Cambridge Assessment

O Level

Chemistry

Session: 1984
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Code: 5070

Subject Syllabus
SS12(HCO)
1984
Chemistry

For All Centres

GENERAL CERTIFICATE OF EDUCATION
SCHOOL CERTIFICATE
HIGHER SCHOOL CERTIFICATE

EXAMINATION SYLLABUSES FOR

1984

CHEMISTRY

UNIVERSITY OF CAMBRIDGE
LOCAL EXAMINATIONS SYNDICATE
INTERNATIONAL EXAMINATIONS

June 1982

ORDINARY LEVEL
SCHOOL CERTIFICATE
5070
CHEMISTRY

Aims and Objectives

Aims

The aims of the syllabus are to:

1. encourage candidates to investigate the phenomena associated with chemistry, to master some of the relevant techniques involved and to understand the distinctive concepts and relationships used to explain chemistry;
2. present some of the models, theories and classification systems developed to explain and rationalise the phenomena observed;
3. illustrate the role of the chemist in seeking ways of converting natural raw materials into useful or desirable products;
4. show how the activities of chemists have social, industrial and economic consequences for the community.

It is hoped that the Ordinary level Chemistry course will promote the qualities summarised below.

Basic qualities

1. Knowledge of chemical facts and terminology.
2. Knowledge of physical and chemical principles.
3. Confidence in using scientific equipment properly and safely.
4. The ability to perform experiments.
5. The ability to observe and record.
6. The ability to formulate and perform relevant calculations.
7. The ability to organise ideas and facts and to present them clearly.

Higher qualities

1. The ability to devise good experiments and draw conclusions from them.
2. The ability to understand and interpret scientific information presented in verbal, mathematical, diagrammatic or graphical form and to translate such information from one to another.
3. The ability to formulate and test hypotheses.
4. The ability to interpret phenomena in terms of models, laws and principles.
5. The ability to solve problems both practical and theoretical which are unfamiliar or presented in a novel manner.
6. A critical approach to information and ideas.

It is also hoped that the course will cultivate the following attitudes:

1. objectivity and impartiality;
2. safety consciousness;
3. an awareness of science as a construct of the human mind and of the philosophical dependence of science on scientific method—observation (establishing facts or laws of experience); hypothesis and theory; testing hypotheses and predictions from theory; investigation by experiment; new facts.

The scope of practical examination is indicated in the Practical Chemistry syllabus printed at the end of the theory syllabus.

MATHEMATICAL NEEDS

It is assumed that candidates will be competent in the techniques described below. The list is intended as a guide but, in essence, no very significant change relative to previous policy is implied.

Basic abilities

Make calculations involving addition, subtraction, multiplication and division of quantities, including the use of mathematical tables, calculators and/or slide rules.

Express small fractions as percentages, and vice versa.

Substitute physical quantities into equations using consistent units so as to calculate one quantity.

Plot results graphically using given scales.

Higher abilities

Comprehend and use the symbols/notations $<$, $>$, $\approx$, $/$, $\propto$.

Transform decimal notation to power of ten notation (standard form).

Test tabulated pairs of values for direct proportionality by a graphical method or by constancy of ratio.

Select appropriate scales for plotting a graph.

Extrapolation and interpolation.

Determine the intercept of, and interpret in a simple way, the slope of and estimate the area under a graph, including relevant units.

Choose by inspection a straight line that will serve as the 'least bad' linear model for a set of data presented graphically.

Comprehend how to handle numerical work so that significant figures are neither lost unnecessarily nor used beyond what is justified.

Be able to estimate orders of magnitude.

STRUCTURE OF THE EXAMINATION

Paper 1 Theory (1 hour, 40 marks) consisting of 40 compulsory multiple choice items of the same two types as currently in use, the majority of the items being of the simple direct choice.

Paper 2 Theory (1½ hours, 65 marks) consisting of two sections. Section A will carry 35 marks and will consist of a small number of compulsory, structured questions of variable mark value. Section B will carry 30 marks and will consist of 5 questions each of 15 marks with candidates being required to attempt 2 questions.

Paper 3 Practical (2 hours, 30 marks) similar in style to that currently set.

Or

Paper 6 Alternative to Practical (1 hour, 30 marks) set as an alternative to Paper 3, intended to test a knowledge of practical work relevant to the theory syllabus. The style and format of the paper is to be revised for examinations in and after 1984. A specimen paper is available on request. Candidates (other than school candidates) who wish to offer this paper must submit satisfactory evidence that they have undergone a proper course of laboratory work.

