IMPORTANT NOTICE

Cambridge International Examinations (CIE) in the UK and USA

With effect from the June 2003 examination Cambridge International Examinations will only accept entries in the UK and USA from students registered on courses at CIE registered Centres.

UK and USA private candidates will not be eligible to enter CIE examinations unless they are repatriating from outside the UK/USA and are part way through a course leading to a CIE examination. In that case a letter of support from the Principal of the school which they had attended is required. Other UK and USA private candidates should not embark on courses leading to a CIE examination after June 2003.

This regulation applies only to entry by private candidates in the UK and USA. Entry by private candidates through Centres in other countries is not affected.

Further details are available from Customer Services at Cambridge International Examinations.

COMBINED SCIENCE 5124

GCE ORDINARY LEVEL

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NOTE

Additional copies of this syllabus and/or the accompanying specimen paper booklet can be ordered from CIE Publications.

NOTES

Information for Teachers

This booklet relates to examinations taken in the year printed on the cover. It is the normal practice of CIE to print and distribute a new version of this booklet each year. Centres should receive copies well in advance of them being required for teaching purposes.

Teachers who are about to teach syllabuses in this booklet for the first time, should obtain and study the relevant past examination papers and Subject Reports.

Any queries relating to this booklet should be addressed to the Product Manager.

Nomenclature

The proposals in 'Signs, Symbols and Systematics (The Association for Science Education Companion to 5-16 Science, 1995)' will generally be adopted. Reference should be made to the joint statement on chemical nomenclature issued by the GCE boards. In particular, the traditional names sulphate, sulphite, nitrate, nitrite sulphurous and nitrous acids will be used in question papers.

It is intended that, in order to avoid difficulties arising out of the use of 1 as the symbol for litre, use of dm^3 in place of 1 or litre will be made.

In chemistry, *full structural formulae (displayed formulae)* in answers should show in detail both the relative placing of atoms and the number of bonds between atoms. Hence – $CONH_2$ and – CO_2H are not satisfactory as full structural formulae, although either of the usual symbols for the benzene ring is acceptable.

Units and Significant Figures

Candidates should be aware that misuse of units and/or significant figures, i.e. failure to quote units where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an inappropriate number of significant figures, is liable to be penalised.

Syllabus Revision

Attention is drawn to alterations in the syllabus by black vertical lines on either side of the text.

Exclusions

The *International Syllabus Synopses* booklet should be consulted for a full list of subject exclusions.

5124 SCIENCE (PHYSICS, CHEMISTRY)
GCE ORDINARY LEVEL/SCHOOL CERTIFICATE

AIMS

These are not listed in order of priority. The aims are to:

1. provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all students, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to
   - 1.1 become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific import;
   - 1.2 recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life;
   - 1.3 be suitably prepared for studies beyond O/SC level in pure sciences, in applied sciences or in science-dependent vocational courses.

2. develop abilities and skills that
   - 2.1 are relevant to the study and practice of science;
   - 2.2 are useful in everyday life;
   - 2.3 encourage efficient and safe practice;
   - 2.4 encourage effective communication.

3. develop attitudes relevant to science such as
   - 3.1 accuracy and precision;
   - 3.2 objectivity;
   - 3.3 integrity;
   - 3.4 enquiry;
   - 3.5 initiative;
   - 3.6 inventiveness.

4. stimulate interest in and care for the environment.

5. promote an awareness that
   - 5.1 the study and practice of science are co-operative and cumulative activities, and are subject to social, economic, technological, ethical and cultural influences and limitations;
   - 5.2 the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

ASSESSMENT OBJECTIVES

A Knowledge with Understanding

Students should be able to demonstrate knowledge and understanding in relation to:

1. scientific phenomena, facts, laws, definitions, concepts, theories;
2. scientific vocabulary, terminology, conventions (including symbols, quantities and units contained in *`Signs, Symbols and Systematics', Association for Science Education, 1995);*
3. scientific instruments and apparatus, including techniques of operation and aspects of safety;
4. scientific quantities and their determination;
5. scientific and technological applications with their social, economic and environmental implications.

The subject content defines the factual material that candidates need to recall and explain. Questions testing these objectives will often begin with one of the following words: *define, state, describe, explain or outline.* (See the glossary of terms.)

B Handling Information and Solving Problems

Students should be able - in words or by using other written, symbolic, graphical and numerical forms of presentation - to:

1. locate, select, organise and present information from a variety of sources;
2. translate information from one form to another;
3. manipulate numerical and other data;
4. use information to identify patterns, report trends and draw inferences;
5. present reasoned explanations for phenomena, patterns and relationships;
6. make predictions and hypotheses;
7. solve problems.

These assessment objectives cannot be precisely specified in the subject content because questions testing such skills may be based on information which is unfamiliar to the candidate. In answering such questions, candidates are required to use principles and concepts that are within the syllabus and apply them in a logical, deductive manner to a novel situation. Questions testing these objectives will often begin with one of the following words: *predict, suggest, calculate* or *determine.* (See the glossary of terms.)

Weighting of Assessment Objectives

A Knowledge with Understanding, approximately 65% of the marks with approximately 30% allocated to recall.
B Handling Information and Solving Problems, approximately 35% of the marks.

SCHEME OF ASSESSMENT

Candidates are required to enter for Papers 1, 2 and 3.

Paper	Type of Paper	Duration	Marks	Weighting
1	Multiple Choice	1 h	40	24%
2	Structured and Free Response (Physics)	1 h 15 min	65	38%
3	Structured and Free Response (Chemistry)	1 h 15 min	65	38%

Paper 1 *(1* h, 40 marks), consisting of 40 multiple choice questions of the direct choice type providing approximately equal coverage of the *two* appropriate sections of the syllabus. This paper will be set at the same time for all *three* subjects, 5124, 5125 and 5126.

