G12 ECZ CHEMISTRY 2020 PAPER 2 SOLUTIONS

Grade 12 ECZ Chemistry 2020 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.

Centre Number	Examination Number

85005028

EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level

Chemistry

5070/2

Paper 2 Theory

2020

Additional materials:
Calculators (non-programmable)
Graph paper

Time: 2 hours **Marks: 80**

Instructions to Candidates

1 Write the **centre number** and your **examination number** on **every page** of this question paper and on the separate **Answer Booklet/Paper** provided.

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

(i) Section A

Answer **all** questions.

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

(ii) 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

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

2 The **Periodic Table** is on page 14.

3 **Cell phones are not allowed in the examination room.**

For Examiner's Use	
Section A	
Section B	
B9	
B10	
B11	
B12	
Total	

Centre Number	Examination Number

Section A: [50 marks]

Answer **all** questions in the spaces provided.

A1 **(a)** **(i)** Explain why most laboratories do not have smooth floors, but have rough floors.

.....

..... [1]

(ii) Give **two** laboratory safety rules you would need to observe when carrying out a titration.

.....

..... [2]

(b) Draw the arrangement of particles in a solid, liquid and gas in the spaces below.

Solid Liquid Gas

[3]

(c) Explain why

(i) for the same space occupied, solids have higher densities than liquids and gases.

..... [1]

(ii) gases are compressible.

..... [1]

[Total: 8]

A2 Crystals of copper (II) sulphate ($CuSO_4.5H_2O$) are obtained from aqueous solutions of copper (II) sulphate ($CuSO_4$)

(a) State the four steps (processes) in their correct order, and for each step give the reason for carrying out such a step, in obtaining the crystals.

(i) Step 1: .....

.....

Reason: .....

..... [1]

(ii) Step 2: .....

.....

Reason: .....

..... [1]

(iii) Step 3: .....

.....

Reason: .....

..... [1]

(iv) Step 4: .....

.....

Reason: .....

..... [1]

[Total: 4]

Centre Number	Examination Number

A3 **(a)** A coefficient and subscript on the symbol of nitrogen atom (N) mean different notations in chemistry.

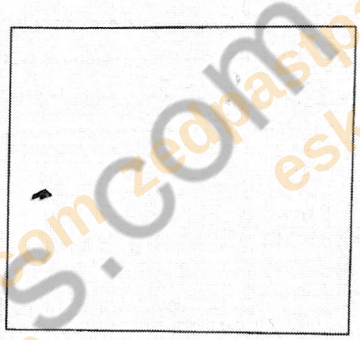
(i) What is the significant difference between the two notations 2N and N_2?

.....

..... [1]

(ii) Draw the dot and cross structures showing outer shells only for the two notations.

2N



N_2

[2]

(b) Both carbon tetrachloride (CCl_4) and Potassium chloride (KCl) are compounds of chlorine.

(i) Compare the electrical conductivity of liquid carbon tetrachloride and liquid potassium chloride.

.....

..... [1]

(ii) Which of the **two** compounds has a higher melting point? Explain your answer.

.....

..... [2]

[Total: 6]

Centre Number	Examination Number

A4 A sample of 0.03g of small pieces of magnesium was added to $20cm^3$ of $0.10mol/dm^3$ of hydrochloric acid. The two reacted according to the equation below.

$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2\,(aq)} + H_{2(g)}$

(a) **(i)** Write the word equation for the above reaction.

..... [1]

(ii) What is the chemical test for hydrogen gas?

..... [1]

(b) **(i)** Calculate the mass of magnesium which was in excess.

[4]

(ii) Calculate the volume of hydrogen that would be produced at r.t.p.

[2]

[Total: 8]

Centre Number	Examination Number

A5 **(a)** Use the Periodic Table to state the

(i) name of the element with electronic configuration: 2,8,18,7

..... [1]

(ii) chemical symbol of the element that forms an acidic oxide of formula XO_2 as its only oxide,

..... [1]

(iii) name of the most electronegative halogen,

..... [1]

(iv) name of the element in Group V and period 3,

..... [1]

(v) number of metals in Group IV.

