



# KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

## 2024 PRELIMINARY EXAMINATION

Secondary 4 Express

NAME

CLASS

REG. NO

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### CHEMISTRY

Paper 1 Multiple Choice

**6092 / 01**

**28 August 2024**

**1 hour**

Additional Materials: Multiple Choice Answer Sheet.

Setter: Ms Koh Li Eng

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#### READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

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

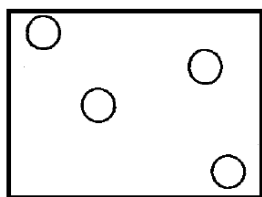
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

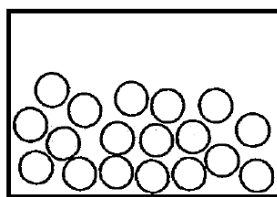
A copy of the Periodic Table is printed on page 22.

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

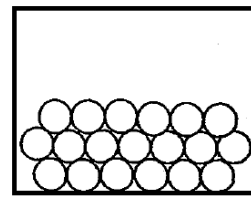
- 1 Diagrams 1, 2 and 3 show the particles of three substances at room temperature and pressure.



1



2

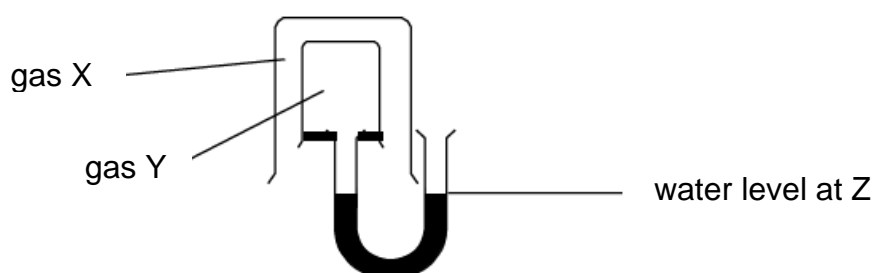


3

Which of these substances are correctly represented by the corresponding diagram?

	1	2	3
<b>A</b>	argon	mercury	dry ice
<b>B</b>	ethane	sodium chloride	mercury
<b>C</b>	ethanol	hydrogen chloride	copper
<b>D</b>	water	helium	zinc

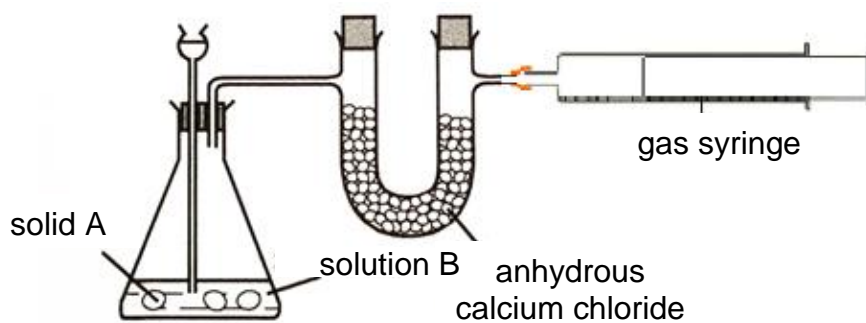
- 2 The set-up below shows how the relative rate of diffusion of gas X and Y can be determined.



Which pair of substances could X and Y be if the water level at Z increases?

	X	Y
<b>A</b>	argon	ethane
<b>B</b>	neon	carbon monoxide
<b>C</b>	oxygen	methane
<b>D</b>	carbon dioxide	nitrogen

- 3 The diagram shows a simple laboratory set-up used to prepare and collect a dry gas.



