Cambridge Assessment

O Level

Chemistry

Session: 1957
Type: Syllabus
Code: 23

UNIVERSITY OF CAMBRIDGE
LOCAL EXAMINATIONS SYNDICATE

SYLLABUSES

SCIENCE SUBJECTS

1957 AND 1958

GENERAL CERTIFICATE OF EDUCATION
(ORDINARY LEVEL)

AND

OVERSEA SCHOOL CERTIFICATE EXAMINATION

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CHEMISTRY.

[For the significance of the italics see under Physics-with-Chemistry, p. 7.]

Syllabus	Notes
1. The air and its chief gaseous constituents including oxygen, nitrogen, water vapour, carbon dioxide and a brief mention of argon *and neon*; proportion of oxygen in air (e.g. by burning phosphorus or by using alkaline pyrogallol). Preparation of oxygen; *its commercial preparation from liquid air*. Properties and uses of oxygen; the burning of carbon, sulphur, phosphorus, sodium, magnesium and iron; acidic and basic oxides.	A detailed knowledge of the rare gases is not expected. Details of apparatus for liquefaction of air are not required.
2. Water as an oxide of hydrogen. Action of the metals sodium, *calcium*, magnesium and iron on water. The rusting of iron. *The composition of water by weight. Commercial production of hydrogen from steam.* The action of steam and magnesium. The reaction between steam and heated iron *as a reversible reaction*. Preparation of hydrogen from dilute acids. Properties and uses of hydrogen.	Rusting should be regarded as slow oxidation.
Oxidation in terms of addition of oxygen or removal of hydrogen; reduction as removal of oxygen or addition of hydrogen.	
3. Water as a solvent for gases and solids. Evaporation, distillation, sublimation, crystallisation, filtration, precipitation, and the use of these processes in preparing pure substances. The uses of other solvents for fats, oils, *paints, lacquers* and for cleaning. Saturated and unsaturated solutions; the determination of solubilities of solids. *Solubility curves and simple deductions from them.* Amospheric gases dissolved in water: their biological significance. Hard and soft water; temporary and permanent hardness; the methods of softening hard water. Hydration, efflorescence and deliquescence as illustrated by sodium carbonate, magnesium sulphate, copper sulphate, ferrous sulphate, and calcium chloride.	It is expected that a simple example of fractional distillation will be included. No chemistry of fats, oils etc. is expected. The emphasis is on solvents other than water. Candidates will be expected to know the hardening effects of calcium *and magnesium salts*. The examiners will take account of the fact that, in some areas, hard water does not occur naturally.
4. Chalk (limestone and marble), quicklime, slaked lime, mortar. Preparation and properties of carbon dioxide, carbonic acid, carbonates and bicarbonates; properties and uses of washing soda and baking soda (sodium bicarbonate); the ways in which carbon dioxide is constantly added to air (combustion, respiration, fermentation and decay, by-product of industrial processes) and removed by plants; carbon cycle; mineral waters; simple fire extinguishers.	A simple knowledge of the manufacture of quicklime will be expected.
5. Combustion of carbon and carbon-containing substances in (*a*) plentiful, (*b*) limited supplies of air. The candle flame. The Bunsen burner and its flame. *Combustion of a candle as typical of hydrocarbons.* Coal: coal-gas, coke, coal-tar, and ammonia as products of the destructive distillation of coal; coal fires and coke fires. *Coal-gas, water-gas and producer-gas (from coke) as fuels: outline of their manufacture.*	*Energy changes in combustion.* The storing of the sun's energy as a result of photosynthesis and its release in respiration and combustion. A detailed description of the gas-works is not required, but candidates should be familiar with the following stages: distillation, removal of tar and ammonia, *and the removal of hydrogen sulphide.*
6. Elements, compounds and mixtures; chemical change and physical change. Law of Conservation of Mass and the constancy of chemical composition (Definite Proportions); *the Law of Multiple Proportions*; simple treatment of Dalton's Atomic Theory. Atoms, molecules, formulae, (simple calculations involving formulae and chemical composition) chemical equations and their use in so far as they assist in giving a mental picture of a chemical action. Simple calculations from equations of reacting weights of substances and volumes of gases. Equivalent weights and the methods of their determination. Valency. Atomic weights. *Dulong and Petit's Law; determination of atomic weights of metals.* *The equivalent weights of simple acids and alkalis, and the use of standard (including normal) solutions of acids and alkalis.*	Candidates will be expected to have made the following experiments: determination of equivalents, (*a*) by replacement of hydrogen; (*b*) by the addition or removal of oxygen; (*c*) *for copper, by the displacement with zinc.* Simple temperature and pressure corrections are included for the subject Chemistry. Methods of determination of Atomic weights are not required for Physics-with-Chemistry.
7. *The study of gases. The Laws of Boyle, Charles,* Gay-Lussac and Avogadro; *volume relations exemplified by hydrogen chloride, steam and sulphur dioxide (or carbon dioxide). Atomicity of hydrogen. The relation between the vapour density of a gas and its molecular weight. Simple calculations based on these Laws.*	