..... [1]

(b) Elements **A**, **B**, **C**, **D** and **E** are arranged in order of their increasing atomic numbers. If element **C** is a noble gas, state the

(i) formulae of the ions formed by **B** and **E**.

.....

..... [2]

(ii) only noble gas that cannot be **C**.

.....

..... [1]

[Total: 8]

A6 Choose from the list of oxides given below to answer the questions that follow. An oxide may be chosen once, more than once or not at all.

Al_2O_3, CaO, CO_2, CO, Fe_2O_3, H_2O, ZnO

(a) Which **two** oxides are amphoteric?

.....

..... [2]

(b) Which **two** oxides are neutral?

.....

..... [2]

(c) State the other **two** types of oxides. Give an example of each type of oxide from the table.

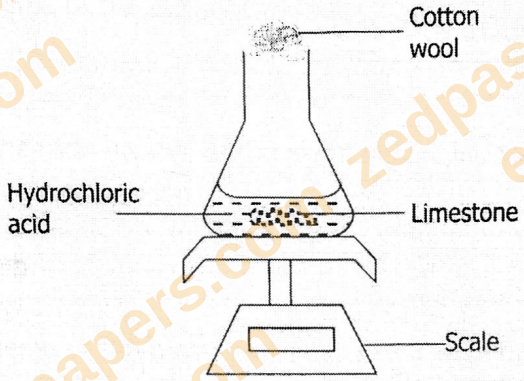
(i) .....

(ii) ..... [2]

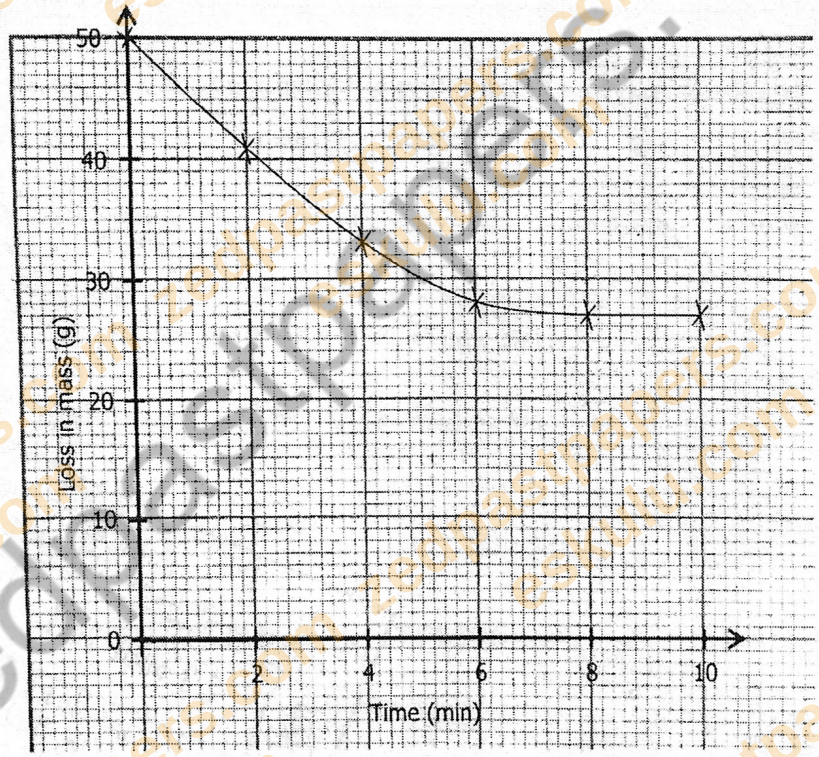
[Total: 6]

Centre Number	Examination Number

A7 The diagram below was used to measure the rate of reaction. The initial mass of the beaker and its contents was 50.0g.



The graph below also shows how the reaction between limestone and hydrochloric acid proceeded with time.



Centre Number	Examination Number

(a) What mass of carbon dioxide was lost when the reaction went to completion?

