PHYSICAL SCIENCE SYLLABUS: 0652

(CHEMISTRY SECTION)

SPECIAL REQUIREMENTS FOR

EDC 279 Curriculum Studies in Chemistry I
2007/8 Main and Supplementary Examinations

AND

EDC 379 Curriculum Studies in Chemistry II
2007/8 Main and Supplementary Examinations

PHYSICAL SCIENCE 0652
IGCSE
FOR EXAMINATION IN 2008

IMPORTANT NOTICE

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UK and USA private candidates are not 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.

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 University of Cambridge International Examinations.

Exclusions

This syllabus must not be offered in the same session with any of the following syllabuses:

0620 Chemistry
0625 Physics
0653 Combined Science
0654 Co-ordinated Sciences (Double Award)
5054 Physics
5070 Chemistry
5124 Science (Physics, Chemistry)
5129 Combined Science
5130 Additional Combined Science

You can find syllabuses and information about CIE teacher training events on the CIE Website (www.cie.org.uk).

Physical Science

Syllabus code: 0652

CONTENTS

NOTES

Conventions (e.g. signs, symbols, terminology and nomenclature)

Syllabuses and question papers will conform with generally accepted international practice. In particular, attention is drawn to the following documents, published in the UK, which will be used as guidelines.

Reports produced by the Association for Science Education (ASE):

SI Units, Signs, Symbols and Abbreviations (1981),
Chemical Nomenclature, Symbols and Terminology for use in school science (1985),
Signs, Symbols and Systematics: The ASE Companion to 5-16 Science (1995).

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

INTRODUCTION

International General Certificate of Secondary Education (IGCSE) syllabuses are designed as two-year courses for examination at age 16-plus.

All IGCSE syllabuses follow a general pattern. The main sections are:

Aims

Assessment Objectives

Assessment

Curriculum Content.

The IGCSE subjects have been categorised into groups, subjects within each group having similar Aims and Assessment Objectives.

Physical Science falls into Group III, Science, of the International Certificate of Education (ICE) together with Agriculture, Biology, Chemistry, Combined Science, Co-ordinated Sciences (Double Award), Environmental Management and Physics.

AIMS

The aims of the syllabus are the same for all students. These are set out below and describe the educational purposes of a course in Physical Science for the IGCSE examination. They 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 impod,
   - 1.2 recognise the usefulness, and limitations, of scientific method and appreciate its applicability in other disciplines and in everyday life,
   - 1.3 be suitably prepared for studies beyond the IGCSE 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 Physical 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 Physical Science such as
   - 3.1 concern for 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 scientific theories and methods have developed, and continue to do so, as a result of co-operative activities of groups and individuals;
   - 5.2 the study and practice of science are subject to social, economic, technological, ethical and cultural influences and limitations;
   - 5.3 the applications of science may be both beneficial and detrimental to the individual, the community and the environment;
   - 5.4 science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal.

ASSESSMENT OBJECTIVES

The three assessment objectives in Physical Science are

A Knowledge with Understanding

B Handling Information and Problem Solving

C Experimental Skills and Investigations

A description of each assessment objective follows.

A KNOWLEDGE WITH UNDERSTANDING

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

1. scientific phenomena, facts, laws, definitions, concepts and theories,
2. scientific vocabulary, terminology and conventions (including symbols, quantities and units),
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 curriculum content defines the factual material that candidates may be required to recall and explain. Questions testing this will often begin with one of the following words: *define, state, describe, explain* or *outline*.

B HANDLING INFORMATION AND PROBLEM SOLVING

Students should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), 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 skills cannot be precisely specified in the curriculum content because questions testing such skills are often 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 skills will often begin with one of the following words: *discuss, predict, suggest, calculate* or *determine*.

C EXPERIMENTAL SKILLS AND INVESTIGATIONS

Students should be able to

1. use techniques, apparatus and materials (including the following of a sequence of instructions where appropriate),
2. make and record observations, measurements and estimates,
3. interpret and evaluate experimental observations and data,
4. plan investigations and/or evaluate methods and suggest possible improvements (including the selection of techniques, apparatus and materials).

SPECIFICATION GRID

The approximate weightings allocated to each of the assessment objectives in the assessment model are summarised in the table below.

Assessment Objective	Weighting
A Knowledge with Understanding	50% (not more than 25% recall)
B Handling Information and Problem Solving	30%
C Experimental Skills and Investigations	20%

ASSESSMENT

All candidates must enter for three Papers. These will be Paper 1, one from either Paper 2 or Paper 3, and one from Papers 4, 5 or 6.

