



ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY 4E

Candidate's Name	Class	Register Number
	4E	

CHEMISTRY

6092/01

26 Aug 2022
1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, index number and class on the OTAS 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** and **D**.

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

Read the instructions on the OTAS 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 17.

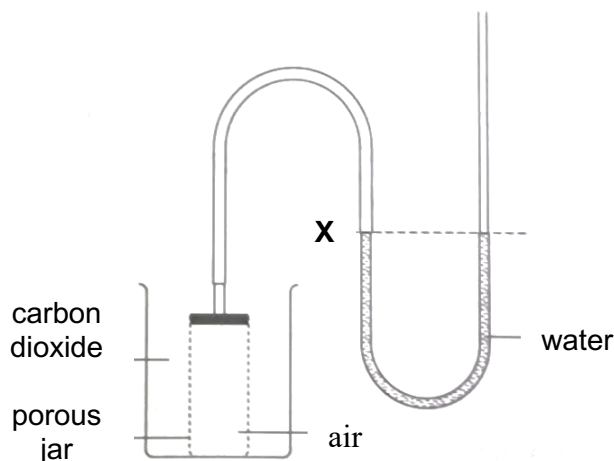
Setter: Ms Ong Lay Hong

Vetter: Ms Julia Yeo

This document consists of **17** printed pages, including this cover page.

[Turn over

- 1 The apparatus shown in the diagram was set up.



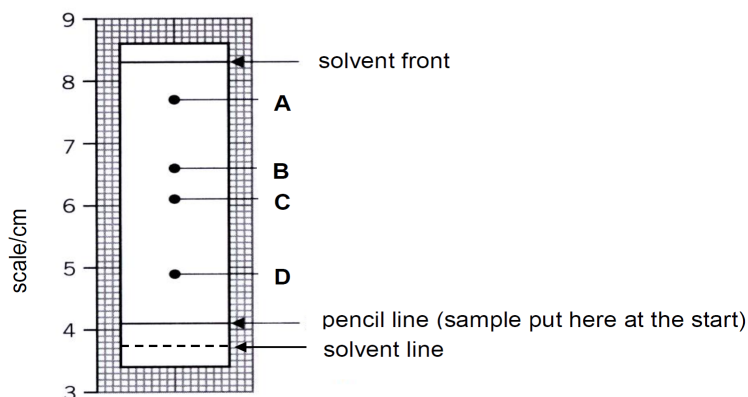
The water level at **X** gradually moved up above the mark. When the water levels were observed to have stopped moving, the beaker of carbon dioxide were removed.

The water level at **X** then fell below the mark before returning back to the mark.

Which of the following is likely to explain why the water level at **X** fell below the mark?

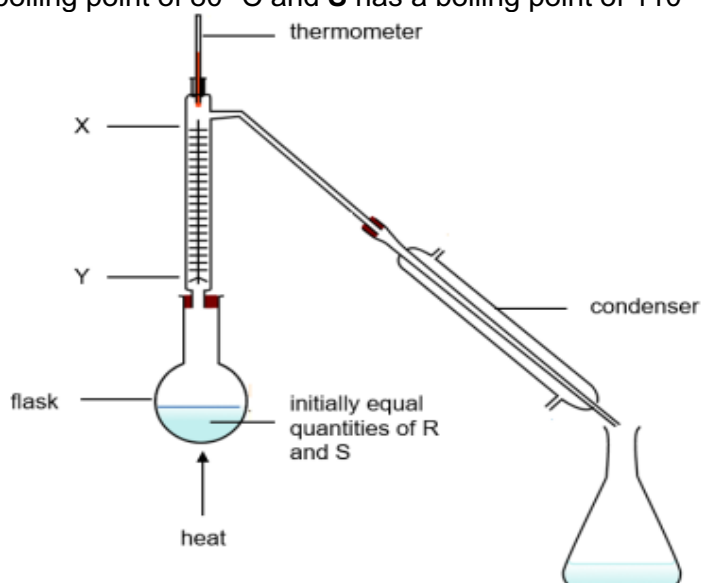
- A** Air inside the porous jar diffused out faster than the carbon dioxide.
 - B** Carbon dioxide in the porous jar diffused out slower than air which diffused in.
 - C** Air around the porous jar diffused in slower than the carbon dioxide diffused out.
 - D** Carbon dioxide around the porous jar continued to diffuse in faster than air diffused out.
- 2 The urine samples of athletes are routinely checked for the presence of drugs which can enhance their performance.

The following diagram (not drawn to scale) shows a chromatogram of the urine sample of an athlete. He is suspected to have taken a banned drug with a retention value, R_f of 0.60.



Which position, **A**, **B**, **C** or **D** indicates the presence of this drug?

- 3 The diagram below shows the fractional distillation of two liquids, **R** and **S**. **R** has a boiling point of 80°C and **S** has a boiling point of 110°C .



