UNIVERSITIES OF MANCHESTER LIVERPOOL LEEDS SHEFFIELD AND BIRMINGHAM

Joint Matriculation Board

General Certificate of Education

CHEMISTRY. PAPER I

ADVANCED

THURSDAY 20 JUNE 1957, 9.30-12.30

Answer **six** *questions as follows:*

(*a*) **two** *from* SECTION (1);

(*b*) **two** *from* SECTION (2);

(*c*) **two** *from* SECTION (3).

Answers to Sections (1), (2) and (3) must be written in different answer-books.

The books must be marked clearly either SECTION (1) *or* SECTION (2) *or* SECTION (3) *and handed in to the Supervisor separately.*

Candidates should wherever possible show by their answers that they have seen or themselves performed experiments on the subjects they are discussing.

Chemical equations should be written for definite chemical reactions wherever possible.

The following data may be required:

Atomic weights: H = 1, C = 12, O = 16, Cl = 35·5, K = 39.

SECTION (1)

Answer **two** *questions from this section.*

1. Outline the procedure and reactions involved in the Solvay (Ammonia-Soda) process for the manufacture of sodium carbonate.

Describe and briefly explain **one** use of sodium carbonate in qualitative analysis.

Explain briefly why calcium hydroxide is used for the detection of carbon dioxide gas whereas potassium hydroxide is used for the absorption of the gas.

2. Describe, giving a diagram, the preparation in the laboratory of pure carbon monoxide.

Under what conditions and with what results does carbon monoxide react with (*a*) sodium hydroxide, (*b*) lead monoxide?

Name **two** industrial gas mixtures of which carbon monoxide is a constituent, and say briefly how these mixtures are made. Comment briefly on the importance of **one** of these mixtures.

3. Describe with full experimental detail **one** method by which you would determine the equivalent weight of **either** (*a*) copper, **or** (*b*) carbon, and state what further information is needed to find the atomic weight of the element selected.

A metal forms three oxides containing 23·53, 31·58 and 48 per cent. of oxygen. Deduce a possible value for the atomic weight of the metal.

4. Discuss the meaning of the term 'electrochemical series'. Arrange the elements calcium, copper, iron, magnesium, potassium and zinc in an order which illustrates the series.

Justify the order you give by considering the behaviour of each of these elements towards water (or steam).

SECTION (2)

(Answers to be written in a separate answer-book.)

Answer **two** *questions from this section.*

5. Define (*a*) exothermic reaction, (*b*) heat of solution, (*c*) heat of formation. Name and define the unit in which heat is usually expressed in chemical problems.

(i) State Hess's Law of Constant Heat Summation.

(ii) Explain why the heat of neutralization of any strong acid by any strong base is the same.

(iii) Explain why heat is evolved when many electrolytes dissolve in water although it would be expected that the work done in separating their ions would be revealed by the absorption of heat.

The heats of formation of steam and ferrosoferric oxide, Fe_3O_4, are respectively 57·8 and 266·9 units evolved. Calculate the heat of the reaction between this oxide and hydrogen to give iron and steam.

6. Describe an experimental method for finding the molecular weight of cane sugar by studying its effect on the freezing point of water.

Two solutions, one containing 10 gm. of potassium chloride ~~per~~ IN 1,000 gm. water and the other 10 gm. of cane sugar, $C_{12}H_{22}O_{11}$, ~~per~~ IN 1,000 gm. water, are allowed to cool in the same freezing bath. (*a*) From which solution and at what temperature will ice first separate, and (*b*) how much ice will have separated from that solution by the time it first appears in the other? Supercooling should be neglected in this calculation and the salt should be regarded as completely dissociated. The freezing point constant per 1,000 gm. water is 1·86° C. per gm. mol.

7. Explain concisely what is meant by the Periodic Classification of the elements, indicating, with one example of each, the significance of the terms ' group ', ' short period ' and ' transition element '.

How is the electronic structure of an element related to (*a*) its position in the periodic classification, (*b*) its valency?

Give the electronic structures of the following atoms: argon, carbon, chlorine, sodium.

How is it that iron (atomic number 26) can have two valencies?

8. Explain the following:

(*a*) Sodium bicarbonate, although an acid salt, reacts alkaline to methyl orange.

(*b*) If ammonium chloride is heated and the vapour is passed through a porous pipe surrounded by an impervious tube, the outer (annular) space can be shown to contain ammonia as well as ammonium chloride.

(*c*) Although under standard atmospheric pressure chlorobenzene and water boil at 132° and 100° C. respectively and are insoluble in each other, a mixture of the two boils below 100° C. under the same atmospheric pressure.

(*d*) Water oxidizes sodium.

SECTION (3)

(Answers to be written in a separate answer-book.)

Answer **two** *questions from this section.*

9. Give **three** general reactions by which an aliphatic carboxylic acid may be prepared, mentioning the necessary reagents and stating whether heat is required.

Describe how you would carry out a practical test to show that alcohols and acids both contain hydroxyl groups.

State briefly how, starting from acetic acid, you would prepare (*a*) methane, (*b*) acetone, (*c*) acetic anhydride.

10. How and under what conditions does chlorine react with (*a*) methane, (*b*) ethylene, (*c*) benzene, (*d*) acetic acid, (*e*) ethyl alcohol?

What are the reactions of warm aqueous sodium hydroxide upon the products from (*b*) and (*e*)?

What deductions concerning the general chemical character of methane, ethylene and benzene can be made from their behaviour with chlorine?

11. Name **four** distinct classes of organic compounds (other than ammonium salts) which contain nitrogen. Write the *structural* formula of **one** example of each class.

For each of these examples outline **one** method of preparation and give **one** reaction which is characteristic of the typical group.

Selecting **three** of these classes, indicate how you would ascertain by experiment to which class an unknown water-insoluble aromatic nitrogen-containing substance belonged.

12. In an experiment for the preparation of ethyl acetate, a mixture of 90 gm. of ethyl alcohol and 120 gm. of acetic acid was gradually added to a mixture of 45 gm. of ethyl alcohol and 100 gm. of sulphuric acid kept at 140° C. in a distilling flask from which the product distilled over.

What is the maximum yield of ethyl acetate (in gm.) which would be obtained from this experiment, if there were no loss from any source?

What are the principal sources of loss in the actual experiment (*a*) in the preparation, (*b*) in the purification ?

By what sequence of reactions could methyl alcohol be prepared, starting from ethyl acetate? Indicate the necessary reagents and reaction conditions.