional organ "systems", although the "systems" may be able to be separated physically.

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(ii) Discuss analgous situations in science, e.g. atomic structure; nature of the far side of the moon; quasars; quarks.

(b) Assignments would be set on areas where considerable modification of a theory has occurred e.g.

(i) The circulation of the blood, - a "glass box" situation.

(ii) The nature of the solar system.

(iii) The Phlogiston theory.

(iv) The atomic nature of matter.

There is no need for these assignments to be completed in class time. However, it is recommended that students should publish either a written report which can be circulated and discussed at a later time, or report verbally in a "seminar" type situation.

(c) Refer to this topic constantly during the remainder of the year.

2. THE TEMPERATURE, PRESSURE AND WATER VAPOUR CONTENT OF THE ATMOSPHERE PRODUCE A VARIETY OF WEATHER CONDITIONS.

(a) Measurement.

(i) Temperature.

I. Explain temperature in terms of energy of the particles of matter. Distinguish temperature from heat - a form of energy.

II. Thermometers. Students could construct a liquid filled thermometer. Discuss the Celsius and Fahrenheit temperature scales. Measure the temperature of air, water and other substances.

III. Shade temperature. The necessity to standardize the conditions under which the temperature of air is measured can be demonstrated by reading the thermometer in sunlight, in the shade, near a radiator, and in a draught.

IV. The operation of the maximum and minimum thermometers and thermographs should be explained.

V. Isotherms. Measure the temperature around the school yard and buildings at fixed times of the day and construct isotherms on a plan of the school.

(ii) Atmospheric pressure.

I. Explain pressure as force per unit area. Use meteorological units and convenient practical units.

II. Construct a Torricellian barometer and discuss its history.

III. Discuss Pascal's experiment and relate to the need to standardize air pressure at sea level.

IV. The operation and uses of the Fortin barometer; aneroid barometer, and barograph should be explained.

V. Discuss isobars as lines joining places of the same atmospheric pressure at a particular time.

VI. High and low pressure zones. Explain on a simple level the reason for these areas developing.

VII. Winds. Winds can be explained as the consequence of high and low pressure areas. The Coriolis effect can be explained by a demonstration where ink is allowed to flow over the surface of a rotating sphere (e.g. a globe). Thus winds do not necessarily flow normal to isobars. Use this effect to explain cyclones and anticyclones.

VIII. Measure wind velocity with an anemometer. Explain the conventions for wind directions and velocity. The use of weather balloons could be explained. Helium filled balloons could be released with tags to plot prevailing winds at various times of the year.

(iii) Water vapour.

I. Leave a bowl of water in the open for several days to permit evaporation. Where has the water gone?

II. Place an ice-salt mixture in a metal container which has a large dry surface area and leave for some minutes. Where did the water (condensation) on the metal surface come from?

III. Pour a small volume of meths. onto the palm of the hand and blow across it. The meths. evaporates and the palm feels cold. Where did the heat go to? This heat will be released if the meths. condenses. What factors affect evaporation?

IV. Which contains the more water vapour - warm air or cold air?

An analogy can be made with the amount of a salt such as potassium nitrate which can be dissolved in hot and cold water. What happens when the hot (saturated) solution cools?

V. The operation of the instrument used to measure relative humidity could be explained, i.e. the hygrometer and the psychrometer. Explain the use of relative humidity tables.

VI. Investigate novelty humidity indicators, (many of which are based on cobalt salts). Cobalt salts can be used in "invisible" inks. Descriptions of weather conditions as "muggy", "dry", "close", "stuffy", and the like could be discussed here.

VII. Precipitation.

A. Cooling

1. Exhale over a block of ice. Breathe on a pane of cold glass.

2. Discuss:

(a) "Fogging" of car windscreens and bathroom mirrors;

(b) Fogs - cooling causing condensation at sea level;

(c) Dew and frost.

3. Cooling by expansion.

(a) Inflate a tyre or balloon. Does it feel warm?

Allow to equilibrate to the ambient temperature, and allow air to escape. Does the escaping air feel cool? Measure its temperature.

(b) Puff air from the mouth onto the bare forearm. The air feels warm. Blow air through pursed lips onto the arm. The air feels cool.

4. Condensation.

(a) Rapidly draw back the plunger of a syringe containing a little warm water. The glass becomes foggy.

(b) Place a beaker containing a piece of cotton wool soaked in hot water in a bell jar to saturate the air with water vapour. Evacuate the bell jar as quickly as possible and measure the temperature of the remaining air.

(c) Relate the drop in temperature and pressure to conditions in the Troposphere.

(d) Discuss cloud formation. The classification of clouds could be investigated.

5. Seeding.

(a) Seed a supersaturated solution of sodium thiosulphate with a small crystal. The solution can be made by warming the solid till it turns to a liquid and some evaporation has occurred, and then allowing to cool.

(b) Demonstrate precipitation in a Wilson cloud chamber. Here the atomic particles serve as nuclei for the cooling vapour to condense on.

(c) Discuss rain making by seeding suitable clouds with silver iodide and powdered dry ice.

(d) Why are fogs so common near cities?

(b) Weather.

(i) The elements of weather:-

1. Temperature.

2. Atmospheric pressure.

3. Precipitation; relative humidity.

4. Wind speed and direction.

5. Cloud.

(ii) Set up a weather station at the school. (The Commonwealth Bureau of Meteorology will supply details.)

Record measurements of the elements affecting weather over periods of weeks. Construct graphs of temperature, atmospheric pressure, and relative humidity over these periods. The diurnal variation will be apparent if the measurements are made at short intervals.

It would be best to conduct this investigation during Summer and Winter, at least. Attempt to interrelate the various elements of weather.

3. MANY WEATHER CHANGES ARE DUE TO THE INTERACTION OF ADJACENT AIR MASSES.

(a) Movement of air masses of different temperatures.

(i) Open a refrigerator while standing barefoot in front of it.