Candidates who have only studied the Core curriculum or who are expected to achieve a grade D or below should normally be entered for Paper 2. Candidates who have studied the Extended curriculum and who are expected to achieve a grade C or above should be entered for Paper 3.

All candidates must take a practical paper, chosen from Paper 4 (School-based Assessment of Practical Skills), or Paper 5 (Practical Test), or Paper 6 (Alternative to Practical).

The data sheet (Periodic Table) will be included in Papers 1, 2 and 3.

Core curriculum Grades C to G available	*Extended curriculum* Grades A* to G available
Paper 1 (45 minutes) **Compulsory** A multiple-choice paper consisting of forty items of the four-choice type. The questions will be based on the Core curriculum, will be of a difficulty appropriate to grades C to G, and will test skills mainly in Assessment Objectives A and B. This paper will be weighted at 30% of the final total available marks.	
Either: **Paper 2** (1 hour 15 minutes) Core theory paper consisting of 80 marks of short-answer and structured questions. The questions will be of a difficulty appropriate to grades C to G and will test skills mainly in Assessment Objectives A and B. The questions will be based on the Core curriculum. This Paper will be weighted at 50% of the final total available marks.	**Or:** **Paper 3** (1 hour 15 minutes) Extended theory paper consisting of 80 marks of short-answer and structured questions. The questions will be of a difficulty appropriate to the higher grades and will test skills mainly in Assessment Objectives A and B. A quarter of the marks available will be based on Core material and the remainder on the Supplement. This Paper will be weighted at 50% of the final total available marks.
Practical Assessment **Compulsory** The purpose of this component is to test appropriate skills in assessment Objective C. Candidates will not be required to use knowledge outside the Core curriculum. Candidates must be entered for one of the following: **Either: Paper 4** Coursework (school-based assessment of practical skills)* **Or: Paper 5** Practical Test (1 hour 30 minutes), with questions covering experimental and observational skills. **Or: Paper 6** Alternative to Practical Paper (1 hour). This is a written paper designed to test familiarity with laboratory based procedures. The practical assessment will be weighted at 20% of the final total available marks.	

*Teachers may not undertake school-based assessment without the written approval of CIE. This will only be given to teachers who satisfy CIE requirements concerning moderation and they will have to undergo special training in assessment before entering candidates. CIE offers schools in-service training in the form of occasional face-to-face courses held in countries where there is a need, and also through the IGCSE Coursework Training Handbook, available from CIE Publications.

CURRICULUM CONTENT

Students can follow either the core curriculum only or they may follow the extended curriculum which includes both the core and the supplement. Students aiming for grades A* to C should follow the extended curriculum.

Note:

1. The curriculum content is designed to provide guidance to teachers as to what will be assessed in the overall evaluation of the student. It is not meant to limit, in any way, the teaching programme of any particular school or college.
2. The content is set out in three columns. The main topic areas and concepts are indicated in the left-hand column. The centre column provides amplification of the core topics, which all students are to study. Topics in the right-hand column are supplementary and should be studied by students following the extended curriculum.
3. Cross-references are provided to indicate areas of overlap or close association within this syllabus.

CHEMISTRY SECTION

It is important that throughout this section, attention should be drawn to

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

TOPIC	CORE *All students should be able to:*	SUPPLEMENT *In addition to what is required in the Core, students following the Extended curriculum should be able to:*
1. The Particulate Nature of Matter	-describe the states of matter and explain their interconversion in terms of the kinetic particle theory -describe diffusion and Brownian motion in terms of kinetic theory	
2. Experimental Techniques	-name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders -describe paper chromatography (including the use of locating agents) and interpret simple chromatograms -recognise that mixtures melt and boil over a range of temperatures -describe methods of purification by the use of a suitable solvent, filtration, crystallisation, distillation (including use of fractionating column) (Refer to the fractional distillation of crude oil (petroleum) (section 11.2) and fermented liquor (section 11.6).)	
3. Atoms, Elements and Compounds		
3.1 Atomic structure and the Periodic Table	-state the relative charge and approximate relative mass of a proton, a neutron and an electron -define *proton number* and *nucleon number*	

