**233/2**

**CHEMISTRY**

**Paper 2**

**Time: 2 hours**

**M A R K I N G S C H E M E**

1. A. In an experiment to determine the percentage of oxygen in air, the apparatus below were set up. Study the set up and the information provided to answer the

questions that follow.

**K**

Copper turnings

100

200

300

400

500

**J**

Water

**I**

Heat

Flask **H** (500cm3)

 A 500cm3 measuring cylinder **K** was filled with water and assembled for gas collection. Copper turnings were heated red hot and water was slowly passed into 500cm3 flask **H** until it reached the 500cm3 mark. A colourless gas was collected in **K**.

 (i) What was the purpose of passing water into flask **H**? **(1 mark)**

 ***To displace air in flask H over the hot copper turnings.***

 (ii) What observations were made in the tube **I**? **(1 mark)**

 ***The brown solid changes to black***

 (iii) Name one of the gases that is likely to be found in **J**. **(1 mark)**

 ***Nitrogen, carbon (IV) oxide, argon, (Xeron, neon) (Any one)***

 (iv) What was the volume of the gas collected in the measuring cylinder at the end of the experiment? **(1 mark)**

 ***410cm3***

(v) Calculate the percentage of oxygen in air using the above results. **(2 marks)**

**🗸1**

 $\frac{\left(500 ×410\right)}{500}×100= \frac{90 ×100}{500}=18\%$**🗸1**

**B.** Study the diagram below and answer the questions that follow.

Ice cold water

Copper (II) oxide

$$H\_{2(g)}$$

Colourless liquid **Y**

Heat

(a) Give ***one*** observation made in the combustion tube after some time. **(1 mark)**

***Black CuO turns to red-brown Cu.***

 (b) Write an equation for the formation of the colourless liquid **Y**. **(1 mark)**

 $2H\_{2(g)} + O\_{2(g)}2H\_{2}O\_{(l)}$

 (c) What was the aim of the above experiment as demonstrated in the combustion

tube? Explain. **(2 marks)**

***To determine the reducing property of hydrogen.* 🗸1*Hydrogen is above Cu* 🗸1 *in the reactivityseries, thus it reduces the oxygen from CuO.***

2. Use the information below to answer the questions that follow. The letters are not the actual symbols of the elements.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Atomic No.** | **M.P0C** | **B.P0C** | **Ionic radius (nm)** |
| P | 11 | 98 | 890 | 0.095 |
| Q | 12 | 650 | 1110 | 0.065 |
| R | 13 | 660 | 2470 | 0.050 |
| S | 14 | 1410 | 2360 | 0.041 |
| T | 15 | 44.2 & 590 | 280 | 0.034 |
| U | 16 | 113 & 119 | 445 | 0.184 |
| V | 17 | -101 | -35 | 0.181 |
| W | 18 | -189 | -186 | - |

 (a) (i) Write the electronic configuration of the atoms represented by letters **T** and **W**. **(1 mark)**

  ***T - 2.8.5* 🗸 ½**

 ***W - 2.8.8* 🗸 ½**

 (ii) State the nature of the oxides of the elements represented by **Q** and **U**.  **(2 marks)**

 ***Q - Basic Oxide* 🗸1**

 ***U - Acidic oxide* 🗸1**

 (b) Why does the elements represented by the letters **T** and **U** have two values of melting points? **(1 mark)**

 ***The two elements exhibit allotropy.***

 (c) Explain the following observations in terms of structure and bonding.

 (i) There is an increase in boiling point from **P** to **R**. **(2 marks)**

***There is gradual increase in the strength of the metallic bonds* 🗸1 *due to the increase in the number of delocalized (valence) electrons in the element* 🗸1**

 (ii) Element **S** has a high boiling point.  **(2 marks)**

***The atomic radius of V is smaller than that of U.* 🗸1 *V has more protons therefore has a stronger nuclear attraction hence the smaller atomic radius.*🗸1**

 (iii) There is a decrease in boiling points from **U** to **W**. **(2 marks)**

***Elements U, V and W have simple molecular structures*🗸1 *in which the molecules are held by weak Van der waals forces. The Van der waals* 🗸1 *forces weaken from U to W.***

 (d) (i) Compare the atomic radius of **U** and **V**. **(1 mark)**

***The atomic radius of V is smaller than that of U.* 🗸1**

 (ii) Why is there no ionic for **W** reported in the table? **(1 mark)**

 ***It has a stable electron configuration hence does not ionize.***

3. (a) The solubilities of potassium nitrate and potassium bromide at different temperatures was determined. The following data was obtained.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Temperature 0C | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| Solubility g/100g H2O | KNO3 | 5 | 15 | 26 | 43 | 61 | 83 | 105 | 135 | 165 |
| KBr | 50 | 55 | 60 | 65 | 70 | 77 | 85 | 90 | 95 |

