For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL (ZIMSEC)

ORDINARY LEVEL SYLLABUS

PHYSICAL SCIENCE (5009)

EXAMINATION SYLLABUS FOR 2013 – 2015

A. INTRODUCTION

This syllabus assumes a knowledge of the content of the two year Zimbabwe Junior Certificate (ZJC) Science Syllabus. It prepares pupils for studies in physical sciences beyond 'O' level as well as being a worthwhile qualification for those not proceeding with study beyond this level. It places less emphasis on factual recall of material and more emphasis on the understanding and application of scientific concepts, principles and skills.

Applications of science and technology to agricultural, environmental, social and economic issues are included to extend subject concepts and skills. A practical and investigative approach must be adopted in teaching this syllabus. This will serve to develop the skills and abilities necessary to achieve the stated aims and objectives.

B. AIMS

The aims of the syllabus are to help pupils:

1 develop interest, and curiosity, in science;

2 develop concepts and skills that are relevant to the study and practice of physical science;

3 appreciate and enjoy physical science and its methods of enquiry;

4 develop creativity, initiative and skills of enquiry;

5 develop good practices for health and safety;

6 develop accuracy and precision, objectivity and integrity;

7 recognise the usefulness and limitations of science;

8 apply scientific method in other disciplines and in everyday life;

9 appreciate the beneficial and detrimental effects of the applications of science;

10 recognise that the study and practice of science are inter-related and are subject to economic, technological, social, political, ethical and cultural influences;

11 communicate scientific information effectively;

12 participate in the technological development of Zimbabwe;

13 develop interest in, and participate in, caring for the local and global environment.

C. ASSESSMENT OBJECTIVES

The following objectives reflect those aspects of the aims that will be assessed. Specific behavioural learning objectives are stated in each section of the syllabus.

1.0 KNOWLEDGE AND UNDERSTANDING

Pupils should be able to demonstrate knowledge and understanding of:

1.1 scientific instruments and apparatus, techniques of operation and aspects of safety;

1.2 scientific units, terminology, symbols and conventions;

1.3 scientific quantities and how they are determined;

1.4 scientific phenomena, facts and laws, definitions, concepts, theories and models;

1.5 personal, social, economic and environmental implications of scientific applications.

2.0 HANDLING INFORMATION AND SOLVING PROBLEMS

Pupils should be able to demonstrate, in familiar and unfamiliar situations, their ability to:

2.1 extract information relevant to a particular context from data presented in diagrammatic, symbolic, graphical, numerical or verbal form;

2.2 use data to recognise patterns, formulate hypotheses and draw conclusions;

2.3 translate information from one form to another;

2.4 communicate logically and concisely;

2.5 explain facts, observations and phenomena in terms of scientific laws, theories and models;

2.6 explain the effects of technological applications on the environment;

2.7 make logical decisions based on the examination of evidence and arguments;

2.8 apply scientific principles, formulae and methods to solve qualitative and quantitative problems;

2.9 suggest explanations of unfamiliar facts, observations and phenomena;

2.10 identify the practical constraints affecting scientific investigations.

3.0 EXPERIMENTAL SKILLS

Pupils should be able to:

3.1 follow instructions for practical work;

3.2 plan, organise and carry out experimental investigations;

3.3 select appropriate apparatus and materials for experimental work;

3.4 use apparatus and materials effectively and safely;

3.5 make accurate, systematic observations and measurements, recognising the variability of experimental measurements;

3.6 observe, measure and record results of experiments systematically;

3.7 identify possible sources of error in experimental procedures;

3.8 draw conclusions and make generalisations from experiments;

3.9 extract information from data presented in diagrammatic, graphical or numerical form.

4.0 WEIGHTING OF ASSESSMENT OBJECTIVES

	ASSESSMENT OBJECTIVES	WEIGHTING
Papers 1 and 2		
Knowledge and understanding	1.0	55%
Handling information	2.0	45%
Paper 3 or Paper 4		
Experimental skills	3.0	100%

D. ASSESSMENT SCHEME

Paper	Type of Paper	Duration	Marks	Paper Weighting
1	Theory	1h	40	30%
2	Theory	2h 15min	100	50%
3	Practical Examination	1h 30min	40	20%
4	Alternative to Practical (Written)	1h	40	20%

Candidates will be required to enter for Papers 1 and 2 and either Paper 3 or Paper 4.

Paper 1 **Theory (1 hour, 40 marks)**
This paper will consist of 40 compulsory multiple choice items.

Paper 2 **Theory (2 hours 15 min, 100 marks)**
Section A (40 marks, 55 min) will consist of eight compulsory short-answer and structured questions based equally on the physics and chemistry sections of the syllabus.

Section B (30 marks, 40 min) will be based on the chemistry section of the syllabus. It will consist of three free-response questions of fifteen marks each and each designed to take 20 minutes. Candidates will be required to answer any two questions. All questions will be designed to give the same weighting to assessment objectives.

Section C (30 marks, 40 min) will be based on the physics section of the syllabus. It will consist of three free-response questions of fifteen marks each and each designed to take 20 minutes. Candidates will be required to answer any two questions. All questions will be designed to give the same weighting to the assessment objectives.

Paper 3 **Practical Examination (1 hour 30 min, 40 marks)**
This paper is designed to assess the extent to which a candidate displays competence in practical skills.

Candidates will be expected to be familiar with apparatus appropriate to school physical sciences laboratories and techniques of the use of such apparatus.

The practical examination will consist of two questions of twenty marks each, one based on the physics section and the other on the chemistry section of the syllabus.

Candidates will be expected to carry out the experiments from the instructions and notes given in the question papers.

Chemistry Question
Candidates may be asked to carry out exercises based on:

(a) quantitative experiments involving the use of a pipette, a burette and an indicator such as methyl orange or screened methyl orange; if the titrations other than acid/alkali are set, full instructions and other necessary information will be given;

(b) speeds of reaction;

(c) measurement of temperatures based on a thermometer with 1°C graduations;

(d) problems of an investigatory nature, possibly including suitable organic compounds;

(e) simple paper chromatography;

(f) filtration;

(g) tests for oxidising and reducing agents as specified in the syllabus.

(h) identification of ions and gases as specified in the syllabus.

The question papers will provide notes on qualitative analysis and data for the use of candidates in the examination – see data sheets (i) and (ii). Candidates may also be required to perform some simple calculations.