SYLLABUS

The syllabus is not intended to be used as a teaching syllabus nor is it intended to suggest a teaching order. The format of the syllabus under the broad headings of 'General Principles' and 'Descriptive chemistry' is such that teachers will need to develop a sequence of lessons in their own way. It is also hoped that teachers will be able to relate the factual content of the syllabus to social, economic and industrial life both on a national scale and on a local scale as appropriate. The topics listed under the heading 'Applications' are intended as a guide only and are not to be regarded as exhaustive. Where a topic is prefixed by 'Refer to', no detail is intended.

It is intended that an experimental approach to the subject be adopted and it is assumed that the subject matter will be amply illustrated by test-tube or other small scale experiments preferably carried out by students where practicable but supplemented as appropriate by demonstration experiments, film and other teaching aids.

In the examination, questions will be set requiring factual knowledge of the syllabus, a sound understanding of the principles involved and the ability to apply these principles to problem situations in the laboratory and in everyday life whether domestic or industrial. In questions relating to topics not specifically mentioned in the syllabus, sufficient information will be given within such a question to enable the candidates to answer the question. (It should be appreciated, however, that the absence of a reference to a particular term, both well established and in common use at this level, does not necessarily preclude the use of such a term in a question paper.)

Candidates will be expected to be able to describe chemical reactions in terms of the colour, physical state (e.g. gaseous, liquid, solid or in aqueous solution) and other important conditions (e.g. room temperature or the use of heat). State symbols will be used where appropriate. They will also be expected to interpret experimental data, including quantitative results expressed graphically or otherwise.

Candidates will be expected to be aware of the hazards associated with chemicals, e.g. the corrosive nature of concentrated alkalis and acids, the poisonous nature of many substances and the combustibility of certain gases and volatile, especially organic, liquids. Questions will not be set on safety measures except insofar as they may affect the techniques in carrying out particular processes, e.g. the dilution of concentrated acids.

The form of the Periodic Table as given on page 16 together with other data will be printed on a foldout sheet at the front of both Papers 1, 2 and 6. In the practical papers the Periodic Table will be given instead of quoting individual relative atomic masses.

GENERAL PRINCIPLES

Topic	*Applications*
1. THE PARTICULATE NATURE OF MATTER	
A simple kinetic—molecular picture as illustrated by diffusion and dilution experiments. Dependence of rate of diffusion on molecular mass, treated qualitatively.	
The concept of Brownian motion is not required.	
2. EXPERIMENTAL TECHNIQUES	
2.1 *(a)* Criteria of purity—melting point and boiling point determination. Paper chromatography, including the idea that the technique is not limited to coloured substances.	Melting point and boiling point as means of identifying substances and testing their purity. Refer to the importance of purity in foodstuffs and drugs.
Knowledge of particular locating agents is not required.	
(b) Methods of purification—use of suitable solvent, filtration, crystallisation, sublimation, distillation (including use of fractionating column).	Refer to the fractional distillation of (i) crude oil, (ii) liquid air, (iii) fermented liquor.
2.2 Preparative methods—examples to include solids, liquids and gases as specified in sections 8 and 10.	
Standard methods of collecting gases based on density, solubility and chemical properties.	
3. CLASSIFICATION OF MATTER ON THE BASIS OF ABILITY TO CONDUCT ELECTRICITY	
Experiments leading to the classification of substances according to their ability to conduct electricity when solid, liquid or gaseous and, where appropriate, in aqueous solution.	Refer to the use of copper and of (steel-cored) aluminium in cables and of plastic and ceramic insulators.
4. ATOMS, ELEMENTS AND COMPOUNDS	
4.1 Atomic structure and the Periodic Table	
The relative charges and approximate relative masses of protons, neutrons and electrons. Atomic number and mass number. Atomic number and the simple structure of atoms as the basis of the Periodic Table with special reference to the elements of atomic number 1 to 20. Isotopes. Valency electrons, based on a simple understanding of the build-up of electrons in principal energy levels and of the significance of 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, as shown on page 16, will be available in the examination.	
4.2 Bonding: the structure of matter	
Distinction between elements, compounds and mixtures and between metals and non-metals.	Refer to alloys.
Formation of molecules and ions from atoms. Metal structures simply as a lattice of positive ions in a 'sea of electrons.' Differences in volatility and electrical conductivity between ionic and covalent compounds.	Refer to the use of water and covalent compounds as solvents and of ionic compounds as refractory materials, e.g. MgO.
Examples of crystals formed from atoms, molecules and ions, e.g. copper, graphite, diamond, silica (sand), iodine, sulphur, sodium chloride. Knowledge of the geometrical form of crystal lattices is *not* expected except for graphite, diamond and sodium chloride. The similarity of structure leading to similarities in physical properties should be emphasized, e.g. diamond and silica (sand).	
5. THE MOLE CONCEPT	
Relative atomic mass, A_r, as the weighted average of relative isotopic masses and relative molecular mass, M_r, as the sum of relative atomic masses (see section 4.1). Molar mass, M. The mole, the Avogadro constant and Avogadro's law. Gas volumes related to the molar volumes 22·4 dm^3 at s.t.p. and 24 dm^3 under room conditions.	
Questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will not be set.	
The calculation of empirical formulae and of molecular formulae.	
The Faraday constant as the charge on 1 mol of electrons.	
Equations with state symbols, including ionic equations. Calculations of stoichiometric reacting masses and gas volumes, including electrolysis.	Calculation of % yield and % impurity.
6. ELECTROLYSIS	
The electrolysis	
(a) of	
(i) at least one molten halide,	
(ii) concentrated hydrochloric acid,	
(iii) concentrated aqueous sodium chloride,	
(iv) aqueous copper(II) sulphate,	
(v) dilute sulphuric acid (as essentially the electrolysis of water),	
between inert (platinum or carbon) electrodes.	An outline of the manufacture of aluminium (purification of bauxite not required), chlorine, sodium and sodium hydroxide, by any one suitable method in each case. Starting materials, essential conditions and electrode processes should be given. Refer to the plating of metals, the anodising of aluminium and the refining of copper.
(b) of aqueous copper(II) sulphate between copper electrodes.	
Simple ionic theory of, and reactions at the electrodes in, the examples above.	