Syllabus	Notes
8. Characteristics of acids, bases and salts. General methods of preparing acids illustrated by hydrochloric acid from common salt, nitric acid from sodium or potassium nitrate, sulphuric acid from sulphur dioxide (contact process); general properties of acids; acids in everyday use (e.g. acetic, citric, tartaric); baking powders. *Preparation of bases; the oxides of common metals. Caustic soda; ammonia.* Neutralisation. Salts.	Candidates are only expected to know that citric, tartaric, and acetic acids are common acids in everyday use. They are not expected to deal with the chemistry of these acids.
9. An elementary study of electrolysis. *Faraday's Laws.* Electrolytes and non-electrolytes; the electrolysis of water (dilute sulphuric acid); the liberation by electrolysis with platinum electrodes of copper from copper sulphate solution (with the subsequent electrolysis of the dilute sulphuric acid); *the use of electrolysis in the purification of copper*; copper-plating; *production of caustic soda from brine by any one electrolytic process.*	This portion of the syllabus has much in common with a corresponding part of the Physics syllabus.
10. In addition to those previously mentioned the study of the following elements and their compounds is required: Non-metallic elements:	
(*a*) Carbon: properties and uses of graphite and charcoal. Carbon monoxide; its preparation and properties. *The sources and uses of hydrocarbons exemplified by methane, petrol and paraffin wax.*	The preparation of carbon monoxide should include both the reduction of carbon dioxide and one dehydration method. *Laboratory preparation of methane is not required. A knowledge of the chemical structure of petrol and paraffin wax is not required.*
(*b*) Nitrogen: "atmospheric nitrogen"; *preparation of pure nitrogen by any one method.* The laboratory preparation and properties of ammonia and its synthesis from nitrogen and hydrogen; ammonium salts, their importance and use; *the oxidation of ammonia in the soil compared with the catalytic oxidation of ammonia to nitric oxide and nitric acid.* The reactions of nitric acid (*a*) as an acid, (*b*) as an oxidising agent. *The preparation and properties of nitrous oxide, nitric oxide and nitrogen dioxide.* Nitrates and the action of heat on them.	The circulation of nitrogen in nature should be discussed. The action of heat on ammonium nitrate will not be required for Physics-with-Chemistry.
(*c*) Sulphur: its extraction and uses. *Hydrogen sulphide: preparation and properties; its part in atmospheric pollution. Sulphides.* Sulphur dioxide: its preparation and properties; sulphurous acid as a bleaching agent and preservative. Sulphuric acid: its commercial preparation by the contact process *or lead chamber process*: its properties when concentrated and as a dilute acid.	The preparation of sulphur dioxide should include its formation from sulphur and natural sulphides in addition to a laboratory preparation. Details of commercial plant, either the contact process or the lead chamber process, are not required.
(*d*) Common salt. Preparation and properties of hydrogen chloride; hydrochloric acid and chlorine. Chlorine: *its production by the electrolysis of brine* and by the oxidation of hydrochloric acid. Its properties (excluding the formation of chlorates); *the preparation and uses of bleaching powder and sodium hypochlorite.*	
11. The metallic elements. The physical and chemical differences between metallic and non-metallic elements. The extraction of iron by the blast furnace process. The action of water (or steam) on sodium, calcium, magnesium, iron. The action of dilute mineral acids on magnesium, *aluminium*. zinc, iron, lead, copper. *The action of sodium hydroxide on aluminium and zinc.* The chief uses of zinc, iron, lead and copper. The preparation of quicklime (heating calcium carbonate) *magnesium oxide* (*heating nitrate and carbonate*), *aluminium oxide* (*heating hydroxide*), zinc oxide (heating nitrate and carbonate), ferric oxide (heating hydroxide and ferrous sulphate), lead monoxide (heating nitrate and carbonate), cupric oxide (heating nitrate and carbonate). The action of dilute mineral acids on these oxides, and the action of alkalis on the oxides of aluminium and zinc. *The preparation of red lead by heating lead monoxide in oxygen. The action of dilute hydrochloric and nitric acids on red lead.* The preparation of *sodium hydroxide* (*by electrolysis of brine and from sodium carbonate*), slaked lime (from calcium oxide), ferric hydroxide (by precipitation) *and cupric hydroxide* (*by precipitation*). The action of dilute mineral acids on these hydroxides. Uses of sodium hydroxide and slaked lime. *The manufacture of sodium carbonate by the Solvay process.* Alloys: Steel, brass, *type-metal*, *duralumin* and soft solder. The simpler reasons for the use of these alloys in preference to the metals from which they are made.	Details of commercial plant not required. Details of commercial plant not required. Candidates will be expected to know the chemistry of the Solvay process, but not the technical details of the commercial plant.
12. The preparation of salts as illustrated	