Which statement(s) about the experiment is/are correct when the thermometer shows 80°C ?

- 1 The liquid left in the flask contains more **S** than **R**.
- 2 The vapour at point **Y** only contains **R**.
- 3 The temperature at **X** is higher than the temperature at **Y**.

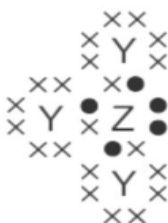
A 1 only

B 1 and 2

C 2 and 3

D 1, 2 and 3

- 4 The diagram shows the outer shell electron arrangement of a molecule of a compound made up of the elements **Z** and **Y**.



What is the formula of the compound formed between **Z** and magnesium?

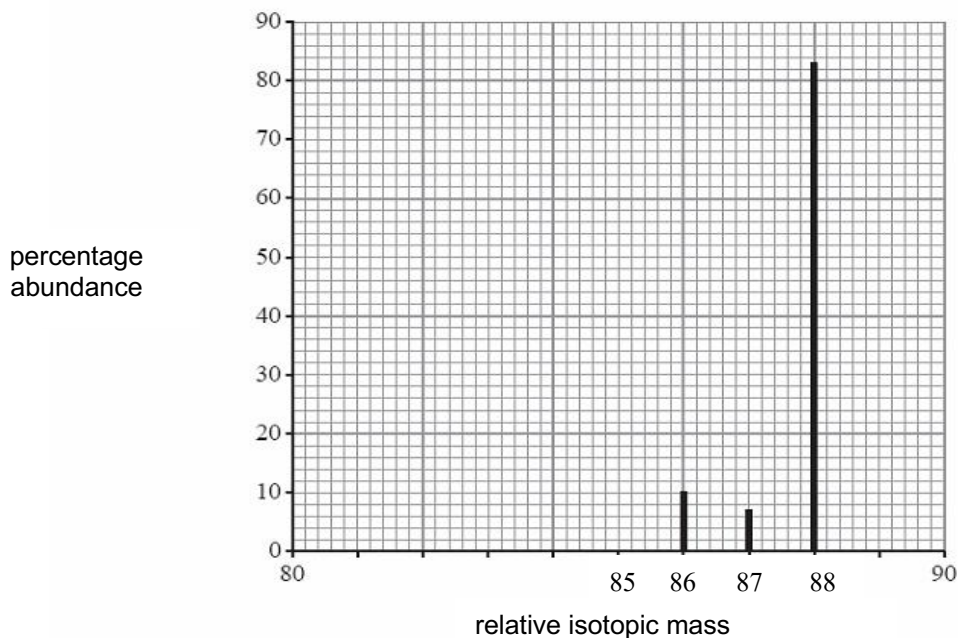
A MgZ

B MgZ_2

C Mg_2Z_3

D Mg_3Z_2

- 5** Strontium is used in fireworks to produce crimson flames. The graph below shows the percentage abundance (%) and relative masses of three naturally occurring isotopes of strontium.



What is the relative atomic mass of naturally occurring strontium?

- | | | | |
|----------|------|----------|------|
| A | 83.4 | B | 87.0 |
| C | 87.7 | D | 88.0 |

- 6** A radioactive isotope of thallium, $^{201}_{81}\text{Tl}$, is used to assess damage in heart muscles after a heart attack.

Which statement about $^{201}_{81}\text{Tl}$ is correct?

- A** The isotope has a nucleon number of 120.
- B** The number of electrons in one atom of this isotope is 81.
- C** The number of neutrons in one atom of this isotope is 201.
- D** $^{201}_{82}\text{Tl}$ is an isotope of $^{201}_{81}\text{Tl}$

- 7 The table below shows the electronic configuration of elements **W**, **X**, **Y** and **Z**.

W	X	Y	Z
2.4	2.6	2.7	2.8.8.1

Which of the following formulae represent compounds with boiling points below room temperature?

- 1 **WX₂**
- 2 **XY₂**
- 3 **Z₂X**

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

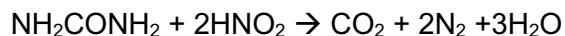
- 8 The following substances all contain covalent bonds.

- 1 ammonia
- 2 carbon dioxide
- 3 ethanol
- 4 diamond

Which substances contain only single bonds?

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

- 9 In a pathology laboratory, a sample of urine containing 0.120 g of urea, NH_2CONH_2 was treated with an excess of nitrous acid. The urea reacted according to the following equation.



The gas produced was passed through aqueous sodium hydroxide and the final volume measured.

What was this final volume of gas left behind at room temperature and pressure?

- A** 9.6 cm³
- B** 14.4 cm³
- C** 48.0 cm³
- D** 96.0 cm³

- 10** Citric acid, the predominant acid in lemon juice, is a tribasic acid. A student titrated 25.0 cm^3 samples of lemon juice with 0.55 mol/dm^3 NaOH. The average titration volume was 29.50 cm^3 . The molar mass of citric acid is 192.12 g/mol . What was the concentration of citric acid in the lemon juice?