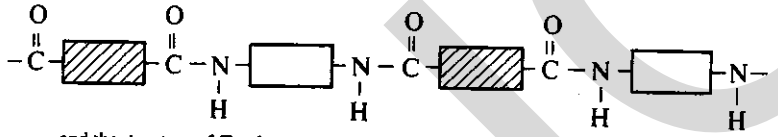
Topic	*Applications*
7. CHEMICAL REACTIONS	
7.1 Energetics of reaction Energy changes during chemical reactions to illustrate: (i) the production and absorption of heat energy, (ii) the production and absorption of light energy (e.g. flames, photosynthesis (simply) and the hydrogen/chlorine reaction), (iii) the production (from simple cells) and absorption (in electrolysis) of electrical energy. (This should be linked with the electrochemical series, section 10.1). Candidates should appreciate that the formation of a bond between isolated atoms involves the release of energy (exothermic) while the breaking of bonds requires an input of energy (endothermic). *Questions involving calculations will not be set.*	Refer to (i) the occurrence of and importance of energy sources, e.g. fossil fuels and nuclear fuels, (ii) the use of batteries as convenient, portable energy sources. The use of silver salts in photography, limited to the idea of reduction to silver.
7.2 Speed of reaction The speed of a reaction at a given instant regarded as the slope of a graph showing the variation of extent of reaction with time. Elementary treatment of the effects on speed of reaction of *(a)* temperature, *(b)* concentration, *(c)* surface area, *(d)* presence of catalyst (including reference to enzymes), *(e)* light, *(f)* type of bond. These effects should be investigated experimentally making use of convenient examples such as (i) sodium thiosulphate with dilute acids, (ii) magnesium or granulated zinc with dilute acids, (iii) calcium carbonate (marble) chips with hydrochloric acid, (iv) decomposition of hydrogen peroxide catalysed by manganese(IV) oxide, (v) the enzymic hydrolysis of starch. A simple reference should be made to reversible reactions. *A treatment of Le Chatelier's principle is not required.*	Refer to pressure cookers and the danger of explosive combustion in flour mills (fine powder) and in mines (combustible gases and coal dust).
7.3 Redox reactions Redox reactions in terms of oxygen/hydrogen gain/loss leading to the concept of electron transfer and changes of oxidation state. Use of oxidation states limited to inorganic compounds and ions mentioned elsewhere in the syllabus, $S_2O_3^{2-}$ being excluded. *Equations for reactions involving* $KMnO_4$ *and* $K_2Cr_2O_7$ *are not expected.*	Refer to suitable practical examples.
8. ACIDS, BASES AND SALTS	
8.1 The meaning of the terms acid, base and alkali in terms of the ions they contain or produce in aqueous solution. The properties of acids in aqueous solution contrasted with the properties of hydrogen chloride dissolved in methylbenzene. The effect of acids on indicators, metals and carbonates. The pH scale as a practical measure of relative acidity and alkalinity *(definition not required)* hence the idea of strong and weak acids.	