[1]

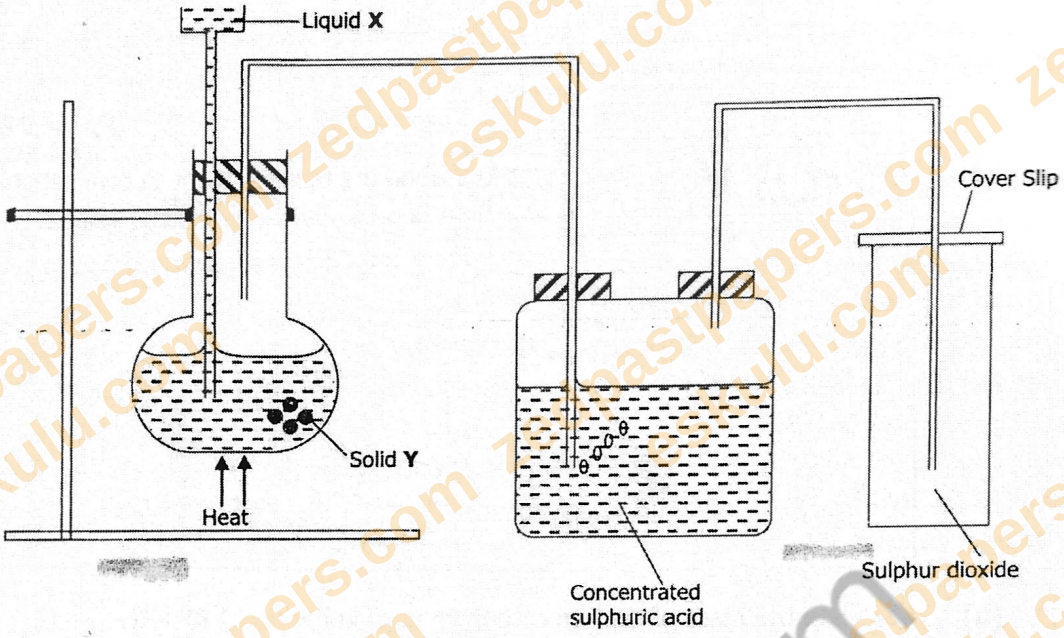
(b) Calculate the mass of calcium carbonate used in the first 1 minute.

[2]

(c) On the same graph, sketch how the curve would appear if powdered limestone was used. [1]

[Total: 4]

A8 The diagram below shows laboratory preparation of sulphur dioxide.



(a) Name the reactants **X** and **Y**.

.....

..... [2]

(b) Write a balanced chemical equation for the reaction in **(a)** above.

.....

..... [2]

(c) What is the chemical test for sulphur dioxide?

.....

..... [1]

(d) Why is the gas passed through concentrated sulphuric acid?

.....

..... [1]

[Total: 6]

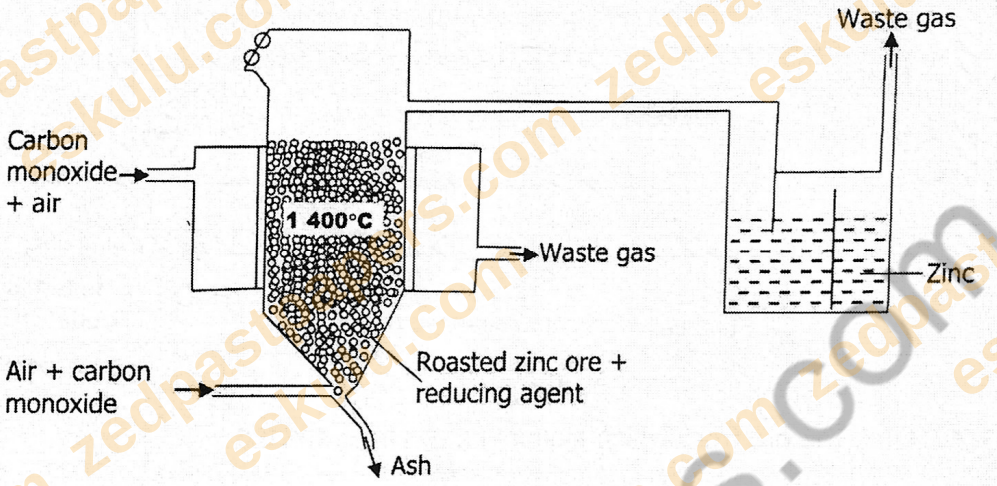
Centre Number	Examination Number

Section B (30 marks)

Answer **three** questions from this section.