(ii) Warm air masses are encountered when entering a crowded classroom, theatres and the like.

(iii) Place a vertical partition in a glass it turns to a liquid and some evaporation has occurred, and then allowing to cool.

(b) Demonstrate precipitation in a Wilson cloud chamber. Here the atomic particles serve as nuclei for the cooling vapour to condense on.

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(iii) Place a vertical partition in a glass tank. Fill one half of the tank with coloured concentrated salt solution. Place water coloured differently in the other half. Withdraw the partition carefully. The boundary slants away from the vertical as the denser salt solution moves under the water.

(iv) Demonstrate convection. Why does the cool fluid sink below the warm fluid?

(v) Use models to demonstrate warm and cold fronts. Study weather maps to monitor the passage of fronts across the continent. Relate to fogs and precipitation in the path of the front.

(b) Local conditions.

(i) Discuss arographic lifting; mountain and valley breezes; rain shadow deserts.

(ii) Investigate land and sea breezes.

(iii) Investigate:

1. Hurricanes;

2. Thunderstorms;

3. Tornadoes.

(iv) Investigate the effect of large bodies of water, deserts, forests.

(v) Investigate the effect of inversions in industrial areas i.e. smog.

4. PREDICTION OF WEATHER CHANGES REQUIRES WIDESPREAD AND CONSTANT COLLECTION OF ATMOSPHERIC DATA.

(a) Discuss the basic wind patterns on the surface of the earth and the convective origin of these. Discuss: Trade winds and relate to the traditional trade routes of sailing ships; the doldrums; and the westerlies.

(b) Record the various factors of weather in Perth and Adelaide and compare with Melbourne's weather over a period of several weeks. There is apparently a pattern in the sequence of the weather experienced across the continent.

(c) The need for weather information from areas known to experience weather in advance of our own should be apparent.

The more frequent and detailed the reports are, the greater reliance can be placed on the predictions. Investigate the means by which this information is collected:

(1) Weather observers from all walks of life spread across the continent;

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The more frequent and detailed the reports are, the greater reliance can be placed on the predictions. Investigate the means by which this information is collected:

(1) Weather observers from all walks of life spread across the continent;

(2) Weather bureaux in main towns;

(3) Weather stations in isolated areas, on ships in the Indian Ocean, and in Antarctica;

(4) Information from ships and planes;

(5) The use of weather balloons and radar;

(6) The use of weather satellites.

(d) Weather prediction depends on analysing and assessing many factors. Computers are being used to assist the interpretation of the variables.

(e) What value is weather forecasting? Discuss the value of forecasts: to farmers; for ships at sea; for planes; for recreation; for community safety and the protection of property.

5. ATOMS CONSIST OF ELECTRONS ORBITING A COMPACT GROUP OF PROTONS AND NEUTRONS.

(a) Concepts of the Atom

(i) Revise the particle concept developed in Forms I and II.

(ii) Indicate the nature of the atom as proposed by Dalton i.e. a solid ball. As the following sections are treated, modify this model so that the more modern model of the atom is developed.

(b) Elementary Electrostatics.

These experiments are best conducted in a dry atmosphere. If necessary, an electric radiator can be used to "dry" the air surrounding the apparatus.

(i) Rub plastic, glass and ebonite rods on various fabrics. Small objects like pieces of paper, chaff and pith balls will be attracted by the rod. (Note Principle 14.)

(ii) Bring rods with like charges together. If one rod is freely suspended repulsion of like charges will be observed.

Repeat with unlike charges to demonstrate attraction.

(iii) Investigate the different types of substances which can be rubbed together to produce these effects. It could be explained that this has been done with many different substances with the result that the body so charged either attracts a rod with a certain charge, or repels it. This is evidence that there are two types of electrical charge.

(iv) Explain the production of charge on a body in terms of the loss or gain of a tiny, negatively charged sub-atomic particle - the electron. A positive charge can be explained as a loss of electrons leaving an excess of positively charged particles, i.e. protons.

(v) The properties of the proton, neutron and electron could be studied, perhaps as an assignment. The comparative mass, charge, and discovery are points which could be covered.

(c) The Nuclear Atom.

(i) Demonstrate that emissions from radioactive sources are capable of penetrating matter. Demonstrate that the emissions can be detected with a Geiger counter.

The emissions are obviously very small as they cannot be seen.
Use a beta source to show that:

1. Air can be penetrated to some extent.

2. Thin pieces of paper can be penetrated. Several thicknesses are needed to stop the particles. How can a particle, even a small one penetrate "solid" matter?

There is no need to identify the beta particle for this demonstration, nor is there any necessity to discuss radioactivity in any detail.

(ii) Use a Wilson cloud chamber to show the limited range of particles, and the deflections produced by collisions.

(iii) The evidence suggests that the atom must have spaces through which these tiny particles can pass, and a "core" which is impenetrable to some particles at least.

(iv) The discovery of the nature of electricity; radioactivity; and nuclear reactions are consistent with this model of the atom. Indicate that more recent research has lead to the discovery of other particles.

(d) The Structure of Atoms.

Investigate the structure of the atoms of some common elements e.g. hydrogen, oxygen, carbon, and iron. Stress that the number of protons in the nucleus of the atom is fixed, and that the protons are not free to leave the nucleus under normal conditions; that the number of neutrons can vary from atom to atom of an element, and these are fixed in the nucleus; and that the orbiting electrons are able to be removed from the atom.

There is no need to mention the term isotope. When referring to the most common isotope of an element, avoid using the term "normal".

6. ELEMENTS AND COMPOUNDS MAY BE FURTHER SUB-CLASSIFIED.

(a) Revise Principles 7, 8 and 9, Form I.

(b) Elements.

(i) Students could be asked to investigate the physical properties of as many elements as possible. It is preferable for them to actually handle or sight samples of the elements. They could be expected to produce a classification based on their observations.