Topic	*Applications*
8.2 Acidic, basic, amphoteric and neutral oxides. *No further classification of oxides is required.* The relative solubilities of the oxides and hydroxides of metals (see section 10.1). Preparation of insoluble hydroxides by precipitation. Amphoteric hydroxides.	Refer to the control of acidity in soil.
8.3 Salts as ionic compounds. The formation of salts by the action of acids on metals, oxides, hydroxides and carbonates. Normal and acid salts, basicity of acids. The relative solubilities of the salts of metals, (see section 10.1). Laboratory methods of preparing salts (see also section 10.1): *(a)* soluble salts by action of acid on (i) a metal, (ii) an oxide, insoluble hydroxide or insoluble carbonate, (iii) a soluble hydroxide or carbonate. *(b)* insoluble salts by precipitation, *(c)* direct combination. Methods of obtaining good crystals. Water of crystallisation and the loss of water when hydrated salts are heated. The ideas of deliquescence, hygroscopy and efflorescence *(formal definitions not required)*, illustrated by calcium chloride, concentrated sulphuric acid and sodium carbonate. Questions on tests for the anions, cations and gases quoted in the Practical syllabus may be set in the Theory papers.	Refer to commercially important salts, e.g. ammonium sulphate.
DESCRIPTIVE CHEMISTRY	
9. THE PERIODIC TABLE: TRENDS IN GROUPS AND PERIODS	
9.1 The relationships between group number, oxidation states and metallic/non-metallic character. This should be illustrated by reference to the period sodium to argon (the elements and their oxides, where appropriate) in terms of characteristic properties and reactions specified elsewhere in the syllabus.	
9.2 Group properties illustrated by *(a)* lithium, sodium, and potassium—their physical properties, the reaction of the metal with water, the solubility of the hydroxide in water to give an alkaline solution. *(b)* chlorine, bromine and iodine—their physical properties, reaction of the element with other halide ions, sulphites and iron(II) compounds, reaction of halide ions with aqueous silver nitrate, the formation of gaseous, acidic hydrides. These two groups also illustrate the extremes of the variation across a period, with special reference to the two short periods.	
9.3 Transition metals as a collection of elements having high densities, high melting points and coloured compounds (in contrast to group I). These elements and their compounds often acting as catalysts. The properties of iron and its compounds detailed under section 10.1 as being typical of a transition metal.	