Physics Question
The question is designed to test candidates abilities to:

(a) follow written instructions for the assembly and use of provided apparatus, e.g. using ray-tracing equipment, wiring up simple electrical circuits;

(b) select, from given items, the measuring device suitable for the task;

(c) carry out specified manipulation of the apparatus, e.g. when determining a quantity such as the extension per unit load for a spring, when testing or identifying the relationship between two variables such as that between the potential difference (p.d) across a wire and its length, when comparing physical quantities such as the heat capacity of two metals;

(d) take readings from a measuring device, including –
- reading a scale with appropriate precision/accuracy,
- making consistent use of significant figures,
- interpolating between scale divisions,
- allowing for zero errors, where appropriate,
- taking repeated measurements to obtain an average value;

(e) record their observations systematically, with appropriate units;

(f) process data as required;

(g) present their data graphically, using suitable axes and scales (appropriately labelled and plotting the points accurately);

(h) take readings from a graph by interpolation and extrapolation;

(i) determine a gradient, intercept or intersection on a graph;

(j) draw and report a conclusion or result clearly;

(k) indicate how they carried out a required instruction;

(l) describe precautions taken in carrying out a procedure;

(m) give reasons for making a choice of items of apparatus;

(n) comment on a procedure used in an experiment and suggest improvements.

Paper 4 **Alternative to Practical (1 hour, 40 marks)**

A written paper consisting of 4 compulsory short-answer and structured questions, 2 on Chemistry and 2 on Physics. These questions will be designed to test familiarity with laboratory practical procedures.

Questions may be set requiring candidates to:

(a) record readings from diagrams of apparatus;

(b) describe, explain, comment on or suggest experimental arrangements, techniques and procedures;

(c) complete tables of data and/or plot graphs;

(d) take readings from graphs by interpolation and extrapolation;

(e) determine a gradient, intercept or intersection on a graph;

(f) interpret, draw conclusions from and evaluate experimental (including graphical) data;

(g) describe tests for gases, ions, oxidising and reducing agents and/or draw conclusions from such tests;

(h) perform simple calculations;

(i) draw clear labelled line drawings;

(j) explain, suggest and/or comment critically on safety precautions taken and possible improvements to techniques and procedures;

(k) identify possible sources of error.

NOTE: Examination questions on all papers may be set requiring candidates to apply knowledge to novel situations.

E. METHODOLOGY

Emphasis is placed on the acquisition of experimental skills though practical experience. Experiments should be planned and designed in advance. A pupil-centred problem-solving approach should be adopted. Individual and group work is encouraged. Emphasis must be on the understanding of concepts rather than on the memorisation of specific examples that illustrate these concepts.

The syllabus is a two-year course of study. A minimum of six teaching periods (3½ hours) per week required.

Teachers may use an integrated, co-ordinated or topic-based approach or any other suitable style of organisation and delivery. Emphasis on investigations and practical work is expected. Schools are encouraged to rearrange the topics to suit their own conditions.

SI units of measurement are to be used, together with those units in common scientific use.

Where it will facilitate learning, the drawing of diagrams should be encouraged.

Guidance should be given on the correct taking of notes and writing up of experiments.

Safety precautions must always be observed.

F. MATHEMATICAL REQUIREMENTS

Many topics in the syllabus provide opportunities for quantitative work, including appropriate calculations. The mathematical knowledge and skills which students may need in order to cope with the specified objectives and content are listed below. Calculators may be used in all papers.

Candidates will be expected to:

- recognise and use expressions in decimal form;

- add, subtract, multiply and divide numbers, including decimal numbers and common fractions;

- make approximations and estimates to obtain quick, order-of-magnitude answers or to make simple mental checks of answers obtained by calculator;

- calculate, and use, averages, ratios, direct and inverse proportion and percentages;

- draw and interpret graphs, bar and pie charts;

- select appropriate axes and scales for plotting graphs;

- choose, by simple inspection, a set of points and then draw the best smooth curve through them;

- determine the intercept of a linear graph;

- read, interpret and draw simple inferences from tables and statistical diagrams;

- substitute numbers for letters or words in simple equations;

- measure triangles, rectangles, circles and cuboids ;

- take account of variability of experimental measurements;

- manipulate and solve simple equations;

- use a ruler graduated in millimetres and centimetres;

- use a protractor to measure angles;

- read graduated scales of various forms.

G. PRESENTATION OF CONTENT

The syllabus consists of chemistry and physics sections. The topics in each section are listed below.

Chemistry

1.0 Atoms, elements and compounds.

2.0 Stoichiometry and the mole concept.

3.0 Chemical reactions.

4.0 Electrochemistry.

5.0 Metals and non-metals.

6.0 Acids, bases and salts.

7.0 Industrial processes.

8.0 Organic chemistry.

Physics

1.0 General physics.

2.0 Motion and force.

3.0 Structures.

4.0 Energy, work and power.

5.0 Mechanical systems.

6.0 Thermal physics.

7.0 Waves.

8.0 Electricity and magnetism.

9.0 Electronics.

10.0 Atomic physics.

The learning objectives are presented in behavioural form.
The content column serves to limit the extent to which the learning objectives should be covered.

The notes and activities in the last column are in no way exhaustive. Teachers are encouraged to use their own additional examples to assist pupils in understanding concepts and acquiring skills.

Assessment objectives marked with an asterisk (*) should have been covered at ZJC. It is anticipated that these will entail revision only and do not need further detailed treatment, although more activities may be required by the syllabus.

