| School Number | Candidate Number |
|---|---|
| | |
| Surname and Initials | |

# CHEMISTRY

**PAPER 3 3051/3**

**Monday 4 JUNE 2012 12.00 – 1.30 P.M.**

**Additional materials:**
**Answer booklet**
**Graph paper**

## MINISTRY OF EDUCATION NATIONAL EXAMINATIONS

**BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION**

### INSTRUCTIONS AND INFORMATION TO CANDIDATES

**Do not open this booklet until you are told to do so.**

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** the questions in **Section A** in the spaces provided on the question paper and any **TWO** questions from **Section B** on the lined paper provided.

Equations and diagrams should be given wherever they are helpful. Essential working must be shown.

The intended marks for each question or part question are given in brackets [ ].

Relative atomic masses are given in the Periodic Table of elements provided.

| FOR EXAMINER'S USE | |
|---|---|
| **Section A** | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| **Section B** | |
| 5 | |
| 6 | |
| 7 | |
| TOTAL | |

### ADDITIONAL INFORMATION

s.t.p. (t = 0 °C, p = 760 mmHg)
The volume of one mole of gas at room temperature and pressure (r.t.p.) is 24 000 $cm^3$.

**This question paper consists of 13 printed pages and 3 blank pages.**

582124

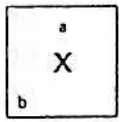
# The Periodic Table of the Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 H Hydrogen 1 | | | | | | | | | | 4 He Helium 2 |
| 7 Li Lithium 3 | 9 Be Beryllium 4 | | | | | | | | | | | 11 B Boron 5 | 12 C Carbon 6 | 14 N Nitrogen 7 | 16 O Oxygen 8 | 19 F Fluorine 9 | 20 Ne Neon 10 |
| 23 Na Sodium 11 | 24 Mg Magnesium 12 | | | | | | | | | | | 27 Al Aluminium 13 | 28 Si Silicon 14 | 31 P Phosphorus 15 | 32 S Sulphur 16 | 35.5 Cl Chlorine 17 | 40 Ar Argon 18 |
| 39 K Potassium 19 | 40 Ca Calcium 20 | 45 Sc Scandium 21 | 48 Ti Titanium 22 | 51 V Vanadium 23 | 52 Cr Chromium 24 | 55 Mn Manganese 25 | 56 Fe Iron 26 | 59 Co Cobalt 27 | 59 Ni Nickel 28 | 64 Cu Copper 29 | 65 Zn Zinc 30 | 70 Ga Gallium 31 | 73 Ge Germanium 32 | 75 As Arsenic 33 | 79 Se Selenium 34 | 80 Br Bromine 35 | 84 Kr Krypton 36 |
| 85 Rb Rubidium 37 | 88 Sr Strontium 38 | 89 Y Yttrium 39 | 91 Zr Zirconium 40 | 93 Nb Niobium 41 | 96 Mo Molybdenum 42 | Tc Technetium 43 | 101 Ru Ruthenium 44 | 103 Rh Rhodium 45 | 106 Pd Palladium 46 | 108 Ag Silver 47 | 112 Cd Cadmium 48 | 115 In Indium 49 | 119 Sn Tin 50 | 122 Sb Antimony 51 | 128 Te Tellurium 52 | 127 I Iodine 53 | 131 Xe Xenon 54 |
| 133 Cs Caesium 55 | 137 Ba Barium 56 | 139 La Lanthanum 57 * | 178 Hf Hafnium 72 | 181 Ta Tantalum 73 | 184 W Tungsten 74 | 186 Re Rhenium 75 | 190 Os Osmium 76 | 192 Ir Iridium 77 | 195 Pt Platinum 78 | 197 Au Gold 79 | 201 Hg Mercury 80 | 204 Tl Thallium 81 | 207 Pb Lead 82 | 209 Bi Bismuth 83 | Po Polonium 84 | At Astatine 85 | Rn Radon 86 |
| Fr Francium 87 | 226 Ra Radium 88 | 227 Ac Actinium 89 † | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | Pm Promethium 61 | 150 Sm Samarium 62 | 152 Eu Europium 63 | 157 Gd Gadolinium 64 | 159 Tb Terbium 65 | 162 Dy Dysprosium 66 | 165 Ho Holmium 67 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 |
| 232 Th Thorium 90 | Pa Protactinium 91 | 238 U Uranium 92 | Np Neptunium 93 | Pu Plutonium 94 | Am Americium 95 | Cm Curium 96 | Bk Berkelium 97 | Cf Californium 98 | Es Einsteinium 99 | Fm Fermium 100 | Md Mendelevium 101 | No Nobelium 102 | Lr Lawrencium 103 |