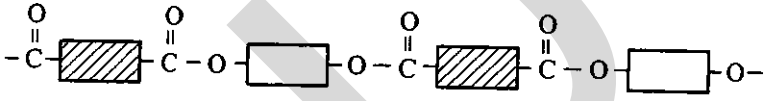
Topic	Applications
10. CHARACTERISATION OF ELEMENTS AS METALS AND NON-METALS	
10.1 Metals: the reactivity (electrochemical) series. The placing of aluminium, calcium, copper, iron, lead, magnesium, potassium, sodium and zinc in order of reactivity in terms of the reactions, if any, of *(a)* these elements with (i) air (considered as diluted oxygen), (ii) water or steam, (iii) dilute, 'non-oxidising' acids with special reference to hydrochloric acid and sulphuric acid, (iv) the aqueous ions of the other listed metals. *(b)* the oxides of these elements with (i) carbon, (ii) carbon monoxide, (iii) hydrogen. *Knowledge of the higher oxides of sodium and potassium and of metallic nitrides is not expected.*	Outlines of the manufacture of sodium (from NaCl), aluminium (from Al_2O_3), iron (from haematite) and zinc (from ZnS) in terms of the choice of reducing method.
The electrochemical series related to the tendency of a metal to form its positive ion. The action of aqueous sodium hydroxide on aqueous solutions containing the ions Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Zn^{2+} (see also section 10.2(c)).	Simple treatment of the changes in the properties of steel by the controlled use of additives.
Action of heat on the hydroxides, carbonates and nitrates of the listed metals related to the reactivity series.	Important uses of aluminium, zinc, iron and copper.
10.2 Non-metals Contrasted with metals in relation to the tendency to form negative ions and to form both ionic and covalent compounds.	
(a) Hydrogen Released as a reduction product by the action of reactive metals on water, steam and dilute acids. The formation of water by the burning of hydrogen. Its reducing properties with the oxides of less reactive metals. (See section 10.1(b))	Uses of hydrogen
(b) Oxygen Released in the decomposition of hydrogen peroxide and as a product of photosynthesis.	
The burning of elements in air and in oxygen. The formation of rust requiring both oxygen and water. The percentage by volume of oxygen in the air by any one method giving 1% accuracy (e.g. a syringe method using hot copper). The composition of the air. The variability of the composition of the air with special reference to water and carbon dioxide due to industrial and natural processes.	The separation of oxygen and nitrogen from liquid air by fractional distillation. Refer to common pollutants of the air and their adverse effect on buildings and health. Methods of rust prevention.
(c) Nitrogen The essential conditions of the Haber reaction. The displacement of ammonia from its salts. The reactions of ammonia (i) as a reducing agent with oxygen and with copper(II) oxide, (ii) as a base with hydrogen chloride and aqueous acids, (iii) as a base and/or complexing reagent with aqueous solutions containing Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Zn^{2+} *(formulae of complex ions not required).*	The important uses of ammonia, ammonium salts, nitric acid and nitrates. The importance of nitrogenous fertilisers.
The thermal dissociation of ammonium chloride.	
Nitric acid, its manufacture from ammonia and displacement from nitrates. Its reactions (i) as an acid with bases and carbonates, (ii) as an oxidising agent with special reference to copper, carbon and iron(II) salts. *Recall of redox equations involving nitric acid is not required.*	
The thermal decomposition of nitrates in relation to the reactivity series of the metals (see section 10.1).	
(d) Sulphur Sources of sulphur *(methods of extraction not required).* Experimental conditions for obtaining the rhombic (*α*) and monoclinic (*β*) allotropes of sulphur.	
Sulphur dioxide as a product of burning sulphur and as a by-product of burning compounds containing sulphur and by the action of dilute acids on sulphites. Its reactions as an acidic oxide and as a reducing agent with special reference to the halogens, iron(III) salts, potassium manganate(VII), potassium dichromate(VI). *Equations for reactions involving* $KMnO_4$ *and* $K_2Cr_2O_7$ *are not expected.* Its catalytic oxidation by oxygen (air).	Refer to sulphur dioxide as a pollutant. The important uses of sulphur, sulphur dioxide and sulphuric acid. The manufacture of sulphuric acid.
Sulphuric acid, its reactions (i) as an acid in dilute aqueous solution, (ii) as a dehydrating agent with special reference to sucrose, hydrated copper(II) sulphate, (iii) as a non-volatile acid displacing more volatile acids with special reference to chlorides and nitrates.	
(e) Chlorine Its formation as a product of the oxidation of hydrochloric acid and in the electrolysis of metallic chlorides. Its reactions (described in terms of its oxidising properties and its ability to form both ionic and covalent bonds) with metals, non-metals, water, cold dilute alkalis, sulphites, iron(II) salts and halide ions. The formation of hydrogen chloride by displacement from chlorides by the action of non-volatile acids, e.g. sulphuric acid.	Important uses of chlorine.
(f) Carbon Allotropy of carbon. The reducing properties of carbon. Carbon monoxide—a product of incomplete combustion, a product of reaction between steam and carbon, its reducing properties. A simple explanation of its toxicity and risks associated with its formation.	The role of carbon in the manufacture of iron. Carbon monoxide as a pollutant.
Carbon dioxide—a product of respiration and of the action of heat and dilute acids on carbonates. Its reactions with alkalis to form carbonates and hydrogencarbonates. The action of heat on, and the relative	The manufacture of lime.