Which pair of reagents would be most suitable to prepare the gas produced using this set-up?

	solid A	solution B
<b>A</b>	ammonium chloride	sodium hydroxide
<b>B</b>	magnesium	sulfuric acid
<b>C</b>	potassium carbonate	aqueous ammonia
<b>D</b>	sodium hydroxide	hydrochloric acid

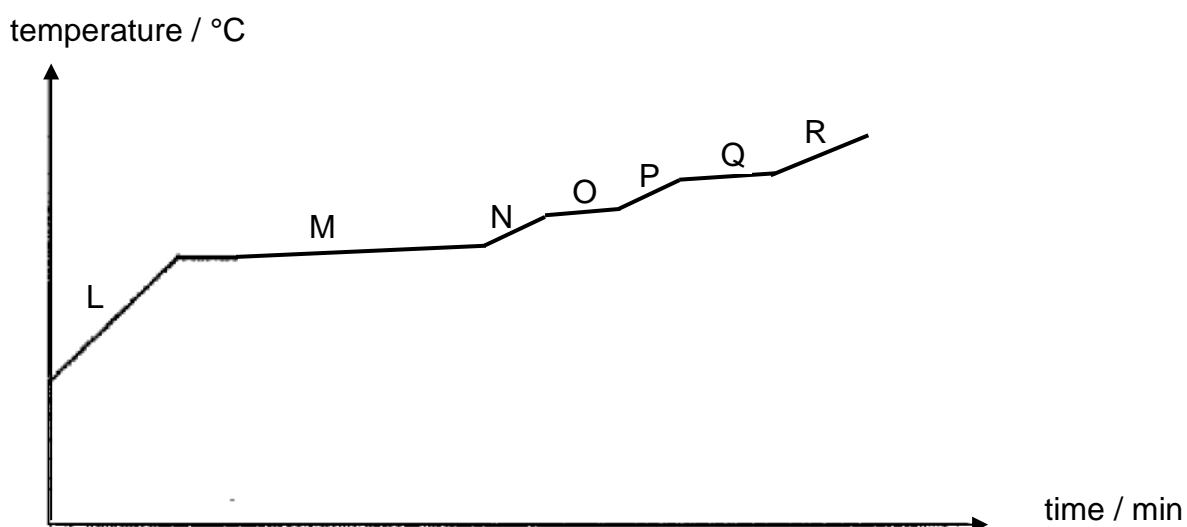
- 4 The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

nitrogen:  $-196^{\circ}\text{C}$

oxygen:  $-183^{\circ}\text{C}$

argon:  $-186^{\circ}\text{C}$

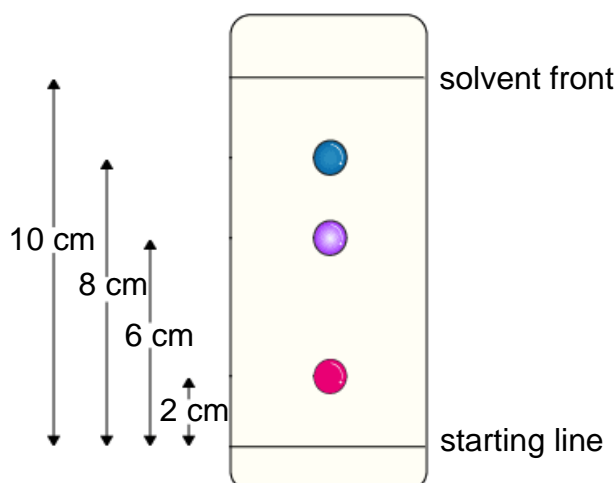
Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section P of the graph, the mixture remaining consists of

- A liquid nitrogen and argon only.
- B liquid nitrogen only.
- C liquid oxygen and argon only.
- D liquid oxygen only.

- 5 The diagram shows the chromatogram obtained from the analysis of a dye mixture. Four measurements are shown in the diagram below.



What is the  $R_f$  value of the most soluble dye?

- A** 0.20  
**B** 0.80  
**C** 1.25  
**D** 5.00
- 6 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	solubility in water	solubility in tetrachloromethane
sand	not soluble	not soluble
sodium chloride	good	not soluble
sulfur	not soluble	good

Which of the experimental procedures would be suitable for obtaining pure sand from a mixture of sand, sodium chloride and sulfur?

- A** Add tetrachloromethane and stir, then filter to collect residue.  
**B** Add tetrachloromethane and stir, then filter. Add the residue to water and stir, then filter to collect residue.  
**C** Add water and stir, then filter. Add tetrachloromethane to filtrate and stir, then evaporate to dryness.  
**D** Add water and stir, then filter. Evaporate the filtrate to dryness.