*58-71 Lanthanoid series
†90-103 Actinoid series

Key




a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

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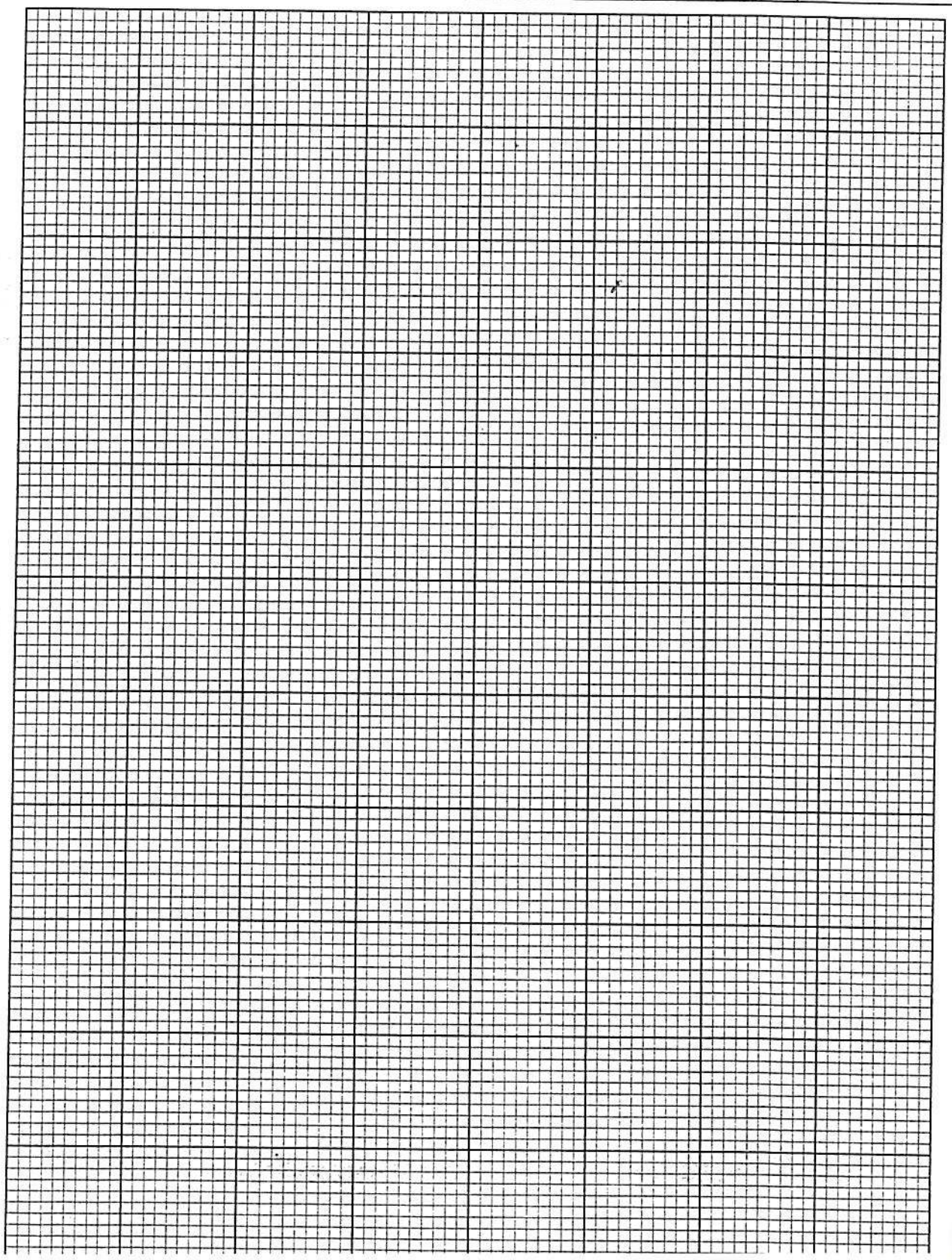
| Surname & Initials: | | Section: | |
| Signature: | Date: | Ques. No. | |



