

[Pure] Chemistry O Level Exam Paper
Preliminary Examination Set [II]
Secondary Four Express



CANDIDATE NAME:

CLASS:

INDEX NUMBER:

(Updated 2024)

6092/01

Chemistry

1 hour

Paper 1 Multiple Choice

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid/tape.

Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A, B, C** or **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

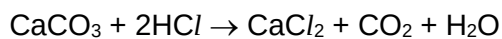
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

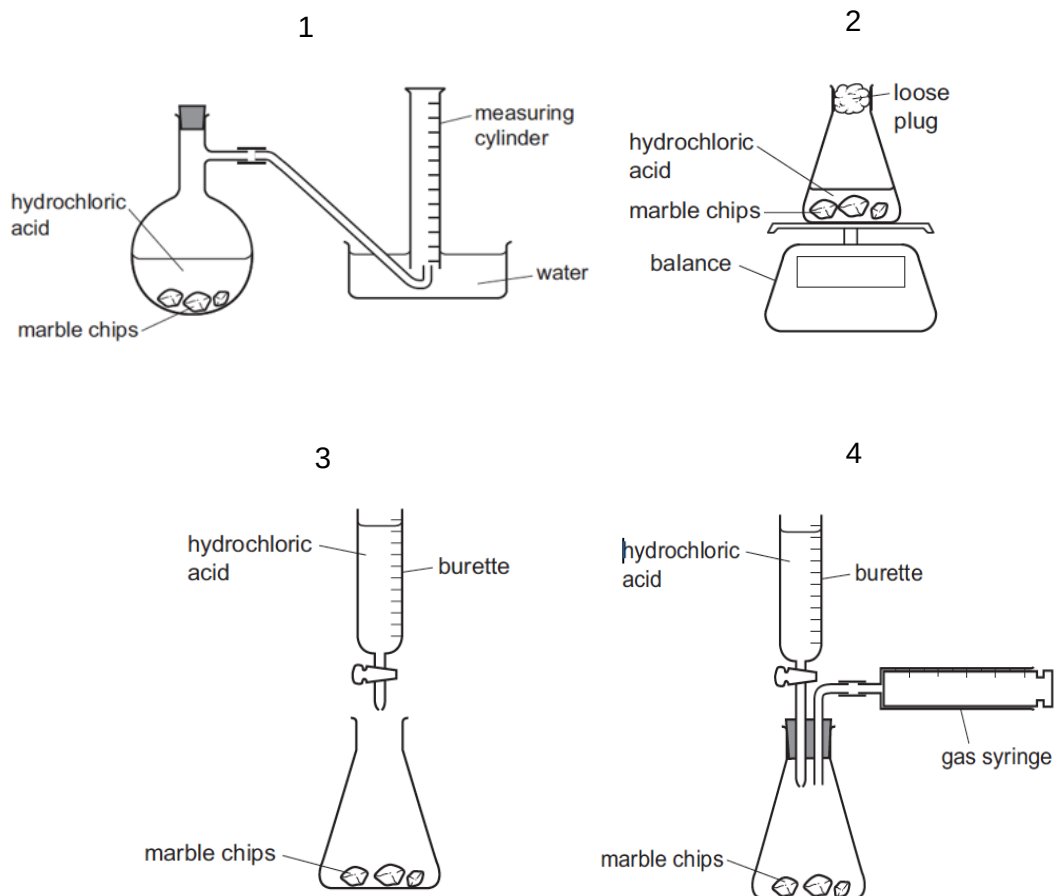
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

- 1 A student follows the rate of the reaction between marble chips, CaCO_3 , and dilute hydrochloric acid.



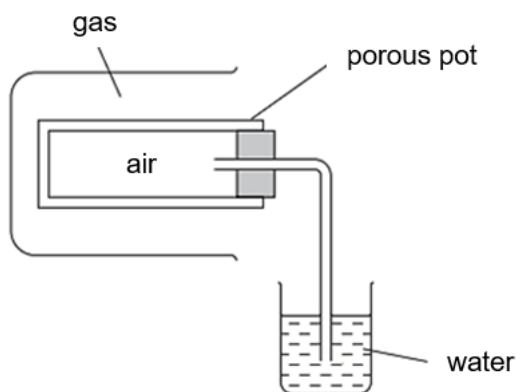
Which set-ups show the apparatus that are required for this experiment?



- A** 1 and 2 only
C 2 and 4 only

- B** 1 and 3 only
D 1, 2 and 4 only

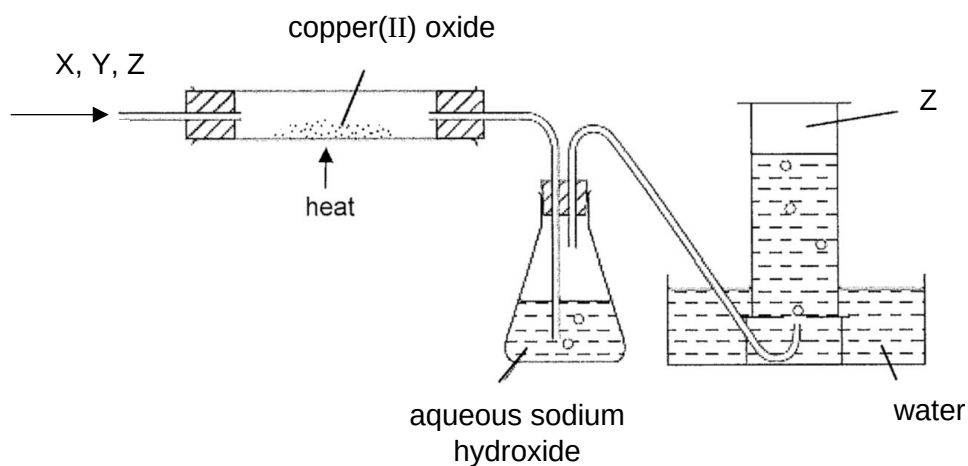
- 2 The apparatus shown in the diagram was used to compare the rate of diffusion between a gas and air.



A beaker containing the gas was placed over the porous pot.

Which gas would cause bubbles to be observed in the beaker of water?

- A carbon monoxide
 - B hydrogen chloride
 - C methane
 - D sulfur dioxide
- 3 An unknown gas, Z can be separated from a mixture of gases, X, Y and Z using the set-up as shown below.

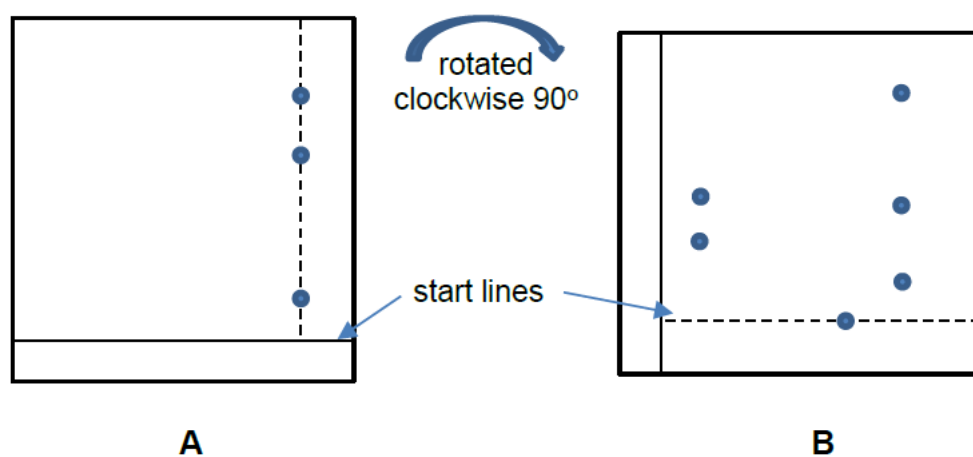


In which mixture will Z be effectively separated from?