 (i) Draw solubility curves for both salts on the same axis. **(3 marks)**



 (ii) What was the solubility of each salt at 650C? **(1 mark)**

 $KNO\_{3}- 120g/100g $ **of water** $\pm 1$ **🗸 ½**

 ***KBr*** $-$ ***87g/100g of water*** $\pm $ ***1 🗸 ½***

 (iii) 100g of a saturated solution of potassium nitrate at 700C was cooled to 200C. What mass of the crystals will be crystallized? **(2 marks)**

 ***At 700C solubility = 135g/100g of water***

 ***If 235g contain 135g of salt***

 ***100g contain 135g***

$\frac{100 ×135}{235}=57.4468g $***🗸 ½***

 ***At 200C solubility = 26g/100g of water***

 ***If 126g contain 26g of salt***

 ***100g contain ?***

$\frac{100 ×26}{126}=20.6349g $***🗸 ½***

 ***Mass which will crystallized***

 ***57.4468 – 20.6349***

 ***= 36.8119g***

 (b) Study the flow chart below and answer the questions that follow.

Solution

**C**

Dil. HCl

Solid **A**

+

Gas **B**

Heat

Metal carbonate

A few drops of NH3(aq)

Deep blue solution **E**

Excess of

NH3(aq)

Solid **D**

 (i) Write an equation for the formation of solid **A** and gas **B**. **(1 mark)**

$CuCO\_{3(s)} heat CuO\_{(s)} + CO\_{2(g)}$

(ii) Name;

 Solution **C** - ***Copper (II) chloride***  **(1 mark)**

 Solid **D** - ***Copper (II) hydroxide*** **(1 mark)**

 (c) Write the formula of the complex ion in solution **E**. **(1 mark)**

2+

$Cu (NH\_{3})\_{4}$

4. Study the flow chart below and answer the questions that follow.

**II**

 **III**

NaOH

Heat

$$CH\_{4}$$

$$CH\_{3}COONa$$

$$CH\_{3}Cl$$

 Na2CO3

**W**

NaOH

**I**

$$CH\_{3}COOCH\_{2}CH\_{2}CH\_{3}$$

$$CH\_{3}COOH$$

$$KM\_{n}O\_{4 }H^{+}$$

NaOH

**IV**

Na

$$CH\_{3}CH\_{2}CH\_{2}OH$$

**Q**

$$CH\_{3}CH\_{2}OH$$

$$CH\_{3}COONa$$

**V**

**Z**

**X**

HI

**R**

$$CH\_{2}=CH\_{2}$$

**VI**

 H H

 C C

 H H

**Y**

n

 (a) Name substance. **(3 marks)** X - ***Sodium ethonoate🗸 1***

 Q - ***Sodium ethoxide 🗸 1***

 R - ***Iodoethane 🗸 1***

 (b) Write down an equation for the reaction represented by step III. **(1 mark)**

 $CH\_{3}COONa\_{\left(s\right)}+ NaOH\_{(aq)}CH\_{4(g)} + Na\_{2}CO\_{3(s)}$

 (c) What are the conditions and reagent required for steps?

1. **I** **(2 marks)**

Reagent - ***Propan-l-ol 🗸 1***

Condition - ***Conc. H2SO4 🗸 1***

1. **IV (2 marks)**

Reagent - ***Conc. H2SO4 🗸 1***

Condition - **Temp 160 – 1800C *🗸 1***

 (b) Name the process represented by: **(4 marks)**

 **I** - ***Esterification***

 **II** - ***Substitution***

 **IV** - ***Oxidation***

 **V** - ***Dehydration***

5. **I.** Study the scheme below and answer the questions that follow.

 Water

Colourless

 gas **D**

Brown gas

Nitric (V) acid

Ammonia gas

Substance **B**

Substance **A**

**Step I**

Oxygen

Catalyst **F**

**Step II**

Oxygen

(a) Identify substances. **(3 marks)**

 **A** - ***Hydrogen***

 **B** - ***Nitrogen***

 **D** - ***NO***

(b) State the catalyst necessary for; **(2 marks)**

 Step **I** - ***Iron finely divided / iron***

 Step **II** - ***Platinum – rhodium catalyst***

 (c) Write a balanced chemical equation for taking place in step **II**. **(1 mark)**

 ***4NH(3) + SO2 2NO(g) + 6H2O***

 (d) Write two balanced chemical equations for the reaction between chlorine

Gas and;

 (i) Hot and concentrated sodium hydroxide. **(1 mark)**

 ***6NaOH(aq) + 3Cl2(g)NaClO3(aq) + 5NaCl(aq) + H2O(l)***

 (ii) Dilute and cold sodium hydroxide. **(1 mark)**

 ***2NaOH(aq) + Cl2 NaOCl + NaCl + H2O***

**II.** The diagram below shows an experiment in which the Lead (II) nitrate crystals are heated.

Powdered Pb(NO3)2

Gas **Y**

Ice

Liquid **P**

1. Name; **(2 marks)**
2. Liquid **P** - ***dinitrogen tetra oxide***
3. Gas **Y** - ***oxygen***
4. Write a balanced chemical equation for the decomposition of Lead (II) nitrate. **(1 mark)**

$2Pb\left(NO\_{3}\right)\_{2}2PbO\_{(s)} +4NO\_{2(s)} + O\_{2(g)}$

1. Explain how you can distinguish between nitrogen (II) oxide and nitrogen (I) oxide.

  **(2 marks)**

* ***Nitrogen (V) oxide relights a glowing splint while nitrogen (II) oxide does not.***
* ***N2O has xtic sweet smell, while. NO2 is odourless.***

6. **I.** Study the standard electrode potentials given below and answer the questions that

follow.

