G12 ECZ CHEMISTRY 2016 PAPER 2 SPECIMEN

Grade 12 ECZ Chemistry 2016 Paper 2 Specimen (5070/2)

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

The full specimen 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 5070/2

Paper 2 Theory

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	
B9	
B10	
B11	
B12	
TOTAL	

This question paper consists of 13 printed pages

Section A: [50 marks]

Answer all questions in the spaces provided.

A1 **(a)** Name any **three** physical properties used to determine whether a substance is pure or not.

.....

.....

..... [3]

(b) Explain why

(i) solids have a fixed shape

.....

(ii) liquids flow

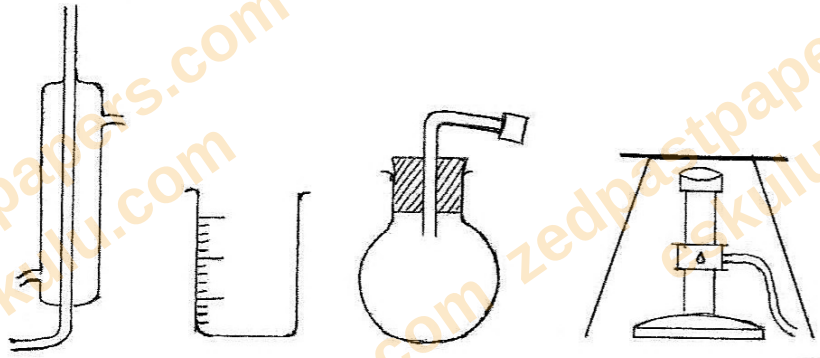
.....

(iii) gases can be compressed

..... [3]

[Total 6]

A2 The set of apparatus below is used in a purification technique. The apparatus are numbered, but not according to how they are assembled during use.



1 **2** **3** **4**

(a) Name the apparatus numbered 1.

..... [1]

(b) **(i)** Give **one** example of a mixture that can be separated by the above set of apparatus if assembled correctly.

.....

(ii) In the space below, arrange the apparatus for the purification of the mixture you have stated in **(b) (i)** above.

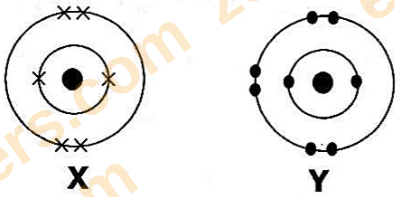
[3]

(c) State an industrial application for the above method of purification.

..... [1]

[Total 5]

A3 You are given two diagrams representing atoms of elements **X** and **Y**.



(a) State the valences of **X** and **Y**.

X: .....

Y: ..... [2]

(b) When **X** and **Y** react, is the compound formed ionic or covalent?

..... [1]

(c) Draw the structure of the compound formed between **X** and **Y**.

[2]

(d) Using the actual chemical symbols for **X** and **Y**, write down the chemical formula of the compound in **(c)** above.

..... [1]

[Total 6]

A4 5.0g of pure calcium carbonate were completely decomposed by heat. 900cm^3 of carbon dioxide were evolved at room temperature and pressure.

$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

(a) Calculate the volume of carbon dioxide which was expected to be produced.

[3]

(b) Calculate the percentage (%) yield of carbon dioxide gas.

[2]

[Total 5]

A5

		$^{1}_{1}H$					$^{4}_{2}He$
$^{7}_{3}Li$	$^{9}_{4}Be$		$^{11}_{5}B$	$^{12}_{6}C$	$^{14}_{7}N$	$^{16}_{8}O$	$^{19}_{9}F$	$^{20}_{10}Ne$
$^{23}_{11}Na$	$^{24}_{12}Mg$		$^{27}_{13}Al$	$^{28}_{14}Si$	$^{31}_{15}P$	$^{32}_{16}S$	$^{35.5}_{17}Cl$	$^{40}_{18}Ar$
$^{39}_{19}K$	$^{40}_{20}Ca$							

The section of the Periodic Table above shows the first 20 elements. Study the table and answer the questions that follow.

(a) **(i)** On the table assign Group and Period numbers to the elements. [2]

(ii) How many Groups and Periods can you identify from the above Periodic Table?

Number of Groups: .....

Number of Periods: ..... [2]

(b) Name any **two** noble gases and state a use of one of them.

Name **1**: .....

2: .....

Use: ..... [3]

[Total 7]

A6 Hydrogen and oxygen react to form water according to the equation below.