	X	Y	Z
A	carbon dioxide	nitrogen	oxygen
B	hydrogen	carbon dioxide	nitrogen
C	nitrogen	oxygen	hydrogen
D	oxygen	hydrogen	carbon monoxide

- 4 A chromatography experiment was done on a brand of food colouring to determine the number of coloured dyes present.

Chromatogram A shows the separation of the coloured dyes using water as a solvent. It is then rotated clockwise 90° and placed in ethanol as a solvent as shown in the chromatogram B.



How many different types of coloured dyes are present in the food colouring?

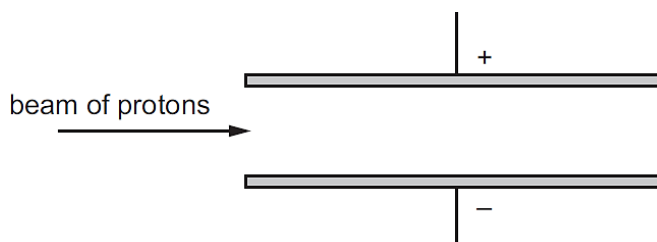
- A 3 B 6 C 9 D 12
- 5 The melting and boiling points of the substances are tabulated in the table.

	melting point / $^\circ\text{C}$	boiling point / $^\circ\text{C}$
P	50	80
Q	70	500
R	65	67
S	-15	-12
T	0	99

At which temperature would two liquids exist?

- A -20°C
 B -15°C
 C 15°C
 D 85°C

- 6 A beam of protons was passed through an electrostatic field between two charged plates. The electrostatic field deflected the beam of protons towards the negatively charged plates. The lower the relative mass of the particle, the larger the deflection.



The experiment was repeated using a beam of electrons in place of the beam of protons.

Which row correctly shows the extent of deflection and the direction of the beam of electrons?

	amount of deflection of beam of electrons	direction of deflection of beam of electrons
A	deflected less than beam of protons	opposite direction to beam of protons
B	deflected less than beam of protons	same direction as beam of protons
C	deflected more than beam of protons	opposite direction to beam of protons
D	deflected more than beam of protons	same direction as beam of protons

- 7 Which compound has both ionic and covalent bonds?

- A** hydrogen chloride
- B** magnesium nitrate
- C** potassium fluoride
- D** zinc chloride

- 8 Which statements correctly describe the sub-atomic particles present in a selenium atom, $^{79}_{34}\text{Se}$?

1. It has the same number of electrons as a $^{32}_{16}\text{S}^{2-}$ ion.
2. It has the same number of neutrons as a $^{80}_{35}\text{Br}$ atom.
3. It has twice the number of protons as a $^{35.5}_{17}\text{Cl}^{-}$ ion.

- | | |
|------------------|---------------------|
| A 1 and 2 | B 1 and 3 |
| C 2 and 3 | D 1, 2 and 3 |

- 9 Which statement about diamond and graphite is correct?

- A** Both diamond and graphite are conductors of electricity and can be used as an electrode.
- B** Both diamond and graphite are macromolecules and allotropes of carbon.
- C** Diamond is hard with high melting point but graphite is soft with low melting point.
- D** Diamond is made up of covalent bonds whereas graphite is made up of ionic bonds.

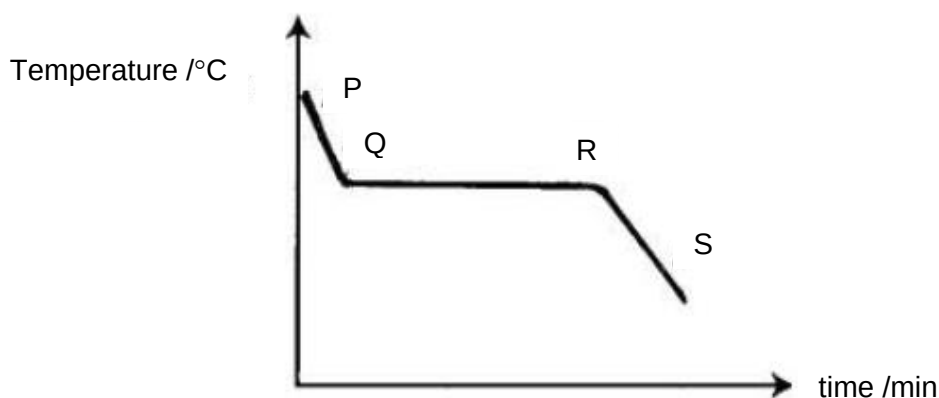
10 The table below shows the properties of some substances.

Which underlined substance has been classified as an element, compound or mixture **incorrectly**?

	property	classification
A	A <u>white solid</u> is formed when a silvery metal is burnt in air.	element
B	<u>Black powder</u> burns in air to form a colourless gas.	element
C	<u>Green powder</u> on heating leaves a black residue and a colourless gas is evolved.	compound
D	<u>White solid</u> melts over 56 °C to 58°C	mixture

11 A sample of solid X is heated until it is completely melted.

The graph shows how its temperature varies with time as molten X is cooled.



Which statements are true about the particles in X as it cools?

1. They are closer to each other at stage RS than at stage PQ.
2. The forces of attraction are stronger at stage P than at stage S.
3. The arrangement is more orderly at stage RS than at stage PQ.
4. Their total energy content at stage QR is lower than stage RS.

- A 1 and 2
B 1 and 3
C 2 and 3
D 2 and 4

- 12 A tablet of aspirin, $\text{C}_9\text{H}_8\text{O}_4$, is crushed and dissolved in water. The acid present in a tablet of aspirin can be neutralized by 12.25 cm^3 of 0.147 mol/dm^3 sodium hydroxide.



Given that one grain of aspirin is 0.0648 g , how many grains of aspirin are there in the tablet?

[M_r : $\text{C}_9\text{H}_8\text{O}_4$, 180]

- A 0.0018 B 0.324 C 5 D 15

- 13 Zinc reacts with dilute hydrochloric acid.

Which solution would give the fastest initial rate of reaction?

- A 10 g of HCl in 50 cm^3 of water
B 25 g of HCl in 100 cm^3 of water
C 30 g of HCl in 500 cm^3 of water
D 45 g of HCl in 1000 cm^3 of water

- 14 Methanethiol gas, CH_3SH , burns as shown in the equation below.



A sample of 20 cm^3 of methanethiol gas was burned with 30 cm^3 of oxygen gas.

What would be the final volume of the resultant mixture of gases when cooled to room temperature and pressure?

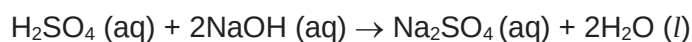
- A 20 cm^3
B 30 cm^3
C 40 cm^3
D 50 cm^3

- 15 Which statements best describe what happens in the Haber process ?

1. The hydrogen needed is obtained from the fractional distillation of liquefied air.
2. The process is reversible.
3. The ratio of the molar volume of hydrogen to nitrogen is 3:1.
4. The unchanged reactants are reused.

- A 1 and 3 only
B 1, 2, 3 and 4
C 2 and 3 only
D 2, 3 and 4 only

- 16 Yanny titrated 25.00 cm³ of 0.100 mol/dm³ of sulfuric acid with 0.250 mol/dm³ of sodium hydroxide using a methyl orange indicator.



She recorded the volume of sodium hydroxide used to be 24.00 cm³.

Which statement(s) is/are correct?

1. The colour of the solution at the end of the titration is yellow.
2. The colour of the solution at the end of the titration is orange.
3. She has exceeded the end-point of the titration.
4. She has just reached the end-point of the titration

- A** 1 and 3 only
B 1 and 4 only
C 2 and 3 only
D 2 and 4 only

- 17 A student is given five reagents as shown below to make salts.

dilute hydrochloric acid
 dilute nitric acid
 dilute sulfuric acid
 solid lead (II) oxide
 solid copper (II) oxide

How many soluble salts can be prepared?