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EXAMINATION

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| Subject Number & Title: | | Paper: | |
| Surname & Initials: | | Section: | |
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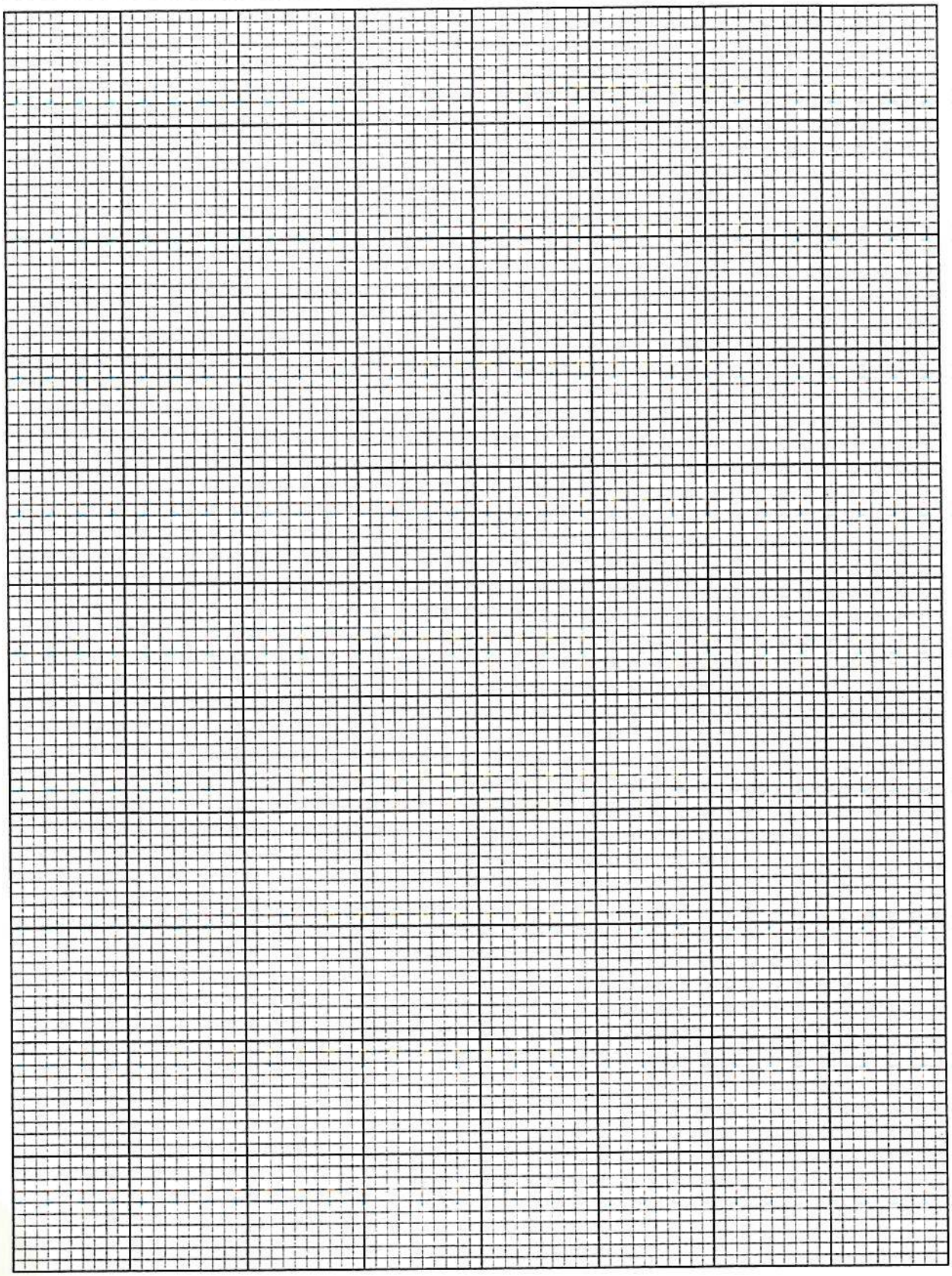
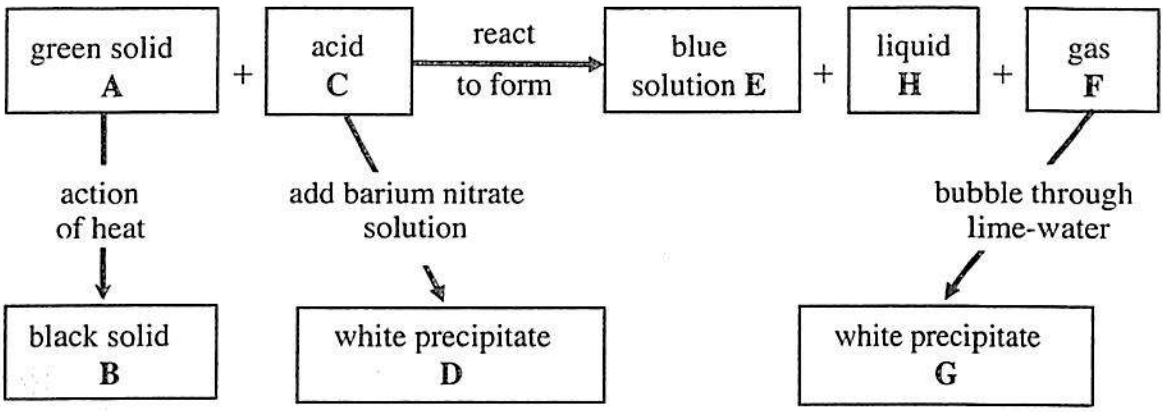