CHEMISTRY

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
1.0 ATOMS, ELEMENTS AND COMPOUNDS			
1.1 Structure of matter	- describe the structure of an atom;	Nucleus: protons, neutrons, electrons.	
	- state the charges and relative masses of sub-atomic particles;	Relative charges and masses; their chemical significance.	
	- define proton number (z) and nucleon number (A);	Proton (atomic) number, nucleon (mass) number.	
	- use and interpret the nuclide notation;	${}^{A}_{Z}X$.	Symbols such as ${}^{12}_{6}C$.
	- define elative atomic mass;	Relative atomic mass (A_r).	
	- define isotope;	Isotopes.	
	- deduce the electronic configuration of elements;	Electronic configuration.	Elements up to Ca to be deduced from proton number. No reference to orbitals.
	- explain the significance of electronic structure in compound formation;	Valency, noble gas electronic structure.	Significance of the noble gas structure.
1.2 Chemical bonding	- describe the formation of bonds;	Ionic bonds: electron loss or gain; electrostatic attraction.	Examples from the first 20 elements of the Periodic Table.
	- construct 'dot and cross' diagrams to represent bonds;	Covalent bonds: electron sharing.	
	- relate the physical properties of compounds to their structures and bonding;	Melting point, boiling point, solubility, and electoral conductivity.	
1.3 Elements, mixtures and compounds	- state the meaning of element, mixture, compound, and chemical reaction;	Elements, mixtures and compounds.	Experiments which illustrate chemical and physical changes.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- state the differences between elements, mixtures and compounds;	Physical and chemical changes.	
	- use chemical symbols and formulae to represent reactions;	Chemical symbols and formulae.	
	- determine the melting points and boiling points of pure substances;	Melting points and boiling points as criteria of purity.	
	- describe the effect of impurities on melting points and boiling points;	Effects of impurities.	
	- describe and carry out separation of mixtures;	Filtration, crystallisation, distillation, fractional distillation.	Experiments on separation techniques.
	- describe and use paper chromatography and interpret paper chromatograms;	Paper chromatography.	
1.4 The Periodic Table	- use proton number and the structure of atoms to explain the Periodic Table;	The Periodic classification of elements.	Arrangements of elements according to electronic configuration of the atoms for the first 20 elements.
	- describe the change from metallic to non-metallic character across a Period;	Periodic trends for Na to Cl; metallic/non-metallic.	Data on melting points and boiling points.
		Characteristics and acid/base behaviour of common oxides.	Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, SO_2, SO_3
	- describe trends	Group II; magnesium, calcium and barium.	Reactions of metals with water, solubility of hydroxide.
		Group VII; chlorine, bromine and iodine.	Colour, physical state, displacement reactions with other halide ions.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
2.0 STOICHIOMETRY AND THE MOLE CONCEPT			
2.1 Stoichometry and the mole concept	- state the symbols of elements and formulae of compounds;	Formulae of compounds; molecular and ionic equations.	Formulae restricted to those compounds or ions mentioned in the syllabus.
	- determine the formula of ain ionic compound from the charges on the ions present and vice versa;		
	- write balanced equations including ionic equations;	Balanced equations. State symbols.	Use the following state symbols in equations: (s), (l), (g), (aq).
	- define and calculate relative molecular mass and formula mass;	Relative molecular mass and formular mass (M_r).	Molecular masses for covalent compounds and formula masses for ionic compounds.
	- calculate stoichiometric reacting masses of reactants and products;	Reacting masses and volumes.	Quantitative treatment of equations and simple calculations. Calculations of volumes of reactants/products.
	- calculate volumes of gases in chemical reactions;	Molar gas volumes.	Molar gas volume as $28dm^3$ at room temperature and pressure under typical Zimbabwean conditions. Calculation of volumes of reactants/products.
	- use the mole concept to calculate empirical and molecular formulae.	The mole, the Avogadro constant, empirical and molecular formulae.	Solution concentration in g/dm^3 and mol/dm^3.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
3.0 CHEMICAL REACTIONS			
3.1 Energy changes	- explain the terms exothermic and endothermic reaction; - relate bond making and breaking to energy changes;	Bond making and bond breaking.	Burning of fuels, reaction of NaCHO3 with dilute acid.
3.2 Speed of reaction	- state the factors that affect speeds of reaction; - devise a method to investigate the effect of a variable on the speed of reaction; - interpret data obtained from experiments on speed of reaction; - explain the terms reversible reaction and dynamic equilibrium;	Graphical representation of data. Forward and backward reactions.	Qualitative effect by experimental study of such examples as: (i) $Na_2S_2O_3$ (sodium thiosulphate) with dilute acids; (ii) Mg or Zn with dilute acids, effects of catalysts such as Cu; (iii) $CaCO_3$ with dilute HCl; (iv) decomposition of H_2O_2 catalysed by MnO_2 and by macerated liver. Limited to reactions that can proceed in either direction, e.g. $N_2 + 3H_2 \rightarrow 2NH_3$. Refer to 7.2 and 8.4

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
3.3 Redox	- define oxidation and reduction; - identify redox reactions; - elate redox reactions to metal extraction;	1 Gain or loss of oxygen and hydrogen 2 Electron transfer 3 Change in oxidation state	Fe^{2+}, Fe^{3+} $CuSO_4$ with Fe. Reaction of metal with acid. Refer to 6.2. Reference to reduction of ores, combustion, rusting. Refer to 5.3.
4.0 ELECTROCHEMISTRY			
4.1 Electrolysis	- define electrolyte and electrode - describe the formation of electrode products in electrolysis of different substances; - state the conditions determining the electrode products; - write equations to show electrode reactions; - predict the likely products of electrolysis of a binary compound in the molten state or in aqueous solution.	Electrolyte, electrodes, cathode and anode. Electrode reactions, concentration and preferential discharge. Half-equations.	Electrolysis of: (i) dilute solutions of sulphuric acid, sodium chloride (carbon electrodes); (ii) copper (II) sulphate (carbon and copper electrodes); (iii) concentrated sodium chloride solution (carbon electrodes); (iv) molten halide, e.g. lead (II) bromide (carbon electrodes).

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
5.0 METALS AND NON-METALS			
5.1 Properties of metals and non-metals	- describe the physical properties of metals and non-metals;	Conductivity, ductility and malleability	Experiments to demonstrate properties.
5.2 Reactivity series	- list metals in order or reactivity;		Experiments illustrating their reactions (if any) with air, water or steam, hydrochloric acid, displacement reactions, effect of heat on carbonates and nitrates, and reduction of oxides. Refer to 3.3
	- relate the activity series to the tendency of a metals to form a positive ion;	Electrochemical series.	Construction of an electrochemical series by experiment.
	- relate the stability of compounds to the activity series;		
	- deduce an order of reactivity from a set of experimental results.		Apparent unreactivity of aluminium due to oxide layer.
5.3 Extraction of metals	- state the occurrence of iron and copper;	Common occurrence in Zimbabwe.	
	- describe the extraction and purification of iron and of copper;	Iron: Extraction by blast furnace. Purification by oxygen lance process.	Main reactions and conditions. Purpose of raw materials in blast furnace.
		Copper: Extraction by concentration, roasting and reduction processes. Purification by electrolysis.	Main reactions and conditions. Experiment on reduction of CuO; refer to 3.3. Practical demonstrations of electrolytic purification.
	- describe the conversion of iron to steel;		
	- state the constituents of alloy of iron and of copper;	Cast iron, mild steel and stainless steel, bronze and brass.	Percentage composition of alloys is <u>not</u> required.