- A** 3
B 4
C 5
D 6

- 18 Four bottles, **A**, **B**, **C** and **D**, containing colourless solutions have no labels. A series of tests are conducted on each of the solutions.

Which bottle contains ammonium chloride solution?

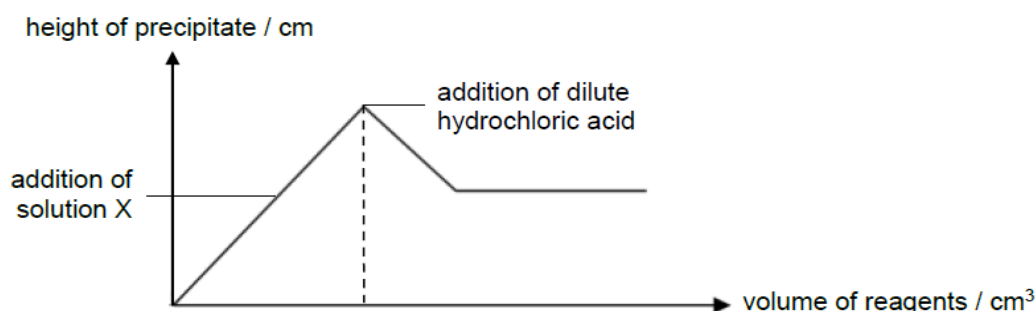
Bottle	test 1: add dilute hydrochloric acid	test 2: add warm aqueous sodium hydroxide	test 3: add dilute nitric acid and aqueous silver nitrate
A	bubbling	gas produced turns damp red litmus blue	no visible change
B	no visible change	gas produced turns damp red litmus blue	no visible change
C	no visible change	gas produced turns damp red litmus blue	white precipitate forms
D	no visible change	no reaction	white precipitate forms

19 Which method produces the highest yield of calcium sulfate from calcium carbonate?

- A Addition of aqueous dilute hydrochloric acid
- B Addition of aqueous sodium sulfate
- C Addition of dilute hydrochloric acid, followed by solid barium sulfate
- D Addition of dilute hydrochloric acid, followed by sodium sulfate solution

20 The graph below shows how the height of the precipitate formed increases when solution X is gradually added to solution Y.

The height of the precipitate then decreases when excess dilute hydrochloric acid is added to the mixture.



What is the identity of solution X and the anions present in solution Y?

	solution X	solution Y
A	aqueous barium nitrate	carbonate, chloride
B	aqueous barium nitrate	iodide, sulfate
C	aqueous silver nitrate	carbonate, chloride
D	aqueous silver nitrate	iodide, sulfate

21 There are four stages of reactions for the conversion of solid candlewax, $C_{30}H_{62}$, to carbon dioxide and water. The reactions can be represented by the chemical equations below.

- 1 $C_{30}H_{62} (s) \rightarrow C_{30}H_{62} (l)$
- 2 $C_{30}H_{62} (l) \rightarrow C_{30}H_{62} (g)$
- 3 $C_{30}H_{62} (g) + 45.5 O_2 \rightarrow 30 CO_2 (g) + 31 H_2O (g)$
- 4 $30 CO_2 (g) + 31 H_2O (g) \rightarrow 30 CO_2 (g) + 31 H_2O (l)$

Which stages are exothermic?

- A 1 and 2 only
- B 1 and 4 only
- C 2 and 3 only
- D 3 and 4 only

- 22 The table below show the chemical formulae of the different compounds formed by carbon and other elements.

compound	chemical formula
potassium cyanide	KCN
iron(II) carbide	Fe ₂ C
carbon dioxide	CO ₂
calcium carbonate	CaCO ₃

In which substance, does carbon has the same oxidation state?

- A carbon dioxide and calcium carbonate
B carbon dioxide and potassium cyanide
C iron(II) carbide and calcium carbonate
D iron(II) carbide and potassium cyanide
- 23 Separate samples of an unknown solution W are added to aqueous potassium iodide and acidified potassium manganate(VII).

It is observed that aqueous potassium iodide turns from colourless to brown and acidified potassium manganate(VII) remains purple.

What conclusion about W is correct?

- A W is both an oxidising agent and a reducing agent.
B W is neither an oxidising agent nor a reducing agent.
C W is only a reducing agent.
D W is only a oxidising agent.
- 24 Each of the following halogens, X₂, Y₂ and Z₂, was added to the respective halide solutions and the observations are shown in the table below.

halogen added	NaX	NaY	NaZ
X ₂	--	Y ₂ displaced	no visible reaction
Y ₂	no visible reaction	--	no visible reaction
Z ₂	X ₂ displaced	Y ₂ displaced	--

Which row lists the elements X, Y and Z in decreasing order of reactivity?

- A X, Y and Z
B Y, X and Z
C Y, Z and X
D Z, X and Y

25 Which statement correctly describes a trend in the properties of the elements going from left to right of Period 3 of the Periodic Table?

- A** The ability of the elements to conduct electricity increases.
B The number of neutrons in the atom increases.
C The number of valence electrons decreases in the atoms.
D The tendency to gain electrons increase.

26 The diagram shows the positions of elements R, S, T, U and V in the Periodic Table.

														R		
S												T				U
																V

Which statement is correct?

- A** S forms a simple molecular compound with U.
B T forms an ionic compound with U.
C The valence shell of an atom of R has an octet structure.
D U is a stronger oxidising agent than V.

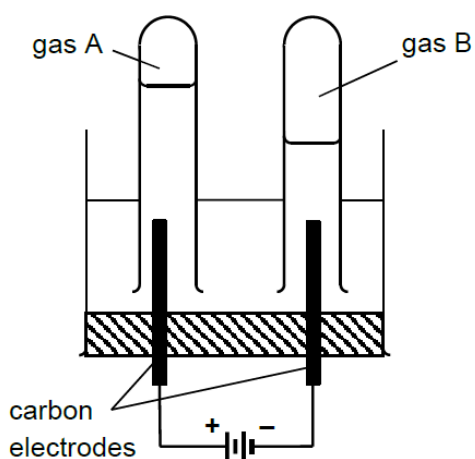
27 Octane reacts very slowly with air at room temperature. When metal T is added to the octane-air mixture, octane ignites quickly.

Which statements about the addition of metal T are correct?

1. T increases the enthalpy change of the reaction
2. T increases the rate of reaction.
3. T increases the yield of the reaction.
4. T provides an alternative pathway with a lower activation energy.

- A** 1 and 2 only
B 1 and 4 only
C 2 and 4 only
D 2, 3 and 4 only

- 28** The diagram shows an electrolytic cell used to electrolyse a solution.



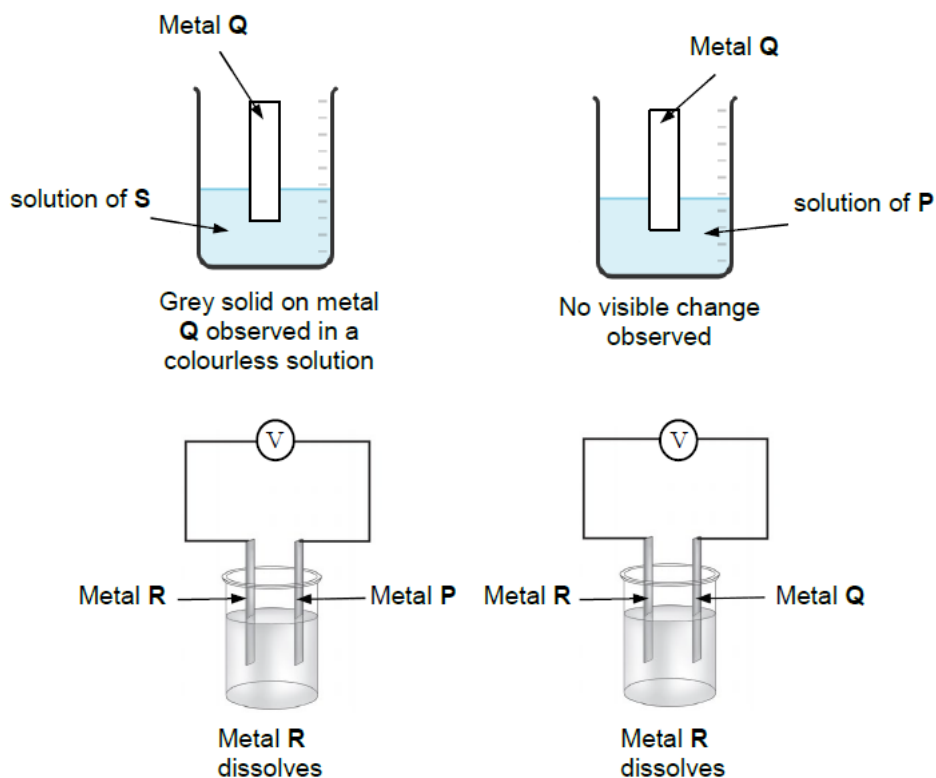
What is a possible identity of this solution?