TOPIC	CORE	SUPPLEMENT
	-use proton number and the simple structure of atoms to explain the basis of the Periodic Table (section 7.1 to 7.4), with special reference to the elements of proton number 1 to 20	
	-use the notation ${}^{a}_{b}X$ for an atom	
	-describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of outer electrons (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 provided in Papers 1, 2 and 3.)	
	-define *isotopes*	
3.2 Bonding: the structure of matter	-describe the differences between *elements*, *mixtures* and *compounds*, and between *metals* and *non-metals* (8.1)	
	-describe *alloys*, such as brass, as mixtures of a metal with other elements	-explain how alloying affects the properties of metals (see (d))
(a) Ions and ionic bonds	-describe the formation of *ions* by electron loss or gain	
	-describe the formation of ionic bonds between the alkali metals and the halogens	-describe the formation of ionic bonds between metallic and non-metallic elements
(b) Molecules and covalent bonds	-describe the formation of single covalent bonds in H_2, Cl_2, H_2O, CH_4 and HCl as the sharing of pairs of electrons leading to the noble gas configuration	-describe the electron arrangement in more complex covalent molecules such as N_2, C_2H_4, CH_3OH and CO_2
	-describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds	
(c) Macromolecules	-describe the structure of graphite and of diamond	-relate these structures to melting point, conductivity and hardness
(d) Metallic bonding		-describe metallic bonding as a lattice of positive ions in a 'sea of electrons' and use this to explain the electrical conductivity and malleability of metals
4. Stoichiometry	-use the symbols of the elements and write the formulae of simple compounds	
	-deduce the formula of a simple compound from the relative numbers of atoms present	-determine the formula of an ionic compound from the charges on the ions present
	-construct word equations and simple balanced chemical equations	-deduce the balanced equation of a chemical reaction, given relevant information
	-define *relative atomic mass*, A_r	
	-define *relative molecular mass*, M_r, and calculate it as the sum of the relative atomic masses (the term relative formula mass or M_r will be used for ionic compounds)	-calculate stoichiometric reacting masses and volumes of gases and solutions, solution concentrations expressed in g/dm^3 and mol/dm^3. (Calculations based on limiting reactants may be set. Questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will not be set.)
5. Chemical reactions		
5.1 Production of energy	-describe the production of heat energy by burning fuels	
	-describe hydrogen as a fuel	
	-describe radioactive isotopes, such as ^{235}U, as a source of energy	

TOPIC	CORE	SUPPLEMENT
5.2 Energetics of a reaction	-describe the meaning of *exothermic* and *endothermic* reactions	
	-describe bond breaking as endothermic and bond forming as exothermic	
5.3 Speed of reaction	-describe the effects of concentration, particle size, catalysts (including enzymes) and temperature on the speeds of reactions	-show awareness that light can provide the energy needed for a chemical reaction to occur
	-state that organic compounds that catalyse organic reactions are called enzymes	-state that photosynthesis leads to the production of glucose from carbon dioxide and water in the presence of chlorophyll and sunlight (energy)
	-describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. mines)	-describe the use of silver salts in photography (i.e. reduction of silver ions to silver)
5.4 Redox	-define *oxidation* and *reduction* in terms of oxygen gain/loss	
6 Acids, bases and salts		
6.1 The characteristic properties of acids and bases	-describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus	-define *acids* and *bases* in terms of proton transfer, limited to aqueous solutions
	-describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only) measured using Universal Indicator paper	-use these ideas to explain specified reactions as acid/base
	-describe and explain the importance of the use of lime in controlling acidity in soil	
6.2 Types of oxides	-classify oxides as either acidic or basic, related to metallic and non-metallic character of the element forming the oxide	-classify other oxides as neutral or amphoteric
6.3 Preparation of salts	-describe the preparation, separation and purification of salts as examples of some of the techniques specified in section 2 and the reactions specified in section 8.1	-suggest a method of making a given salt from suitable starting materials, given appropriate information, including precipitation
6.4 Identification of ions	-describe the use of the following tests to identify: *aqueous cations:* ammonium, copper(II), iron(II), iron(III) and zinc, using aqueous sodium hydroxide and aqueous ammonia as appropriate. (Formulae of complex ions are not required.) *anions:* carbonate (by reaction with dilute acid and then limewater), chloride (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium to ammonia) and sulphate (by reaction under acidic conditions with aqueous barium ions)	
6.5 Identification of gases	-describe the use of the following tests to identify: ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using a lighted splint), oxygen (using a glowing splint).	