## Section A

Candidates are to answer ALL questions in **Section A**.

1. Use the information in the chart to answer this question.




(a) (i) Identify the following substances from **A** to **H**.

green solid **A** _____

black solid **B** _____

acid **C** _____

white ppt. **D** _____

blue solution **E** _____

gas **F** _____

white ppt. **G** _____

liquid **H** _____ [8]

(b) Gas **F** is bubbled through a mixture of water and Universal Indicator. The Universal Indicator turns orange.

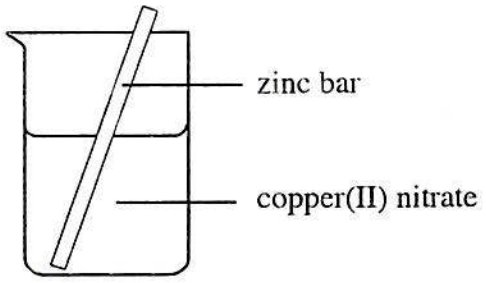
Suggest the

(i) pH of the new compound; _____ [1]

(ii) formula of the new compound formed. _____ [1]

**Total marks [10]**

2. The diagram shows a zinc bar placed in copper(II) nitrate solution undergoing a redox reaction.




(a) (i) Describe **ONE** observation in the experiment which indicates that a chemical reaction is taking place.

_____

_____ [1]

(ii) Write a balanced equation for the reaction taking place in the diagram.

[2]

Iron rusts in the presence of oxygen and water. The simple version of the chemical reaction could be written as

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

(b) Name the substance which acts as an oxidizing agent.

_____ [1]

(c) The Alaskan oil pipeline has zinc bars attached to it to prevent rusting of the steel pipeline.

Explain in terms of electrons how this is achieved.

_____

[1]

(d) The oxidation number of chromium can vary from compound to compound, resulting in chromium compounds with strikingly different colours.

State the oxidation number of chromium in $CrCl_2$.

_____ [1]

Sodium azide ($NaN_3$) is the chemical that produces nitrogen gas to inflate the air bag in cars. Immediately after an accident or collision, the sodium azide in the air bag decomposes into nitrogen gas and sodium, the sodium immediately reacts with iron(III) oxide to form sodium oxide and iron.