- 7 Which pair of statement correctly describes the properties of the compound iron(II) sulfide, FeS, and a mixture of iron and sulfur?

	iron(II) sulfide	mixture of iron and sulfur
1	The ratio of iron to sulfur is always 2 : 1.	The ratio of iron to sulfur can vary.
2	Iron(II) sulfide has the same properties as iron and sulfur.	The mixtures do not have the same properties as iron and sulfur.
3	Iron and sulfur react when heated to form iron(II) sulfide.	Iron and sulfur mix together with no energy change.

- A 1 and 2  
 B 1 and 3  
 C 3 only  
 D All the above
- 8 An ion of formula  $X^{2-}$  contains 10 electrons.
- If the relative atomic mass of X is 16, what is present in the nucleus of the ion?
- A 8 protons and 8 neutrons  
 B 10 protons and 6 neutrons  
 C 10 protons and 10 neutrons  
 D 12 protons and 8 electrons
- 9 Which compound contains both ionic and covalent bonds?
- A ammonia  
 B barium chloride  
 C methyl propanoate  
 D potassium sulfate

**10** Which substance has metallic bonding?

substance	electrical conductivity		property of product formed from the reaction between substance and oxygen
	in solid state	in molten state	
<b>A</b>	X	X	reacts with alkali
<b>B</b>	X	✓	no reaction with acid or alkali
<b>C</b>	✓	✓	reacts with alkali
<b>D</b>	✓	✓	reacts with both acid and alkali

**11** An investigation of the properties of the chlorides of Period 3 elements shows that the boiling points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively.

This difference in boiling points is a result of

- A** covalent bonds being weaker than ionic bonds.
- B** metallic character decreasing across the period.
- C** silicon forming weaker bonds with chlorine as compared to sodium.
- D** silicon tetrachloride having weak intermolecular forces of attraction.

**12** Two comments about hydrogen chloride are made below.

Comment 1: Hydrogen chloride has strong covalent bonds in its simple molecular structure.

Comment 2: Hydrogen chloride is soluble in water.

Which statement is correct?

- A** Both comments are correct and comment 1 explains comment 2.
- B** Both comments are correct but comment 1 does not explain comment 2.
- C** Both comments are incorrect.
- D** Comment 2 is correct but comment 1 is incorrect.

- 13** Bismuth is in the same group as nitrogen in the Periodic Table.

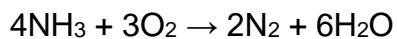
What is the chemical formula of lithium bismuthide?

- A**  $\text{Li}_3\text{Bi}$
- B**  $\text{LiBiO}_3$
- C**  $\text{LiBi}_3$
- D**  $\text{Li}_3\text{BiO}$

- 14** Which substance contains the greatest number of atoms in 1g?

- A**  $\text{CO}_2$
- B**  $\text{NO}$
- C**  $\text{O}_3$
- D**  $\text{SO}_3$

- 15** 200 cm<sup>3</sup> of ammonia burns in 100 cm<sup>3</sup> of oxygen according to the following equation:



What volume of gas will be collected at the end of the reaction when cooled to room temperature?

- |                                |                                |
|--------------------------------|--------------------------------|
| <b>A</b> 66.7 cm <sup>3</sup>  | <b>B</b> 100.0 cm <sup>3</sup> |
| <b>C</b> 133.3 cm <sup>3</sup> | <b>D</b> 333.3 cm <sup>3</sup> |



- 16** Magnesium oxide is produced by heating magnesium carbonate.



When 84 g of magnesium carbonate is heated, 34 g of magnesium oxide is produced.

What is the percentage yield of magnesium oxide?

[Mr:  $\text{MgCO}_3$ , 84;  $\text{MgO}$ , 40]

- A**  $\frac{34}{40} \times 100$
- B**  $\frac{34}{84} \times 100$
- C**  $\frac{40}{34} \times 100$
- D**  $84 \times \frac{34}{40} \times 100$

- 17** 20.0 cm<sup>3</sup> of 0.500 mol/dm<sup>3</sup> hydrochloric acid were added to 0.7 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 10.0 cm<sup>3</sup> of 0.400 mol/dm<sup>3</sup> of sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?

