

## CHEMISTRY—ORDINARY LEVEL

MONDAY, 22 JUNE—AFTERNOON, 2 to 5

Six questions to be answered  
All questions carry the same marks

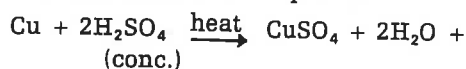
Relative atomic masses (atomic weights): H = 1, C = 12, N = 14, O = 16, Na = 23, S = 32, Cl = 35.5, Ca = 40

Avogadro's constant (number) =  $6 \times 10^{23}$

1 Faraday = 96,500 Coulombs

1. Answer *eleven* of the following items (a), (b), (c), etc. All items carry the same marks. *Keep your answers short.*

- (a) Write down an expression for the general gas equation.  
 (b) Write down the structural formula for formaldehyde (methanal).  
 (c) What is the percentage by weight of nitrogen in ammonium sulphate?  
 (d) Complete the following equation and name the compound.



- (e) In the electrochemical series the following elements are in order of *decreasing* chemical activity: sodium, aluminium, copper. Justify this order by referring to the reaction, if any, of each of these three elements with water.  
 (f) Give an example of an element that exhibits variable valence.  
 (g) What is a polymer? Give an example of a polymer.  
 (h) What is meant by the first ionisation energy of an element?  
 (i) How many atoms of sodium are there in 4.6 g of the metal?  
 (j) What is the pH of a 1M NaOH solution?  
 (k) Indicate the shape of a p orbital.  
 (l) In what respect does a strong acid differ from a weak acid?  
 (m) What is meant by a metallic bond?  
 (n) State, on the basis of electron transfer, which species is oxidised and which is reduced in the following reaction:



- (o) Outline a characteristic test which shows that a hydrocarbon is unsaturated.

2. (a) Outline the principles of the electron pair repulsion theory and indicate how they may be applied to determine the shape of each of the following molecules:  $\text{CH}_4$ ,  $\text{H}_2\text{O}$ ,  $\text{BeH}_2$ .  
 (b) Select, from the following list below, one example in each case of (i) a covalent crystal; (ii) a molecular crystal; (iii) a metallic crystal; (iv) an ionic crystal:

diamond, sodium chloride, sulphur, iron, calcium oxide, iodine.

Outline the general properties of covalent compounds.

3. What is meant by (i) atomic number, (ii) relative atomic mass (atomic weight), (iii) isotopes?  
 Write down the electronic configuration (s,p) of the elements of atomic number 14 and 21 and name these two elements.

In terms of atomic structure explain the following observation:

When a sample of a metal salt is heated on a platinum wire a colour characteristic of the metal is often observed.

4. What is an electrolyte?

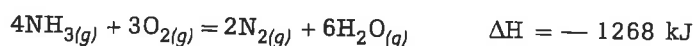
State Faraday's laws of electrolysis.

In the electrolysis of molten calcium bromide,  $\text{CaBr}_2$ , a current of 5 A is passed for 193 seconds. Calculate (i) the number of coulombs, (ii) the number of faradays, in the electrolysis, (iii) the mass of calcium produced at the cathode.

In terms of electron transfer show where oxidation and reduction occur in the electrolysis of the molten salt.

5. Define (i) heat of formation of a compound,  
(ii) heat of combustion of a compound.

Calculate the heat change for the reaction,  $\text{N}_{2(g)} + 3\text{H}_{2(g)} \longrightarrow 2\text{NH}_{3(g)}$   
given the following data:



Describe how you would measure the heat of neutralisation of an acid.

6. What is the general formula that represents each of any *three* of the following homologous series of organic compounds:

alkenes, alkynes, alcohols, carboxylic acids?

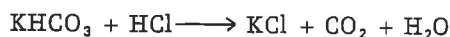
Give the name and the structural formula of one compound in each of the series you have chosen.