Some criteria which may emerge are -

1. Colourless - coloured elements.

2. Dense - "light" elements.

3. Solids - liquids - gases.

4. Good - medium - poor conductors of electricity.

5. ~~Crystalline - non~~-crystalline.

6. Metals - non-metals.

7. Soluble - non-soluble (in water).

Each of these classifications can be justified. From a chemistry point of view, however, some are more useful than others.

The teacher is expected to exploit the classifications of the elements suggested by the student to study the chemistry of the elements. At the onset, physical properties will be used as a basis, but as experience grows (as a result of student experiment, only supplemented by teacher demonstration where safety is paramount), other properties will be used e.g. -

8. Combustible - non-combustible.

9. Reactive - non-reactive.

Care should be taken to deal with exceptions to a classification. A decision as to whether a classification is useful could be made.

(c) Compounds.

After the experience with the elements the students will probably be more discriminating in classifying compounds.

Classifications such as -

White - blue - green etc.
Dense - "light"

- will probably be dismissed by the students as trivial.

Bearing in mind the explanation of a compound as a pure substance formed by the chemical bonding of 2 or more elements, the students could be expected to classify compounds in more sophisticated ways, e.g. -

1. Compounds with 2, 3, 4, etc., elements present. The opportunity to explain the systematic naming of compounds should be taken at this point.

2. Different crystalline forms.

3. Compounds with specific elements present, e.g. oxides, sulphides, chlorides, metals.

4. Compounds which may be formed from acids, e.g. sulphates, nitrates, carbonates.

5. Organic - non-organic.

6. Acid - non-acid. The student will probably be familiar with the term acid, but alkali will probably have to be explained, as well as base.

The teacher should be able to encourage practical work based on the classifications suggested.

As one example: -

Acids - bases.

(i) Feel a dilute solution of the compound between the fingers.

(ii) Effect on litmus and other indicators.

(iii) Reaction with metal elements.

(iv) Reaction with fats.

(v) Reaction with carbonates.

(vi) Preparation of some acids and bases.

(vii) Salts formed from the compounds.

(viii) Can all compounds be placed in this classification?

7. THERE ARE SEVERAL "FAMILIES" OF ELEMENTS.

In this topic, rather than rely on classifications arrived at by the students, the teacher will be responsible for exposing the student to classifications used by chemists. (Nevertheless, these may have been foreshadowed by the students in the previous topic.)

The "families" suggested for consideration are:

Inert gases.
Alkali metals.
Alkaline earths.
Group 4.
Group 5.
Group 6.
Halogens.

There is no need to deal exhaustively with the chemistry of all of these. It is recommended however, that the major chemical properties of at least 2 "families" should be explored to demonstrate:

1. The "family" similarity.

2. The differences between "families"

Small class groups could be given different pairs of "families" to investigate. Their conclusions should be made available to the rest of the class.

After this has been completed, it would be expected that the properties of a typical member of each "family" would be investigated by all the class.

For example, the properties of Group 1A (the Alkali metals) could be studied as below.

(Much of this would have to be a teacher demonstration because of safety considerations.)

1. The physical properties: Colour; hardness; density; melting point; boiling point; conductivity.

2. Burning in oxygen. (CARE!)

3. Reaction with water. (CARE!)

4. Solution of oxide in water: Properties of hydroxide; (effect on litmus, feel, salts formed with acids.)

5. Corrosion by air: Precautions for storage.

The chemistry of this family would then be summarized. The summary possibly would be - low density, highly reactive metals.

8. THERE IS A VARIETY OF CHEMICAL REACTIONS.

(Word equations should be written for all chemical reactions studied.)

(a) Revise Principle 9, Form I and Principles 3, 4 and 5, Form II.

(b) Some types of chemical reactions are:

1. Combination.
2. Decomposition.
3. Oxidation. (the combination with oxygen only.)
4. Reduction. (the removal of oxygen only.)
5. Precipitation.
6. Neutralization.
7. Displacement.
8. Substitution.

The following outline for some types of reactions could be extended to the other categories of reactions.

(i) Combination

I. Gently warm iron and sulphur in a crucible. Compare the properties of the elements with the properties of the product(s) - e.g. colour; odour; solubility in carbon disulphide (demonstration only); reaction with dilute acid; magnetic properties.

Is any other substance formed apart from the iron sulphide?

II. Demonstrate the reaction of heated steel wool plunged into a jar of chlorine.

(ii) Decomposition

I. Heat mercuric oxide in an ignition tube.
What could the silvery deposit on the side of the tube be?
Where did it come from?
What other substance could be produced?
How could we test for this substance?

II. Heat an organic compound such as sugar on a metal plate.
What could the black substance be?
Where did it come from?
What other substances could be produced?
Can we test for these?

(iii) Oxidation.

I. Plunge burning magnesium into a gas jar of oxygen. Examine the residue. What could this substance be? Compare the properties of the residue with the properties of the magnesium.

II. This could be repeated with many other elements.

(iv) Reduction.

I. Use a blow pipe to reduce lead oxide on a charcoal block. What could the pellet be? Can this be tested? Where did this element come from. Where did the oxygen go to?

II. This could be repeated with copper oxide, and iron oxide.

9. FOODS CONTAIN CHEMICAL COMPOUNDS WHICH MAY BE CLASSIFIED AS CARBOHYDRATES, PROTEINS, FATS AND OILS, MINERAL SALTS, WATER AND VITAMINS.

This involves the identification of some food constituents with appropriate tests. Other tests can be used to widen the scope suggested.

(a) Carbohydrates.

(i) Establish the iodine test for starch. Grind or mash various foods and boil a sample in water. Add a few drops of iodine solution to the cool supernatant. (The iodine solution is made by dissolving 0.6 gram of iodine in the minimum of meths. and then adding to 1 litre of water.)

(ii) Establish the Fehling's solution test with a reducing sugar such as glucose. Carry out this test on foods as above.

(b) Protein.