[Mr:  $\text{HCl}$ , 36.5;  $\text{Na}_2\text{CO}_3$ , 106;  $\text{NaOH}$ , 40]

- |          |       |          |       |
|----------|-------|----------|-------|
| <b>A</b> | 31.8% | <b>B</b> | 45.4% |
| <b>C</b> | 63.6% | <b>D</b> | 90.9% |

- 18** Arsine ( $\text{AsH}_3$ ) is a gas that behaves like ammonia.

Which of the following particles are found in the solution when Arsine dissolves in water?

- A**  $\text{As}^+$  and  $\text{OH}^-$
- B**  $\text{AsH}_3$ ,  $\text{As}^+$  and  $\text{OH}^-$
- C**  $\text{AsH}_4^+$  and  $\text{OH}^-$
- D**  $\text{AsH}_3$ ,  $\text{AsH}_4^+$  and  $\text{OH}^-$

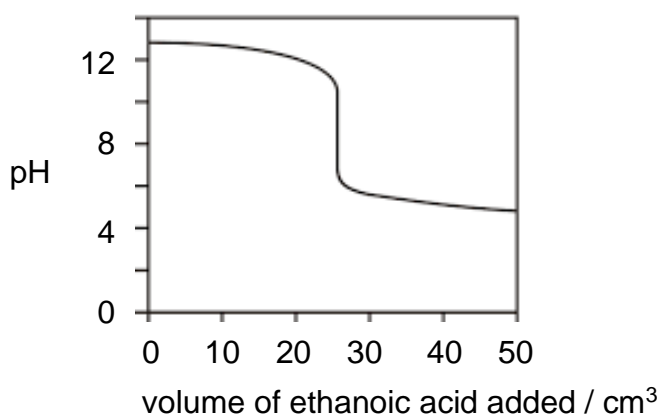
**19** Which method(s) is/are suitable to test the strengths of acids and alkalis?

- 1 titration
- 2 using a pH meter
- 3 measuring their electrical conductivity

- A** 1 only
- B** 1 and 2
- C** 2 and 3
- D** all of the above

**20** Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

The graph below shows the change of pH when ethanoic acid is added to a fixed volume of aqueous sodium hydroxide in a titration.



Which would be the most suitable indicator to use in this titration?

indicator	pH range for the colour change	colour	
		lower pH	higher pH
<b>A</b>	0.3 – 3.0	yellow	violet
<b>B</b>	4.2 – 6.3	red	yellow
<b>C</b>	8.2 – 10.0	colourless	pink
<b>D</b>	11.6 – 14.0	blue	yellow

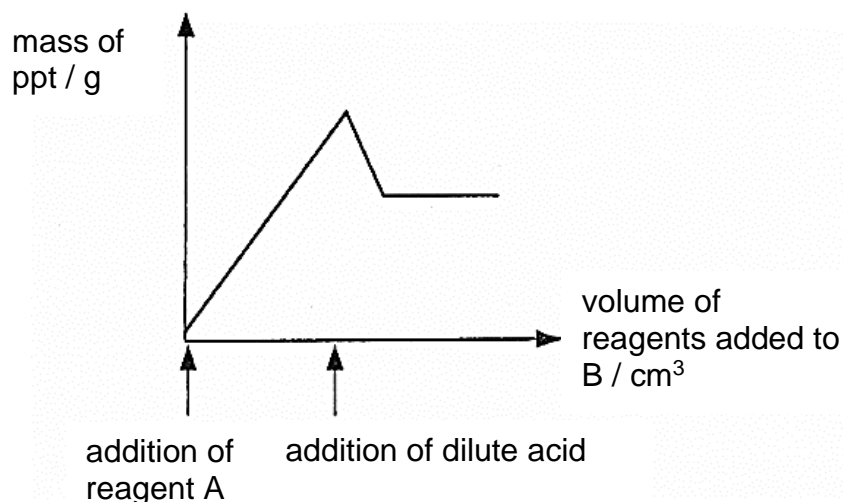
21 In the Haber process,

- 1 the hydrogen used is obtained from the cracking of petroleum
- 2 the reaction is pressurised to increase the yield
- 3 the ammonia formed is collected by distillation

Which of the statement(s) is/are true?