(e) (i) The chemical equation for one of the reactions is given. Balance this redox reaction.

_____ $NaN_3(s) \rightarrow$ _____ $N_2(g)$ + _____ $Na(s)$ [1]

(ii) Calculate the mass of sodium azide required to produce 45 $dm^3$ of nitrogen gas at r.t.p.

[3]

**Total marks [10]**

3. A chemistry student was asked to verify the advertised concentration of lye (sodium hydroxide) in a locally sold container of drain cleaner. The student accurately measured 25.00 $cm^3$ of the drain cleaner and placed it in a 250 $cm^3$ beaker. The student added a few drops of neutral litmus solution indicator to colour the lye solution. The student used hydrochloric acid, concentration 2.0 $mol/dm^3$, to find out the concentration of the lye.

**Figure A** shows **FOUR** pieces of glassware used to verify the concentration.

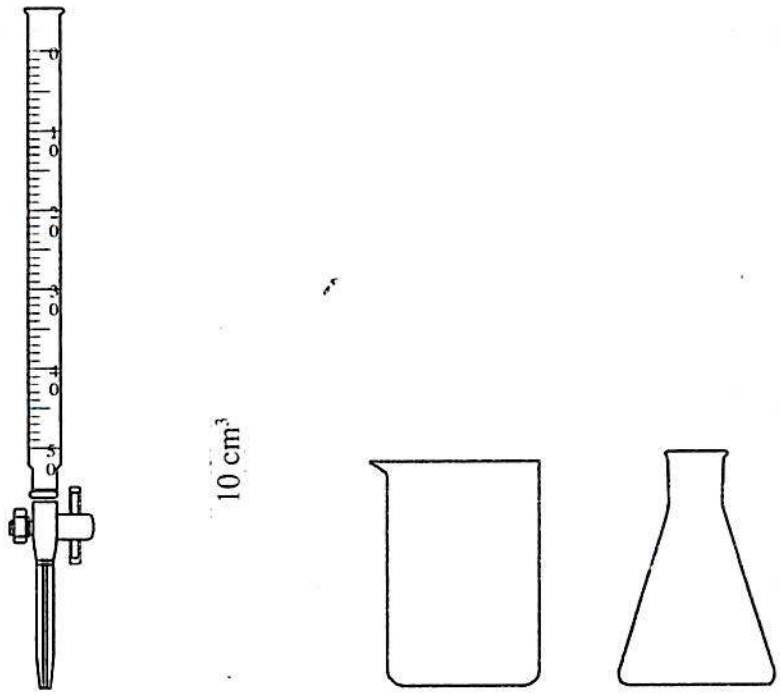



**Fig. A**

(a) Name the apparatus

(i) used to transfer the lye to the beaker; _____

(ii) which contains the hydrochloric acid. _____ [2]

(b) The litmus changes colour when the last drop of 20.0 $cm^3$ of the 2.0 $mol/dm^3$ hydrochloric acid is added to the lye solution.

(i) Calculate the number of moles of hydrogen ions present in 20.0 $cm^3$ of 2.0 $mol/dm^3$ hydrochloric acid.

[1]

(ii) Calculate the concentration of sodium hydroxide in mol/dm$^3$ in 25.0 cm$^3$.

[2]

(c) The same test was carried out using 2.0 mol/dm$^3$ of sulfuric acid.

(i) Find the volume of sulfuric acid needed to neutralize 25.0 cm$^3$ of the lye solution.

[1]

Explain your answer.

