

G12 ECZ CHEMISTRY 2019 PAPER 2 SOLUTIONS

Grade 12 ECZ Chemistry 2019 Paper 2 (5070/2)

Worked solutions — structured questions (Section A + Section B)

The full question paper appears first — worked answers are at the end. Answer ALL of Section A and any THREE questions in Section B.

Candidate Name _____

Centre Number				Candidate Number									

EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level

Chemistry Paper 2 Theory

5070/2

Tuesday

19 NOVEMBER 2019

Candidates answer on the question paper

Additional Information:

Mathematical tables/Calculators (non-programmable)

Graph paper

Time 2 hours

Instructions to Candidates

Write your **name, centre number and candidate number** in the spaces at the top of this page and on any separate answer paper used.

There are **twelve (12) questions** in this paper.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question-paper.

Section B

Answer any **three** questions.

Write your answers in the separate Answer Booklet provided.

At the end of the examination, fasten your Answer Booklets securely to the question paper.

Information for Candidates

The number of marks is shown in brackets [] at the end of each question or part question.

The **Periodic Table** is printed on page 13.

Cell phones are not allowed in the examination room.

FOR EXAMINER'S USE	
Section A	
Section B	
B9	
B10	
B11	
B12	
TOTAL	

This question paper consists of 12 printed pages.

Section A: [50 marks]

Answer all questions in the spaces provided.

A1 A learner opened a bottle of ammonia in a room. The smell of ammonia soon spread in the room by diffusion.

(a) What is meant by the term diffusion?

.....
.....

[1]

(b) (i) What happens to the rate of diffusion of ammonia as the temperature of the room increases? Explain your answer in terms of the kinetic particle theory.

.....
.....
.....
.....

[2]

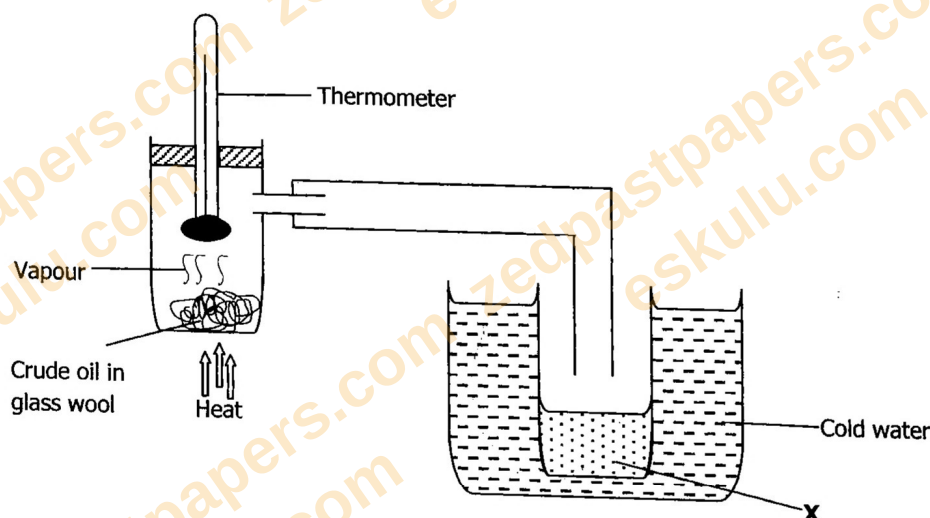
(ii) Apart from temperature, state **two** other factors that can affect the rate of diffusion.

.....
.....

[2]

[Total: 5]

A2 The diagram below shows apparatus used in separating components of crude oil in a school laboratory.



- (a) Name the process by which crude oil is separated into petrol and other products on a large scale.

..... [1]

- (b) What is the purpose of the cold water?

..... [1]

- (c) Why is the thermometer included in the diagram?

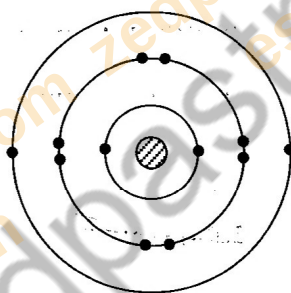
..... [1]

- (d) What is the general term used to refer to substance X?