Paper 2 *(1* h 15 min, 65 marks), consisting of *two* sections.
Section A will carry 45 marks and will contain a number of compulsory structured questions of variable mark value.

Section B will carry 20 marks and will contain *three* free response questions, each of 10 marks. Candidates are required to answer any *two* questions.
The questions will be based on the Physics section of the syllabus.

Paper 3 (1 h 15 min, 65 marks), consisting of *two* sections.
This Paper will each have the same structure as Paper 2 but will be based on the Chemistry section of the syllabus.

Science (Physics, Chemistry), Syllabus 5124

Paper 1 will be based on the Physics and Chemistry sections of the syllabus.

Paper 2 will be based on the Physics section of the syllabus.

Paper 3 will be based on the Chemistry section of the syllabus.

SUBJECT CONTENT

PHYSICS SECTION

Students are expected to have adequate mathematical skills to cope with the curriculum.
Throughout the course, attention should be paid to showing the relevance of concepts to the students' everyday life and to the natural and man-made world.

1. Physical Quantities and Units

Content

1.1 Measurement of length, time and volume

Learning Outcomes:

Candidates should be able to:

(a) use and describe how to use rules, micrometers, vernier scales and calipers to determine lengths

(b) use and describe how to use clocks and other devices for measuring an interval of time, including the period of a pendulum

(c) use and describe how to use a measuring cylinder to measure a volume

2. Kinematics

Content

2.1 Speed, velocity and acceleration
2.2 Graphical analysis of motion
2.3 Free fall

Learning Outcomes:

Candidates should be able to:

(a) state what is meant by *speed, velocity* and *acceleration*

(b) recognise motion for which the acceleration is constant and calculate the acceleration

(c) recognise motion for which the acceleration is not constant

(d) plot and interpret a speed-time graph

(e) recognise from the shape of a speed-time graph when a body is
- (i) at rest
- (ii) moving with constant speed
- (iii) moving with constant acceleration
- (iv) moving with an acceleration that is not constant

(f) calculate the area under a speed-time graph to determine the distance travelled for motion with constant speed or constant acceleration

(g) show understanding that the acceleration of free fall for a body near to the Earth is constant

(h) describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity)

3. Dynamics

Content

3.1 Motion
3.2 Friction

Learning Outcomes:

Candidates should be able to:

(a) describe the ways in which a force may change the motion of a body

(b) use the relation between force, mass and acceleration

(c) demonstrate an understanding of the effects of friction on the motion of a body

4. Mass, Weight and Density

Content

4.1 Mass and weight
4.2 Density

Learning Outcomes:

Candidates should be able to:

(a) demonstrate an understanding that mass is a measure of the amount of substance in a body
(b) demonstrate an understanding of inertia as the property of a mass which resists change from its state of rest or motion
(c) describe, and use the concept of, weight as the effect of a gravitational field on a mass
(d) demonstrate understanding that two weights, and therefore masses, can be compared using a balance
(e) use appropriate balances to measure mass and weight
(f) describe experiments to determine the density of a liquid, of a regularly shaped solid and of an irregularly shaped solid (by the method of displacement) and make the necessary calculations

5. Turning Effect of Forces

Content

5.1 Moments
5.2 Centre of mass
5.3 Stability

Learning Outcomes:

Candidates should be able to:

(a) describe the moment of a force in terms of its turning effect and give everyday examples
(b) perform and describe an experiment to verify the principle of moments
(c) make calculations involving the principle of moments
(d) perform and describe an experiment to determine the position of the centre of mass of a plane lamina
(e) describe qualitatively the effect of the position of the centre of mass on the stability of simple objects

6. Deformation

Content

6.1 Elastic deformation

Learning Outcomes:

Candidates should be able to:

(a) state that a force may produce a change in size and shape of a body
(b) plot, draw and interpret extension-load graphs for elastic solids and describe the associated experimental procedure
(c) recognise the significance of the term *limit* of *proportionality* for an extension-load graph of an elastic solid
(d) use proportionality of an elastic solid in simple calculations involving extension or force required

7. Energy, Work and Power

Content

7.1 Energy conversion and conservation
7.2 Major sources of energy
7.3 Work
7.4 Power

Learning Outcomes:

Candidates should be able to:

(a) give examples of energy in different forms, its conversion and conservation, and apply the principle of energy conservation to simple examples
(b) use the terms *kinetic energy* and *potential energy in* context
(c) calculate kinetic energy and gravitational potential energy

(d) describe, and express a qualitative understanding of, processes by which energy is converted from one form to another, including reference to
  (i) chemical/fuel energy (a re-grouping of atoms)
  (ii) hydroelectric generation (emphasising the mechanical energies involved)
  (iii) solar energy (nuclei of atoms in the Sun)
  (iv) nuclear energy
  (v) geothermal energy
  (vi) wind energy

(e) show a qualitative understanding of *efficiency*

(f) relate work done to the magnitude of a force and the distance moved and make calculations involving *F x d*

(g) relate power to energy transferred and time taken, using appropriate examples and using the equation *P=E/t* in simple systems

8. Transfer of Thermal Energy

Content

8.1 Conduction
8.2 Convection
8.3 Radiation

Learning Outcomes:

Candidates should be able to:

(a) describe experiments to distinguish between good and bad conductors of heat

(b) give a simple molecular account of heat transfer in solids

(c) relate convection in fluids to density changes and describe experiments to illustrate convection