Perform the Biuret reaction with a protein solution. Test various foods as above.

(c) Fats and Oils.

(i) Press warm brown paper on a fatty substance such as butter and allow to dry. A translucent patch indicates the presence of fat.

(ii) Shake foodstuffs with a small quantity of ether, and then allow to evaporate. A greasy residue indicates the presence of fat. (Take care! Ether is highly inflammable.)

(d) Water.

Weigh a sample of food into a clean, dry crucible and then dessicate, either by warming or by placing in a dessicator for some days. Weigh again. A small beaker containing water could be used as a control. The percentage composition of water could be calculated. Repeat with foodstuffs including those apparently "dry", such as breakfast cereals.

(e) Mineral Salts.

(i) Ash a food sample in a clean crucible. A residue indicates the presence of mineral salts, some of which could be identified with the flame test. Flame tests should be established with known salts if they are used.

(ii) Discuss the use of common salt in food preparation.

(f) Vitamins.

Identification of vitamins in foods is considered beyond the scope of this section.

Students could compile a list of the known vitamins. Vitamin C can be identified by precipitation of silver from a silver solution such as silver nitrate. Alternatively, Vitamin C reacts with iodine and excess iodine can be identified with a starch solution. (See below, 12 c, Part (i).)

10. A BALANCED DIET IS NECESSARY TO DEVELOP AND MAINTAIN A HEALTHY BODY.

(a) Food as an energy source.

(i) Burn a fuel such as kerosene or a chemical such as magnesium or phosphorus. Note the energy released by the oxidation. Where does the energy come from?

Where does the energy used by the body come from? The energy of food is released (gradually) by subjecting the various compounds in food to a series of chemical reactions.

(ii) The following points can be covered on an assignment basis.

1. How is the energy value of food measured?

2. What foods are good (poor) energy sources?

3. How do the energy requirements of different people vary?

4. What are the energy considerations for the three main meals of the day?

(b) A balance of food constituents.

The area is probably best done as an assignment.

(i) The function of food.

1. Energy. Carbohydrates are the immediate energy source. Fats provide energy over an extended period. Excess energy is stored in the form of fats.

2. Growth and maintenance. Stress the vital role played by protein, including an investigation of first and second class protein.

3. Water supply and salts. The importance of water in the body and the role of salts should be investigated.

4. Protection from disease. The role of many vitamins was discovered as a result of a study of deficiency diseases. The vitamin requirements of different people and the consequences of oversupply should be considered.

5. Roughage. This is mainly supplied by cellulose.

(ii) Starvation. Examine the sequence of events.

(iii) Dehydration. Examine the sequence of events.

(iv) Special diets: weight control; metabolic disorders e.g. diabetes; systemic disorders e.g. high blood pressure; convalescence; space travellers.

11. CAREFUL COOKING AND PREPARATION PREVENT LOSS OF FOOD NUTRIENTS.

Some items to consider are:

(a) Proteins.

(i) Pour sufficient egg white into a test tube to cover the bulb of a thermometer. Heat in a water bath and note the temperature at which coagulation occurs. Is it necessary to boil an egg in order to cook it? Is a hard boiled egg any easier to digest than a raw egg?

(ii) Coagulation of protein on the surface of meat prevents the loss of flavour and extractives. (i.e. soluble minerals, proteins, fats and vitamins.) Place a cube of meat in a beaker of cold water and heat till boiling. Continue till the meat is cooked. Examine both the cubes and the residue.
When would it be desirable to remove the extractives in meat?
What is the scum on the water in the second beaker?

(b) Carbohydrates.

Examine starch cells from potato, rice etc., under the microscope and compare with grains obtained after the food has been cooked by boiling.
How can the starch grains be broken down, yet little starch lost in the water?

(c) Vitamins.

(i) Vitamin C is destroyed by heat, oxidation, alkalis and prolonged storage.
Remove equal volumes of water from cooking peas or beans in boiling salt water at say, 3 minute intervals. Add a small fixed volume of starch solution (2 gram of powdered starch dissolved in 1 litre of boiling water. This solution will not keep.) Note the number of drops of iodine solution which must be added before a blue colour persists. As vitamin C is slowly extracted, the concentration may slowly rise before falling.
Iodine reacts with vitamin C. After all the vitamin C has been reacted, the iodine will form a blue colour with the starch.

(ii) This experiment could be performed on a quantitative basis if the peas used were weighed, and the volume of water measured. The vitamin C present could be measured in terms of the number of drops of iodine solution needed for the blue colour. A standard vitamin C solution could be made with vitamin C tablets.

(iii) Experiments using this method could be devised to partially test the following hypotheses:

1. It is better to cook greens in a large volume of water.
2. There is less loss of nutrients from greens if they are cooked in a pressure cooker.
3. The lid of the container cooking greens should be removed.
4. Salt should not be added to water for cooking greens.
5. Bicarbonate (which imparts a vivid green colour to vegetables) does not affect the nutritive value of the vegetable.

(iv) Discuss the solution of fat soluble vitamins in cooking oils when frying.

(v) Discuss the loss of minerals in cooking.

12. THERE ARE MANY TECHNIQUES OF FOOD PROCESSING AND PRESERVATION.

(a) Cooking.

Cook equal samples of meat by boiling, frying, and grilling. Keep these samples for some days, half of them sealed in foil or plastic, the other half open to the air. Compare the samples for odour, colour, and texture during this period.

(b) Preservatives.

Soak meat in strong salt solution and compare with untreated samples as above.
What is the function of the salt? What concentration of salt should be used? What is the function of sugar in conserves and jams? How are pickles preserved? What foods have preservatives added? What are the preservatives in each? Is there any danger to health from these substances?

(c) Drying and smoking.

Dry meat and fruit samples either in a dessicator and/or sunlight. Weigh each sample before and after drying and compare with an untreated sample. Compare the colour, odour and texture of the drying and the untreated samples during this time.