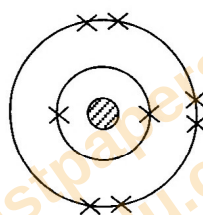
..... [1]

[Total: 4]

- A3** The diagram below shows the structures of atoms of two elements **A** and **B**.



A



B

- (a) State the Group and Period number of each of the two elements **A** and **B**.

A Period..... Group

B Period..... Group [2]

- (b) If atoms of element **A** and element **B** combined to form a compound, what type of bonding would be involved? Using electron-shell diagrams draw the structure of the compound formed between **A** and **B**.

Type of bonding:

Structure of compound:



[3]

[Total: 5]

A4 Benzoic acid, $\text{C}_6\text{H}_5\text{COOH}$, is a naturally occurring carboxylic acid. It burns completely in oxygen forming carbon dioxide and water only.

- (a) Write a balanced chemical equation for the complete burning of benzoic acid in air.

..... [2]

- (b) If 0.1 mole of benzoic acid was reacted, calculate the volume of carbon dioxide expected to be produced at room temperature and pressure (r.t.p).



[3]

- (c) If the volume of carbon dioxide obtained was 6.5dm^3 , what was the percentage yield of the carbon dioxide?

[2]

[Total: 7]

A5 Use a copy of the Periodic Table to identify, by name and chemical symbol, the element which

- (a) is in Group IV Period 5,

.....

[1]

- (b) has proton number 91,

.....

[1]

- (c) is a metallic element in Group VI,

.....

[1]

- (d) is the most reactive alkaline earth metal,

.....

[1]

- (e) contains 3.0×10^{23} atoms in 20g of it.

.....

[1]

- (f) has an electronic configuration of 2, 8, 18, 8, 1.

.....

[1]

[Total: 6]

- A6** Zinc is extracted industrially using fire clay retort. Zinc blende is one of the ores from which zinc is extracted. When zinc blende is strongly heated in air, solid compound **D** and gaseous compound **E** are produced.

(a) Name compound **D** and gas **E**.

..... [2]

(b) Write a balanced chemical equation for the reaction which occurs when zinc blende is heated strongly in air.

..... [2]

(c) Describe with the aid of an equation how **D** is converted into zinc metal.

..... [2]

(d) Give **one** use of zinc metal.

..... [1]

(e) Explain why zinc is usually mixed with copper metal before it is used in industry.

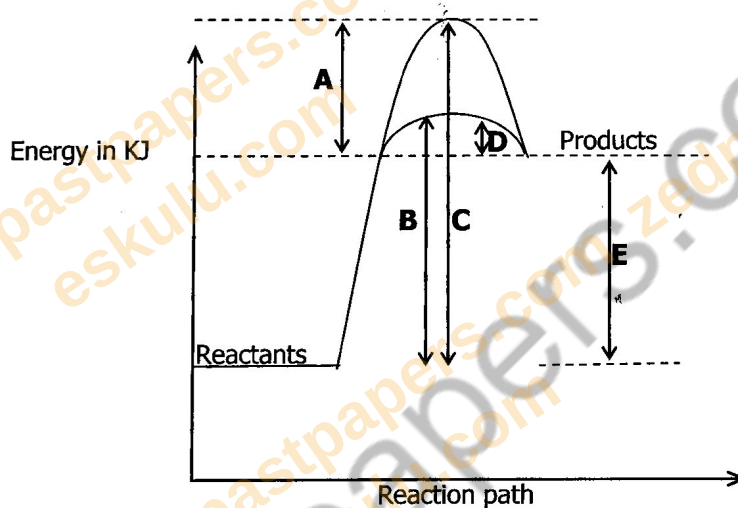
..... [1]

[Total: 8]

- A7 (a)** When concentrated sulphuric acid is added to cold water, the temperature of the mixture rises. Is the process endothermic or exothermic? Give a reason for your answer.

[2]

- (b)** The diagram below shows an energy level diagram for a catalysed and non-catalysed reaction.



Which letter represents the

- (i)** activation energy of the uncatalysed reaction,

[1]

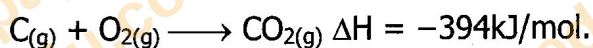
- (ii)** activation energy of the catalysed reaction,

[1]

- (iii)** enthalpy change of reaction.