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

(a) Using the bond energies below, calculate the enthalpy change of reaction, ΔH for the above reaction.

Bond	Bond energy/KJ/mol
H – H	436
O = O	490
H – O	464

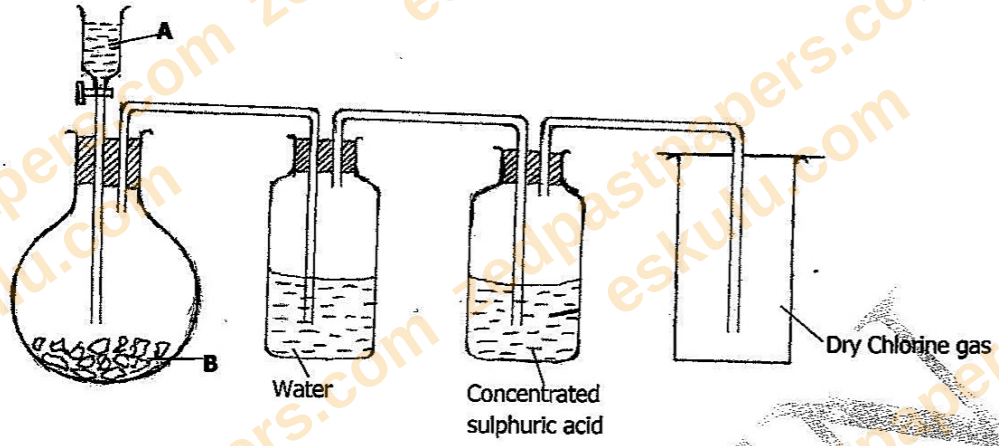
[3]

(b) Draw the energy level diagram for the reaction above.

[3]

[Total 6]

A7 Chlorine gas can be prepared in the laboratory using the apparatus below.



(a) Name the labelled reactants **A** and **B**.

A: .....

B: ..... [2]

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

..... [1]

(c) Describe the chemical test for chlorine gas.

.....

..... [2]

(d) On a large scale, chlorine is manufactured by electrolysis of brine (concentrated sodium chloride solution).

(i) Write the overall equation for the electrolysis of brine to produce chlorine gas.

.....

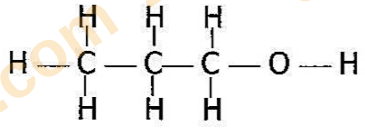
(ii) State any **one** use of chlorine.

..... [2]

[Total 7]

A8 **(a)** Name the organic compounds with the structural formulae shown below.

(i)



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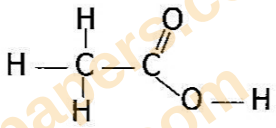
(ii)



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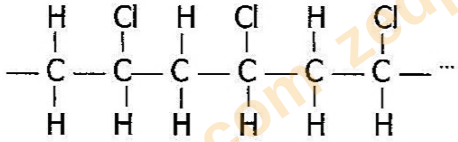
(iii)



.....

[3]

(b) A hydrocarbon belonging to the alkane family has the molecular formula C_4H_x, where **X** is the number of hydrogen atoms in one molecule of the hydrocarbon.

(i) State the general formula of the alkanes.

.....

(ii) Use the general formula to find the value of X in C_4H_x and state the name of the hydrocarbon.

.....

(iii) Draw the structures of the two isomers of the above hydrocarbon.

[5]

[Total 8]

Section B (30 marks)

Answer three questions from this section.

Write your answers in the Answer Booklet provided.

B9 Copper is purified by electrolysis.

(a) For the purification of copper, state the names of;

(i) the electrolyte

(ii) the anode

(iii) the cathode [3]