- A** 1 only  
**B** 1 and 2  
**C** 2 and 3  
**D** all of the above

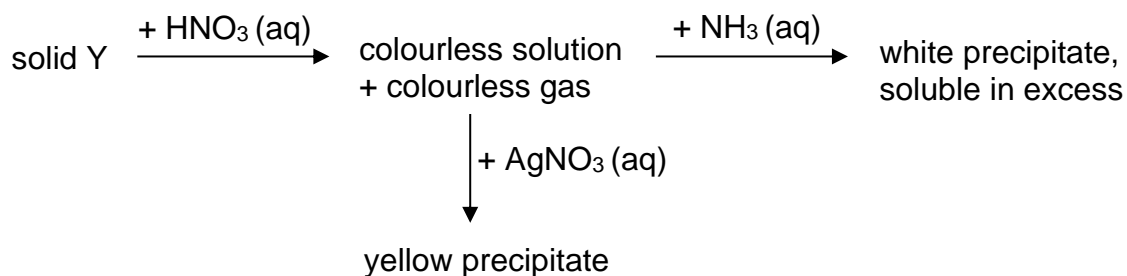
22 In a quantitative analysis, reagent A is gradually added to a salt solution B (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



Which of the following combinations would produce the graph above?

	anions in salt solution B	reagents (A and acid) added
<b>A</b>	$\text{Cl}^-$	$\text{AgNO}_3$ and $\text{HNO}_3$
<b>B</b>	$\text{CO}_3^{2-}$ , $\text{Cl}^-$	$\text{Ba}(\text{NO}_3)_2$ and $\text{HNO}_3$
<b>C</b>	$\text{CO}_3^{2-}$ , $\text{SO}_4^{2-}$	$\text{AgNO}_3$ and $\text{HCl}$
<b>D</b>	$\text{CO}_3^{2-}$ , $\text{SO}_4^{2-}$	$\text{Ba}(\text{NO}_3)_2$ and $\text{HCl}$

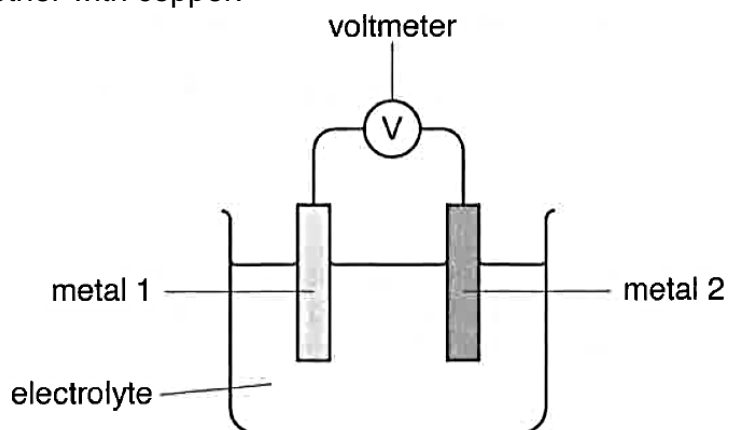
- 23** Solid Y contains a mixture of two salts. The scheme below shows some reactions of solid Y.



Which of the following could be the two salts present in solid Y?

- A** aluminium carbonate and ammonium chloride
- B** calcium chloride and zinc carbonate
- C** copper(II) carbonate and sodium iodide
- D** zinc iodide and calcium carbonate

- 24** The table shows the voltage produced by some cells when different metals are used together with copper.

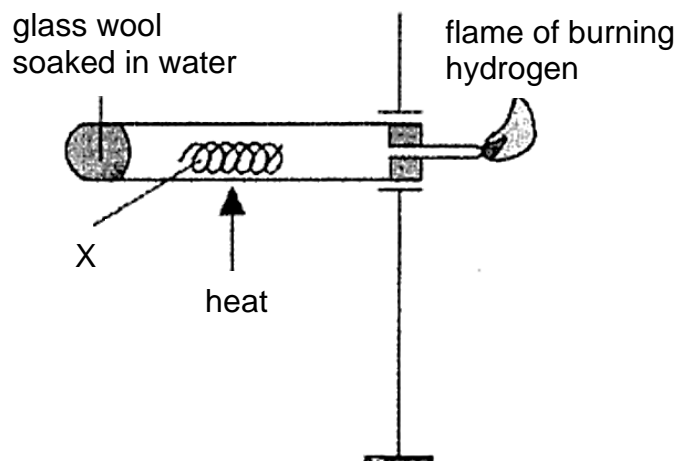


metal 1	metal 2	voltage / V
silver	copper	-0.46
magnesium	copper	+2.69

What would be the likely voltage obtained when silver is used as metal 1 and magnesium is used as metal 2?