[1]

- (c)** Consider the combustion reaction below:

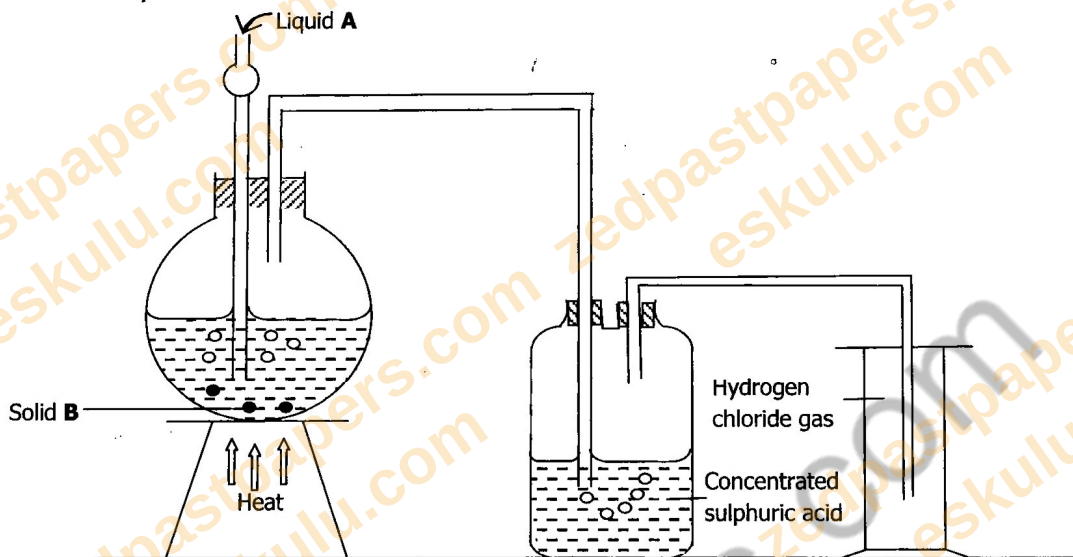


How much heat is released to the surroundings when one mole of carbon is burnt completely in oxygen?

[2]

[Total: 7]**Turnover**

- A8** The diagram below shows how hydrogen chloride gas is prepared in the laboratory.



- (a) (i) Name the reactants **A** and **B**.

A

B [2]

- (ii) What is the purpose of concentrated sulphuric acid in the wash bottle?

..... [1]

- (iii) Write a balanced chemical equation for the reaction of **A** and **B**.

..... [1]

- (b) Describe the chemical test for hydrogen chloride gas.

.....

..... [2]

- (c) State any physical property of hydrogen chloride.

..... [1]

- (d) Give a use of hydrogen chloride gas in industry.

..... [1]

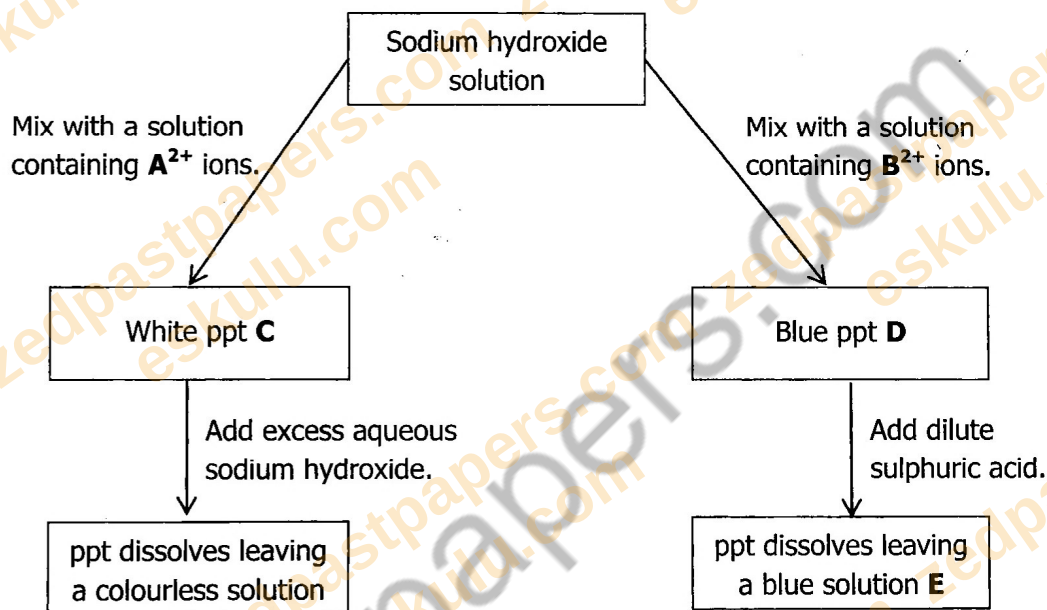
[Total: 8]