Write your answers in the separate Answer Booklet provided.

B9 Zinc is extracted from its sulphide ore, zinc blende, in a blast furnace shown below.



(a) What reducing agent is used in the extraction process shown above? [1]

(b) Name another ore from which zinc can be extracted. [1]

(c) Write a balanced chemical equation for the reaction which occurs when zinc blende is roasted in air. [2]

(d) Name a pollutant gas which is produced when zinc blende is roasted in air. [1]

(e) Describe how the named pollutant in **(d)** is converted to a useful product in industry. [3]

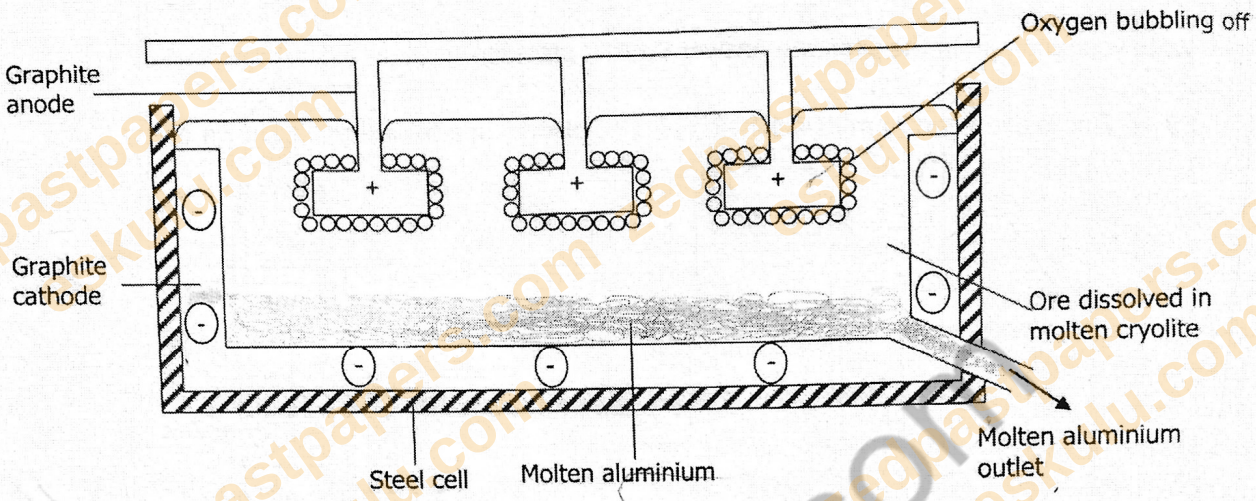
(f) **(i)** Zinc is often alloyed with other metals. Name an element which is alloyed with zinc to form brass. [1]

(ii) Give **one** use of brass. [1]

[Total: 10]

Centre Number	Examination Number

B10 The diagram below shows how aluminium is extracted in industry.



(a) Name the ore from which aluminium can be extracted. [1]

(b) Why is aluminium oxide dissolved in cryolite? [1]

(c) Which electrode has to be frequently replaced during the process? Explain your answer. [2]

(d) Write equations for the reactions taking place at the anode and cathode. [2]

(e) Aluminium is used to make pots and pans because it is a good conductor of heat and it is light. Give another property of aluminium that makes it suitable to be used for making pots and pans. [1]

(f) A current of 50A is passed in the electrolyte for 1 hour. Calculate the mass of aluminium that will be produced. (1F = 1 mole of electrons = 96 500C) [3]

[Total: 10]

Centre Number	Examination Number

B11 The molar enthalpy changes of combustion of the first 4 alkanes are given as follows from calorimetric combustion analysis:

–890kJ/mol, –1 600kJ/mol, –2 220kJ/mol and –2 880kJ/mol, respectively.