_____

_____

_____

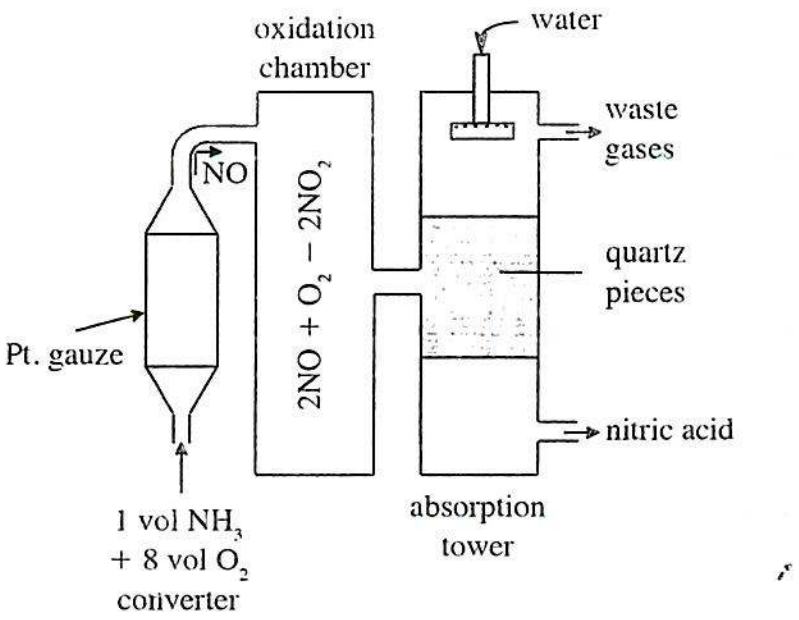
_____ [2]

(ii) Write a balanced equation for the reaction in (c)(i).

[2]

**Total marks [10]**

4. The diagram shows the Ostwald process for the production of nitric acid.




(a) (i) State what part the platinum(Pt) plays in the reaction.

_____ [1]

(ii) Explain why the platinum used is in a gauze form instead of a sheet.

_____ [1]

(b) Calculate the oxidation number of nitrogen for each of the two oxides inside the oxidation chamber.

NO

$NO_2$

[2]

(c) An accident at the factory allowed some of the gases in the oxidation chamber to escape, causing pollution of the air.

(i) Use a chemical equation to show the reaction of one of these gases with naturally occurring substances in the atmosphere.

[2]

(ii) Use your answer in (c)(i) to describe **ONE** effect of this pollutant on the environment.

_____ [1]

Most of the nitric acid made by the Ostwald process is used to make salts for use elsewhere.

(d) (i) State the main use for these salts of nitric acid.

_____ [1]

(ii) Explain what happens if these chemicals are allowed to leak into a lake or river.

_____

_____ [2]

**Total marks [10]**

## Section B

Answer any TWO questions in the answer booklet provided.

5. Some industrial processes use reversible reactions that do not produce 100% yields. Two such reactions lead to the production of sulfuric acid and ammonia.

(a) (i) Name the **TWO** industrial processes used to produce sulfuric acid and ammonia. [2]

(ii) Name the raw materials and their sources used in each process. [4]

(iii) Write the reversible reaction that is part of each process including the state symbols and a symbolic representation of the energy change that takes place. [4]

Choose one of the reversible reactions from part (iii). Use Le Chatelier's Principle to state and explain the effect on the concentration of the reactants at equilibrium if

(iv) the temperature is increased;

(v) one of the products is removed. [4]

(b) One of the uses of ammonia is the manufacture of nitric acid which when used with more ammonia can form ammonium nitrate. The solid form of this salt can be obtained by evaporating away the solvent. The reaction is:

$$NH_3(g) + HNO_3(aq) \rightarrow NH_4NO_3(s)$$

(i) Calculate the mass of solid that would be produced from exactly 30000.0 $cm^3$ of ammonia measured at r.t.p. [3]

In another reaction, under the same conditions, $9.03 \times 10^{23}$ molecules of nitric acid reacted with ammonia. The same mass of ammonium nitrate was produced.

(ii) Use Avogadro's constant to calculate the number of moles of $HNO_3$ present. [2]

(iii) Compare your answers in (b)(i) and (b)(ii) and state why the same mass of solid is produced. [1]

**Total marks [20]**

6. Some students performed two experiments using equal masses of calcium. In one experiment 0.2 grams of calcium was added to excess water and in the second experiment 0.2 grams of calcium was added to excess dilute hydrochloric acid. The volume of hydrogen produced in each experiment was measured at regular intervals and recorded in the form of a table. All gas volumes are measured at r.t.p.