The same procedure could be attempted with smoking. What is the reason for the preservation? As part of an attempt to answer this question, reconstitute some dried fruit and allow to stand for several days. Compare with dried samples.

(d) Canning.

A similar approach is suggested to that above. Why are the cans or bottles sealed when the food in them is still hot?

(e) Freezing.

Investigate the types of foods which could be preserved by this method. It is best to freeze food quickly or slowly? Is it best to thaw food quickly or gradually? Will frozen food decay when thawed? Note the discovery of food supplies found at early Polar exploration bases; and the discovery of the Woolly Mammoth in Siberia in a good state of preservation.

(f) Irradiation.

This may have to be developed as a project, although an X-ray source, an ultra violet lamp, and the radio-active sources could be used. Thin slices of foods would be best to use. Take care when handling the radio-active sources, the X-ray machine, and the ultra violet lamp.

(g) How is preservation achieved?

(i) Allow food to decay. Monitor the changes in colour, texture, and odour over a period of many days, noting any special features.

(ii) Using sterile agar plates collect air samples from various places and examine microscopically after several days. A smear from the hand could be used also.
TAKE CARE!
Investigate botulism and ptomaine poisoning.

(iii) Investigate the health inspection of places where food is prepared such as slaughter houses.

(iv) What is the purpose of food preparation techniques? What methods are suitable for different foods? Is any one method better than another for a particular food?

(h) Constituents removed from food; food additives.

(i) Investigate the constituents removed from foods during processing. (Note food additives below.)

e.g.
1. Loss of vitamin E in wheat milling and bleaching.
2. Loss of protein due to heating in the production of puff cereals.
3. Loss of vitamin content in polishing rice.

(ii) Investigate the chemicals added to foods and their dangers.

e.g.
1. Preservatives: sulphur dioxide; benzoic acid; antibiotics.
2. Colouring material: cochineal; saffron; annatto.
3. Sweetening agents: saccharin; sucaryl; p4000.
4. Contaminants: insecticides; radioactive isotopes.

(iii) Investigate supplements added to foods to improve their nutritive value.

e.g.
1. $CaCo_3$ to bread.
2. KI to salt.

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e.g.

1. $CaCo_3$ to bread.
2. KI to salt.
3. Vitamins to margarine, bread, flour.
4. Lysine to wheat products.
5. Methionine to milk products.

(iv) Investigate synthetic foods.

e.g. synthetic cream from cellulose derivatives.

13. A CHANGE IN A BODY'S MOTION OCCURS IF A RESULTANT FORCE ACTS ON IT.

(a) Illustrate various types of forces. Force can be regarded simply as a push or pull by way of introduction.
e.g. Tensional forces - use springs, and elastic bands.
Compressive forces - use a bike pump, and printer's press.
Torsional forces - twist a weight on a length of wire.
Weight forces - drop small objects.

(b) If it is considered necessary to introduce units of force use only the SI unit - the newton.
Have students experience forces of various magnitudes e.g. 1 N, 10 N, 100 N by applying force to a spring balance graduated in newton.

(c) Place objects such as "tinker" toys, blocks of wood, trolleys on a smooth ("frictionless") surface. The air track could be used. The use of an object of considerable inertia such as a trolley loaded with bricks is advised.

(i) Students should experiment to realize that a very small force is needed under "frictionless" conditions to initiate or change a body's motion. The effects of a force can be summarized:

A. force can cause -

1. a moving object to slow down or stop.

2. a moving object to move faster or change direction.

3. a stationary object to move.

Why is there a change in the motion of the body? (There is a resultant force acting.)

(ii) Have two students apply forces to the body so that it does not move.
Why does the object remain stationary? (One force is "cancelled" out by the other, - the resultant or combined force is zero.)

(iii) Apply forces to a body in different directions. Why, and where, does the body move? It should become clear that the direction (and sense) of the forces are very important.

(d) Apply a force to a body on a bench top by means of a length of rubber band attached to a spring balance (graduated in newton). Measure the largest force acting before the body moves.
Why does the body remain stationary?
(There must be another force cancelling out the first.)

(e) Consider a body on a horizontal surface.
What forces are acting on it?
(The students will probably suggest the weight force.)
Why doesn't the body move?

(f) Hold a body stationary on a smooth inclined plane with a length of string.
Why doesn't the body move?
Burn through the string to allow the body to move.
Why did the body move?

(g) Explain the use of vectors, to represent forces.
Draw vector diagrams for the several situations investigated.

14. SOME FORCES ACT AT A DISTANCE IN REGIONS CALLED FORCE FIELDS.

(a) Magnetic Force Fields.

(i) Allow students to bring like magnetic poles into opposition to experience first hand that forces do not have to be applied by contact.

(ii) Attract ball bearings with a magnet.

(iii) Map magnetic fields with fine iron filings. Show that a magnetic compass needle is affected when placed in this region - a force field.

(iv) Discuss the magnetic field of the earth, and the use made of this in navigation.

(v) Use an electromagnet to cause movement of a piece of metal. Examine the electric bell, and make one from simple parts.

(vi) Examine the electric motor. A motor can be simply constructed from improvised parts.

(b) Electric Force Fields.

(i) Rub plastic objects on various fabrics and show the effect on small pieces of paper, dust, pith balls, and a steady stream of water.

(ii) Charge a pointed insulated body. A few cat's hairs will stand normal to the surface of the body along the lines of force, particularly near the point.

(iii) Discuss everyday applications of electric force fields.
e.g. electrostatic precipitators;
electrostatic clothes brushes;
electrostatic record cleaners;
electrostatic metal coating processes;
and the nuisance caused by electric
fields in industrial ...

(f) Hold a body stationary on a smooth inclined plane with a length of string.
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(c) Gravitational Force Fields.

(i) Drop various objects to earth. Perform the Pisa experiment and Newton's experiment. Discuss Newton's law of gravitation.

(ii) Discuss the motion of natural satellites and planets.