Section B (30 marks)

Answer three questions from this section.

Write your answers in the Answer Booklet provided.

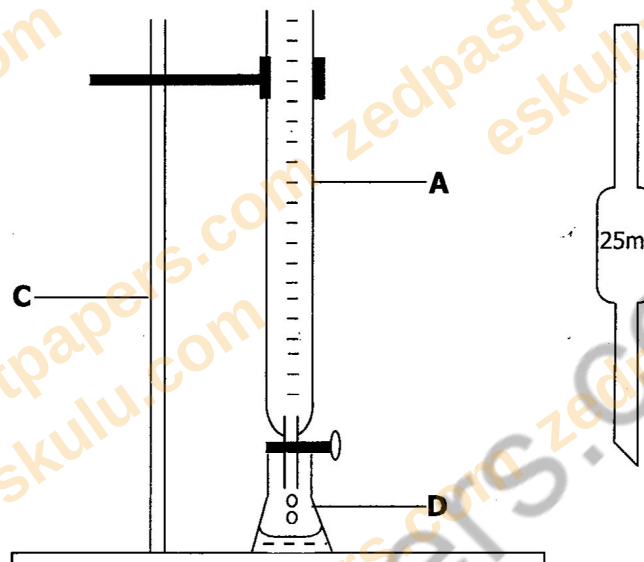
- B9** The diagram below shows some properties and reactions of the ions A^{2+} and B^{2+} and the substances **C**, **D** and **E**.



- (a) (i) Identify the elements **A** and **B**.
(ii) Name the compounds **C**, **D** and **E**. [5]
- (b) Write a chemical equation for one of the reactions shown in the diagram. [2]
- (c) Describe how the sodium hydroxide solution can be used to distinguish between a solution containing an **iron (II)** compound and a solution containing an **iron (III)** compound. [3]

[Total: 10]

B10 In a titration experiment between potassium hydroxide and sulphuric acid solution to prepare potassium sulphate, a soluble salt, the following set up was used:



- (a) Name the apparatus **A** and **B**. [2]
- (b) Why is it not advisable to put potassium hydroxide in apparatus **D**? [1]
- (c) How is apparatus **B** filled safely with potassium hydroxide solution? [1]
- (d) Write a balanced chemical equation for the reaction between aqueous potassium hydroxide and aqueous sulphuric acid. [2]
- (e) Calculate the concentration of 25.0cm^3 of sulphuric acid that reacted with 25.0cm^3 of aqueous potassium hydroxide whose concentration was 0.5M . [4]

[Total: 10]

B11 A current of 0.5 amperes was passed for 2 400 seconds through colorimeters in series. One colorimeter contains dilute sodium hydroxide and the other molten potassium iodide. Graphite electrodes were used.