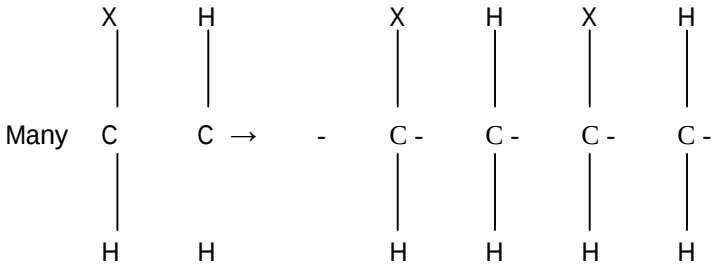
TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- relate the uses of metals and alloys to their properties	Properties and uses of metals and alloys.	Examples of uses e.g. industrial, domestic, protective, ornamental, structural and medical uses.
5.4 Coating	- state reasons for coating materials; - describe coating processes; - explain the choice of coating materials.	Electroplating: copper, nickel and chromium.	Experiments on rushing and its prevention; electroplating or iron nail with copper. Practical examination of coated objects.
6.0 ACIDS, BASES AND SALTS			
6.1 Acids and bases	- explain the terms acid, base and alkali; - describe the characteristics of acids and bases; - explain the meaning of pH; - describe the characteristic reactions of acids;	The production of H+ (aq) ions by acids and OH (aq) ions by alkalis. Corrosive action, the role of water, action of litmus and universal indicator paper. Acidity and alkalinity. Reactions with metals, bases and carbonates.	An alkali as a soluble base. pH (whole number only) as a measure of acidity or alkalinity.
6.2 Preparation of salts	- explain the term neutralisation; - describe the preparation of pure samples of salts;	$H^+ + OH \rightarrow H_2O$ Displacement, neutralisation and precipitation; purification by evaporation and crystallisation.	Spectator ions remaining as a salt in solution. Preparation of salts by action of dilute acids on metals, carbonates and bases; refer to 1.3.
6.3 Identification of ions and gases	- identify cations, anions and gases;	Cations: Mg^{2+}, Al^{3+}, Fe^{3+}, Fe^{2+}, Cr^{3+}, Cu^{2+}, Zn^{2+}, NH^{4+} Anions: Cl^-, I^-, CO_3^{2-},SO_4^{2-}, NO^{3-} Gases: O_2, Cl_2, H_2, NH_3, SO_2, CO_2	Observation and deduction; qualitative experiments based on simple reactions of cations and anions. (See notes for use in qualitative analysis Data Sheet page ii).

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
7.0 INDUSTRIAL PROCESSES			
7.1 Sulphuric acid	- outline the manufacturer of sulphuric acid;	Contact process; sources of raw materials.	
	- explain the optimum conditions for the manufacture of sulphuric acid;	Temperature and catalyst.	Qualitative understanding of conditions only. Refer to 3.2 Le Chatelier's principle is <u>not</u> required.
	- describe the properties of sulphuric acid;	Strong non-volatile acid. Reactions with metals and bases. Dehydrating agent.	Oxidising properties not required.
	- state the industrial uses of sulphuric acid;	Drying agent; production of fertilizer, paint, plastic and detergents and in paper making.	
7.2 Ammonia	- outline the manufacture of ammonia;	Harber process; sources of raw materials.	
	- explain the optimum conditions of the manufacture of ammonia;	Temperature, pressure and catalyst.	Le Chatelier's principle is <u>not</u> required.
	- state the industrial uses of ammonia;	Manufacture of fertilisers, refrigerant, nitric acid and household cleansers.	
7.3 Nitric acid	- outline the manufacture of nitric acid;	Catalytic oxidation of ammonia; sources of raw materials.	
	- state the industrial uses of nitric acid;	Production of fertilizers, explosives, dyes and extraction of gold.	
	- outline the manufacture of nitrogen fertiliser;	Ammonium nitrate. Neutralisation of HNO_3 with NH_3. Crystallisation.	Refer to 6.1