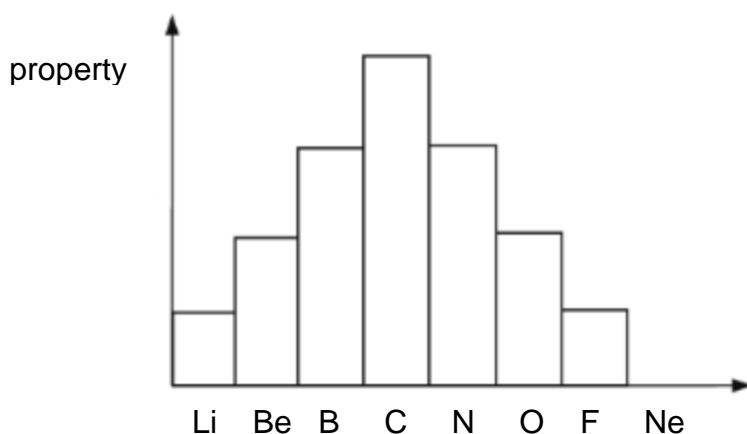
- A**     -2.23 V
- B**     -3.15 V
- C**     2.23 V
- D**     3.15 V
- 25** Which of the following reactions takes place in a hydrogen fuel cell?
- A**     Hydrogen ions are oxidised at the anode.
- B**     Hydrogen ions are reduced at the cathode.
- C**     Hydrogen loses electrons to form  $\text{H}^+$  ions at the anode.
- D**     Oxygen gains electrons to form  $\text{O}^{2-}$  at the cathode.

- 26** The set-up below shows the reaction of substance X.



What is the possible identity of X?

- A** X is a metal above hydrogen in the reactivity series.
  - B** X is a metal below hydrogen in the reactivity series.
  - C** X is an oxide of a metal that is above hydrogen in the reactivity series.
  - D** X is an oxide of a metal that is below hydrogen in the reactivity series.
- 27** The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon.



Which property of these elements is shown in the chart?

- A** atomic radius
- B** melting point
- C** number of electrons used in bonding
- D** number of shells holding electrons

**28** The elements in a group of Periodic Table shows the following trends.

- The element with the lowest proton number has the lowest reactivity.
- The melting point of the elements decreases down the group.
- The density of the elements increases down the group

Which group can the elements be found in?

- A** 1  
**B** 17  
**C** 18  
**D** transition

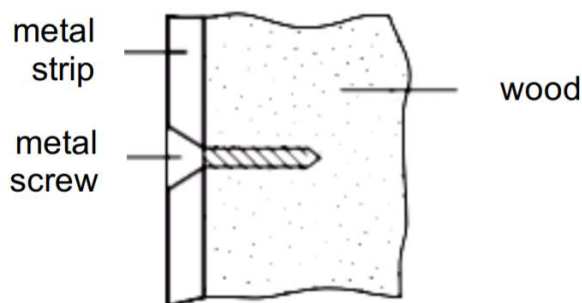
**29** The following observations were made when nickel and iron were placed separately into salt solutions of metals S, T and U.

	salt solution of S	salt solution of T	salt solution of U
nickel	solid deposit formed	no visible change	no visible change
iron	solid deposit formed	solid deposit formed	no visible change

What is the correct order in decreasing reactivity of the five metals?

- A** S > Ni > Fe > T > U  
**B** S > Ni > T > Fe > U  
**C** U > Fe > T > Ni > S  
**D** U > T > Fe > Ni > S

- 30** An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.



After a few weeks of being exposed to wind and rain, the screws are heavily corroded but the metal strips are not.