How could (i) an alkyne be converted to an alkene, (ii) an alcohol be converted to a carboxylic acid?

Using a labelled diagram, show how the preparation in (ii) could be carried out in the laboratory.

State *three* of the principal chemical properties of carboxylic acids.

7. Potassium hydrogen carbonate ( $\text{KHCO}_3$ ) reacts with hydrochloric acid according to the equation:



It was found that  $25.0 \text{ cm}^3$  of a solution containing  $10.8 \text{ g}$  per litre ( $\text{dm}^3$ ) of  $\text{KHCO}_3$  reacted with  $27.0 \text{ cm}^3$  of a solution of hydrochloric acid.

Calculate (i) the molarity of the hydrochloric acid solution, (ii) the concentration in grams per litre ( $\text{dm}^3$ ). Outline the precautions necessary for an accurate result in this titration.

How could you confirm the presence of (a) chloride ions, (b) sulphate ions, in aqueous solution?

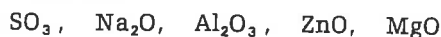
8. (a) Ethane is an aliphatic hydrocarbon and benzene is an aromatic hydrocarbon. Both of these compounds chiefly undergo substitution reactions. Explain the underlined terms and give an appropriate equation for a substitution reaction in the case of each compound.

(b) A compound of vapour density 21 was analysed and shown to contain 85.7% carbon and 14.3% hydrogen, by weight.

Find (i) the empirical formula, (ii) the molecular formula, of the compound.

b3

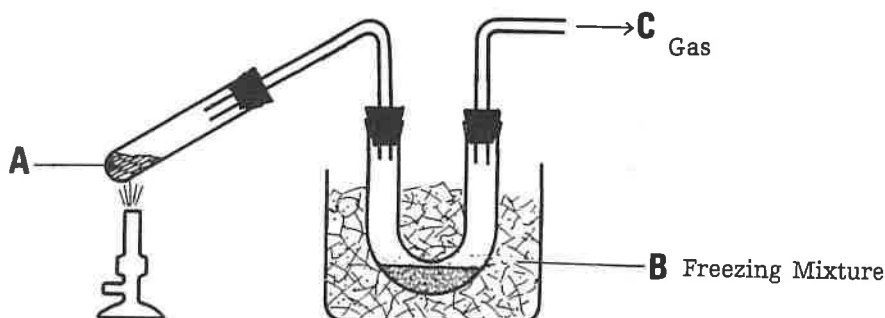
9. (a) From the following list of compounds



select (i) an acidic oxide, (ii) an amphoteric oxide, (iii) a basic oxide.

Show, by means of an equation, the reaction, if any, with water of the compounds selected and name the products obtained.

- (b) The diagram shows an apparatus used for the preparation of nitrogen dioxide.

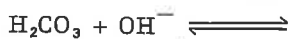


- Name the solid A.
- What is the purpose of the freezing-mixture B?
- What is the gas C that emerges from the U-tube?
- Give the equation for the reaction that occurs in the preparation.

10. Answer any two of the following.

- (a) What is (i) a base, (ii) a conjugate acid, in terms of the Brønsted-Lowry theory?

Complete the following equations and, in each case, indicate the appropriate acid-base pairs.



- (b) What is meant by the electronegativity of an element?

The electronegativity values of three elements represented by the symbols A, B, and C are 0.9, 2.5 and 3.0 respectively. Using these values state what type of bond is most likely to be found in the compounds AB, AC and BC.

A compound XY (where X and Y are symbols representing elements) is soluble in a polar solvent. What information about the electronegativity values of X and Y does this indicate?

- (c) Name (i) a hydride of sulphur, (ii) a hydride of nitrogen.

Outline the laboratory preparation of one of the hydrides named and state three of its principal chemical properties.

- (d) "The halogens can be considered to be a typical group in the Periodic Table having similar chemical properties".

Show that this statement may be justified by reference to two reactions of each of any three members of the halogen group.