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
7.4 Industrial gases	- outline the manufacture of industrial gases;	Oxygen: liquefaction of air and electrolysis of water. Steel making, welding and medical treatment.	Interdependence of Zimbabwe Electricity Supply Authority (ZESA), Zimbabwe Iron And Steel Company (ZISCO) and Sable Chemical Company (SCC) with reference to manufacture of industrial gases should be emphasised.
	- state the uses of the gases.	Nitrogen: liquefaction of air. Production of ammonia and nitric acid. Hydrogen: electrolysis of water Welding, fertiliser and margarine manufacture. Carbon dioxide: fermentation. Fire extinguisher, dry ice and carbonated drinks.	Hydrogenation of oils in margarine manufacture to be mentioned.
8.0 ORGANIC CHEMISTRY			
8.1 Fuels	- define fuel;	Energy source.	Fuel as a material that can be burned to give out heat or provide chemical energy.
	- identify fuels;	Solid fuels: wood, coal, coke, charcoal. Liquid fuels: diesel (fuel) oil, paraffin, petrol and ethanol. Gaseous fuels: butane, biogas and hydrogen.	Blend as containing ethanol and petrol.
	- state the uses of fuels;		
	- describe destructive distillation of coal;	Coal to coke.	Destructive distillation as a means of producing better fuels.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- state the uses of the products of destructive distillation;	Coke, coal gas, benzol and ammonia.	
	- compare the thermal efficiency of fuels;	Energy production related to carbon number.	Comparative practical study of thermal efficiency of liquid fuels.
	- explain complete and incomplete combustion;	Reactants, products, energy production and equations.	Practical exercise using a burner with air-hole open and closed. Dangers of incomplete combustion.
	- describe the social and economic implications of using fuels;	Deforestation, pollution, acid rain, ozone layer depletion, greenhouse effect, and carcinogenic effects of by-products.	
8.2 Hydrocarbons	- state the composition of hydrocarbon;	Carbon and hydrogen only.	
	- state the sources of hydrocarbons;	Petroleum and natural gas.	
	- describe the general characteristics of a homologous series;	Formular and chemical properties.	
	- define isomer;	Isomer.	Only names of C1 to C5 unbranched alkanes required.
	- name and give the general and structural formulae of alkanes and ethene;	General formulae and structural formulae.	Only structural formulae of methane, ethane, propane, butane, 2-methyl propane, pentane, 2-methyl butane, 2,2-dimethyl propane and ethene required; no names required
	- describe chemical properties of ethane and ethene;	Ethane: combustion; Ethene: combustion, reactions with hydrogen and bromine.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- distinguish between saturated and unsaturated hydrocarbons;	Double bonds and reactivity.	Use of any liquid alkene to show unsaturation.
8.3 Alcohols	- describe general characteristics of alcohols;	General formula and function group.	
	- describe the preparation of ethanol by fermentation;	Fermentation: role of yeast and conditions. Fractional distillation.	Practical preparation of ethanol from sugar or maize.
	- describe chemical properties of ethanol;	Combustion, oxidation to ethanoic acid; dehydration.	Treatment of aldehydes not required.
	- state the uses of ethanol;	Solvent, fuel, alcoholic beverages and medical purposes.	
8.4 Carboxylic acids	- describe the general characteristics of carboxylic acids;	General formula and functional group.	Only structural formula of ethanoic acid required.
	- describe the formation of ethanoic acid;	Oxidation of ethanol by air and potassium dichromate (IV).	Vinegar as a product of oxidation by air.
	- describe chemical properties of ethanoic acid;	Reactions with carbonates and alkalis.	
8.5 Soaps and detergents	- outline the manufacture of soaps and detergents;	Soaps: alkalis and fats and vegetable oils. Detergents: acids and petroleum products.	Glycerol as a by-product.
	- explain the action of soaps;		Qualitative description of cleansing action of soap molecules in terms of wetting of material and of hydrophilic and hydrophobic parts. Experiment to show the action of soaps.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
8.6 Polymers	- describe polymers; - state the uses of synthetic polymers; - distinguish between addition and condensation polymerization; - deduce the structure of the polymer from a given monomer.	Macromolecules. Poly(ethene), poly(vinyl chloride), (PVC), polystyrene, polyamide (nylon) and polyester *(Terylene)*. Joining of units.	Joining of units with or without the elimination of water or some other molecule. Addition polymerisation represented by:  Condensation polymerization represented by: - Many $C_6H_{12}O_6 \rightarrow H_2O + -[C_6H_{10}O_5] – O – [C_6H_{10}O_5] – O –$

PHYSICS

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
1.0 GENERAL PHYSICS			
1.1 Measurement of length and time	- identify the scale division on measuring devices; - read an instrument scale to the nearest division; - handle measuring devices correctly; - measure the period of a pendulum; - identify methods of improving accuracy of measurement; - use SI units; - convert units.	Ruler, vernier calliper, thermometer, measuring cylinder, stopwatch, forcemeter, ammeter and voltmeter. Time. The use of many readings. Metre, second, kilogram, Kelvin and ampere.	Practice on measuring should be given throughout the course wherever applicable. Correct reading of volumes of liquids with menisci. Derivation of other units from these, e.g. newton, joule, watt, etc.
1.2 Scalars and vectors	- distinguish between scalar and vector quantities; - determine resultant vectors.	Magnitude and direction. In-line and perpendicular vectors.	 Restricted to two vectors.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
2.0 MOTION AND FORCE			
2.1 Speed, velocity and acceleration	- state the meaning of displacement, speed, velocity and acceleration;	Displacement, speed, velocity and acceleration.	
	- determine speed, velocity and acceleration of a body;		Experiments to measure distance, speed and acceleration using ticker timer or other method to record motion.
	- plot, draw and interpret distance/time and speed/time graphs;	For a body (a) at rest, (b) moving with constant speed, (c) moving with constant acceleration. Shapes of curves.	Ability to handle negative acceleration is expected. No derivation or use of the three equations of motion required.
	- determine acceleration and distance from speed/time graphs;	Slope and area under the curve.	
	- explain that the acceleration of a free fall for a body near to the Earth is constant;	Free-fall.	
	- describe the motion of bodies falling in uniform gravitational field without air resistance.		Acceleration of free fall = $10 m/s^2$. Experiments to show that objects fall at the same rate.
2.2 Forces	- state the effects of a force;	Change of size, shape, speed or direction. Newton's first law.	Experiments to demonstrate the effects of forces.
	- describe the effects of friction on the motion of an object;	Reducing motion.	Friction as a force that opposes motion. Experiments to show how friction can be reduced.
	- use the relation between force, mass and acceleration;	Newton's second law in the form $F = ma$.	F to be the resultant force.
	- identify forces as existing in pairs;	Newton's third law.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- describe the moment of a force in terms of its turning effect; - describe an experiment to verify the principle of moments; - use the principle of moments in calculations;	Moments of force. Principle of moments.	Use of everyday examples to illustrate principle.
2.3 Mass, weight and centre of mass	- define mass; - define weight; - measure mass and weight; - describe an experiment to determine the position of the centre of mass of a plane lamina; - describe the effect of the position of the centre of mass on the stability of objects;	Mass. Weight. Beam and spring balances. Centre of mass. Stable, unstable and neutral positions.	Mass defined as a measure of the inertia of an object. Weight defined using $F = ma$. Concepts to be illustrated by practical work.
2.4 Density	- calculate the density of liquids and solids; - determine the density of liquids and solids;	Liquids and regular and irregular solids. Use of kg/m^3 as units of density.	Practical determination by the method of displacement of irregular solids.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
3.0 STRUCTURES			
3.1 Beams	- define beam; - describe a beam by its cross-sectional area; - compare the strength of beams; - explain the effects of push and pull forces; - explain how stress is distributed in a loaded beam;	Beams. T, L, and I shaped beam, solid and hollow box (▪ and□) and cylindrical beams. Relation between strength, cross-sectional shape and depth. Compression, tension and shear. Compression, tension and neutral zones. Internal stress, areas of strength and weakness.	A supported bar which bears a load. Practical work on beams using similar quantities (mass per unit length) of material but different cross-sectional shapes. Experiments to demonstrate crushing, compressing, buckling and bending: stretching and snapping. Experiments using foam rubber blocks, green twigs and hollow stems.
3.2 Trusses	- construct a truss; - explain the use of triangles in a truss; - explain the advantages of trusses over beams; - explain how a load can be distributed throughout a truss; - Identify struts and ties in a truss; - explain the design of a roof truss;	Trusses. Stability. Economy, mass and strength/mass ratio. Compressive and tensile forces. Transmission of forces by connecting members. Distribution of load.	A Truss as composed of many members performing the function of a beam. Problems associated with scale. Lighter structures to have less mass to sustain their own weight. Experiments to illustrate strength/mass ratio of a beam and truss. Experiments to determine members under tension or compression. Construction of models.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
3.3 Joining materials	- describe methods of joining materials. - compare the strength of joints;	Pinning: Wood – screws, nails and bolts; Metal – bolts and rivets. Surface contact: wood – gluing with or without dowels and tongue and groove; Metals – soldering, brazing and welding; Plastic – plastic welding and gluing. Sizes of contact area, number and position of pins.	An example of each type of joint should be made and tested.
3.4 Large structures	- identify materials used in large structures; - compare properties of construction materials; - explain the design and materials used in different types of bridges; - explain the use of arches in construction of large structures; - explain composition and shape of dam walls; - identify how weight is distributed in a large structure.	Wood, metal, concrete and stone. Compressive and tensile strengths, mass and durability. Pier and beam bridge, arch bridge and suspension bridge. Strength. Earth and concrete; straight and arch dams. Weight distribution.	Durability in relation to decay, corrosion and rusting. Construction and loading of models. An appreciation of both durability and cost as factors in determining choice. Arches enable material goods in compression to be used in place of materials good in tension in certain structures.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
4.0 ENERGY, WORK AND POWER			
4.1 Energy	- identify different forms of energy;	Kinetic, heat, light, electrical, chemical, gravitational potential and nuclear energy. The joule as the unit of energy.	Reference to fuel (chemical) energy, hydro electrical generating, solar energy, geothermal energy and wind energy.
	- describe energy changes from one form to another;	Energy conversions.	Experiments to show energy conversions.
	- explain how energy is conserved when it is changed;	Energy conservation.	
	- explain the relationship between gravitational potential energy and kinetic energy;	Dependence of potential energy on mass and height; of kinetic energy on mass and speed.	Experiments to show that P.E. depends on mass and height and K.E. on mass and speed.
	- calculate gravitational potential energy and kinetic energy;	P.E. – mgh K.E. = ½ mv^2	
4.2 Work	- explain that when work is done energy is changed from one form to another or transferred;	Relationship between work and energy.	
	- make calculations involving work;	Work = force x distance *(F x d)*.	
	- calculate efficiency;	P = E/t; the watt as the unit of power.	Efficiency expressed as a percentage or fraction.
4.3 Power	- relate power to rate of energy transferred;		Experiments to measure power.
	- calculate power;		