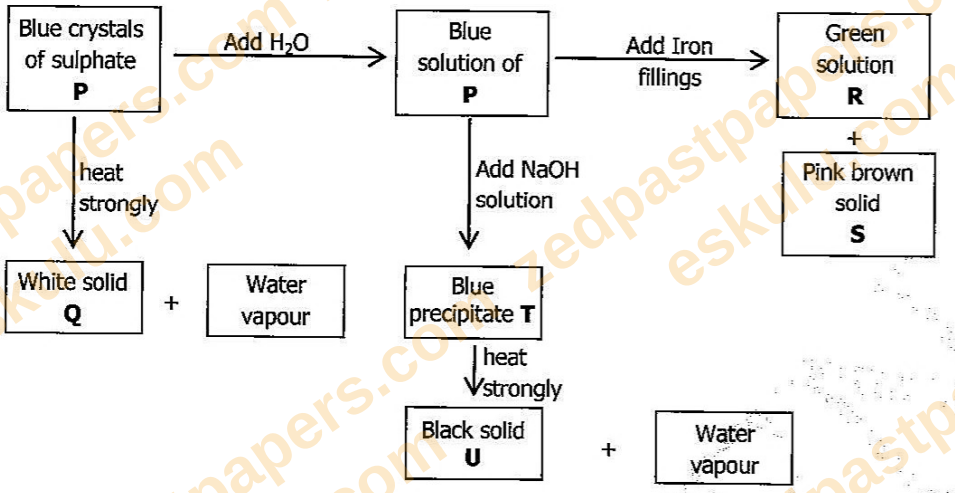
(b) Draw a simple labelled diagram to show how copper is purified. [2]

(c) Write ionic equations for the reactions taking place at the electrodes. [2]

(d) A current of 5A is passed through the electrolyte for half an hour during the purification of copper. What mass of pure copper is obtained from the impure copper during the stated time? [1F = 96 500C] [3]

[Total 10]

B10 Study the flow diagram of various reactions below and answer the questions that follow.



(a) Name the substances labelled **P**, **Q**, **R**, **S**, **T** and **U**. [6]

(b) What do we call the reaction involved when ...

(i) solution **P** reacts with iron to form solution **R** and solid **S**?

(ii) solution **P** reacts with sodium hydroxide to form a blue precipitate **T**? [2]

(c) Write a balanced chemical equation with state symbols for the reactions of;

(i) blue solution **P** with iron fillings

(ii) substance **T** when strongly heated [2]

[Total 10]

B11 Iron is extracted in a blast furnace.

(a) Name any **two** ores of iron [2]

(b) Write the formula of the two ores mentioned above. [2]

(c) What **two** other substances are introduced in the blast furnace together with the ore named above. [2]

(d) Write a chemical equation for the reduction of any ore named in **(a)** above. [1]

(e) What property does iron have for it to be used to make iron sheets? [1]

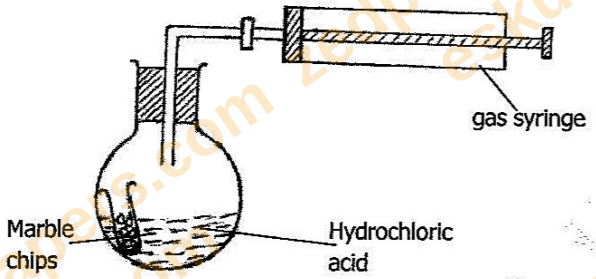
(f) Explain why aluminium is extracted by electrolytic reduction while iron is extracted by reduction with carbon. [2]

[Total 10]

B12 Some marble chips (lumps of calcium carbonate) were reacted with excess hydrochloric acid according to the equation below.

$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

The carbon dioxide produced was collected in a gas syringe and its volume was recorded every 10s.



The results are given in the table below.

Time/s	0	10	20	30	40	50	60	70	80
Volume/cm^3	0	22	43	58	66	70	70	70	70

(a) Plot a graph of volume of carbon dioxide produced in cm^3 against time in seconds. [4]

(b) Use your graph to determine the

(i) volume of gas produced during the first 25s of the reaction.

(ii) time taken to produce $45cm^3$ of carbon dioxide gas. **[2]**

(c) How long did it take for the reaction to end? [1]

(d) What was the total volume of gas produced in the experiment? [1]

(e) State two factors which can be altered to increase the rate of the above reaction. [2]

[Total 10]

DATA SHEET

The Periodic Table of the Elements

Group I	Group II										Group III	Group IV	Group V	Group VI	Group VII	Group 0
																4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4						1 H Hydrogen 1				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 Tchnetium 43	104 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 Mecury 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
X
b

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

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

NA = 6.0 × 10^{23}/mol; 1F = 96500C.

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Question 1. A1 — Purity and the states of matter.

(a) Three physical properties used to decide whether a substance is pure

Answer: Its melting point, its boiling point and its density (a pure substance has sharp, fixed values).

(b) Explain why …

(b)(i) Solids have a fixed shape

Answer: Their particles are held in fixed positions by strong forces and can only vibrate, so the shape does not change.

(b)(ii) Liquids flow

Answer: Their particles are free to move and slide past one another (they are not held in fixed positions).