| time/s | 10 | 20 | 30 | 40 | 50 | 60 | 80 | 90 | 100 | 110 |
|---|---|---|---|---|---|---|---|---|---|---|
| volume of hydrogen produced using $H_2O/cm^3$ | 6 | 12 | 20 | 29 | 40 | 54 | 88 | 109 | 119 | 120 |
| volume of hydrogen produced using $HCl(aq)/cm^3$ | 24 | 50 | 80 | 100 | 116 | 120 | 120 | 120 | 120 | 120 |

(a) (i) Using the data in the table, plot two graphs of volume of hydrogen against time on the same axes. [8]

(ii) Use your graph to determine the volumes of hydrogen produced in each experiment at 70 s. [2]

(iii) State which of the reactions was most rapid at the start. [1]

(iv) In a third experiment a more concentrated acid was used. Predict, without calculating, a volume of hydrogen that would be produced with the same mass of calcium in 30 seconds. [1]

(b) (i) Write a chemically balanced equation for the reaction between calcium and water. [2]

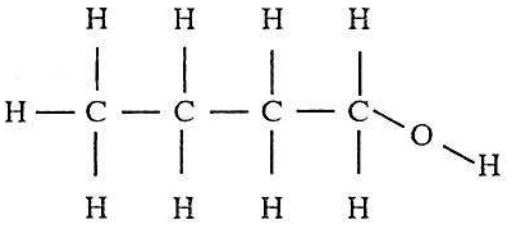
(ii) The mass of calcium used in each experiment is 0.2 g. Use your equation in (b)(i) to calculate the mass of calcium that remain unreacted in water at 20 s. [3]

(c) Universal Indicator was added to the two solutions remaining after all the gas has been given off from the two experiments. Students observed the colour **green** in one and **blue** in the other.

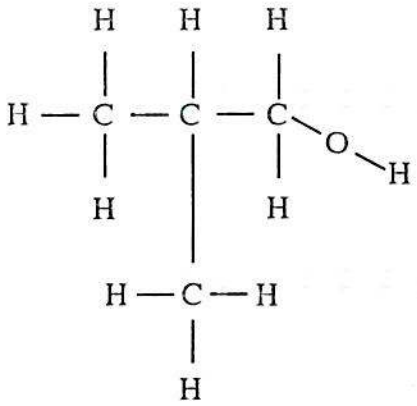
Write the **TWO** formulas of the products in the solutions and explain the reasons for the colours. [3]

**Total marks [20]**

7. (a) These structures of molecules represent two isomers labeled X and Y of a homologous series.



X



Y

(i) Identify the functional group and name the homologous series to which these substances belong. [2]

(ii) State three similar characteristics of these **TWO** isomers. [1]

(b) Esters are common in plants and are responsible for distinctive flavours and scents. The flavour of pineapple is caused by ethylbutanoate.

(i) Write the formulas of **TWO** chemical compounds that react to form ethylbutanoate. [2]

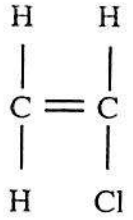
(ii) Write a word equation for the reaction. [2]

(c) When ethene reacts with $H_2$ under the proper conditions, the double bond is broken and hydrogen atoms are added to produce an alkane.

(i) Draw the structural formulas of ethene and of the product of its reaction with hydrogen. [2]

(ii) Name the type of reaction taking place in (c)(i). [1]

(d) PVC is used to make pipes, bubble wraps, insulation for cables and automobile parts. It is made from the monomer shown.



(i) Draw a portion of the PVC molecule to show the combination of 3 molecules of the monomer. [2]

(ii) Name the type of reaction that takes when PVC is formed. [1]

(e) This mathematical question is about substances extracted from plants.

(i) A sample of an unknown compound with a mass of 0.2370 g is extracted from the roots of a plant. Decomposition of the sample produces 0.0948 g of carbon, 0.1264 g of oxygen and 0.0158 g of hydrogen.

State the percentage composition of carbon, hydrogen and oxygen in the compound. [3]

(ii) Use the percentage composition determined in (e)(i) to find the empirical formula of the compound extracted from the roots of the plant. [2]

(iii) Two chemical compounds **A** and **B** in the plant have the same empirical formula as in (e)(ii) but their molecular formulas are different.

Find the molecular formulas of the two compounds if their relative molecular masses are 150 and 180 respectively. [2]

**Total marks [20]**



**End]**

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