(d) describe experiments to distinguish between good and bad emitters and good and bad absorbers of infra-red radiation

(e) identify and explain some of the everyday applications and consequences of conduction, convection and radiation

9. Temperature

Content

9.1 Principles of thermometry
9.2 Liquid-in-glass thermometers

Learning Outcomes:

Candidates should be able to:

(a) appreciate how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties

(b) recognise the need for, and identify, fixed points

(c) show understanding of *sensitivity* and *range*

(d) apply a given property to the measurement of temperature

(e) describe the structure and action of liquid-in-glass thermometers (laboratory and clinical) and of a thermocouple thermometer, showing an appreciation of its use for measuring high temperatures and those which vary rapidly

10. Thermal Properties of Matter

Content

10.1 Thermal expansion of solids, liquids and gases
10.2 Melting, boiling and evaporation

Learning Outcomes:

Candidates should be able to:

(a) describe qualitatively the thermal expansion of solids, liquids and gases

(b) show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases

(c) identify and explain some of the everyday applications and consequences of thermal expansion

(d) describe melting/solidification and boiling/condensation in terms of energy transfer without a change in temperature

(e) state the meaning of *melting point* and of *boiling point*

(f) distinguish between *boiling* and *evaporation*

11. General Wave Properties

Content

11.1 Describing wave motion

11.2 Wave terms
11.3 Longitudinal and transverse waves

Learning Outcomes:
Candidates should be able to:
(a) describe what is meant by *wave motion* as illustrated by vibration in ropes, springs and by experiments using a ripple tank
(b) give the meaning of *speed, frequency, wavelength* and *amplitude* and use the equation $c = f \times \lambda$
(c) distinguish between *longitudinal* and *transverse* waves and give suitable examples

12. Light

Content
12.1 Reflection of light
12.2 Refraction of light
12.3 Thin converging lens

Learning Outcomes:
Candidates should be able to:
(a) perform and describe experiments to illustrate the laws of reflection
(b) describe an experiment to find the position of an optical image formed by a plane mirror
(c) use the law $i = r$ in reflection
(d) perform simple constructions, measurements and calculations for reflection
(e) describe and perform experiments to demonstrate refraction of light through glass blocks
(f) use the terminology for the angles i and r in refraction and describe the passage of light through parallel-sided transparent material
(g) use the equation $\sin i / \sin r = n$ (refractive index)
(h) give the meaning of *refractive index*
(i) describe the action of a thin converging lens on a beam of light
(j) use and understand the term *focal length*
(k) draw ray diagrams to illustrate the formation of real and virtual images of an object by a lens
(l) use and describe the use of a single lens as a magnifying glass

13. Electromagnetic Spectrum

Content
13.1 Properties of electromagnetic waves

Learning Outcomes:
Candidates should be able to:
(a) state that all electromagnetic waves are transverse waves that travel with the same high speed *in vacuo* and state the magnitude of this speed
(b) describe the main components of the electromagnetic spectrum

14. Sound

Content
14.1 Sound waves
14.2 Speed of sound

Learning Outcomes:
Candidates should be able to:
(a) describe the production of sound by vibrating sources
(b) describe the longitudinal nature of sound waves and describe compression and rarefaction
(c) state the approximate range of audible frequencies
(d) show understanding that a medium is required in order to transmit sound waves
(e) describe an experiment to determine the speed of sound in air and make the necessary calculation
(f) state the order of magnitude of the speed of sound in air, liquids and solids

15. Static Electricity

Content

15.1 Principles of electrostatics

Learning Outcomes:

Candidates should be able to:

(a) show understanding that there are positive and negative charges and that charge is measured in coulombs

(b) show understanding that unlike charges attract and that like charges repel

16. Current Electricity

Content

16.1 Electric current
16.2 Electromotive force
16.3 Potential difference
16.4 Resistance

Learning Outcomes:

Candidates should be able to:

(a) show understanding that a current is a rate of flow of charge and is measured in amperes

(b) use the equation $I = Q/t$

(c) use and describe the use of an ammeter

(d) use the concept that the e.m.f. is measured by the energy dissipated by a source in driving charge round the complete circuit

(e) show appreciation that the volt is given by J/C

(f) show understanding that the potential difference across a circuit component is measured in volts

(g) use and describe the use of a voltmeter

(h) state that *resistance* = *p.d./current* and use the equation $R = V/I$

(i) describe an experiment to determine resistance using a voltmeter and an ammeter and make the necessary calculation

(j) use quantitatively the relationship between resistance and the length and the cross-sectional area of a wire

(k) sketch and interpret the V/I characteristic graphs for metallic (ohmic) and non-ohmic conductors

(l) appreciate the limitations of Ohm's Law

17. d.c. Circuits

Content

17.1 Current and potential difference in circuits
17.2 Series and parallel circuits

Learning Outcomes:

Candidates should be able to:

(a) draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), ammeters, voltmeters, magnetising coils, bells, fuses and relays

(b) show understanding that the current at every point in a series circuit is the same

(c) use the fact that the sum of the p.d.s in a series circuit is equal to the p.d. across the whole circuit

(d) calculate the combined resistance of two or more resistors in series

(e) use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit, the current from the source being larger than the current in each branch

(f) calculate the effective resistance of two resistors in parallel

18. Practical Electricity

Content

18.1 Electric power and energy
18.2 Dangers of electricity
18.3 Safe use of electricity in the home

Learning Outcomes:

Candidates should be able to:

(a) describe the use of electricity in heating, lighting (including lamps in parallel) and motors
(b) use the equations $P = VI$ and $E = VIt$
(c) calculate the cost of using electrical appliances
(d) state the hazards of
  (i) damaged insulation
  (ii) overheating of cables
  (iii) damp conditions
(e) show understanding of the use of fuses and fuse ratings
(f) explain the need for earthing metal cases and for double insulation
(g) give the meaning of the terms *live, neutral* and *earth*
(h) wire, and describe how to wire, a mains plug
(i) give the reasons for switches and fuses in live leads

19. Magnetism

Content

19.1 Laws of magnetism
19.2 Magnetic properties of matter

Learning Outcomes:

Candidates should be able to:

(a) state the properties of magnets
(b) give an account of *induced magnetism*
(c) distinguish between *magnetic* and *non-magnetic* materials
(d) describe methods of magnetisation and of demagnetisation
(e) describe the use of a plotting compass to plot the field lines of magnetic field (Earth's field excluded)
(f) distinguish between the magnetic properties of iron and steel
(g) distinguish between the design and use of permanent magnets and electromagnets

20. Electromagnetic Induction

Content

20.1 Principles of electromagnetic induction
20.2 The a.c. generator
20.3 The transformer

Learning Outcomes:

Candidates should be able to:

(a) describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit
(b) state the factors affecting the magnitude of the induced e.m.f
(c) show understanding that the direction of the induced e.m.f. opposes the change producing it
(d) describe a simple form of generator (e.g. rotating coil or rotating magnet) and the use of slip rings
(e) sketch a graph of voltage output against time for a simple a.c. generator
(f) describe the structure and principle of operation of a basic iron-cored transformer as used for voltage transformations
(g) use the equations $(V_p/V_s) = (N_p/N_s)$ and $V_p I_p = V_S I_S$ (for 100% efficiency)

21. The Nuclear Atom

Content

21.1 Atomic model
21.2 Composition of a nucleus
21.3 Proton number and nucleon number
21.4 Nuclide notation

Learning Outcomes:

Candidates should be able to:

(a) describe the structure of an atom in terms of a nucleus and electrons
(b) describe the composition of the nucleus in terms of protons and neutrons
(c) use the term *nucleon number, A*
(d) use the term *proton number, Z*
(e) use the term *nuclide* and use the nuclide notation ${}^{A}_{Z}\mathrm{X}$

22. Radioactivity

Content

22.1 Detection of radioactivity
22.2 Characteristics of the three types of emission
22.3 Nuclear reactions
22.4 Half-life
22.5 Safety precautions

Learning Outcomes:

Candidates should be able to:

(a) describe the detection of alpha-particles, beta-particles and gamma-rays
(b) show understanding that radioactive emissions occur randomly over space and time
(c) state, for radioactive emissions,
  (i) their nature
  (ii) their relative ionising effects
  (iii) their relative penetrating powers
(d) show understanding of the meaning of *radioactive decay,* using equations (involving symbols) to represent changes in the composition of the nucleus when particles are emitted
(e) use the term *half-life* in simple calculations which might involve information in tables or in decay curves
(f) describe how radioactive materials are handled, used, stored and disposed of, in a safe way

CHEMISTRY SECTION

It is important that, throughout the course, attention should be drawn to:

(i) the finite life of the world's resources and hence the need for recycling and conservation;

(ii) some economic considerations in the chemical industry, such as the availability and cost of raw materials and energy;

(iii) the importance of chemicals in industry and in everyday life.

1. Experimental Chemistry

Content

1.1 Experimental design
1.2 Methods of purification and analysis
1.3 Identification of ions and gases

Learning Outcomes:

Candidates should be able to:

(a) name and use appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders

(b) design arrangements of apparatus, given information about the substances involved

(c) describe and use methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation (including description but **not** use of fractional distillation) (Refer to the fractional distillation of
(i) crude oil (petroleum) (topic 20.2(c))
(ii) fermented liquor (topic 23.1(a)).)

(d) suggest suitable purification techniques, given information about the substances involved

(e) describe and use paper chromatography and interpret chromatograms

(f) identify substances and test their purity by melting point and boiling point determination and by paper chromatography

(g) identify
nitrate (by reduction with aluminium)
carbonate (by reaction with acid and then limewater)
chloride and iodide (by reaction with acidified silver nitrate or with acidified lead (II) nitrate)
sulphate (by reaction with acidified barium nitrate)

(h) identify
aluminium, calcium, copper (II), iron(II), iron(III), zinc and ammonium (by using aqueous sodium hydroxide and aqueous ammonia, as appropriate) (Formulae of complex ions are **not** required.)

(i) identify
hydrogen (by lighted splint)
oxygen (by glowing splint)
carbon dioxide (by limewater)
chlorine (using indicator paper)
ammonia (using indicator paper)

2. Kinetic Particle Theory

Learning Outcomes:

Candidates should be able to:

(a) describe the states of matter and explain their inter-conversion in terms of the kinetic particle theory

3. Atomic Structure

Content

3.1 Atomic structure
3.2 Isotopes

Learning Outcomes:

Candidates should be able to:

(a) state the relative charge and approximate relative mass of a proton, a neutron and an electron

(b) define *proton number* and *nucleon number*

(c) use and interpret such symbols as $^{12}_{6}\mathrm{C}$

(d) use proton number and the simple structure of atoms to explain the Periodic Table, with special reference to the elements of proton number 1 to 20
(e) define *isotopes*
(f) describe the build-up of electrons in 'shells' and understand the significance of outer electrons and the noble gas electronic structures (The ideas of the distribution of electrons in s- and p-orbitals and in d-block elements are **not** required. Note that a copy of the Periodic Table will be available in the examination.)