- (a) What quantity of electricity was used? [2]
- (b) Write ionic equations for reactions occurring at the two anodes. [2]
- (c) How many moles of electrons were passed through each electrolyte? [2]
- (d) What mass of product is liberated at the cathode in the potassium iodide voltameter? [2]
- (e) State any **two** applications of electrolysis. [2]

[Total: 10]

- B12**
- (a) (i) State the meaning of the word polymer. [1]
 - (ii) Name **two** nutrient polysaccharides. [2]
 - (iii) Name the common monomer unit for polysaccharides. [1]
 - (b) (i) Show how these monomer units are bonded when forming cellulose. Use only **four** monomer units. [2]
 - (ii) State the name of the bond between the monomer units. [1]
 - (c) (i) Name **two** synthetic polymers that are used in making clothes. [2]
 - (ii) Which of the polymers you have named in (c) (i) above is similar in structure to protein? [1]

[Total: 10]

The Periodic Table of the Elements

Periodic Table of Elements																	
Group		I		II		III		IV		V		VI		VII		0	
		1		2		3		4		5		6		7		8	
		H Hydrogen 1															
		9		10		11		12		13		14		15		16	
		Be Beryllium 4		B Boron 5		C Carbon 6		N Nitrogen 7		O Oxygen 8		F Fluorine 9		Ne Neon 10		He Helium 2	
		23		24		25		26		27		28		29		30	
		Na Sodium 11		Mg Magnesium 12		Al Aluminium 13		Si Silicon 14		P Phosphorus 15		S Sulphur 16		Cl Chlorine 17		Ar Argon 18	
		39		40		41		42		43		44		45		46	
		K Potassium 19		Ca Calcium 20		Sc Scandium 21		Ti Titanium 22		V Vanadium 23		Cr Chromium 24		Mn Manganese 25		Fe Iron 26	
		85		86		87		88		89		90		91		92	
		Rb Rubidium 37		Sr Strontium 38		Y Yttrium 39		Zr Zirconium 40		Nb Niobium 41		Mo Molybdenum 42		Tc Technetium 43		Ru Ruthenium 44	
		133		137		138		139		140		141		142		143	
		Cs Caesium 55		Ba Barium 56		La Lanthanum 57		Ce Cerium 58		Pr Praseodymium 59		Nd Neodymium 60		Pm Promethium 61		Sm Samarium 62	
		226		227		228		229		230		231		232		233	
		Fr Francium 87		Ra Radium 88		Ac Actinium 89		Th Thorium 90		Pa Protactinium 91		U Uranium 92		Np Neptunium 93		Pu Plutonium 94	
*58-71 Lanthanoid series +90-103 Actinoid series																	
		a		X		b		a = relative atomic mass X = atomic symbol b = proton (atomic) number									
Key																	

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

$$N_A = 6.0 \times 10^{23}/\text{mol}; 1^\circ\text{F} = 96500\text{C}.$$

Chemistry/5070/2/2019



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Question 1. A1 — The smell of ammonia spreads across a room by diffusion.

(a) What is meant by diffusion

Answer: The random spreading of particles from a region of high concentration to a region of low concentration until they are evenly mixed.

(b)(i) Effect of raising the temperature on the rate of diffusion (kinetic theory)

Answer: The rate increases — at a higher temperature the particles gain more kinetic energy and move faster, so they spread out more quickly.

(b)(ii) Two other factors that affect the rate of diffusion

Answer: The molecular mass of the gas (lighter molecules diffuse faster) and the concentration gradient.

Question 2. A2 — Apparatus separating the components of crude oil.

(a) Name of the process

Answer: Fractional distillation.

(b) Purpose of the cold water

Answer: To cool and condense the vapour back into a liquid.

(c) Why a thermometer is included

Answer: To measure the temperature of the vapour, so each fraction is collected at its own boiling point.

(d) General term for substance X

Answer: The distillate (a fraction).

Question 3. A3 — Atoms of A (2,8,3) and B (2,6).

(a) Group and Period

A has 13 electrons (2,8,3) and B has 8 electrons (2,6).

Answer: A: Period 3, Group III (aluminium). B: Period 2, Group VI (oxygen).

(b) Compound of A and B: bonding type and structure

A (aluminium, valency 3) is a metal and B (oxygen, valency 2) is a non-metal, so the bonding is ionic. They combine as Al_2O_3 .

Answer: Ionic bonding; the compound is Al_2O_3 (Al_2O_3) — two Al^{3+} ions and three O^{2-} ions.

Question 4. A4 — Benzoic acid, $\text{C}_6\text{H}_5\text{COOH}$, burns completely in oxygen to CO_2 and H_2O .