- A** concentrated magnesium chloride
 - B** concentrated silver nitrate
 - C** concentrated sodium iodide
 - D** dilute potassium fluoride
- 29** During an experiment, a student found out the following properties of element X.
1. Oxide of element X can react with both acid and base to form salt and water.
 2. X can only be extracted from its ore by electrolysis of molten compound of X.

What could element X be?

- A** aluminium
- B** calcium
- C** lead
- D** zinc

- 30 Stephy conducted four experiments to find out the reactivity of four metals P, Q, R and S. The results and set-ups of her four experiments can be shown below.

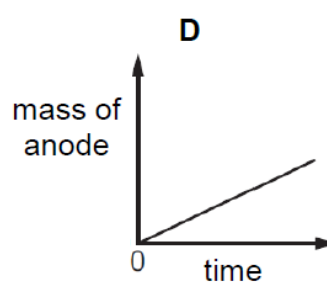
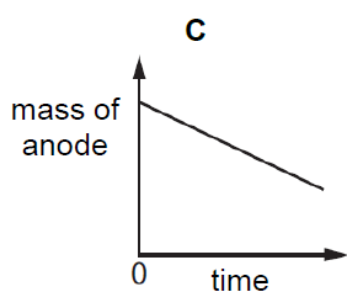
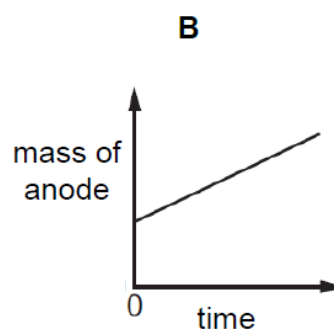
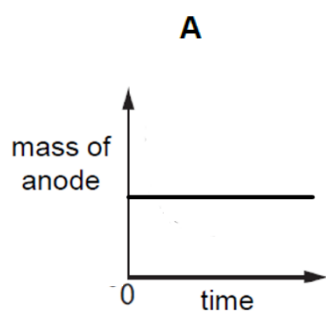


Based on the results of the experiments, arrange the metals in decreasing order of reactivity.

	most reactive  least reactive			
A	P	Q	R	S
B	R	P	Q	S
C	S	Q	P	R
D	S	R	Q	P

- 31 Aqueous copper(II) sulfate is electrolysed using copper electrodes. The current is constant and the anode is weighed at regular time intervals.

Which graph is obtained when the mass of the anode is plotted against time?

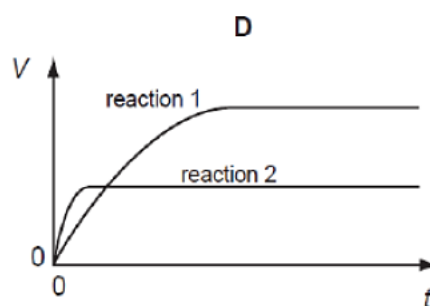
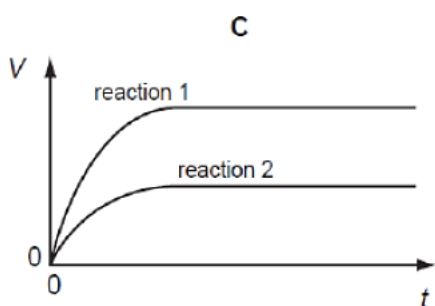
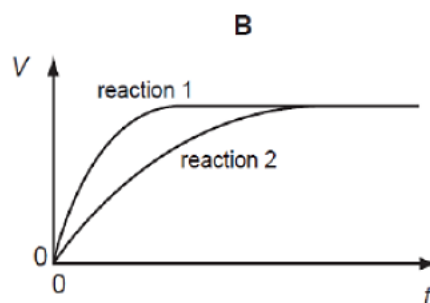
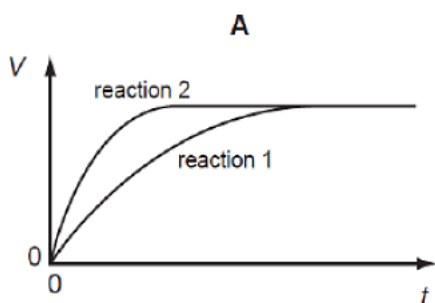


32 Amy conducted two experiments.

Experiment 1	10 g of granules of calcium carbonate with 1 dm ³ of 2.0 mol/dm ³ dilute hydrochloric acid
Experiment 2	5 g of powdered calcium carbonate with 1 dm ³ of 3.0 mol/dm ³ dilute hydrochloric acid

In both experiments, the volume of carbon dioxide produced, V is measured against time, t and the results are plotted graphically.

Which set of graphs is correct?



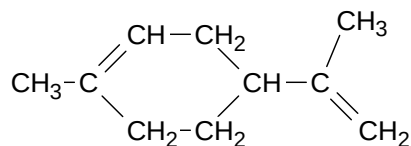
33 When 50 cm³ of 1 mol/dm³ HCl is mixed with 50 cm³ of 1 mol/dm³ NaOH, the temperature of the resulting solution increases by 6°C. What will be the temperature change when 100 cm³ of each of these solutions are mixed?

- A 3 °C
- B 6 °C
- C 12 °C
- D 24 °C

34 Which formula below best represents a straight-chain hydrocarbon that contains only single covalent bonds?

- A C₆H₆
- B C₆H₁₂
- C C₆H₁₄
- D C₆H₅OH

- 35** Limonene is found in oils of orange, grapefruit and lemon. The structure of limonene is as shown.

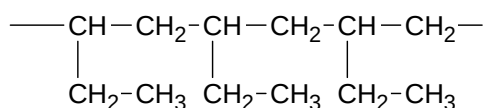


Which statements are true about limonene?

1. It reacts with chlorine in the presence of light.
 2. It is flammable.
 3. It can react with hydrogen gas to form saturated hydrocarbon.
- A** 1 and 2 only
B 1 and 3 only
C 1, 2 and 3
D 2 and 3 only
- 36** A molecule of hydrocarbon, $C_{16}H_{34}$, undergoes cracking to produce one molecule of butane and the rest ethene molecules.

How many ethene molecules are produced?

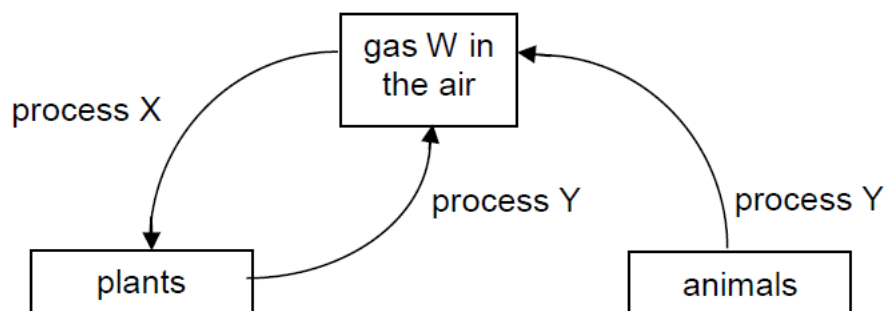
- A** 4
B 6
C 8
D 10
- 37** The structure of a polymer is shown below.