(iii) Discuss rocket launched satellites.
What is escape velocity?
What dangers do spacemen face from forces on space flights?

(iv) Release a balloon filled with helium or hot air. Why doesn't the balloon fall to earth? (Relate to the previous topic.)

(v) Discuss how the gravitational force is overcome in aeroplanes, hovercraft, and rockets.

15. THERE ARE MANY KINDS OF RADIATIONS THAT HAVE THE SAME SPEED AS LIGHT.

(a) Revise the properties of light: speed; reflection; refraction; and dispersion.

(b) Just as light can be separated into slightly different types (i.e. the colours), so there exist other similar radiations to light.
Demonstrate how each type of radiation is detected.

(i) Detect wireless waves with a receiver.

(ii) Heat rays (infra red) can be detected with a thermometer, or Crooke's radiometer.

(iii) Visible light is detected with the eye, or a photo-electric cell as in a camera exposure meter.

(iv) Ultra violet light can be detected photographically and will cause some materials to flouresce.

(v) X rays can be detected with a Geiger counter.

(vi) Gamma rays can be detected with a Geiger counter.

(c) Discuss the uses of the radiations.

(i) Radio waves: Communications; radar.

(ii) Infra-red rays: Heating; medical uses; night photography; night-light view finders.

(iii) Visible light: Revise Principle 17, Form I. The visible spectrum; rainbows; burglar alarms.

(iv) Ultra violet light: Suntan; germicidal action; fluorescence; burglar alarms.

(v) X rays: Medical uses; food preservation; examination of castings.

(vi) Gamma radiation: Atomic explosions; radioactive isotopes; food preservation.

(vii) Cosmic radiation: Space research and

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(vi) Gamma radiation: Atomic explosions; radioactive isotopes; food preservation.

(vii) Cosmic radiation: Space research and travel; auroras.

(d) Investigate the dangers of the radiations. The widespread use of some radiations makes it advisable to be aware of the dangers and appropriate precautions.

(i) Physical damage: Burns; carcinogenic action; sterility.

(ii) Genetic damage: Mutations.

16. RADIATIONS MAY TRANSFER INFORMATION FROM ONE POINT TO ANOTHER.

This is intended to be a very practical topic catering for special interest in this area. Students should construct simple circuits and test them in the classroom. Discourage elaborate projects until success has been experienced with simple circuits. The opportunity to develop understanding of conventions such as the International Morse Code; resistor colour code; electrical components; and circuit diagrams should not be neglected.

(a) Radio waves are part of the electromagnetic spectrum. Like any of the other radiations, energy can be transported through matter or vacuum by radio waves.

(i) Visit a broadcasting station. Note the transmitting antennae. Why are these sited on a tall building or a hill?

(ii) Investigate radio telescopes. These are receiving antennae. How were they developed?

(iii) What is the function of a radio transmitter, and also of a receiver?

(iv) Investigate radar. How was this discovered? What use is made of radar?

(b) Demonstrate that sound energy in music, the voice, and the like is "patterned". Use a microphone linked to an amplifier and CRO.

Some wireless transmitters are used to convert the pattern of sounds into a pattern of wireless waves. In this way the energy carries information.

(c) Build wireless receivers. It is strongly recommended that the students themselves construct their own sets.

(i) The crystal set.
Why is a long aerial necessary?
Why is reception better at night?

(ii) A simple valve-amplified set.
In what way is this superior to the crystal set?

(iii) A simple transistor set.
What advantage has this over the valve set?
When was the transistor discovered?

(d) Enthusiasts may be inclined to build a transmitter. Some schools have set up their own "ham" station.

(e) Discuss the tremendous impact of the wireless on our culture. An investigation of the history of the development of the wireless could be made.

17. AN ELECTRIC CURRENT IS A FLOW OF CHARGE.

(a) Charge a GLE by contact. Connect this electroscope to another by means of a well insulated conductor. A change in the deflection of the leaf in each electroscope indicates that charge has moved.

(b) Use a galvanometer to demonstrate that charge is flowing in:

(i) Various conventional circuits including lamps, switches, fuse wire, and the like. What evidence apart from that provided by the galvanometer is available that a current is flowing? Demonstrate the use of a switch. Use a dry cell as a current source at first. Why is one pole of the battery "negative"? What is the nature of the current in the circuit?
Which way does the current flow?

(ii) Circuits including a cell containing a solution of an electrolyte such as sodium chloride with carbon electrodes.
What is the nature of the current in the cell?

(iii) Circuits including a Giesler tube. Demonstrate the flow of current in a variety of vacuum tubes. What is the nature of the current in these tubes?

18. A MAGNETIC FIELD SURROUNDS A FLOW OF CHARGE.

(a) Revise the concept of a force field. Demonstrate that a compass needle points north and south because it is orientated to the Earth's magnetic field.

(b) (i) Pass an electric current through a conductor which pierces a card held horizontally. Show the effect on a small compass needle placed on the card in various positions. Repeat with the current reversed.

(ii) Pass a current through a straight conductor in a magnetic field to demonstrate the force acting on such a conductor. Repeat with the current reversed.

(iii) Pass a current through a coil in a magnetic field. Repeat with the current reversed.

(iv) Demonstrate Barlow's wheel.

(c) Students should be encouraged to make the following working models. They can be constructed from simple, inexpensive materials outside the normal class time. Some models are: an electromagnet; a simple electric motor; and a galvanometer.

(d) Discuss:

(i) Theories of the Earth's magnetic field.

(ii) The deflection of alpha and beta particles in a magnetic field.

(iii) Cosmic radiations near the poles of the Earth.

(iv) The basis of natural magnetism in materials like iron.

19. LIVING CELLS CONTAIN A REGULATING CENTRE CALLED THE NUCLEUS.

(a) Examine a wide variety of prepared, stained microscope slides as a revision of the cellular theory of living things. This is an opportunity for the students to discover the potentialities and limitations of the microscope.