(a) Balanced equation for complete combustion

Answer: $2\text{C}_6\text{H}_5\text{COOH} + 15\text{O}_2 \rightarrow 14\text{CO}_2 + 6\text{H}_2\text{O}$.

(b) Volume of CO_2 from 0.1 mol of benzoic acid at r.t.p.

Each mole of $\text{C}_2\text{H}_4\text{COOH}$ ($\text{C}_2\text{H}_4\text{O}_2$) gives 7 mol CO_2 , so 0.1 mol gives 0.7 mol; volume = $0.7 \times 24000 = 16\,800\text{ cm}^3$.

Answer: $16\,800\text{ cm}^3$ (16.8 dm^3).

(c) Percentage yield if 6.5 dm^3 of CO_2 was obtained

% yield = $6.5 \div 16.8 \times 100 \approx 39\%$.

Answer: $\approx 39\%$.

Question 5. A5 — Use the Periodic Table to name and give the symbol of the element which ...

(a) Is in Group IV, Period 5

Answer: Tin, Sn.

(b) Has proton number 91

Answer: Protactinium, Pa.

(c) Is a metallic element in Group VI

Answer: Polonium, Po.

(d) Is the most reactive alkaline-earth (Group II) metal

Answer: Radium, Ra.

(e) Contains 3.0×10^{23} atoms in 20 g of it

Moles = $3.0 \times 10^{23} \div 6.0 \times 10^{23} = 0.5$; molar mass = $20 \div 0.5 = 40$.

Answer: Calcium, Ca.

(f) Has the electron configuration 2,8,8,1

Answer: Potassium, K.

Question 6. A6 — Zinc from zinc blende: heating strongly in air gives solid D and gas E.

(a) Name D and E

Zinc blende is zinc sulphide; roasting in air gives zinc oxide and sulphur dioxide.

Answer: D = zinc oxide (ZnO); E = sulphur dioxide (SO_2).

(b) Equation for roasting zinc blende in air

Answer: $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$.

(c) How D is converted to zinc metal (with equation)

Answer: Heat the zinc oxide with carbon (coke), which reduces it to zinc: $2\text{ZnO} + \text{C} \rightarrow 2\text{Zn} + \text{CO}_2$.

(d) One use of zinc metal

Answer: Galvanising iron/steel to prevent rusting.

(e) Why zinc is usually mixed with copper before use

Answer: To make the alloy brass, which is harder, stronger and more resistant to corrosion than pure zinc.

Question 7. A7 — Energy and reactions.

(a) Concentrated sulphuric acid added to cold water makes the temperature rise — endo- or exothermic?

Answer: Exothermic — heat is given out to the surroundings (so the temperature rises).

(b) Energy-level diagram (catalysed and uncatalysed reaction)

On the diagram, the reactants are low and the products higher; B and C are measured from the reactants up to the catalysed (lower) and uncatalysed (higher) peaks, and E is the gap between reactants and products.

Answer: (i) Activation energy of the uncatalysed reaction = C. (ii) Activation energy of the catalysed reaction = B. (iii) Enthalpy change of the reaction = E.

(c) $\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$, $\Delta H = -394 \text{ kJ/mol}$ — heat released when 1 mol of carbon burns completely

Answer: 394 kJ (released).

Question 8. A8 — Preparation of hydrogen chloride gas (liquid A on solid B, dried in a wash bottle).

(a)(i) Name reactants A and B

Answer: A = concentrated sulphuric acid; B = sodium chloride.

(a)(ii) Purpose of the concentrated sulphuric acid in the wash bottle

Answer: To dry the hydrogen chloride gas (remove water vapour).

(a)(iii) Balanced equation for A + B

Answer: $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$.

(b) Chemical test for hydrogen chloride gas

Answer: It gives dense white fumes when a rod dipped in ammonia is held near it (and turns damp blue litmus red).

(c) One physical property of hydrogen chloride

Answer: It is a colourless gas with a sharp, choking smell (and is very soluble in water).

(d) One industrial use of hydrogen chloride

Answer: Making hydrochloric acid. (Also: pickling/cleaning metals.)