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
5.0 MECHANICAL SYSTEMS			
5.1 Machines	- calculate mechanical advantage, velocity ratio, and efficiency; - explain energy losses in machines; - describe methods of improving efficiency;	Levers, pulleys and inclined planes. Movement of mass of machines and friction. Reduction of friction and mass in machines.	Calculations on screws <u>not</u> required.
5.2 Pressure	- relate pressure to force; - calculate pressure; - calculate the pressure of columns of fluids from their densities; - describe the construction and use of a simple manometer;	$P = F/A$; the pascal as the unit of pressure. $P = \rho gh$ The manometer.	Densities will be given. Refer to section 3.4 on dams. The influence of atmospheric pressure on the manometer to be discussed.
5.3 Fluid systems	- describe the structure of simple pumps; - explain the function and operation of simple pumps; - explain the operation of a siphon; - explain the operation of simple hydraulic system.	Lift and force pumps. Siphon. Hydraulic system: the motor car braking system and hydraulic jack.	Lift pumps illustrated by the Blair shallow well pump (model) and force pumps by the bicycle pump. Calculations on hydraulics should be covered.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
6.0 THERMAL PHYSICS			
6.1 The kinetic theory	- explain the physical properties of matter in terms of kinetic theory of matter;	Solids, liquids and gases.	
	- describe the relationship between motion of molecules and temperature;		Compression of gases in syringes and bicycle pumps to illustrate relationship between temperature and pressure of a gas.
	- interpret the pressure of a gas in terms of motion of its molecules;		
	- relate variation of volume with the Celsius temperature of a gas at constant pressure;	Absolute zero. Volume and temperature.	Calculations based on : $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
	- describe the diffusion of gases;	Molecular mixing.	
	- show an appreciation of the relative order of magnitude of expansion of solids, liquids and gases;	Thermal expansion.	Experiments to compare expansion in solids, liquids and gases.
	- identify and explain applications and consequences of thermal expansion;	Thermostats, thermometers, bridges and railway lines.	
	- state the meaning of melting point and boiling point;	Melting and boiling.	Relate melting and boiling to solidification and condensation respectively.
	- describe melting and boiling in terms of energy transfer without a change of temperature;		The influence of atmospheric pressure on melting points and boiling points to be discussed in terms of kinetic energy.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
6.2 Heat capacity	- define specific heat capacity;	Heat capacity.	
	- describe an experiment to determine the specific heat capacity for a liquid and for a solid;	Experimental determination.	
	- Calculate the heat capacities of objects from experimental data;	Heat supplied = $mc(\theta 1 - \theta 2)$ = heat gained	Calculations on electrical method and method of mixtures.
	- Explain why different materials have different heat capacities;		Particles of different materials responding differently to heat input.
6.3 Heat transfer	- describe experiment to distinguish between good and bad conductors of heat;	Good and bad conductors.	Metals, non-metals, liquids and gases.
	- give a molecular account of heat transfer in solids;	Conduction.	
	- relate convection to density changes in liquids and gases;	Convection.	
	- describe experiments to illustrate convection;	Gases and liquids.	
	- describe experiments to distinguish between good and bad emitters and good and bad absorbers of infra-red radiation;	Solar radiation.	Heat energy transferred by infra-red radiation. Simple experiments with parabolic reflectors and on radiation using dull and bright surfaces.
	- identify applications and consequences of conduction, convection and radiation;	Solar cooker and vacuum flask.	
	- describe the function and design of a solar water heater.	The solar water heater.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
7.0 WAVES			
7.1 Wave properties	- describe wave motion;		Demonstrate practically sing springs, ropes and ripple tank.
	- describe the characteristic of a wave;	Amplitude, wavelength and frequency.	
	- distinguish between transverse and longitudinal waves;	Transverse and longitudinal waves.	
	- calculate velocity, frequency and wavelength;	$v = f\lambda$	
	- draw wave-fronts and rays to represent the passage of waves;	Reflection and refraction of wave fonts and rays.	Demonstrate practically reflection and refraction of wave-fronts.
7.2 Electromagnetic wave	- describe the regions of the electromagnetic spectrum;	Radio, microwaves, infra-red, visible light, ultraviolet, X-rays and gamma rays.	No recall of actual wavelength is required.
	- state the differences and similarities between electromagnetic waves;	Wavelength, frequency, speed and transmission	
7.3 Light	- describe an experiment to illustrate the law of reflection;	Reflection at plane surface.	Experiments using plane mirrors.
	- use the law $i = r$;		
	- describe experiments to demonstrate refraction of light through transparent blocks;	Refraction at plane surface.	
	- calculate refractive index;	$\frac{\sin i}{\sin r}$ = n(a constant i.e. refractive index)	Experiment to determine the refractive index using a rectangular prism.
	- explain total internal reflection;	Critical angle and total internal reflection.	Experiment on total internal reflection using a rectangular prism.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- describe the action of a thin converging lens on a beam of light;	Refraction by a lens.	
	- draw ray diagrams to illustrate the formation of real and virtual images;	Nature and position of the images.	
	- explain how to measure the focal length of a convex lens;	Focal length.	Lens formula not required.
	- calculate magnification of a lens;	$m = \frac{u}{v} = \frac{\text{distance of image from lens}}{\text{distance of object from lens}} = \frac{\text{size of image}}{\text{size of object}}$	
	- describe the use of a single lens as a magnifying glass;	Magnifying glass.	
	- describe the use of a single lens to form a real image;	Camera and eye.	Practical application expected, but no details of operation required.
7.4 Sound	- describe how sound is produced;	Vibration.	
	- describe the longitudinal nature of sound waves;	Wavelength, amplitude, frequency and velocity.	
	- explain the need of a medium in the transmission of sound waves;	Transmission of sound.	
	- describe an experiment to determine the speed of sound in air;	Speed of sound.	Practical determination of speed of sound in air.
	- relate pitch and loudness of sound waves to frequency and amplitude;	Pitch and loudness.	
	- explain how echoes are produced;	Reflection of sound.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
8.0 ELECTRICITY AND MAGNETISM			
8.1 Magnetism	- state the properties of magnets;	Polarity, field direction and strength.	Practical activities on magnetism to be carried out.
	- plot and draw field lines for pairs of in-line bar magnets;	Magnetic fields.	Use of a plotting compass and iron filings.
	- show an understanding that the field gets weaker as the distance from the magnet increases;	Strength of field.	Qualitatively only.
	- account for the attraction and repulsion of magnets in terms of interacting magnetic fields;	Like and unlike poles.	
8.2 Electrostatic	- show an understanding that there are positive and negative charges;	Concept of charge, the electron.	Experiments to illustrate attraction and repulsion of charged objects.
	- describe simple experiments to show electrostatic charging;	Surplus or deficit of electrons.	
	- account for repulsion and attraction of charges in terms of interacting electric fields;	Like and unlike charges.	
	- state the unit of charge;	The coulomb.	
	- explain the production of lightning;	Charge distribution on earth and in clouds.	
	- explain the dangers of lightning;	High voltage: electrocution and heating effects.	
	- explain the principles of a lightning conductor;	Discharge at a point, height, conduction and earthing.	Design of domestic lightning conductors.
	- describe precautions to be taken against lighting;	Safety precautions.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
8.3 Primary and Secondary cells	- construct primary cells;	Electrolyte and electrodes.	
	- distinguish between primary and secondary cells;	Charging.	
	- describe a secondary cell;	Lead-acid accumulator.	
	- explain the maintenance of a secondary cell;		Effects of short-circuiting.
8.4 Current electricity	- explain the flow of current in a circuit;	Charge flow.	Distinction between direction of flow of electrons and convectional current must be made.
	- measure current;	Ammeter. The ampere.	
	- demonstrate that current is the same at every point in a series circuit;		Experiments using the ammeter in a series circuit.
	- define potential difference;	The volt.	
	- measure potential difference;	Voltmeter.	
	- demonstrate that the sum of the potential differences in a series circuit is the same as the potential difference across the whole circuit;		Experiments using voltmeter in a series circuit.
	- Explain the relationship between potential difference across a conductor and the current passing through it;	Potential differences proportional to current.	Experiment to verify Ohm's Law.
	- Use Ohm's law;	Resistance; $V = IR$	Calculations on Ohm's law should be covered.
	- describe an experiment to determine resistance using a voltmeter and an ammeter;	Experimental determination of resistance.	