What is the molecular formula of the monomer?

- A** C_2H_4
B C_3H_8
C C_4H_8
D C_4H_{10}

38 The diagram shows part of the carbon cycle.



What is the correct identity of gas W and processes X and Y?

	gas W	process X	process Y
A	carbon dioxide	photosynthesis	respiration
B	carbon dioxide	respiration	photosynthesis
C	carbon monoxide	photosynthesis	respiration
D	carbon monoxide	respiration	photosynthesis

39 Which pair of pollutants can cause the most damage to limestone buildings?

- A** carbon monoxide and oxygen
- B** chloroflurocarbons and ozone
- C** methane and sulfur dioxide
- D** nitrogen oxides and sulfur dioxide

40 A car burning lead-free fuel has a catalytic converter filled to its exhaust. On analysis, its exhaust gases are shown to contain small quantities of nitrogen oxides.

What modification(s) would result to a lower exhaust concentration of nitrogen oxides?

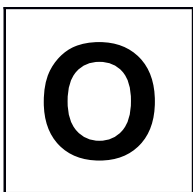
1. An increase in the surface area of the catalyst in the converter.
2. An increase in the percentage of oxygen going into the car.
3. A higher temperature of combustion in the engine.

- A** 1 only
- B** 1 and 2
- C** 1,2 and 3
- D** 2 and 3

The Periodic Table of Elements

Group																													
1	2	1 H hydrogen 1														13	14	15	16	17	18								
		Key																											
3	4	proton (atomic) number atomic symbol name relative atomic mass														5	6	7	8	9	10	11	12	13	14	15	16	17	18
Li lithium 7	Be beryllium 9															B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20								
11	12															13	14	15	16	17	18								
Na sodium 23	Mg magnesium 24															Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40								
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36												
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84												
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54												
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium -	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131												
55	56	57-71 lanthanoids		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86											
Cs caesium 133	Ba barium 137			Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium -	At astatine -	Rn radon -											
87	88	89-103 actinoids		104	105	106	107	108	109	110	111	112																	
Fr francium -	Ra radium -			Rf rutherfordium -	Db dubnium -	Sg seaborgium -	Bh bohrium -	Hs hassium -	Mt meitnerium -	Ds darmstadtium -	Rg roentgenium -	Cn copernicium -																	

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –



[Pure] Chemistry O Level Exam Paper
Preliminary Examination Set [II]
Secondary Four Express



CANDIDATE NAME:

CLASS:

INDEX NUMBER:

(Updated 2024)

6092/02

Chemistry

1 hour 45 minutes

Paper 2 Theory

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid/tape.

Section A

Answer **all** questions.

Section B

Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Section A	
Section B	
Total	

Section A

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

A1 The formulae of some elements and compounds are listed.



Answer the following questions using elements or compounds from the list. You may use each element or compound once, more than once or not at all.

(a) Which substance can react with both an acid and an alkali?

..... [1]

(b) Which substance in aqueous form reacts with aqueous chlorine to form a brown solution with black crystals?

..... [1]

(c) Which substance has a mass of 8.00 g for every 0.125 mol?

..... [1]

(d) Which substance can be prepared by precipitation?

..... [1]

(e) Which substance produces a reddish brown vapour when electricity is passed through its molten state?

..... [1]

[Total: 5]

A2 Chlorine exists as two isotopes, chlorine-35 and chlorine-37.

- (a)** In a sample of 100 chlorine atoms, there are 76 atoms of chlorine-35 and 24 atoms of chlorine-37.

Find the average relative atomic mass of this chlorine sample.

average relative atomic mass = [1]

- (b)** An element T is found in period 3 of the Periodic Table. It reacts with chlorine to form a chloride with a formula T_2Cl_2 , which has a melting point of -80°C and a boiling point of 137°C .

- (i)** Use ideas about bonding and structure to explain why T_2Cl_2 is a liquid at room temperature and pressure.

.....
.....
..... [2]

- (ii)** Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in T_2Cl_2 .

[2]

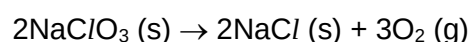
[Total: 5]

- A3** Sodium chlorate(V), NaClO_3 , is used in some aircrafts as a source of emergency oxygen when there is a drop in cabin pressure. The catalyst, iron powder, is mixed with sodium chlorate(V) and can be ignited by a charge, which is activated by pulling on the emergency mask.

Some information on sodium chlorate(V) is shown.

	NaClO_3
melting point/ $^{\circ}\text{C}$	248
boiling point/ $^{\circ}\text{C}$	--

- (a)** Sodium chlorate(V) decomposes as shown.



- (i)** What does (V) in sodium chlorate(V) indicate?

..... [1]

- (ii)** The decomposition of sodium chlorate(V) is a redox reaction.

Use oxidation states to show that this statement is true.

.....
.....
.....
..... [2]

- (iii)** After the catalytic decomposition of sodium chlorate(V), the catalyst, iron is mixed with the sodium chloride product. Describe how sodium chloride salt can be separated, if all the sodium chlorate(V) has fully decomposed.

.....
..... [1]

- (b)** Suggest why there is no data for the boiling point in the table for sodium chlorate(V).

..... [1]

- (c)** If 5.00g of impure sodium(V) chlorate can decompose to form 450 cm^3 of oxygen gas, calculate the percentage purity of sodium(V) chlorate in the sample.

[3]

[Total: 8]

- A4** Methane, methanol and hydrogen have been investigated as possible alternative fuels for motor vehicles that currently use petrol. The table below compares the energy released on combustion of these fuels.

The enthalpy change of combustion of a substance, ΔH , is defined as the energy released when one mole of the substance is completely burnt in oxygen.

Table 4.1

fuel	density/g/dm ³	ΔH / kJ/mol
petrol	710 - 770	–
methane	0.667	–891
methanol	792	–726
hydrogen	0.0884	–286

- (a) Suggest a reason why no value is quoted for the enthalpy change of combustion of petrol in Table 4.1.

.....
..... [1]

- (b) Methane and methanol undergo complete combustion to give the same products.

- (i) Write a chemical equation for the combustion of methane.

..... [1]

- (ii) Explain why the enthalpy change of combustion of methane is more negative than the enthalpy change of combustion of methanol.

.....
.....
.....
..... [2]

- (iii) Draw the energy profile diagram for the reaction in (b)(i). Label on the diagram the activation energy and the enthalpy change.



[3]

- (c) Although the combustion of hydrogen releases less energy as compared to methane per mole, many people believed that hydrogen is a better alternative fuel compared to methane, in terms of environment impact. Suggest why is this so.

.....
.....
..... [2]

- (d) One alternative fuel technology involves the conversion of liquid methanol into hydrogen gas as shown by the chemical equations below. The hydrogen obtained can then be used as a fuel.

Step 1: $\text{CH}_3\text{OH} (l) \rightarrow \text{CH}_3\text{OH} (g)$

Step 2: $\text{CH}_3\text{OH} (g) \rightarrow 2\text{H}_2 (g) + \text{CO} (g)$

Suggest why this alternative fuel technology to produce hydrogen is sometimes said to have a harmful effect.

.....
.....
..... [1]

[Total: 10]

- A5** To investigate the rate of reaction between magnesium and an excess of dilute hydrochloric acid, Amy set up an experiment as shown in Fig. 5.1.