4. Structure and Properties of Materials

Learning Outcomes:
Candidates should be able to:
(a) describe the differences between elements, compounds and mixtures, and between metals and non-metals
(b) describe alloys, such as brass, as a mixture of a metal with other elements

5. Ionic Bonding

Content
5.1 Ion formation
5.2 Ionic bond formation

Learning Outcomes:
Candidates should be able to:
(a) describe the formation of ions by electron loss or gain
(b) describe the formation of ionic bonds between metallic and non-metallic elements (e.g. in NaCl and $CaCl_2$)

6. Covalent Bonding

Content
6.1 Covalent bond formation
6.2 Physical properties of covalent compounds

Learning Outcomes:
Candidates should be able to:
(a) describe the formation of covalent bonds as the sharing of pairs of electrons leading to the noble gas configuration (e.g. H_2, Cl_2, HCl, H_2O, CH_4 and CO_2)
(b) deduce the electron arrangement in other covalent molecules
(c) construct 'dot and cross' diagrams to show the outer electrons in covalent molecules
(d) describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds

7. Formulae, Stoichiometry and the Mole Concept

Content
7.1 Formulae
7.2 Equations
7.3 Stoichiometric calculations

Learning Outcomes:
Candidates should be able to:
(a) state the symbols of the elements and the formulae of the compounds mentioned in the syllabus
(b) deduce the formula of a simple compound from the relative numbers of atoms present and vice versa
(c) determine the formula of an ionic compound from the charges on the ions present and vice versa
(d) construct equations with state symbols, including ionic equations
(e) deduce, from experimental results, the identity of the reactants and the products and the balanced chemical equation for a chemical reaction
(f) define *relative atomic mass*, A_r
(g) define *relative molecular mass*, M_r
(h) use the mole and the Avogadro constant
(i) use molar gas volume, taken as 24 dm^3 at room temperature and pressure
(j) calculate the stoichiometric reacting masses and volumes of gases (Questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will **not** be set.)
(k) use solution concentrations expressed in g/dm^3 and mol/dm^3 (Calculations based on reacting volumes of solution (e.g. titrimetric data) will **not** be set.)

8. Energy from Chemicals

Content

8.1 Exothermic and endothermic reactions
8.2 Photosynthesis

Learning Outcomes:

Candidates should be able to:

(a) describe the meaning of *exothermic* and *endothermic* reactions
(b) describe bond breaking as an endothermic process and bond forming as an exothermic process
(c) describe the use of silver salts in photography as an endothermic process involving the reduction of silver ions to silver
(d) describe photosynthesis as the reaction between carbon dioxide and water in the presence of chlorophyll and using sunlight (energy) to produce glucose

9. Chemical Reactions

Content

9.1 Rate of reaction
9.2 Redox

Learning Outcomes:

Candidates should be able to:

(a) describe the effect of concentration, pressure, particle size, catalysts (including enzymes) and temperature on the rates of reactions
(b) describe how the above factors are used to explain the danger of explosive combustion with fine powders (e.g. in flour mills) and combustible gases (e.g. in mines)
(c) interpret data obtained from experiments concerned with rate of reaction
(d) define *oxidation* and *reduction* in terms of oxygen/hydrogen gain/loss
(e) define *redox* in terms of electron transfer

10. The Chemistry and Uses of Acids, Bases and Salts

Content

10.1 Characteristic properties of acids and bases
10.2 pH
10.3 Types of oxides
10.4 Preparation of salts

Learning Outcomes:

Candidates should be able to:

(a) describe the meanings of the terms *acid* and *alkali* in terms of the ions they contain or produce in aqueous solution
(b) describe the characteristic properties of acids as in their reactions with metals, bases, carbonates and their effects on indicator paper
(c) describe the characteristic properties of bases as in their reactions with acids and with ammonium salts and their effects on indicator paper
(d) describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only), measured using Universal Indicator paper
(e) describe and explain the importance of controlling acidity in soil
(f) classify oxides as either acidic, basic, or amphoteric related to metallic/non-metallic character
(g) describe the preparation, separation and purification of salts as examples of some of the techniques specified in topic 1.2(c): methods of preparing salts to illustrate the practical techniques should include the action of acids with insoluble bases, and acids with insoluble carbonates
(h) suggest a method of preparing a given salt from suitable starting materials, given appropriate information

11. The Periodic Table

Content

11.1 Periodic trends
11.2 Group properties

Learning Outcomes:

Candidates should be able to:

(a) describe the Periodic Table as a method of classifying elements and describe its use in predicting properties of elements
(b) describe the change from metallic to non-metallic character across a period
(c) describe the relationship between group number, number of outer electrons and metallic/non-metallic character
(d) describe lithium, sodium and potassium in Group I (the alkali metals) as a collection of relatively soft metals showing a trend in melting point and in reaction with water and with chlorine
(e) predict the properties of other elements in Group I, given data, where appropriate
(f) describe chlorine, bromine and iodine in Group VII (the halogens) as a collection of diatomic non-metals showing a trend in colour, state, and in their displacement reactions with other halide ions
(g) predict the properties of other elements in Group VII, given data, where appropriate
(h) identify trends in other groups, given information about the elements concerned
(i) describe the noble gases as being unreactive
(j) describe the uses of the noble gases in providing an inert atmosphere (e.g. argon in lamps and helium for filling balloons)

12. Properties of Metals

Content

12.1 Physical properties
12.2 Alloys

Learning Outcomes:

Candidates should be able to:

(a) describe the general physical properties of metals
(b) explain why metals are often used in the form of alloys
(c) identify representations of metals and alloys from diagrams of structures

13. Reactivity Series

Content

13.1 Order of reactivity

Learning Outcomes:

Candidates should be able to:

(a) place in order of reactivity calcium, copper, (hydrogen), iron, magnesium, potassium, sodium and zinc by reference to the reactions, if any, of the metals with water (or steam) and dilute hydrochloric acid
(b) account for the apparent unreactivity of aluminium in terms of the presence of an oxide layer which adheres to the metal
(c) deduce an order of reactivity from a given set of experimental results

14. Extraction and Uses of Metals

Content

14.1 Metal ores
14.2 The blast furnace
14.3 Iron and steel
14.4 Aluminium
14.5 Zinc
14.6 Copper

Learning Outcomes:

Candidates should be able to:

(a) describe the ease in obtaining metals from their ores by relating the elements *to* the reactivity series
(b) describe the essential reactions in the extraction of iron from haematite
(c) describe the idea of changing the properties of iron by the controlled use of additives to form alloys called steels

(d) state the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)
(e) state the uses of aluminium (e.g. in the manufacture of aircraft parts because of its strength and low density and in food containers because of its resistance to corrosion)
(f) state the uses of zinc for galvanising and for making brass (with copper)
(g) state the uses of copper related to its properties (e.g. electrical wiring)

15. Atmosphere and Environment

Content

15.1 Air
15.2 Corrosion
15.3 Pollution
15.4 Water

Learning Outcomes:

Candidates should be able to:

(a) describe the volume composition of clean air in terms of 79% nitrogen, 20% oxygen, with the remainder being noble gases (with argon as the main constituent) carbon dioxide and variable amounts of water vapour
(b) name the uses of oxygen in making steel, oxygen tents in hospitals, and with acetylene (a hydrocarbon) in welding
(c) describe, in simple terms, the ideas of respiration, combustion and rusting
(d) describe methods of rust prevention by painting and other coatings (including galvanising)
(e) name common pollutants of air (carbon monoxide, sulphur dioxide, oxides of nitrogen and lead compounds)
(f) state the source of each of these pollutants
  (i) carbon monoxide from the incomplete combustion of carbon-containing substances
  (ii) sulphur dioxide from the combustion of fossil fuels which contain sulphur compounds (leading to acid rain)
  (iii) oxides of nitrogen and lead compounds from car exhausts
(g) state the adverse effect of acidic pollutants on buildings and plants, and of carbon monoxide and lead compounds on health
(h) describe, in outline, the purification of the water supply in terms of filtration and chlorination
(i) state some of the uses of water in industry and in the home

16. Hydrogen

Learning Outcomes:

Candidates should be able to:

(a) describe the formation of hydrogen as a product of the reaction between
  (i) reactive metals and water
  (ii) metals and acids
(b) name the uses of hydrogen in the manufacture of ammonia and margarine, and as a fuel in rockets

17. Nitrogen

Content

17.1 Ammonia and the Haber process
17.2 Fertiliser manufacture

Learning Outcomes:

Candidates should be able to:

(a) describe the need for nitrogen, phosphorus and potassium compounds in plant life
(b) name the use of nitrogen in the manufacture of ammonia
(c) describe the essential conditions for the manufacture of ammonia by the Haber process
(d) name the uses of ammonia in the manufacture of fertilisers such as ammonium sulphate and nitrate

18. Carbon and Carbonates

Content

18.1 Allotropes of carbon
18.2 Manufacture and uses of lime
18.3 Uses of calcium carbonate

Learning Outcomes:

Candidates should be able to:

(a) name the allotropes of carbon as graphite and diamond
(b) relate their structures to the use of graphite as a lubricant and diamond in cutting
(c) describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of the chemical reaction involved
(d) state some uses of lime and slaked lime as in treating acidic soil and neutralising acidic industrial waste products
(e) state the uses of calcium carbonate in the manufacture of iron, glass and cement

19. Organic Chemistry

Content

19.1 Names of compounds
19.2 Structures of compounds
19.3 Homologous series

Learning Outcomes:

Candidates should be able to:

(a) name, and draw the structure of, the unbranched alkanes, alkenes (**not** cis-trans), alcohols and acids containing up to four carbon atoms per molecule and the products of the reactions stated in topics 21 to 24.
(b) state the type of compound present given a chemical name, ending in -ane, -ene, -ol, or -oic acid, or given a molecular structure
(c) describe the general characteristics of a homologous series

20. Fuels

Content

20.1 Natural gas and petroleum as energy sources
20.2 Fractional distillation
20.3 Uses of fractions

Learning Outcomes:

Candidates should be able to:

(a) name natural gas and petroleum as sources of fuels
(b) name methane as the main constituent of natural gas
(c) describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation
(d) name the uses of petroleum fractions: petrol (gasoline), as fuel in cars; paraffin (kerosene), for oil stoves and aircraft fuel; diesel, for fuel in diesel engines; oils, for lubricants and making waxes and polishes; bitumen, for making roads

21. Alkanes

Content

21.1 Properties of alkanes

Learning Outcomes:

Candidates should be able to:

(a) describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning

22. Alkenes

Content

22.1 Cracking
22.2 Unsaturated hydrocarbons
22.3 Polymerisation

Learning Outcomes:

Candidates should be able to:

(a) describe the manufacture of alkenes and of hydrogen by cracking
(b) describe the properties of alkenes in terms of burning and addition reactions with hydrogen and steam
(c) distinguish between saturated and unsaturated hydrocarbons
  (i) from molecular structures
  (ii) by using aqueous bromine
(d) describe the formation of poly(ethene) as an example of addition polymerisation of monomer units
(e) name some uses of poly(ethene) as a typical plastic (e.g. plastic bags)