(b) Cytoplasm.

(i) Examine with the microscope cells obtained from: the lining of the mouth; banana pulp; blood; epidermis of leaves and roots; water from a hay infusion; a stagnant pool or a fish tank. The almost colourless, jelly-like appearance of the cell will be apparent and the students will probably have difficulty in examining these preparations for this reason. Is the nucleus clearly visible?

(ii) Stain specimens obtained from the sources above using simple staining procedures. Aqueous iodine can be used as a start, but students should also use other stains such as methylene blue or eosin. (Refer to standard microscopy texts.) Staining will reveal some of the structure of the cytoplasm.

(iii) Using fresh tissue, staining of cells can be carried out without slicing with a microtome. The tissue can be teased apart with needles on a microscope slide to produce thin enough tissue for staining. A microtome could be used, if available. Commercially prepared slides could be re-examined.

(c) Nucleus.

(i) Students should be encouraged to examine the nucleus of cells after staining. The size of the nucleus in relation to the size of the cell; the density of staining; the shape; the presence of darkly staining bodies within the nucleus itself can be used as a basis of classification of cells according to the nucleus.

(ii) A stained blood smear could be examined using a microprojector. Although quite rare in relation to the red cells, white blood cells present a wide range of different types of nuclei.

(iii) The human blood cell has no nucleus - one of the few a-nucleate cells. One percent of human blood cells die each day, and these could be considered to be degenerate cells. This provides some evidence that the nucleus of a cell is essential to the cell.

(iv) An account of the acetabularia experiments found in most standard biology texts would be valuable. The type of cap grown by a transplanted cell depends on the nucleus present.

(v) Examine stained preparation of onion root tips or other similar fast growing tissues. The mitotic figures can be easily seen in such cells. Discuss cell division. Excellent short films are available on this subject. In what way are the daughter cells different from the cells from which they originate?

20. DIFFERENT TYPES OF CELLS HAVE DIFFERENT FUNCTIONS.

(a) Bearing in mind the advice given in the Form I syllabus regarding the structure of cells revealed by microscopic examination, students should be encouraged to classify cells according to their shape. For example, some cells are almost spherical, others spindle shaped or fat cylinders, and some have long extensions. Examine and classify cells from: muscle; nerve; exocrine glands; skin; hair; bone.
Suggest functions for each type of cell.

(b) Examine ultramicrographs of muscle tissue. Fibrils are clearly displayed.
If a muscle dissected from a recently dead animal (e.g. a frog) is stimulated using electrodes attached to a power source, the muscle can be seen to contract, and then relax.
It would be reasonable to conclude that muscle cells, having a fibrillar structure, have the function of contracting and relaxing.

(c) The same approach can be used with other tissues, e.g.:

(i) Nerve trunks can be shown to consist of fibrils also. When stimulated as above, however, the nerve does not contract.
If one end of a nerve from a recently dead animal is stimulated with a pair of electrodes at one end, the arrival of the nerve impulse ("message") at the other can be detected with a pair of electrodes and displayed on a CRO, if sufficiently amplified.

(ii) Examine salivary gland cells microscopically. Chewing a piece of rubber will elicit a good flow of saliva.

(iii) If a nerve still attached to a muscle is stimulated the attached muscle can be seen to contract. Stimulation can be done electrically, as above, or simply by squeezing the end of the nerve with tweezers. It seems reasonable to conclude that nerve cells carry "messages" and muscle cells contract.

(iv) A study of red blood cells from an animal could be carried out to investigate their specialization as an oxygen carrier.

(v) This investigation could be extended to include other animals with peculiar specializations e.g. the muscle foot of snails, the erectile eyes of crabs, the ink glands of the squid.

(d) Reproduction.

(i) Examine stained sperm and ovum cells under the microscope.

(ii) Discuss fertilization. Excellent short films are available on this subject. In what way is the fertilized cell different from the sperm and the ovum?

(iii) In what way can the fertilized cell be damaged? Investigate the effects of drugs and irradiation on cells.

21. MANY DIFFERENT TYPES OF CELLS ARE NEEDED TO CARRY OUT THE ACTIVITY OF AN ORGAN.

(a) Dissect suitable animals. Freshly killed animals have the advantage that colour differences and softness of tissues aid separation and dissection. (By law, animals must be killed before presentation in the classroom.) Fresh organs may be obtained from a local butcher. Preserved animals, on the other hand, can be dissected over several sessions.

(i) The digestive organs could first be dissected out from the animal and then examined microscopically. Regional differences in the digestive tract should be noted.

(ii) Examine slides prepared from these regions and describe the cells present. Suggest function for these cells. How many different types of cells are present?

(iii) This approach could be used for other organs e.g. heart, lungs, eye, brain, bladder, liver.

(b) Careful use of charts, overlays for the overhead projector and films would support this development. It should be kept in mind that dissection and microscopic examination is the recommended approach.

22. PARTS OF THE BODY ACT TOGETHER TO PERFORM SPECIAL FUNCTIONS.

Teachers could use appropriate films to supplement the development of this topic, but not at the expense of student practical work.

(a) Motor function.

(i) Investigate the organs involved in the performance of simple motor tasks like: threading a needle; walking a chalk line; adjusting a pointer to the vertical; locating the source of a sound. Repeat these tasks when: carrying a heavy weight in one hand; blindfolded; and after being spun in an office chair for a few minutes. The interplay of several "systems" can be demonstrated in this way.

(ii) Motor tasks can be improved with practice. Draw a pencil line around a figure such as a star when viewing the activity in a mirror. Measure the improvement in time taken for the task after practice. Discuss the training of athletes and the refinement of technique.

(iii) Measure: body temperature; respiratory rate; pulse rate; blood pressure; skin colour; and moistness of skin of a resting individual. Repeat immediately after graded exercise. (This can be arranged by having the subject step up onto a box about one foot high a certain number of times per minute.) These measures change in response to exercise.
Why do they change?
How do they change?