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- state the limitations of Ohm's law;	Variation of resistance of conductor with temperature (e.g. in a bulb), bending, tension or if placed in a strong magnetic field.	Ohm's law does not apply to semi-conductors, rectifiers or conduction through gases.
	- explain the relationship between the resistance, length and cross-sectional area of a wire;	Thickness and length of a conductor.	Qualitative only.
	- calculate resistance in simple circuits;	Series and parallel resistors.	No more than three resistors in parallel.
8.5 Electric circuits	- set up simple electric circuits;	Cells, switches, resistors, variable resistors, bulbs, ammeters, voltmeters and fuses.	Practical activities on electric circuits.
	- draw and interpret circuit diagrams;		
8.6 Electromagnetic	- describe an experiment to show that a current-carrying conductor in a magnetic field experiences a force;	Motor principle.	
	- predict the direction of motion of a current-carrying conductor in a magnetic field;	Fleming's Left-Hand Rule.	Experiments to show relationship between directions of current, field and motion.
	- explain why a coil carrying a current turns in a magnetic field;	Interaction of magnetic fields.	
	- describe the operation of a d.c. motor;	Electrical to mechanical energy; field, current and motion.	Construction and manipulation of a simple d.c. motor.
	- describe the operation of a generator;	Mechanical to electrical energy.	Generator as reverse of a motor.
	- state factors affecting the magnitude and director of induced potential difference across a generator coil;	Strength of field; number of turns and relative motion between field and coil.	Experiments to illustrate the effect of the three factors on the induced potential difference.
	- state the difference between a.c. and d.c.;	Voltage-time graphs.	Sketching of graphs of voltage output against time for a.c and d.c. circuits.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
8.7 Electricity in the home	- describe uses of electricity in the home;	Heating, lightning and motors.	Including lamps in parallel.
	- calculate power and energy used;	$P = VI; E = VIt.$	
	- calculate the cost of electricity;	The kilowatt-hour.	Practical work on reading of electricity meters.
	- describe electrical hazards and safety precautions;		Experiments demonstrating electrical hazards must **NOT** be done.
	- describe the wiring of a three-pin plug;		Practical wiring to be carried out.
	- explain the use of fuses and fuse ratings;		
	- explain the function of fuses and switches in live leads;		Demonstrate the principle of a fuse using steel wool in a d.c. circuit.
8.8 Transformers	- describe the structure and principle of operation of a basic iron-cored transformer;	Primary and secondary coils; laminated core. Voltage transformations. Efficiency and cooking. Eddy currents.	No calculations on the efficiency of transformer.
	- use the equations $(V_P/V_S) = (N_P/N_S)$ *and* $V_PI_P = V_SI_S$ (for 100% efficiency);	Current and potential difference in transformers.	
	- describe the use of the transformer in high voltage transmission.	Advantages of high voltage transmission. Energy loss in cables.	
9.0 ELECTRONICS			
9.1 Thermionic emission	- explain that a hot filament emits electrons;	The electron gun.	
	- describe how these electrons can be directed into an electron beam;	Acceleration and collimation of electrons.	
	- describe the effect of a magnetic or electric field on an electron beam;	Bending of electron beam.	No details of shape required.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
9.2 Diodes	- describe a diode; - draw and interpret diodes in a circuit diagrams; - draw a circuit for a.c. rectification; - explain a voltage-time graph of rectified current;	Diode. Circuit diagrams. Full-wave rectification.	
10.0 ATOMIC PHYSICS			
10.1 Radioactivity	- explain how an unstable nucleus disintegrates; - describe detection of α-particles, β-particles and γ-rays; - describe properties of α-particles, β-particles and γ-rays; - explain the meaning of radioactive decay; - draw and interpret radioactive decay curves; - explain the meaning of half-life;	Spontaneous and random emission: release of particles and energy. Photographic plates and scintillation counter. Their nature, relative ionising effects and relative penetrating powers. Deflection by magnetic and electric fields. Nuclear equations. Natural disintegration of radio-isotopes. Decay curve.	The effect of stability of the proportion of neutrons to protons. Use of equations involving symbols to represent changes in the composition of the nucleus when particles are emitted. Simple calculations which might involve information in tables or decay curves.