23. Alcohols

Content

23.1 Formation of ethanol
23.2 Combustion and oxidation
23.3 Uses of ethanol

Learning Outcomes:

Candidates should be able to:

(a) describe the formation of ethanol by fermentation and by the catalytic addition of steam to ethene
(b) describe the properties of ethanol in terms of combustion and of oxidation
(c) name the uses of ethanol (e.g. as a solvent, as a fuel and as a constituent of wine and beer)

24. Acids

Content

24.1 Ethanoic acid

Learning Outcomes:

Candidates should be able to:

(a) describe the formation of ethanoic acid as the oxidation of ethanol by the action of atmospheric oxygen
(b) describe the reaction of ethanoic acid with ethanol to give an ester (ethyl ethanoate)

25. Macromolecules

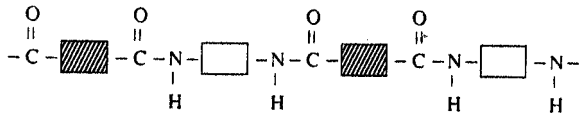
Content

25.1 Monomers and polymers
25.2 Man-made fibres
25.3 Pollution
25.4 Natural macromolecules

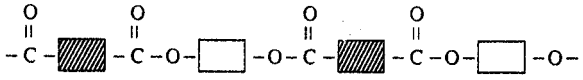
Learning Outcomes:

Candidates should be able to:

(a) describe macromolecules in terms of large molecules built up from small units, different macromolecules having different units and/or different linkages
(b) deduce the structure of the polymer product from a given alkene and vice versa
(c) describe the formation of *nylon* (a polyamide) and *Terylene* (a polyester) by condensation polymerisation, the structure of nylon represented as



and the structure of *Terylene* as



(Details of manufacture and mechanisms of these polymerisations are **not** required.)

(d) name some typical uses of man-made fibres such as nylon and *Terylene (e.g.* clothing)

(e) describe the pollution problems caused by non-biodegradable plastics

(f) name proteins, fats and carbohydrates as the main constituents of foods

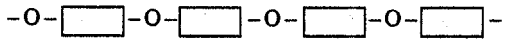
(g) describe proteins as possessing the same (amide) linkages as nylon but with different units

(h) describe the hydrolysis of proteins to amino acids (structures and names **not** required)

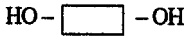
(i) describe fats as esters possessing the same linkages as *Terylene* but with different units

(j) describe soap as a product of the hydrolysis of fats

(k) describe the carbohydrate starch as a macromolecule represented as



being formed by the condensation polymerisation of smaller carbohydrate units called sugars, represented as



(l) describe the acid hydrolysis of carbohydrates such as starch to give simple sugars

(m) describe the fermentation of simple sugars to produce ethanol (and carbon dioxide) and its importance to brewing and wine-making (Candidates will **not** be expected to give the molecular formulae of sugars.)

The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
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 As 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 Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radius 88	227 Ac actinium 89 †															

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*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	163 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 one mole of any gas is 24dm3 at room temperature and pressure (r.t.p)..

RESOURCE LIST

Resources – Combined Sciences Ordinary Level

Science	(Physics, Chemistry) 5124
	(Physics, Biology) 5125
	(Chemistry, Biology) 5126

Combined Science 5129

Additional Combined Science 5130

BOOKS

Brian Samual Beckett; Illustrated Biology; Oxford University Press; 0 19 914044 8;

Beckett & Gallagher; Co-ordinated Science: Biology; Oxford University Press; 0 19 914653 5;

Kevin Byrne; Revise GCSE in a week – Science Double & Single Award; BPP (Letts Educational) Ltd; 1 85758 702 2;

Gallagher, Ingram & Whitehead; Co-ordinated Science: Chemistry; Oxford University Press; 0 19 914652 7;

Pople and Whitehead; Co-ordinated Science: Physics; Oxford University Press; 0 19 914651 9
Activities Books and Teacher's Guides are also available for this series;

K Foulds; GCSE Science Double Award Physics; John Murray; 07195 7159;

S Gater & V Wood-Robinson; GCE Science Double Award Biology; John Murray; 07195 7157 X;

G Hill; Science for GCSE Double Award 2nd ed (June '01); Hodder & Stoughton; Text 0340800445 Pupils' Handbook 034073079X
Existing edition has been very highly praised by international teachers teaching IGCSE;

K Hirst; The Complete A-Z Double Award Science Handbook; Hodder & Stoughton; 0340730609;

Jones & Jones, et al; Balanced Science; Cambridge University Press; Book 1 - 0521 59979 2 Book 2 – 0521 59980 6;
Also available as a three volume set:

Jones & Jones; Cambridge Co-ordinated Science: Biology (2nd ed); Cambridge University Press; 0 521 59981 4;
Jones, Jones & Acaster; Cambridge Co-ordinated Science: Chemistry; Cambridge University Press; 0 521 59983 0;
Jones, Jones & Marchington; Cambridge Co-ordinated Science: Physics (2nd ed); Cambridge University Press; 0 521 59982 2;

Jones & Jones; Biology; Cambridge University Press; 0 521 45618 5;

Terry Parkin Series Editor; Longman Co-ordinated Science Series; Longman;
Terry Parkin Series Editor; Biology; Longman; 0582 276535;
Terry Parkin Series Editor; Chemistry; Longman; 0582 279852;
Terry Parkin Series Editor; Physics; Longman; 0582 279844;
Terry Parkin Series Editor; Biology Copymasters; Longman; 0582 287332;
Terry Parkin Series Editor; Chemistry Copymasters; Longman; 0582 287340;
Terry Parkin Series Editor; Physics Copymasters; Longman; 0582 287367;
Terry Parkin Series Editor; Teachers' and Technicians' Guide; Longman; 0582 287359;