Which two metals would give this result?

	screw	strip
<b>A</b>	copper	iron
<b>B</b>	copper	zinc
<b>C</b>	iron	copper
<b>D</b>	iron	magnesium

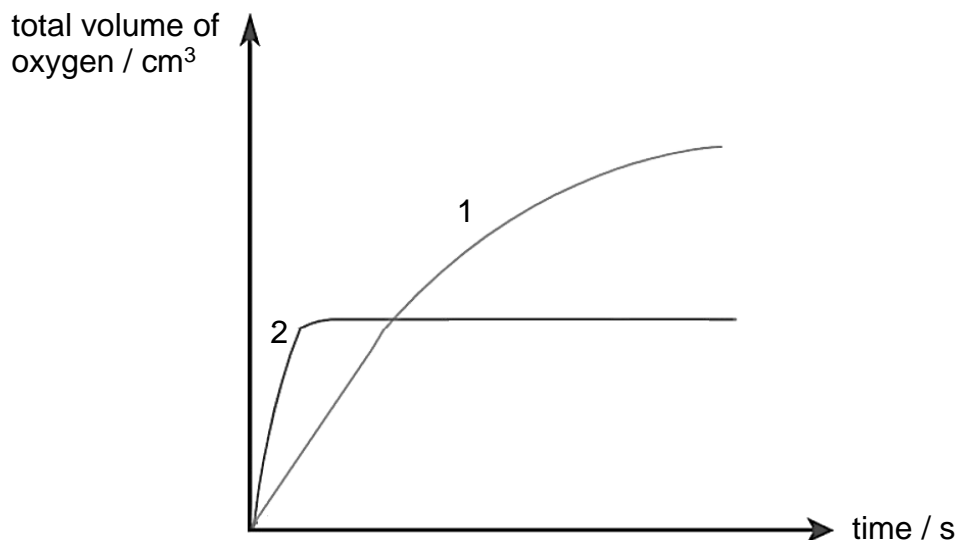
- 31** For which process is the enthalpy change always positive?

- A** boiling
- B** combustion
- C** dissolving of acids in water
- D** respiration



- 32** Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen.

In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts were used and the temperature was kept constant.



If curve 1 corresponds to 25.0 cm<sup>3</sup> of 4.0 mol/dm<sup>3</sup> of solution, curve 2 would correspond to

- A** 7.5 cm<sup>3</sup> of 8.0 mol/dm<sup>3</sup> solution.  
**B** 12.5 cm<sup>3</sup> of 4.0 mol/dm<sup>3</sup> solution.  
**C** 25.0 cm<sup>3</sup> of 2.0 mol/dm<sup>3</sup> solution.  
**D** 25.0 cm<sup>3</sup> of 8.0 mol/dm<sup>3</sup> solution.
- 33** Which statement about the fractional distillation of crude oil is correct?
- A** At each level of the fractionating column, only one compound is collected.  
**B** The fraction at the top of the column is the least flammable.  
**C** The fraction collected at the bottom of the column has the highest viscosity.  
**D** The higher up the fractionating column, the higher the temperature.

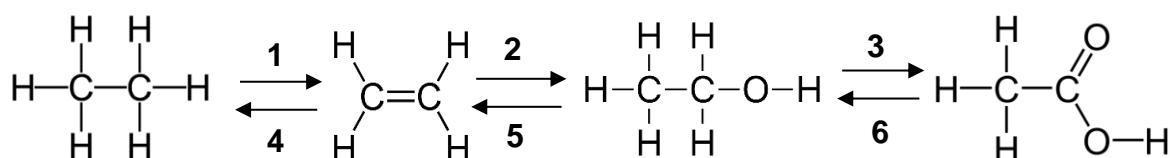
- 34** Banana releases a gas that is able to make other fruit ripen. When this gas is bubbled into aqueous bromine, the reddish-brown solution decolourises.

What could be the identity of this gas?

- A** ethane
- B** ethene
- C** iodine
- D** sulfur dioxide

**Answer questions 35 and 36 based on the following information.**

The reaction pathways of the conversions between the 4 organic chemistry homologous series are as shown below.



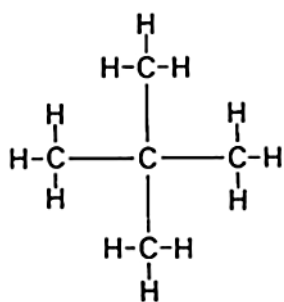
- 35** How many of the above reactions are redox reactions?