(a) Suggest the molar enthalpy of combustion of the fifth alkane. [1]

(b) Explain why the amount of heat energy produced increases consecutively when 1 mole of each alkane burns completely. [2]

(c) Write the balanced equation for the complete combustion of the second alkane showing the enthalpy of combustion. [2]

(d) **(i)** Use the following bond energies to calculate the ΔH for the reaction:

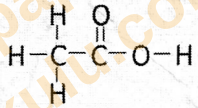
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Bond	Bond energy kJ/mol
C–H	412
O=O	490
C=O	826
O–H	464

(ii) Draw an energy level diagram for the combustion of methane? [5]

[Total: 10]

B12 The following table shows information about some homologous series of organic compounds. Each compound shown is the second member of the homologous series.

Homologous series	IUPAC name of compound	Displayed structure
Alkanes		
	Ethanol	
		
Alkenes (Olefins)		

N.B: Each homologous series has an alternative name.

(a) Copy and complete the table. [4]

(b) The third member in the family of alkenes is isomeric. Draw **two** of the isomers and give the IUPAC name of each isomer. [4]

(c) The formula $C_2H_4O_2$ generates two different compounds **A** and **B**. **A** is sweet smelling while **B** choke(s, but reacts with Na_2CO_3 to produce CO_2. Identify **A** and **B** by their structures. [2]

[Total: 10]

Question 1. A1 — Laboratory safety and the states of matter.

(a)(i) Why most laboratories have rough rather than smooth floors

Answer: Rough floors give more grip (friction), so people are less likely to slip and fall (especially if liquids are spilt).

(a)(ii) Two safety rules when carrying out a titration

Answer: Wear safety goggles, and fill the pipette using a pipette filler (never by mouth).

(b) Arrangement of particles

Answer: Solid: particles closely packed in a regular, fixed pattern. Liquid: particles close together but irregularly arranged. Gas: particles far apart and randomly spread out.

(c)(i) Why solids are denser than liquids and gases

Answer: In a solid the particles are packed very closely together, so there is more mass in the same volume than in a liquid or gas, where the particles are more spread out.

(c)(ii) Why gases are compressible

Answer: There are large spaces between gas particles, so they can be pushed closer together.

Question 2. A2 — Obtaining crystals of CuSO■·5H■O from aqueous copper(II) sulphate (four steps in order).

(i) Step 1 + reason

Answer: Heat (evaporate) the solution to concentrate it. Reason: to remove water and make the solution saturated so crystals can form.

(ii) Step 2 + reason

Answer: Allow the hot, concentrated solution to cool slowly. Reason: solubility falls on cooling, so crystals form.

(iii) Step 3 + reason

Answer: Filter. Reason: to separate the crystals from the remaining solution (mother liquor).

(iv) Step 4 + reason

Answer: Wash with a little cold distilled water and dry between filter papers. Reason: to remove impurities and give pure, dry crystals.

Question 3. A3 — The notations 2N and N■; and the compounds CCl■ and KCl.

(a)(i) Difference between 2N and N■

Answer: 2N means two separate (free) nitrogen atoms; N■ means one nitrogen molecule — two nitrogen atoms chemically bonded together.

(a)(ii) Dot-and-cross structures (outer shells only)

Answer: 2N: two separate N atoms, each with 5 outer electrons (unbonded). N■: the two N atoms share three pairs of electrons (a triple bond), each atom also keeping one lone pair.

(b)(i) Electrical conductivity of liquid CCl■ and molten KCl

Answer: Liquid CCl■ does not conduct (it is molecular, with no free ions); molten KCl conducts (it is ionic, with free-moving ions).

(b)(ii) Which has the higher melting point (with reason)

Answer: KCl — it is ionic, with strong electrostatic forces between the ions that need a lot of energy to break; CCl■ is simple molecular with only weak forces between molecules.

Question 4. A4 — 0.03 g of magnesium added to 20 cm³ of 0.10 mol/dm³ HCl: Mg + 2HCl → MgCl■ + H■.