V Slaughter; Living Things 2nd Ed (Sept '01); Hodder & Stoughton; 03407 72816;

TEACHERS' RESOURCES

BOOKS

K Everett & E W Jenkins; A Safety Handbook for Science Teachers; John Murray; 0 7195 4645 1

WEBSITES

Coordination Group Publications; www.cgpbooks.co.uk; (a useful and extensive set of resources available at an economical price);

PROFESSIONAL ASSOCIATIONS

Royal Society of Chemistry; Burlington House, Piccadilly, London W1J 0BA, UK; tel +44 (0) 20 7437 8656; fax +44 (0) 20 7437 8883; website www.rsc.org;

Institute of Physics; 76 Portland Place, London W1B 1NT. UK; tel +44 (0)20 7470 4800; fax: +44 (0)20 7470 4848; Email: physics@iop.org; website www.iop.org;

Institute of Biology; 20 Queensberry Place, London SW7 2DZ, UK; tel +44(020) 7581-8333; fax: +44(020) 7823-9409; Email: info@iob.org; website www.iob.org;

MATHEMATICAL REQUIREMENTS

Calculators may be used in all parts of the examination.

Candidates should be able to:

1. add, subtract, multiply and divide;
2. understand and use *averages, decimals, fractions, percentages, ratios* and *reciprocals;*
3. recognise and use standard notation;
4. use direct and inverse proportion;
5. use positive, whole number indices;
6. draw charts and graphs from given data;
7. interpret charts and graphs;
8. select suitable scales and axes for graphs;
9. make approximate evaluations of numerical expressions;
10. recognise and use the relationship between length, surface area and volume, and their units on metric scales;
11. use usual mathematical instruments, (ruler, compasses, protractor, set square);
12. understand the meaning of *angle, curve, circle, radius, diameter, square, parallelogram, rectangle* and *diagonal;*
13. solve equations of the form $x = yz$ for any one term when the other two are known;
14. recognise and use points of the compass (N, S, E, W).

SYMBOLS, UNITS AND DEFINITIONS OF PHYSICAL QUANTITIES

Students should be able to state the symbols for the following physical quantities and, where indicated, state the units in which they are measured.

Quantity	*Symbol*	*Unit*
Length	*l, h...*	km, m, cm, mm
area	*A*	m^2, cm^2
volume	*V*	m^3, cm^3
weight	*W*	N
mass	*m, M*	kg, g, mg
time	*t*	h, min, s
density	*d, p*	g/cm^3, kg/m^3
speed	*u, v*	km/h, m/s, cm/s
acceleration	*a*	m/s^2
acceleration of free fall	*g*	
force	*F, P...*	N
moment of a force		Nm
work done	*W, E*	J
energy	*E*	J, kW h
power	*P*	W
pressure	*p, P*	Pa, N/m^2
atmospheric pressure		use of millibar
temperature	*t*	°C
frequency	*f*	Hz
wavelength	*λ*	m, cm
focal length	*f*	
angle of incidence.	*i*	degree (°)
angles of reflection, refraction	*r*	degree (°)
critical angle	*c*	degree (°)
potential difference/voltage	*V*	V, mV
current	*I*	A, mA
charge		C, A s
e.m.f.	*E*	V
resistance	*R*	Ω

GLOSSARY OF TERMS USED IN SCIENCE PAPERS

During the moderation of a question paper, care is taken to try and ensure that the paper and its individual questions are, in relation to the syllabus, fair as regards balance, overall difficulty and suitability. Attention is also paid to wording to make questions as concise and yet as unambiguous as possible. In many instances, Examiners are able to make appropriate allowance for an interpretation that differs, but acceptably so, from the one intended.

It is hoped that the glossary (which is relevant only to Science subjects) will prove helpful to candidates as a guide (i.e. it is neither exhaustive nor definitive). The glossary has been deliberately kept brief not only with respect to the number of terms included but also to their definitions. Candidates should appreciate that the meaning of a term must depend in part on its context.

1. *Define (the term(s)...) is* intended literally, only a formal statement or equivalent paraphrase being required.

2. *What do you understand by/What is meant by (the term(s)...)* normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3. *State* implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').

4. *List* requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified, this should not be exceeded.

5. *State and explain* normally also implies conciseness; *explain* may imply reasoning or some reference to theory, depending on the context.

6. *Describe* requires the candidate to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. In the latter instance, the answer may often follow 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 has greater discretion about the nature and the organisation of the material to be included in the answer). *Describe and explain* may be coupled in a similar way to *state and explain* - see paragraph 5.

7. *Discuss* requires the candidate to give a critical account of the points involved in the topic.

8. *Outline* implies brevity (i.e. restricting the answer to giving essentials).

9. *Predict* implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

   Predict also implies a concise answer with no supporting statement required.

10. *Deduce* is used in a similar way to *predict* except that some supporting statement is required (e.g. reference to a law/principle or the necessary reasoning is to be included in the answer).

11. *Suggest* is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may be formally `not in the syllabus'.

12. *Find* is a general term that may variously be interpreted as *calculate, measure, determine,* etc.

13. *Calculate is* used when a numerical answer is required. In general working should be shown, especially where two or more steps are involved.

14. *Measure* implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length, using a rule or mass, using a balance).

15. *Determine* often 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 (e.g. Young modulus, relative molecular mass).

16. *Estimate* implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

17. *Sketch,* when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct *but* candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value).

    In diagrams, *sketch* implies that a simple freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.