(b) Digestion and absorption of food.

(i) Apply Fehling's test to tubes containing:

1. Saliva and starch solution.
2. Saliva.
3. Starch solution.
4. A reducing sugar such as glucose.

(The tubes should be kept at a body temperature for 10 minutes before the test.)
Saliva can be obtained by chewing on a rubber ball after the mouth has been rinsed with clean water. The starch has been changed by the saliva. Suggest reason for the secretion of saliva. Why isn't the saliva secreted continuously?

(ii) Place a protein food (uncooked egg white, or a thin sliver of meat) in M/10 HCI solution. Note any changes in appearance and any solution taking place. Where is acid produced in the digestive tract? Why is acid normally produced only when food is in the stomach? (Note gastric ulcers.)

(iii) Shake an oil in water with a few drops of a detergent. Where is there a detergent-like substance produced in the body? What is the function of such a substance?

(iv) How does food move through the various parts of the digestive tract? Demonstrate peristalsis with a newly killed animal.

(v) Outline the stages the food passes through between entry at the mouth and arrival at individual cells. Tabulate the organs involved and the type of cell for each activity.

(c) This approach could be developed for many other body functions to underline the complex interactions and interdependence of different parts of the body. For example: elimination of waste products from the body; maintenance of body temperature; control of body water; control of growth.

23. SOME MATERIALS NEEDED BY MAN MUST BE EXTRACTED FROM NATURALLY OCCURRING MATERIALS.

(a) Extraction of metals from ores.

(i) Lead may be produced by reduction of lead oxide on a charcoal block in a reducing blowpipe flame. Scrape a clean cavity in the charcoal block. (Be careful of burns.) Test the lead so produced by marking paper with it.

(ii) Discuss the production of iron and lead in a blast furnace. Investigate the production of aluminium, copper, and zinc in Australia. The separation of the rarer metals such as radium and uranium could be investigated.

(b) Extraction of eucalyptus oil from gum leaves.

Boil gum leaves with water in a flask and condense the vapours in a Liebig condenser. Collect the condensate, the oil floating on the water. Separate the two layers and examine the properties of the oil, i.e., colour; S.G.; and odour. (The yield will be improved if a little of the eucalyptus oil is added to the leaves in the flask, where it is believed to have a catalytic action. Suitable leaves may be used.)

(c) Submit crudo oil to fractional distillation. Collect the fractions which condense at various temperatures. (A mixture which can be used as "crude" oil can be made from sump oil, kerosene, and various other oils.)
Beware of inflammable components.

(d) Evaporate sea water to produce salt.

The main components are sodium chloride and magnesium chloride. Each of these could be identified with appropriate tests. For example: the flame test for sodium; a silver nitrate solution for chloride; and a sodium di-hydrogen phosphate solution for magnesium.

(e) Dyes.

Plants are a good source of substances which have dye properties (and indicator properties.) Boil the plants in water and test the concentrated liquor produced for dyeing properties with suitable uncoloured fabrics or paper. Test for indicator properties with dilute acid and alkali solutions. Some suitable material to use: onions; rose hips; red cabbage; beetroot; and mosses.

(f) Assignments.

The following are only a few of the areas which could be investigated.

1. Iodine production from seaweed.
2. Penicillin production from mould.
3. Production of hormones.
4. Carbon black as a by-product of the refining industry.
5. Oxygen, nitrogen, and argon production from air.
6. Production of casein.
7. Insulin productions.
8. Production of linen by the retting of flax.

24. MAN IS NOW ABLE TO SYNTHESIZE MANY MATERIALS.

The commercial production of many synthetic substances require conditions of temperature and pressure which are not easy to duplicate in the classroom. For this reason many substances can only be studied on an

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The commercial production of many synthetic substances require conditions of temperature and pressure which are not easy to duplicate in the classroom. For this reason many substances can only be studied on an assignment basis.

(a) Production of nylon.

Dissolve adipyl chloride in carbon tetrachloride in a beaker. (USE THE FUME CUPBOARD.) Dissolve di-amino hexane in water and pour carefully into the first beaker to form a separate layer. A filament of nylon can be drawn out at the interface on a glass rod. The length of fibre produced from small quantities of reagents is impressive. (Take care with inflammable substances.)

(b) Detergents.

(i) To a beaker containing 6 gram of sodium hydroxide dissolved in 55 gram of water, add a suitable sulphonic acid (e.g. I.C.I. alkanate A46) until it is neutral to litmus. Allow a few minutes for the reaction to get started, and then place in an icebath to absorb some of the heat produced. When the reaction has subsided, withdraw 4 ml. of the pasty material (detergent slurry) and warm gently in an evaporating basin to dry. The off white powder should be tested for detergent properties by shaking with an oil-water mixture to determine if a stable emulsion is produced.

(ii) One alternative method is to add sulphuric acid to n-dodecyl alcohol to form a gardinol. Neutralize with sodium hydroxide solution. The product (a gardinol i.e. the sodium salt of a sulphonated alcohol), has detergent properties.

(c) Dyes.

Place equal amounts of resorcinol and phthalic anhydride into a test tube. (Use about 0.5 gram.) Moisten with a few drops of concentrated sulphuric acid and heat gently until a permanent colour change has persisted. Cool to room temperature. Dissolve the solid in sodium hydroxide solution, (8 gram in 100 ml. water.)
The due fluorescein will show even when diluted with large volumes of water.

(d) Assignments.

Investigate the synthesis of:

1. Insulin.
2. Drugs.
3. Insecticides.
4. Polyester fibres e.g. "Terylene" and "Dacron".
5. Rubber.
6. Plastics.
7. Saccharine.
8. Methanol.
9. Flavourings.

Include the history and the social consequences of these processes.

C. REFERENCES

KEY: CS Suitable for student reference, class sets recommended.
RL At least one copy for the reference library.

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