TOPIC	CORE	SUPPLEMENT
7. The Periodic Table	-describe the Periodic Table as a method of classifying elements and describe its use in predicting properties of elements	
7.1 Periodic trends	-describe the change from metallic to non-metallic character across a Period	-describe the relationship between group number and the number of outer electrons
7.2 Group properties	-describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and reaction with water	
	-predict the properties of other elements in the group given data, where appropriate	
	-describe chlorine, bromine and iodine in Group VII as a collection of diatomic non-metals showing a trend in colour and state their reaction with other halide ions	
	-predict the properties of other elements in the group given data, where appropriate	-identify trends in other groups given data about the elements concerned
7.3 Transition elements	-describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts	
7.4 Noble gases	-describe the noble gases as being unreactive	
	-describe the uses of the noble gases in providing an inert atmosphere (e.g. argon in lamps and helium for filling weather balloons)	
8. Metals		
8.1 Properties of metals	-compare the general physical and chemical properties of metals with those of non-metals	
8.2 Reactivity series	-place in order of: reactivity, calcium, copper, (hydrogen), iron, magnesium, potassium, sodium and zinc by reference to the reactions, if any and where relevant, of the metals with water or steam, dilute hydrochloric acid, (equations not required) the aqueous ions of other metals	-account for the apparent unreactivity of aluminium in terms of the oxide layer adhering to the metal
	-deduce an order of reactivity from a given set of experimental results	
8.3 a) Extraction of metals	-describe the ease in obtaining metals from their ores by relating the elements to the reactivity series	-describe the essential reactions in the extraction of iron from haematite
	-name metals that occur 'native', including copper and gold	
	-name the main ores of aluminium, copper and iron	
b) Uses of metal	-describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys	-name the uses, related to their properties, of copper (electrical wiring and in cooking utensils) and of aluminium (aircraft parts and food containers)
	-name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)	
	-name the uses of zinc for galvanising and making brass	

TOPIC	CORE	SUPPLEMENT
9. Air and Water	-describe a chemical test for water	
	-show understanding that hydration may be reversible (e.g. by heating hydrated copper(II) sulphate or hydrated cobalt(II) chloride)	
	-describe, in outline, the purification of the water supply in terms of filtration and chlorination	
	-name some of the uses of water in industry and in the home	
	-describe the composition of clean air as being approximately 79% nitrogen, 20% oxygen and the remainder as being a mixture of noble gases, water vapour and carbon dioxide	
	-name the common pollutants in the air as being carbon monoxide, sulphur dioxide, oxides of nitrogen and lead compounds	
	-state the source of each of these pollutants: -carbon monoxide from the incomplete combustion of carbon-containing substances -sulphur dioxide from the combustion of fossil fuels which contain sulphur compounds (leading to 'acid rain') -oxides of nitrogen and lead compounds from car exhausts	-explain the catalytic removal of nitrogen oxides from car exhaust gases
	-state the adverse effect of common pollutants on buildings and on health	
	-describe the separation of oxygen and nitrogen from liquid air by fractional distillation	
	-name the uses of oxygen in oxygen tents in hospitals, and with acetylene (a hydrocarbon) in welding	
	-describe methods of rust prevention: paint and other coatings, to exclude oxygen, and galvanising	-explain galvanising in terms of the reactivity of zinc and iron
	-describe the need for nitrogen-, phosphorous- and potassium-containing fertilisers	
	-describe the formation of carbon dioxide: as a product of complete combustion of carbon-containing substances as a product of respiration as a product of the reaction between an acid and a carbonate	
10. Lime and Limestone	-describe the manufacture of calcium oxide (lime) from calcium carbonate (limestone) in terms of the chemical reactions involved	
	-name some uses of lime and calcium hydroxide (slaked lime) as in treating acidic soil and neutralising acidic industrial waste products	

TOPIC	CORE	SUPPLEMENT
11. Organic Chemistry		
11.1 Names of compounds	-name, and draw, the structures of methane, ethene, ethanol, ethenoic acid and the products of the reactions stated in section 11.4 to 11.6 -state the type of compound present given a chemical name, ending in *-ane, -ene, -ol,* or *-oic acid* or a molecular structure	
11.2 Fuels	-name the fuels coal, natural gas and petroleum -name methane as the main constituent of natural gas -describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation -name the uses of the fractions: petrol fraction as fuel in cars; paraffin fraction for oil stoves and aircraft fuel; diesel fraction for fuel in diesel engines; lubricating fraction for lubricants and making waxes and polishes; bitumen for making roads	
11.3 Homologous series	-describe the concept of homologous series as a 'family' of similar compounds with similar properties due to the presence of the same functional group	
11.4 Alkenes	-describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning	
11.5 Alkenes	-describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam -distinguish between *saturated* and *unsaturated* hydrocarbons from molecular structures, by simple chemical tests -describe the formation of poly(ethene) as an example of addition polymerisation of monomer units	-describe the manufacture of alkenes and of hydrogen by cracking
11.6 Alcohols	-name the uses of ethanol; as a solvent; as a fuel and as a constituent of wine and beer	-describe the formation of ethanol by fermentation and by the catalytic addition of steam to ethene