Question 9. B9 — Reactions of A^{2+} and B^{2+} with sodium hydroxide (substances C, D, E).

(a)(i) Identify elements A and B

A^{2+} gives a white precipitate that dissolves in excess NaOH (so it is zinc); B^{2+} gives a blue precipitate (so it is copper).

Answer: A = zinc; B = copper.

(a)(ii) Name substances C, D and E

Answer: C = zinc hydroxide, $\text{Zn}(\text{OH})_2$ (white precipitate); D = copper(II) hydroxide, $\text{Cu}(\text{OH})_2$ (blue precipitate); E = sodium zincate (the colourless solution formed when C dissolves in excess NaOH).

(b) Equation for one of the reactions

Answer: $\text{Zn}^{2+} + 2\text{OH}^- \rightarrow \text{Zn}(\text{OH})_2$ (or $\text{Cu}^{2+} + 2\text{OH}^- \rightarrow \text{Cu}(\text{OH})_2$).

(c) Using NaOH to distinguish iron(II) from iron(III) compounds

Answer: Add sodium hydroxide solution: an iron(II) compound gives a green precipitate, while an iron(III) compound gives a reddish-brown precipitate.

Question 10. B10 — Titrating potassium hydroxide against sulphuric acid to make potassium sulphate (A = burette, B = pipette, C = stand/clamp, D = conical flask).

(a) Name apparatus A and B

Answer: A = burette; B = pipette.

(b) Why it is not advisable to fill the pipette with potassium hydroxide by mouth

Answer: Potassium hydroxide is a corrosive (caustic) alkali, so sucking it up by mouth could draw it into the mouth and burn you.

(c) How the pipette is filled safely with the potassium hydroxide

Answer: Use a pipette filler (a rubber safety bulb) to draw the solution up to the mark — never by mouth.

(d) Balanced equation for the reaction

Answer: $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$.

(e) Concentration of the 25.0 cm^3 of sulphuric acid (reacted with 25.0 cm^3 of 0.5 M KOH)

Moles $\text{KOH} = 0.025 \times 0.5 = 0.0125$; from $2\text{KOH} : 1\text{H}_2\text{SO}_4$, moles acid = 0.00625 in 0.025 dm^3 ; concentration = $0.00625 \div 0.025 = 0.25 \text{ mol/dm}^3$.

Answer: 0.25 mol/dm^3 .

Question 11. B11 — 0.5 A for 2400 s through two voltmeters in series: dilute NaOH and molten KI (graphite electrodes).

(a) Quantity of electricity used

$Q = I \times t = 0.5 \times 2400 = 1200 \text{ C}$.

Answer: 1200 C .

(b) Ionic equations at the two anodes

Answer: Dilute NaOH: $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$ (oxygen). Molten KI: $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$ (iodine).

(c) Moles of electrons passed through each electrolyte

Moles $\text{e}^- = 1200 \div 96500 = 0.0124$.

Answer: ≈ 0.0124 mol.

(d) Mass of product at the cathode in the molten-KI voltameter

$K^+ + e^- \rightarrow K$, so moles K = 0.0124; mass = $0.0124 \times 39 \approx 0.49$ g.

Answer: ≈ 0.49 g of potassium.

(e) Two applications of electrolysis

Answer: Electroplating and the purification (refining) of copper. (Also: extracting reactive metals.)

Question 12. B12 — Polymers.

(a)(i) Meaning of the word polymer

Answer: A very large molecule made by joining together many small molecules (monomers).

(a)(ii) Two nutrient polysaccharides

Answer: Starch and glycogen.

(a)(iii) Common monomer unit of polysaccharides

Answer: Glucose.

(b)(i) How the monomer units are bonded in cellulose (four units)

**Answer: Four glucose units join by condensation (each link loses a molecule of water):
glucose–O–glucose–O–glucose–O–glucose.**

(b)(ii) Name of the bond between the monomer units

Answer: A glycosidic bond (an oxygen bridge).

(c)(i) Two synthetic polymers used to make clothes

Answer: Nylon and terylene (polyester).

(c)(ii) Which of these is similar in structure to a protein

Answer: Nylon — it is a polyamide, containing amide (peptide) links like a protein.

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