(a)(i) Word equation

Answer: Magnesium + hydrochloric acid → magnesium chloride + hydrogen.

(a)(ii) Chemical test for hydrogen gas

Answer: A lighted splint gives a squeaky 'pop'.

(b)(i) Mass of magnesium in excess

Moles HCl = 0.020 × 0.10 = 0.002; Mg : HCl = 1 : 2, so Mg reacting = 0.001 mol = 0.024 g. Mg added = 0.03 g, so excess = 0.03 – 0.024 = 0.006 g.

Answer: 0.006 g.

(b)(ii) Volume of hydrogen produced at r.t.p.

Moles H■ = ½ × moles HCl = 0.001; volume = 0.001 × 24000 = 24 cm³.

Answer: 24 cm³.

Question 5. A5 — Using the Periodic Table.

(a)(i) Element with configuration 2,8,18,7

Answer: Bromine.

(a)(ii) Symbol of the element whose only oxide is acidic XO■

Answer: Si (silicon — its only oxide is SiO■).

(a)(iii) Most electronegative halogen

Answer: Fluorine.

(a)(iv) Element in Group V and Period 3

Answer: Phosphorus.

(a)(v) Number of metals in Group IV

Group IV: C and Si/Ge are non-metal/metalloids; the metals are tin and lead.

Answer: 2 (tin and lead).

(b) Elements A, B, C, D, E in order of increasing atomic number; C is a noble gas.

(b)(i) Formulae of the ions formed by B and E

B is the halogen just before the noble gas C (forms a 1– ion); E is the Group II element two places after C (forms a 2+ ion).

Answer: B■ and E²■.

(b)(ii) The only noble gas that cannot be C

There must be two elements (A and B) before C; helium has only hydrogen before it.

Answer: Helium.

Question 6. A6 — Oxides: Al■O■, CaO, CO■, CO, Fe■O■, H■O, ZnO.

(a) Two amphoteric oxides

Answer: Al■O■ and ZnO.

(b) Two neutral oxides

Answer: CO and H■O.

(c) The other two types of oxide, with an example of each

Answer: Basic oxide — e.g. CaO (or Fe■O■); Acidic oxide — e.g. CO■.

Question 7. A7 — Limestone + HCl; the balance reading (beaker + contents, starting at 50.0 g) is followed with time: ≈50 g at 0 min, 41 at 2, 35 at 4, 31 at 6, 30 at 8, 30 at 10 min.

(a) Mass of CO■ lost when the reaction is complete

Final reading = 30 g, so CO■ lost = 50.0 – 30 = 20 g.

Answer: 20 g.

(b) Mass of calcium carbonate used in the first 1 minute

From the graph the reading at 1 min is about 45 g, so CO■ lost ≈ 5 g. Moles CO■ = 5 ÷ 44 ≈ 0.11; CaCO■ : CO■ = 1 : 1, so mass CaCO■ = 0.11 × 100 ≈ 11 g.

Answer: ≈ 11 g (read from the graph).

(c) Curve for powdered limestone

Answer: A steeper curve that falls faster at first but levels off at the same final reading (30 g) sooner.

Question 8. A8 — Laboratory preparation of sulphur dioxide (liquid X added to solid Y, gas dried over concentrated H■SO■).

(a) Name reactants X and Y

Answer: X = dilute sulphuric acid; Y = sodium sulphite (Na■SO■).

(b) Balanced equation

Answer: Na■SO■ + H■SO■ → Na■SO■ + H■O + SO■.

(c) Chemical test for sulphur dioxide

Answer: It turns acidified potassium dichromate(VI) paper from orange to green.

(d) Why the gas is passed through concentrated sulphuric acid

Answer: To dry the sulphur dioxide (remove water vapour).

Question 9. B9 — Extraction of zinc from zinc blende in a blast furnace.

(a) Reducing agent used

Answer: Carbon monoxide (CO).

(b) Another ore from which zinc can be extracted

Answer: Calamine (zinc carbonate, ZnCO■).

(c) Equation for roasting zinc blende in air

Answer: 2ZnS + 3O■ → 2ZnO + 2SO■.