 $D^{2+}\_{(aq)}+2e^{-}D\_{(s)}E^{θ} = -2.92V$

 $G^{2+}\_{(aq)}+2e^{-}G \_{(s)}E^{θ} = -2.36V$

 $\frac{1}{2}J^{2+}\_{\left(g\right)}+e^{-}J\_{\left(s\right)}E^{θ} = 0.00V$

$M^{2+}\_{(aq)}+2e^{-}M\_{(s)}E^{θ} = +0.34V$

$\frac{1}{2}R^{2+}\_{\left(aq\right)}+e^{-}R\_{\left(s\right)}E^{θ} = 2.87V$

1. Identify the strongest:
2. Reducing agent ***D*** **(1 mark)**
3. Oxidizing agent ***R2+***  **(1 mark)**

 (b) Calculate the e.m.f of a cell made of G and M. **(2 marks)**

 ***e.m.f =*** $E^{θ}R- E^{θ}O$

 ***=*** $+0.34-^{-}2.36$

 ***= +2.70V***

(c) Write the cell representation for the above cell in (b). **(1 mark)**

 $G\_{(s)}G^{2+}\_{(aq)}M^{2+}\_{(aq)}M\_{(s)} ;E= +2.70V$ ***Penalize for lack of states and E***

 ***value***

1. Draw a cell diagram for the cell in (b) above. **(2 marks)**

***Workability 🗸1***

***Labelling 🗸1***

$$G\_{(s)}$$

M(s)

$$M^{2+}\_{(aq)}$$

$$G^{2+}\_{(aq)}$$

Salt bridge

1. Write the cell reaction for the drawn cell diagram in (d) above. **(1 mark)**

 $G\_{(s)}+ M^{2+}\_{(aq)}G^{2+}\_{(aq)}+ M\_{(s)} ;E= +2.70V$

**II**. Electrolysis of aqueous solution of metal M resulted in the deposition of 1.07g of metal upon passage of a current of 1.32 amperes for 75 minutes.

(M = 52, 1F = 96500C)

1. Calculate the quantity of electricity passed through the cell. **(1 mark)**

$$Q=1t$$

$=1.32 ×75×60$ **🗸 ½**

$ =5940C$ **🗸 ½**

1. Calculate the charge on the metal ion. **(3 marks)**

***If 1.07g is departed by 5940C***

***52g “ “***

$\frac{52×5940}{1.07}=288,672.8972C $***🗸1***

***If 1F is 96500C***

 ***? “ 288672.8972C***

$\frac{1×288,672.8972}{96500}$**🗸1**

$$=2.994$$

$\~$ **3**

 **+3🗸 1**

7. Extraction of iron involves two main processes, smelting and refining. Below is the blast furnace which is used to smelt iron from its ore.

CO2, CO

as waste

3000C

5000C

6000C

8000C

16000C

**C**

Carbon (IV) oxide recycled

**B**

**A**

Fire brick lining

Hot air blast from stove

Slag tap

Slag

Iron

Molten iron from tap

 (a) (i) What does the word smelt mean? **(1 mark)**

***Extraction of a metal from its ore using a reducing agent and heat.***

 (ii) Name the reducing agent in the process. **(1 mark)**

 ***Carbon ( in form of coke)***

1. What is the role of the hot air blast in the process? **(2 marks)**

***Hot air reacts with coke to form carbon (IV) oxide producing a lot of heat which melts the iron formed in the blast furnace.***

(b) Write equations for the reactions that take place at the region marked A, B and C. **(3 marks)**

 ***A*** $C\_{(s)} + O\_{(2)}CO\_{2(g)}$

 ***B*** $CO\_{2(g)}+ C\_{(s)} 2 CO\_{(g)}$

 ***C*** $2Fe\_{2}O\_{3}\_{(s)}+ 3C\_{(s)}4Fe\_{(s)}+ 3CO\_{2(g)}$

(c) What is the purpose of limestone in the extraction process? **(1 mark)**

 ***To remove silica impurities in the ore.***

1. Write equations to show how impurities are removed from the ore.

***(3 marks)***

heat

$CaCO\_{3(s)}CaO\_{(s)}+ CO\_{2(g)}$

 $CaO\_{(s)}+ SiO\_{2(s)}CaSiO\_{3(s)}$

 $Al\_{2}O\_{3(s)}+ CaO\_{(s)}CaAl\_{2}O\_{4(s)}$

***slag***