(b)(iii) Gases can be compressed

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

Question 2. A2 — A set of apparatus (1 condenser, 2 beaker, 3 round-bottomed flask, 4 stand/heat) for a purification technique.

(a) Name apparatus number 1

Answer: A (Liebig) condenser.

(b)(i) One mixture that can be separated by this set

Answer: A salt solution (to obtain pure water) — or a mixture of ethanol and water.

(b)(ii) Correct assembly order

The technique is distillation.

Answer: Heat source (4) under the flask of mixture (3) → vapour into the condenser (1) → distillate collected in the beaker (2). Order 4 → 3 → 1 → 2.

(c) An industrial application of this method

Answer: Fractional distillation of crude oil (petroleum refining).

Question 3. A3 — Atoms of X (2,6) and Y (2,7).

(a) Valencies of X and Y

X has 6 outer electrons (needs 2 more) and Y has 7 outer electrons (needs 1 more).

Answer: X: 2; Y: 1.

(b) Ionic or covalent compound?

Both X and Y are non-metals.

Answer: Covalent.

(c) Structure of the compound

X (oxygen) shares one electron pair with each of two Y (fluorine) atoms.

Answer: Y–X–Y with a shared pair (single covalent bond) in each X–Y bond (i.e. F–O–F).

(d) Chemical formula using the actual symbols

Answer: OF■ (X = oxygen, Y = fluorine).

Question 4. A4 — 5.0 g of pure CaCO■ decomposed; 900 cm³ of CO■ evolved at r.t.p. (CaCO■ → CaO + CO■).

(a) Volume of CO■ expected

Moles CaCO■ = 5.0 ÷ 100 = 0.05; 1 : 1 → 0.05 mol CO■; volume = 0.05 × 24000 = 1200 cm³.

Answer: 1200 cm³.

(b) Percentage yield of CO■

% yield = 900 ÷ 1200 × 100 = 75 %.

Answer: 75 %.

Question 5. A5 — Section of the Periodic Table showing the first 20 elements.

(a)(i) Assign Group and Period numbers

Answer: Across: Groups I, II, III, IV, V, VI, VII and 0 (VIII). Down: Periods 1, 2, 3 and 4.

(a)(ii) How many Groups and Periods

Answer: Number of Groups = 8; Number of Periods = 4.

(b) Two noble gases and one use

Answer: Helium and neon. Use: helium fills weather/party balloons (it is light and non-flammable); neon is used in advertising lights.

Question 6. A6 — 2H■ + O■ → 2H■O; bond energies (kJ/mol): H–H 436, O=O 490, H–O 464.

(a) Enthalpy change ΔH

Bonds broken = 2(H–H) + (O=O) = 2(436) + 490 = 1362 kJ. Bonds made = 4(H–O) [two H■O × 2 O–H] = 4(464) = 1856 kJ. ΔH = 1362 − 1856 = −494 kJ.

Answer: ΔH = −494 kJ (exothermic).

(b) Energy-level diagram

Answer: Reactants (2H■ + O■) drawn at a higher energy than the products (2H■O); a curved 'hump' (activation energy) rises between them, and the downward gap from reactants to products is ΔH = −494 kJ.

Question 7. A7 — Preparing chlorine in the laboratory; reactant A is added to solid B, the gas is washed (water), dried (concentrated H■SO■) and collected as dry chlorine.

(a) Name reactants A and B

Answer: A = concentrated hydrochloric acid; B = manganese(IV) oxide (MnO■).

(b) Balanced equation

Answer: MnO■ + 4HCl → MnCl■ + Cl■ + 2H■O.

(c) Chemical test for chlorine gas

Answer: It turns damp blue litmus paper red and then bleaches it white.

(d) Manufacture by electrolysis of brine

(d)(i) Overall equation for the electrolysis of brine

Answer: 2NaCl + 2H■O → 2NaOH + H■ + Cl■.

(d)(ii) One use of chlorine

Answer: Sterilising (treating) drinking water. (Also: bleaching, making PVC.)

Question 8. A8 — Naming organic compounds and the alkanes.

(a) Name the compounds

Answer: (i) CH■CH■CH■OH — propan-1-ol (propanol). (ii) CH■COOH — ethanoic acid. (iii) the –CH■–CHCl– repeating chain — poly(chloroethene), PVC.

(b) Alkane of formula C■H■

(b)(i) General formula of the alkanes

Answer: C■H■■■■.