(d) Pollutant gas produced on roasting

Answer: Sulphur dioxide (SO■).

(e) How that pollutant is converted to a useful product

Answer: It is used to make sulphuric acid (Contact process): SO■ is oxidised to SO■ over a vanadium(V) oxide catalyst (2SO■ + O■ ■ 2SO■); the SO■ is dissolved in concentrated sulphuric acid (forming oleum), which is then diluted to give sulphuric acid.

(f)(i) Element alloyed with zinc to form brass

Answer: Copper.

(f)(ii) One use of brass

Answer: Making ornaments/decorative fittings (also musical instruments).

Question 10. B10 — Extraction of aluminium by electrolysis of molten alumina in cryolite.

(a) Ore from which aluminium is extracted

Answer: Bauxite (impure aluminium oxide).

(b) Why aluminium oxide is dissolved in cryolite

Answer: To lower its melting point, so the electrolysis can be done at a lower temperature (saving energy).

(c) Which electrode is replaced frequently (with reason)

Answer: The (carbon) anode — the oxygen made there reacts with the hot carbon, burning it away to carbon dioxide, so it must be replaced.

(d) Electrode equations

Answer: Cathode: Al^{3}■ + 3e■ → Al. Anode: $2O^{2}$■ → O■ + 4e■.

(e) Another property making aluminium suitable for pots and pans

Answer: It resists corrosion (it does not rust — a protective oxide layer forms).

(f) Mass of aluminium from 50 A for 1 hour (1F = 96 500 C)

Q = 50 × 3600 = 180 000 C; moles e■ = 180000 ÷ 96500 = 1.865; Al^{3}■ + 3e■ → Al, so moles Al = 1.865 ÷ 3 = 0.622; mass = 0.622 × 27 ≈ 16.8 g.

Answer: ≈ 16.8 g.

Question 11. B11 — Molar enthalpies of combustion of the first four alkanes: –890, –1600, –2220, –2880 kJ/mol.

(a) Suggested molar enthalpy of combustion of the fifth alkane

Each extra CH■ adds roughly 660 kJ: 2880 + 660 ≈ 3540.

Answer: About –3540 kJ/mol (≈ –3500).

(b) Why the heat released increases consecutively

Answer: Each successive alkane has one more CH■ group (more atoms and bonds), so burning one mole breaks and makes more bonds and releases more energy.

(c) Equation for the complete combustion of the second alkane (with ΔH)

Answer: C■H■ + 3½O■ → 2CO■ + 3H■O, ΔH = –1600 kJ/mol.

(d)(i) ΔH for CH■ + 2O■ → CO■ + 2H■O (C–H 412, O=O 490, C=O 826, O–H 464)

Bonds broken = 4(412) + 2(490) = 2628; bonds made = 2(826) + 4(464) = 3508; ΔH = 2628 – 3508 = –880 kJ/mol.

Answer: –880 kJ/mol.

(d)(ii) Energy-level diagram

Answer: Reactants (CH■ + 2O■) above the products (CO■ + 2H■O); the downward gap is ΔH = –880 kJ/mol (exothermic), with an activation-energy hump between them.

Question 12. B12 — Homologous series (each compound shown is the second member).

(a) Completing the table

Answer: Alkanes: ethane, CH■–CH■. Alcohols (alkanols): ethanol, CH■CH■–OH. Carboxylic acids (alkanoic acids): ethanoic acid, CH■–COOH. Alkenes (olefins): propene, CH■=CH–CH■.

(b) Two isomers of the third alkene, with IUPAC names

The third alkene is butene, C■H■.

Answer: But-1-ene: CH■=CH–CH■–CH■; and but-2-ene: CH■–CH=CH–CH■. (Also 2-methylpropene.)

(c) C■H■O■ gives two compounds A (sweet) and B (choking, fizzes with Na■CO■)

B reacts with a carbonate giving CO■, so it is an acid; A is a sweet-smelling ester.

Answer: A = methyl methanoate, H–COO–CH■ (sweet-smelling ester). B = ethanoic acid, CH■–COOH (pungent acid that reacts with Na■CO■).

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