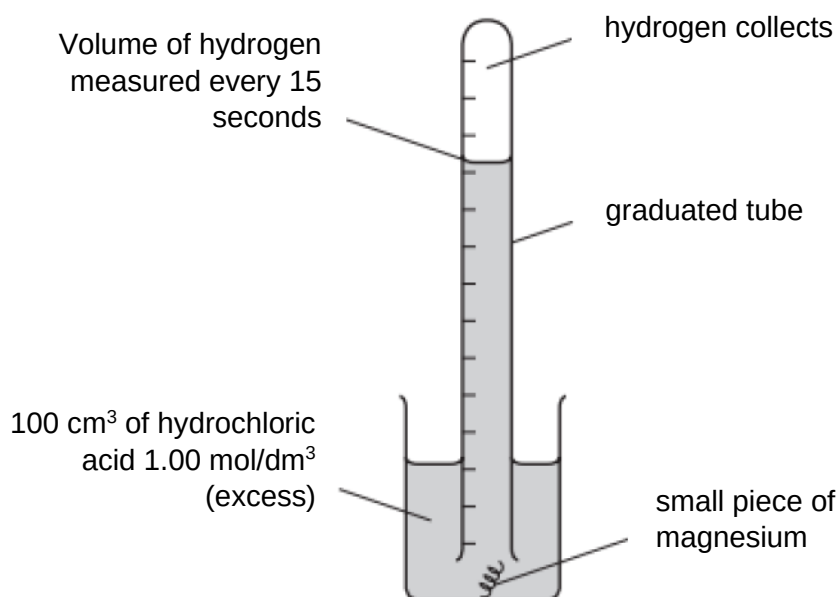


Fig. 5.1

- (a)** Explain why Amy added dilute hydrochloric acid in excess.

.....
..... [1]

- (b)** Explain, in terms of collisions and energy, how the rate of reaction would be affected if the concentration and the temperature of the acid is increased in Fig 5.1.

.....
.....
.....
.....
..... [3]

- (c)** During the experiment, the small piece of magnesium kept rising to the surface. Suggest a reason why the small piece of magnesium kept floating to the surface.

.....
..... [1]

- (d) To prevent the piece of magnesium from rising to the surface. Amy decided to attach the piece of magnesium to another substance. To determine if the choice of the substance affects the rate of reaction, she conducted the experiment twice, once with copper and the other time with plastic. The results from the two experiments are shown in Fig. 5.2.

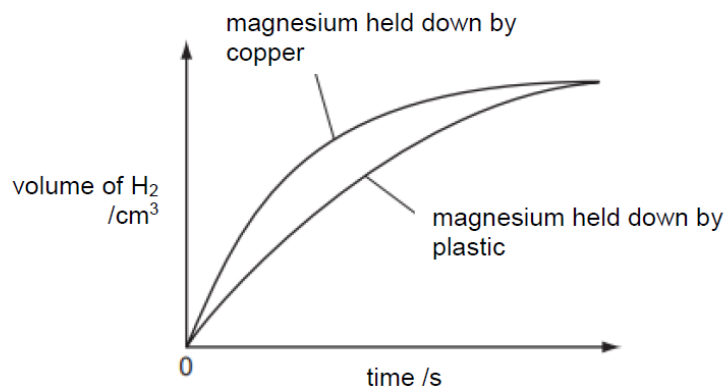


Fig. 5.2

- (i) Iron, zinc and copper have similar densities.

Stanley said that copper is a better choice than iron or zinc to weigh down the magnesium. Do you agree with him? Explain your answer.

.....
 [1]

- (ii) With reference to Fig. 5.2, which experiment shows a faster rate of reaction? Suggest a reason for your answer.

.....

 [1]

- (iii) Describe how the shape of the graph will change if ethanoic acid is used instead.

.....

 [1]

[Total: 8]

- A6** Fig. 6.1 shows the electrolysis of concentrated aqueous potassium chloride while Fig. 6.2 shows the simple cell used in the electrolysis. A few drops of Universal Indicator were added to the concentrated aqueous potassium chloride before the start of the experiment.

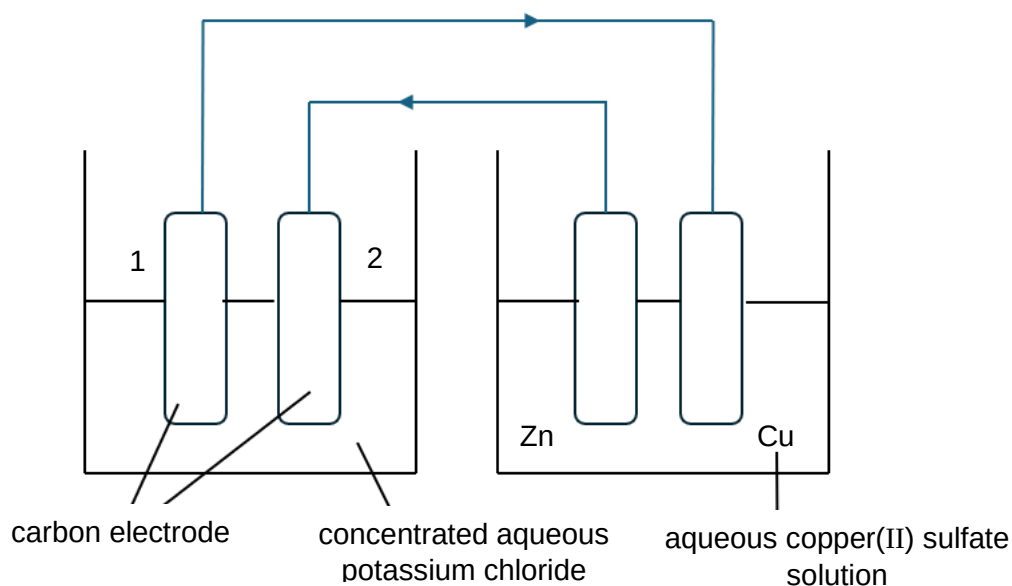


Fig. 6.1

Fig. 6.2

- (a)** State and explain if electrode 2 is the anode or cathode.
Write the half-equation for the reaction that occurs at this electrode.

.....

 [2]

- (b)** Describe the observations at electrode 1.

.....
 [1]

- (c)** State and explain the observations made on the electrolyte in Fig. 6.1 as the experiment proceeds.

.....

 [2]

- (d) The electrolyte used in Fig. 6.2 is aqueous copper(II) sulfate.
Write the half-equation for the reaction at the copper metal.

..... [1]

- (e) Suggest a way to increase the voltage of the simple cell.

.....
..... [1]

- (f) If the position of the zinc and copper electrodes in Fig. 6.2 were switched with each other, what would be observed instead at the electrode 1 and 2 in Fig. 6.1?

.....
.....
..... [1]

[Total: 8]

- A7** Most vehicles operated using the petrol engine where the air: fuel ratio in the engine plays an important role to determine the relative levels of emission of different air pollutants as shown in Fig. 7.1.

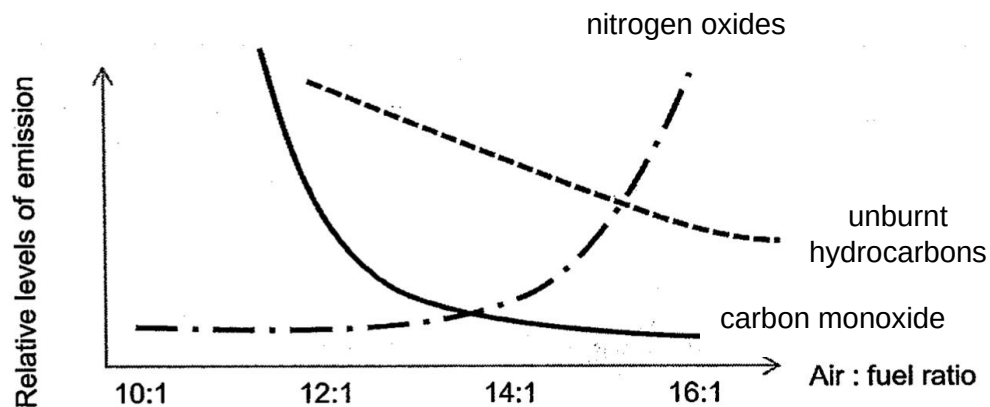


Fig. 7.1

- (a)** Use the information from Fig. 7.1, explain why the trends of emission of unburnt hydrocarbon and carbon monoxide follow the same general trend.