SYLLABUS

NOTES

(*a*) by neutralisation (sodium and ammonium salts of common mineral acids);

(*b*) by the action of an acid on the appropriate metal (zinc and ferrous sulphates), or oxide (cupric sulphate and lead nitrate) or carbonate (calcium chloride or nitrate);

(*c*) by precipitation involving the double decomposition (copper carbonate, lead chloride, lead sulphate);

(*d*) *by direct union, e.g. ferric chloride.*

13. The study of the following topics: types of chemical change; *reversible reactions*; catalysts as substances which alter the speeds of reactions; *allotropy as exemplified by carbon and sulphur; basicity of acids, acid salts and normal salts; variable valency illustrated by ferrous and ferric salts; oxidation and reduction extended to a change in valency; methods of detecting oxidising and reducing agents.*

Some consideration should be given to the importance of surface area catalysts, e.g. contact process.

PRACTICAL CHEMISTRY

[Not for candidates offering Physics-with-Chemistry.]

In the PRACTICAL EXAMINATION candidates may be asked to observe the effects of heat and of reagents on substances supplied to them. Simple exercises in visual observation and experiments may include the recognition of the gases hydrogen, oxygen, carbon dioxide, chlorine, hydrogen chloride, hydrogen sulphide, sulphur dioxide, ammonia, nitrogen dioxide, water vapour; of the acid radicals nitrate, chloride, carbonate, sulphate, sulphite, sulphide; and of the metallic radicals lead, copper, iron, zinc and calcium. Knowledge of a formal scheme of analysis is not required.

Volumetric analysis: the use of standard solutions of acids and alkalis and the indicators methyl orange (or screened methyl orange) and phenolphthalein in determining (*a*) the concentration of solutions of acids and alkalis (including sodium carbonate and bicarbonate); (*b*) the equivalent weights of acids and alkalis by direct titration; (*c*) simple exercises to test a knowledge of the principles of volumetric analysis. Back titrations will not be required and calculations may be worked either from normalities or from reacting weights. Candidates will not be expected, in the examination, to prepare their own standard solutions.

ALTERNATIVE-TO-PRACTICAL CHEMISTRY. The Practical Chemistry paper will be alternative to a 1½-hour written paper to be known as the Alternative-to-Practical paper. This paper is designed to test a knowledge of the practical work cognate to the theoretical syllabus; candidates taking it are required to submit satisfactory evidence that they have undergone a proper course of laboratory work. (See p. 3.)