(b)(ii) Value of X, and the name of the hydrocarbon

For n = 6: x = 2(6) + 2 = 14.

Answer: X = 14; the hydrocarbon is hexane (C■H■■).

(b)(iii) Two isomers of the hydrocarbon

Answer: n-hexane: CH■–CH■–CH■–CH■–CH■–CH■; and 2-methylpentane: CH■–CH(CH■)–CH■–CH■–CH■.

Question 9. B9 — Purification of copper by electrolysis.

(a) Names for the purification of copper

Answer: (i) Electrolyte: copper(II) sulphate solution (acidified). (ii) Anode: impure copper. (iii) Cathode: pure copper.

(b) Labelled diagram

Answer: An impure-copper anode and a pure-copper cathode dipped in copper(II) sulphate solution, both connected to a d.c. supply (battery).

(c) Ionic equations at the electrodes

Answer: Anode: Cu → Cu²■ + 2e■ (copper dissolves). Cathode: Cu²■ + 2e■ → Cu (copper deposited).

(d) Mass of pure copper from 5 A for half an hour (1F = 96 500 C)

Q = 5 × 1800 = 9000 C; moles e■ = 9000 ÷ 96500 = 0.0933; Cu²■ + 2e■ → Cu, so moles Cu = 0.0466; mass = 0.0466 × 64 ≈ 3.0 g.

Answer: ≈ 3.0 g.

Question 10. B10 — Flow chart of copper reactions: P (blue sulphate crystals), Q (white solid), R (green solution), S (pink-brown solid), T (blue precipitate), U (black solid).

(a) Names of P, Q, R, S, T and U

Answer: P = copper(II) sulphate (hydrated, blue crystals); Q = anhydrous copper(II) sulphate (white); R = iron(II) sulphate (green solution); S = copper (pink-brown solid); T = copper(II) hydroxide (blue precipitate); U = copper(II) oxide (black solid).

(b)(i) Name of the reaction when solution P reacts with iron filings

Answer: Displacement (a redox reaction — iron displaces copper).

(b)(ii) Name of the reaction when solution P reacts with sodium hydroxide to give T

Answer: Precipitation (double decomposition).

(c)(i) Equation: blue solution P with iron filings (state symbols)

Answer: Fe(s) + CuSO■(aq) → FeSO■(aq) + Cu(s).

(c)(ii) Equation: substance T when strongly heated

Answer: Cu(OH)■(s) → CuO(s) + H■O(g).

Question 11. B11 — Extraction of iron in the blast furnace.

(a) Two ores of iron

Answer: Haematite and magnetite.

(b) Formulae of the two ores

Answer: Fe■O■ (haematite) and Fe■O■ (magnetite).

(c) Two other substances added with the ore

Answer: Coke (carbon) and limestone (calcium carbonate). [Hot air is also blasted in.]

(d) Equation for the reduction of the iron ore

Answer: Fe■O■ + 3CO → 2Fe + 3CO■.

(e) Property that lets iron be made into sheets

Answer: It is malleable (it can be hammered/rolled into sheets).

(f) Why aluminium is extracted by electrolysis but iron by reduction with carbon

Answer: Aluminium is more reactive than carbon, so carbon cannot reduce its oxide — electrolysis is needed; iron is less reactive than carbon, so carbon can reduce its oxide.

Question 12. B12 — Marble chips + hydrochloric acid; CO■ collected in a gas syringe. Volumes (cm³) at 0,10,20,30,40,50,60,70,80 s: 0,22,43,58,66,70,70,70,70.

(a) Graph

Answer: Plot volume of CO■ (y-axis) against time (x-axis): a curve rising steeply at first, then bending over and flattening at 70 cm³.

(b)(i) Volume of gas produced in the first 25 s

Reading the curve at 25 s (between 43 cm^3 at 20 s and 58 cm^3 at 30 s).

Answer: About 50 cm^3.

(b)(ii) Time taken to produce 45 cm^3 of CO■

45 cm^3 falls just after the 20 s reading (43 cm^3).

Answer: About 21 s.

(c) Time for the reaction to end

The volume first becomes constant (70 cm^3) at 50 s.

Answer: About 50 s.

(d) Total volume of gas produced

Answer: 70 cm^3.

(e) Two factors that can be changed to increase the rate

Answer: Increase the temperature, and increase the concentration of the acid (or use smaller/powdered marble chips for a larger surface area).

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