.....

.....

.....

..... [2]

- (b)** Explain why the level of oxides of nitrogen increases when the air : fuel ratio is greater than 14 : 1.

.....

.....

..... [2]

- (c)** An engineer suggests that air : fuel ratio of 13.8 : 1 is the optimum condition for the engine to produce the least amount of pollutants. Explain why this statement is not true.

.....

.....

..... [1]

- (d)** Catalytic converter installed in cars reduce the amounts of carbon monoxide and nitrogen oxides from cars.

- (i)** Write an equation to show how a catalytic converter reduces the amount of carbon monoxides and nitrogen oxides from cars.

..... [1]

- (ii) A statement reads, "Catalytic converters do not solve all environmental problems."

Based on the equation in (d)(i) and Fig. 7.1, explain why this is true.

.....

..... [1]

[Total: 7]

- A8 (a)** Ammonium iodide, NH_4I , is a white solid which decomposes when heated.



Describe how you would know when all the ammonium iodide has decomposed.

.....

..... [1]

- (b) Aqueous ammonium iodide reacts with three halogens, fluorine, chlorine and bromine, but not with astatine.

- (i) Write a general equation to show the reaction of ammonium iodide with a halogen. Use X_2 as the symbol of the halogen.

..... [1]

- (ii) Explain why aqueous ammonium iodide will have no reaction with astatine.

.....

..... [1]

- (c) Ammonium iodide is able to conduct electricity in aqueous state but not in the solid state.

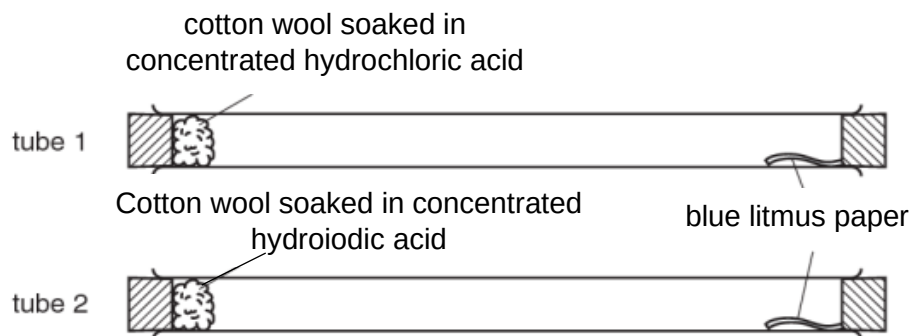
Explain this observation.

.....

.....

..... [2]

- (d) Two students set up an experiment to investigate the rate of diffusion of gases.



Concentrated hydrochloric acid produces fumes of hydrogen chloride, HCl .

Concentrated hydroiodic acid produces fumes of hydrogen iodide, HI .

The students made the following observations and conclusions:

Observations

- Four minutes after setting up the experiment, the litmus paper in tube 1 turns red.
- Twelve minutes after setting up the experiment, the litmus paper in tube 2 turns red.

Conclusion

'The rate of diffusion is inversely proportional to the relative molecular mass of each gas.'

Do the observations support this conclusion? Explain your reasoning.

.....

.....

.....

..... [2]

[Total: 7]

A9 Plastics

Plastics are commonly made up of polymers. The properties of plastic polymers depend on the monomers they are made up from, and all plastic polymers have their own characteristic physical properties, depending on their specific molecular structure.

Homopolymer

A homopolymer is a polymer that consists of only one kind of monomer which repeats regularly to construct the polymer chain.

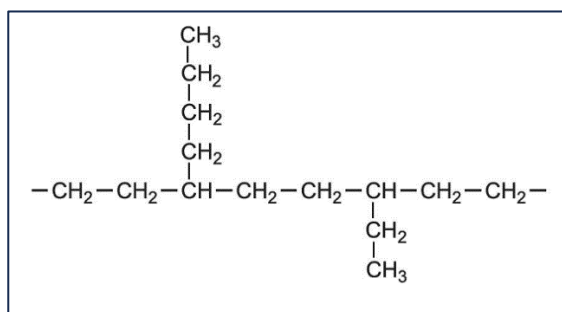
Poly(ethene) is a type of homopolymer which is made from the polymerisation of ethene and is usually represented as a simple addition polymerisation reaction which produces a linear chain of carbon and hydrogen atoms as shown in Fig. 9.1.



Fig. 9.1

Different processes can be used to manufacture several types of poly(ethene), each with a different structure. Fig. 9.2 shows the structure of two types of poly(ethene).

low-density poly(ethene) (LDPE)



high-density poly(ethene) (HDPE)

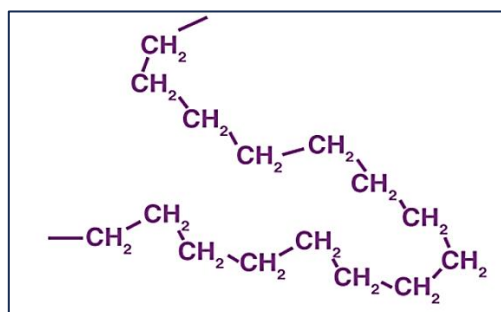


Fig. 9.2

Co-polymer

A co-polymer is a polymer that is formed from two (or more) different types of monomer.

Poly(ethylene terephthalate) is an example of co-polymer formed by condensation polymerisation of ethylene glycol and terephthalic acid. Fig. 9.3 show the structure of a repeat unit of poly(ethylene terephthalate).

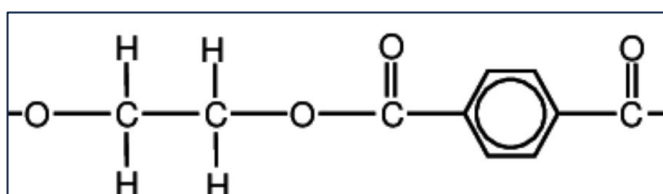


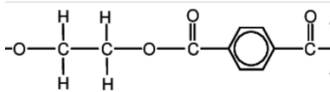
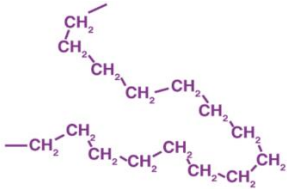
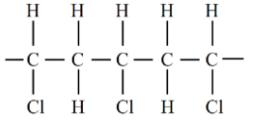
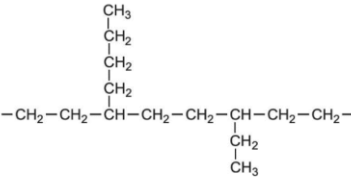
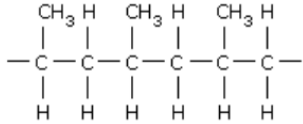
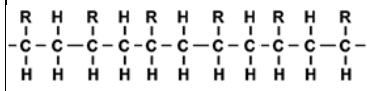
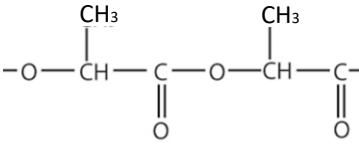
Fig.9.3

Plastic Recycling

Plastic recycling is the processing of plastic waste into new and useful products. To ensure the quality and value of the recycled plastic, plastics of different polymer types have to be sorted out before they can be recycled. The Resin Identification Code (RIC) was introduced so that plastic item can be labelled for easier sorting.