TOPIC	LEARNING OBJECTIVES	CONTENT	NOTES AND ACTIVITIES
	- describe uses of radioactivity;	(i) Carbon-14 dating (ii) Biochemical tracers (iii) Radiotherapy (iv) Detection of leaks in pipes (v) Determination of thickness of materials (vi) Power generation (vii) Sterilisation	
	- describe safe handling and storage of radioactive materials;	Safety precautions and storage.	Use of photographic film badges for exposure detection.
	- describe the effects of radioactive emissions on the environment.	Soil, water, air, plant and animal life.	

Glossary of terms used in question papers in Science

The glossary is meant only as a guide; it is neither exhaustive nor definitive. The glossary has been kept brief in respect of the number of terms and their definitions. It should be borne in mind that the meaning of a term depends in part on its context.

1. *Calculate* is used when a numerical answer is required. Working should be shown.

2. *Deduce* means that the candidate is expected to draw logical and valid conclusions from given information. Such information may be all be given in the question or may depend on answers extracted in an earlier part of the question. Candidates are not expected to produce and answer by recall.

3. *Define* (the term(s) …..) means to state precisely the meaning of a term.

4. *Describe* is often used with reference either to particular phenomena or to particular experiments. When used with reference to particular phenomena the term usually implies that the description should include reference to (visual) observations associated with the phenomena. When used with reference to particular experiments the description usually follows a standard pattern, e.g. Apparatus, Method, Measurements, Results and Precautions.

   In other contexts, *describe and give an account of* should be interpreted more generally, i.e. the candidate had greater discretion about the nature and the organisation of the material to be included in the answer.

5. *Determine* implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula, for instance density of an object may be calculated using $d = \frac{m}{V}$

6. *Estimate* implies an approximate calculation of the magnitude or quantity concerned.

7. *Find* means that the candidate is expected to calculate, measure or determine.

8. *Find* means to establish the quantity concerned using a suitable measuring instrument, e.g. length, using a ruler, or mass, using a balance.

9. *Measure* means to establish the quantity concerned using a suitable measuring instrument, e.g. length, using a ruler, or mass, using a balance.

10. *Outline* means to give the essential points.

11. *Predict* implies that the candidate is expected to state what is likely to happen by analysis given information. Such information may all be given in the question or may depend on answers extracted in an earlier part of the question. Candidates are not expected to produce an answer by recall.

12. *Sketch,* when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct.

    In diagrams, sketch implies that the candidate is expected to make a simple, freehand drawing: nevertheless, care should be taken over proportions. Important details must be shown.

13. *State* means to give a concise answer with little or no supporting argument.

14. *Suggest* may imply that there is more than one possible answer or that candidates are expected to apply their general knowledge to a novel situation.

15. *What do you understand by/What is meant by* (the term(s) ….) implies that a definition should be given, as well as some relevant comment or explanation. The amount of detail expected is determined by the marks allocated.

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
																4 **He** Helium 2
						1 **H** Hydrogen 1										
7 **Li** Lithium 3	9 **Be** Beryllium 4										11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12										27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **At** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Polonium 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 +															

*58-71 Lanthanoid series
+90-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of any mole of any gas is 24dm^3 at room temperature and pressure (r.t.p.)

QUALITATIVE ANALYSIS NOTES (5071/3)

Tests for anions

anion	*test*	*test result*
Carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
Chloride (CI^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt
iodine (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous lead (ii) nitrate	yellow ppt
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully/dervada's alloy	ammonia produced
sulphate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid then add aqueous barium nitrate	white ppt

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (AI^{3+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	-
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt
copper (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess giving a dark blue solution
iron (ii) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron (iii) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., soluble in excess giving a colourless solution

Tests for aqueous cations

gas	test and test results
ammonia(NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	"pops" with a lighted splint
oxygen (O_2)	relights a glowing splint
sulphur dioxide (SO_2)	Turns aqueous potassium dichromate (VI) from orange to green