- A** 0
- B** 2
- C** 4
- D** 6

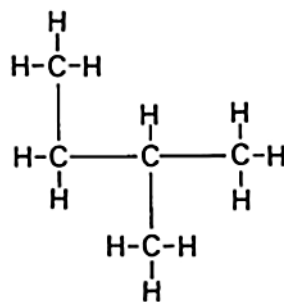
- 36** Which of the following shows the correct reactant and conditions for reaction pathway 1?

	reactant	conditions
<b>A</b>	hydrogen	150 °C, Ni catalyst
<b>B</b>	hydrogen	UV light
<b>C</b>	none	600 °C, $Al_2O_3$ and $SiO_2$ as catalysts
<b>D</b>	none	37 °C, yeast, absence of oxygen

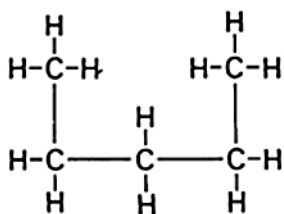
37 Five structural formulae are shown below.



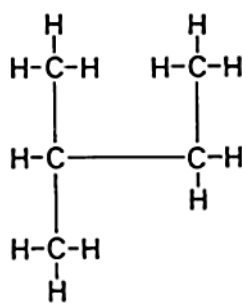
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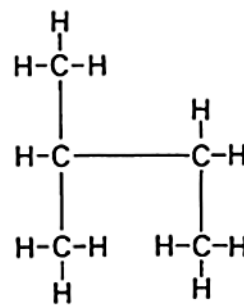
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5

How many of the structures represent isomers of one another?

**A** 2

**B** 3

**C** 4

**D** 5

- 38** A student investigated the reaction of different vegetable oils and margarines with hydrogen.

100 cm<sup>3</sup> of hydrogen was passed through 1 g samples containing a catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

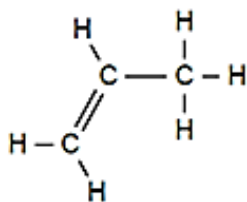
sample	volume of hydrogen remaining / cm <sup>3</sup>
P	0
Q	87
R	100

Which sample(s) is/are unsaturated vegetable oils?

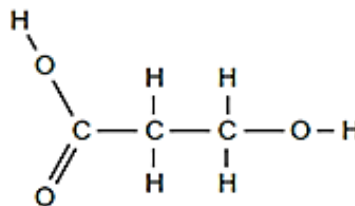
- A** P only
  - B** P, Q and R
  - C** P and Q
  - D** R only
- 39** In which reaction is water **not** a product?
- A** combustion of petroleum gases
  - B** esterification between propanoic acid and butanol
  - C** fermentation of glucose
  - D** neutralization between dilute nitric acid and aqueous ammonia

- 40 Which of the following monomer(s) would undergo polymerisation on their own?

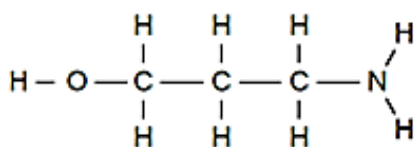
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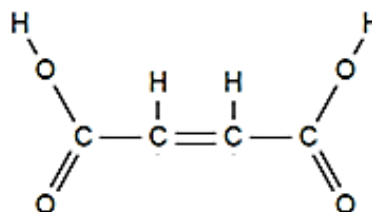
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3



4



- A** 1 and 2 only  
**B** 1, 2 and 4  
**C** 2 and 4  
**D** all of the above

**End of Paper**

# The Periodic Table of Elements

Group																						
1	2											13	14	15	16	17	18					
<div>Key</div> <div>proton (atomic) number</div> <div>atomic symbol</div> <div>name</div> <div>relative atomic mass</div>							1 H hydrogen 1										2 He helium 4					
							3 Li lithium 7	4 Be beryllium 9									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
							11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84					
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131					
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –					
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –					

22

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
actinoids	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 –

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).  
The Avogadro constant,  $L = 6.02 \times 10^{23} \text{ mol}^{-1}$ .