Plastics usually consist of polymer chains of varying lengths. Table 9.1 shows the names of the polymers that fall under the seven different RIC, the general range of molar masses of the different plastics and their percentages of plastic waste generated.

Table 9.1

RIC	polymer name	chemical structure	molar mass / (g/mol)	% of plastic waste generated
	poly(ethylene terephthalate)		8000 – 31 000	18.8
	high density poly(ethene)		100 000 – 250 000	19.8
	poly(vinyl chloride)		50 000 – 120 000	5.3
	low density poly(ethene)		100 000 – 250 000	13.9
	poly(propene)		75 000 – 700 000	19.1
	poly(styrene)	 R:represents a hydrocarbon	100 000 – 400 000	5.9
	other plastics, such as polycarbonate, polyamides	 Eg: Poly(lactic acid)	—	17.2

Two commonly used methods of plastic recycling are mechanical recycling and chemical depolymerisation.

Mechanical recycling is a physical method that melts plastics of the same polymer before making them into small pellets to be used again, while chemical depolymerisation is a chemical method that uses either heat or chemical reactions to convert the polymers back into its monomers.

Since each polymer has its unique chemical properties, the method of recycling is based on the RIC. Mechanical recycling is mostly used to recycle plastics with RIC 1,2, 4 and 5 whereas depolymerisation is mostly used to recycle plastics with RIC 1 and 7.

(a) (i) State one similarity and one difference between the structures of LDPE and HDPE

.....
.....
..... [2]

(a) (ii) Explain how and why HDPE has a different density from LDPE.

.....
.....
.....[2]

(b) (i) Draw the repeat unit of poly(lactic acid).

[1]

(ii) Hence classify if poly(lactic acid) is a homopolymer or a co-polymer.

.....
..... [1]

- (c) The shortest chain of poly(styrene) consists of 962 repeating units. Elemental analysis of poly(styrene) found that the polymer contains 92.3% of carbon and 7.7% of hydrogen by mass.

Calculate and deduce the formula of **R** in poly(styrene) in Table 9.1.

formula of **R** in poly(styrene) [3]

- (d) Some people think that “mechanical recycling can only recycle homopolymers while depolymerisation can only recycles co-polymers.”

Explain why this information is incorrect.

.....
.....
..... [1]

- (e) (i) Suggest a possible reason why RIC 3-PVC is not recycled using mechanical recycling or chemical depolymerisation.

.....
..... [1]

- (ii) Since RIC 3-PVC is not commonly recycled. Suggest a reason why its percentage of plastic waste generated is still low.

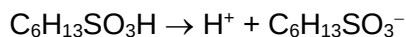
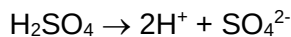
.....
.....
..... [1]

[Total: 12]

Section B

Answer **one** question in this section.

- B10 (a)** A student investigated the strength of sulfuric acid and hexanesulfonic acid.



The student is given 0.1 mol/dm³ of aqueous sulfuric acid and 0.2 mol/dm³ of aqueous hexanesulfonic acid.

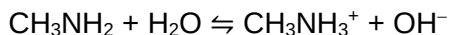
- (i)** Describe how the student could prove that both acids are also strong acids.

.....
.....
..... [2]

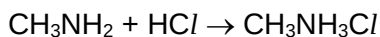
- (ii)** Explain why the student was given two different concentrations for this investigation.

.....
..... [1]

- (b)** Methylamine, CH₃NH₂, is a weak alkali, with properties like aqueous ammonia.



Methylamine can neutralise acids, such as hydrochloric acid, to form methylammonium chloride as shown in the equation below.



- (i)** Write a chemical equation for the reaction between methylamine and sulfuric acid.

..... [1]

- (ii)** Predict what will be observed when aqueous methylamine is added to aqueous iron(II) sulfate and then left to stand in air.

.....
.....
..... [2]

- (c) Methylamine is a member of the amine homologous series and some information about the first 4 amines is shown in Table 10.1.

Table 10.1

name	molecular formula	boiling point /°C
methylamine	CH ₃ NH ₂	–6.3
ethylamine	CH ₃ CH ₂ NH ₂	16.6
propylamine	CH ₃ CH ₂ CH ₂ NH ₂	48.6
butylamine	CH ₃ CH ₂ CH ₂ CH ₂ NH ₂	

- (i) Deduce the general formula of the amine homologous series.

..... [1]

- (ii) Predict the boiling point of butylamine.

..... [1]

- (iii) Propylamine can react with nitrous acid to form propanol. Propanol can be further reacted with ethanoic acid in the presence of warm concentrated sulfuric acid to form a sweet-smelling liquid.

Write the chemical equation for the reaction between propanol and ethanoic acid.

..... [1]

- (iv) Draw the full structural formula of this sweet-smelling liquid as mentioned in (c)(iii).

[1]

[Total: 10]

- B11 (a)** Alkynes are a homologous series of organic compounds.
Table 11.1 shows the names and structures of the first four members of alkynes.

Table 11.1

n	name of alkyne	structure of alkyne
2	ethyne	$\text{H}-\text{C}\equiv\text{C}-\text{H}$
3	propyne	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}\equiv\text{C}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
4	butyne	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}\equiv\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
5	pentyne	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}\equiv\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$

- (i) Use the information in Table 11.1 and deduce the general formula and functional group of alkynes.

general formula [1]

functional group

..... [1]

- (ii) Explain why alkynes undergo addition reactions similar to alkenes. [2]

.....

..... [1]

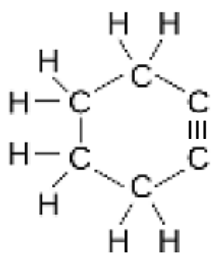
- (iii) Predict and draw the structural formula of the product formed by the reaction between butyne and aqueous bromine. Predict the possible observation from the reaction.

structural formula of product

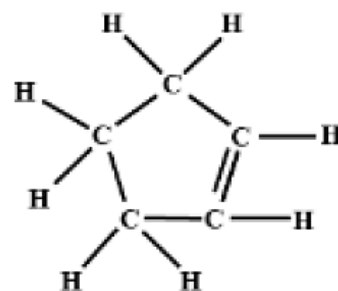
observation

..... [2]

(iv) The structure of two organic compounds (X and Y) are shown below.



compound X



compound Y

A statement from the internet states that “compound X and compound Y are isomers of pentyne”.

Do you agree with the statement? Explain your answer.

.....
.....
.....
..... [2]

(b) Ethanoic acid is a compound from another homologous series. Ethanoic acid is added to an alloy that consists of magnesium and copper.

(i) Write an equation to show how ethanoic acid reacts with the alloy.

..... [1]

(ii) Describe how pure copper can be obtained from the alloy by using ethanoic acid.

.....
.....
..... [2]

[Total: 10]

The Periodic Table of Elements

Group																					
1	2	1 H hydrogen 1												13	14	15	16	17	18		
		Key																			
3	4	proton (atomic) number atomic symbol name relative atomic mass																			
Li lithium 7	Be beryllium 9																				
11	12																				
Na sodium 23	Mg magnesium 24	3	4	5	6	7	8	9	10	11	12						5	6	7	8	9

lanthanoids	57La lanthanum 139	58Ce cerium 140	59Pr praseodymium 141	60Nd neodymium 144	61Pm promethium -	62Sm samarium 150	63Eu europium 152	64Gd gadolinium 157	65Tb terbium 159	66Dy dysprosium 163	67Ho holmium 165	68Er erbium 167	69Tm thulium 169	70Yb ytterbium 173	71Lu lutetium 175
	89Ac actinium -	90Th thorium 232	91Pa protactinium 231	92U uranium 238	93Np neptunium -	94Pu plutonium -	95Am americium -	96Cm curium -	97Bk berkelium -	98Cf californium -	99Es einsteinium -	100Fm fermium -	101Md mendelevium -	102No nobelium -	103Lr lawrencium -