Topic	*Applications*
solubilities of, the carbonates and hydrogencarbonates of calcium and sodium. *Methods of softening water are not required.*	Refer to the occurrence and simple consequence of hydrogencarbonates in water supplies. A simple reference to the advantages and disadvantages of synthetic detergents relative to soap.
11. ORGANIC CHEMISTRY	
11.1 The importance of chain formation by carbon. The structure and names of the unbranched alkanes, alkenes, primary alcohols and acids containing up to five carbon atoms per molecule. The structures, not names, of the alkanes and alkenes *(not cis—trans)* containing four and five carbon atoms per molecule. *Questions on isomerism of alcohols and acids will not be set.*	
11.2 Natural gas and petroleum. Distillation of crude oil. The general characteristics of a homologous series. The reactions to be treated should include;	The important uses of the fractions.
(i) for alkanes—burning and substitution by chlorine and bromine,	
(ii) for alkenes—burning and addition with hydrogen, chlorine and bromine and the addition reaction of ethene with steam,	Refer to the importance of alkenes as the starting compounds for the industrial manufacture of many organic compounds including solvents.
(iii) for alcohols—burning, reaction with sodium, dehydration to give alkenes and oxidation to give acids.	
(iv) for acids—reactions with metals, oxides, hydroxides and carbonates and ester formation.	
11.3 Macromolecules To be considered simply as large molecules built up from small units, different macromolecules having different units and/or different linkages.	
(a) Synthetic Polymers The formation of (i) poly(ethene) by addition polymerisation of monomer units, (ii) nylon (a polyamide) and *Terylene* (a polyester) by condensation polymerisation.	Refer to typical uses of plastics and man-made fibres.

The structure of nylon represented as



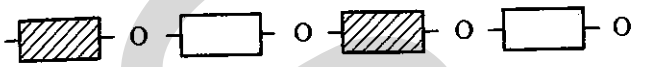
and the structure of *Terylene* as



Details of manufacture and mechanisms of these polymerisations are not required.

(b) Natural Macromolecules Proteins as possessing the same linkages as nylon but with different units. Their hydrolysis to aminoacids *(structures and names not required).*	
Fats as possessing the same linkages as *Terylene* but with different units.	Refer to their hydrolysis to soap.

Topic	*Applications*
Carbohydrates, considered simply as a large number of sugar units joined together by oxygen atoms, e.g.	



The acid hydrolysis of carbohydrates (e.g. starch) to give simple sugars. The fermentation of simple sugars to ethanol. *Candidates will not be expected to give the molecular formulae of sugars other than sucrose.*	Refer to brewing and wine making.
A brief reference should be made to the usefulness of chromatography in separating and identifying the products of hydrolysis.	

PRACTICAL CHEMISTRY

A major aim of the practical examination is to test the extent to which a candidate's knowledge is firmly grounded in experiment.

N.B. ***Candidates will be allowed to refer to note books and text books in the practical examination.***

Within the limitations imposed by cost, availability of apparatus in school laboratories, restriction to simple techniques, time and (most important) safety, the examination is designed to evaluate the ability of the candidate in the following skills:

(i) ability to make accurate quantitative measurements (in terms of the available apparatus) and use the results in relevant calculations;
(ii) ability to make and interpret accurate observations of a qualitative nature;
(iii) ability to make precise and concise records of all observations and conclusions.

To achieve these aims, candidates may be asked to carry out simple exercises involving:

(a) volumetric analysis; if titrations other than acid/alkali titrations are set, full instructions and other necessary information will be given;
Candidates may be asked to carry out simple quantitative experiments such as determining the concentrations of solutions, or finding the mole ratio in which substances react together. Concentrations will be given in mol/dm^3 or in g/dm^3.
Candidates will not be asked to prepare their own standard solutions.

(b) speeds of reaction;

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

(d) problems of an investigatory nature using one or more of the above or other simple techniques;

(e) tests for oxidising agents in solution using potassium iodide and iron(II) salts and for reducing agents using potassium manganate(VII), potassium dichromate(VI) and aqueous bromine;

(f) identification of:
hydrogen, carbon dioxide, ammonia, oxygen, sulphur dioxide, hydrogen chloride, water vapour, nitrogen dioxide, chlorine;
carbonate, nitrate, sulphate, sulphite, chloride, bromide, iodide (wet tests only for the last three ions);
lead, aluminium, calcium, iron(II), iron(III), copper, zinc and ammonium ions.

Apparatus requirements will be kept simple but candidates will be expected to be familiar with chromatography using ordinary filter paper, and the use of suitable organic compounds in qualitative questions is not excluded.

Candidates will not be required to carry out weighing for the Practical examination.

The Periodic Table

I	II											III	IV	V	VI	VII	VIII
							1 H 1										4 He 2
7 Li 3	9 Be 4											11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12											27 Al 13	28 Si 14	31 P 15	32 S 16	35·5 Cl 17	40 Ar 18
39 K 19	40 Ca 20	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	64 Cu 29	65 Zn 30	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	— Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	La to Lu	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	— Po 84	— At 85	— Rn 86
— Fr 87	— Ra 88																
		— Ac 89	— Th 90	— Pa 91	— U 92												

In each box: a = relative atomic mass, X = atomic symbol, b = atomic number