- | | | | |
|----------|-----------------------|----------|-----------------------|
| A | 1.04 g/dm^3 | B | 41.6 g/dm^3 |
| C | 125 g/dm^3 | D | 374 g/dm^3 |

- 11** A washing powder contains sodium hydrogencarbonate, NaHCO_3 as one of its ingredients. In a titration, a solution containing 1.00 g of the washing powder was found to react completely with 7.15 cm^3 of 0.100 mol/dm^3 of dilute hydrochloric acid.

Assuming that sodium hydrogen carbonate is the only ingredient that reacts with the acid, what is the percentage by mass of sodium hydrogencarbonate in the washing powder?

- | | | | |
|----------|-----------|----------|-----------|
| A | 3.0% | B | 6.0% |
| C | 12.0% | D | 24.0% |

- 12** Compound **X** has the molecular formula, Mn_2O_3 .

The following are some statements about compound **X**.

- One mole of compound **X** contains 110 g of manganese and 48 g of oxygen.
- The oxidation state of manganese is $+2$ in Mn_2O_3 .
- The charge of the oxide ion is -2 .
- The empirical formula of compound **X** is Mn_2O_3 .
- Three moles of oxygen molecules are needed to make one mole of compound **X**.

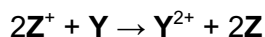
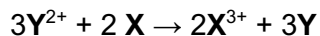
How many statements about compound **X** are correct?

- | | | | |
|----------|---|----------|---|
| A | 2 | B | 3 |
| C | 4 | D | 5 |

- 13** Which equation suggests that a metal oxide, RO, behaves as an amphoteric oxide?

- A** $\text{RO (s)} + 2\text{H}^+ \text{ (aq)} \rightarrow \text{R}^{2+} \text{ (aq)} + \text{H}_2\text{O (l)}$
- B** $\text{RO (s)} + 2\text{OH}^- \text{ (aq)} \rightarrow \text{RO}_2^{2-} \text{ (aq)} + \text{H}_2\text{O (l)}$
- C** $\text{RO (s)} + \text{H}_2\text{O (l)} \rightarrow \text{R}^{2+} \text{ (aq)} + 2\text{OH}^- \text{ (aq)}$
- D** $\text{RO (s)} + \text{NH}_4^+ \text{ (aq)} \rightarrow \text{R}^{2+} \text{ (aq)} + \text{H}_2\text{O (l)} + \text{NH}_3 \text{ (g)}$

- 17** X, Y and Z are metals which form the cations X^{3+} , Y^{2+} and Z^{+} respectively.



Given the following information above, what is the order of increasing reactivity of the metals?

- D Z, Y, X**

- 18** Which of the statement(s) is/are true about the elements in Group I of the Periodic Table?

- 1 They are reducing agents.
- 2 The ionic radius increases down the group.
- 3 The melting point decreases down the group.

- D** 1, 2 and 3

- 19** Chlorine is reacted with aqueous potassium iodide and a brown solution is formed. Which statement about this reaction is correct?

- A** Iodide ions gain electrons.
- B** The oxidation state of chlorine decreases.
- C** Chlorine is reduced because it loses electrons.
- D** Iodine gains electrons more easily than chlorine.

- 20** An element **R** reacts in the following ways.

- 1 $2\text{R(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{RO(s)}$
- 2 $\text{R(s)} + 2\text{HCl(aq)} \rightarrow \text{RCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- 3 $\text{R(s)} + \text{H}_2\text{O(l)} \rightarrow \text{no reaction}$
- 4 $\text{RO(s)} + \text{H}_2\text{(g)} \rightarrow \text{no reaction}$

Which statement can be deduced about element **R**?

- A** R can be obtained from its oxide by reduction with carbon.
- B** R can displace magnesium from a solution of magnesium nitrate.
- C** R forms a metal carbonate that will not decompose under strong heating.
- D** R reacts more vigorously with hydrochloric acid than to calcium.

- 21** Which statement correctly shows the general trend of the oxides of Period 3 elements from sodium to chlorine?

A The melting points of the oxides increase.

B The electrical conductivities of the molten oxides increase.

C The bonds of the oxides show a trend from ionic to covalent.

D The oxides show a trend from acidic to amphoteric and then to basic.

- 22** Four stages in making steel from iron ore are listed below.

1 Carbon dioxide reacts with coke.

2 Limestone and hot air are added.

3 Basic oxides remove impurities.

4 Haematite is reduced.

In which order do these stages occur?

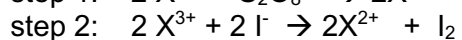
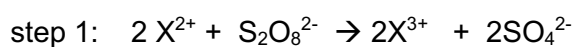
A 1, 2, 3 and 4

B 1, 4, 2 and 3

C 2, 1, 4 and 3

D 2, 4, 1 and 3

- 23** The following reactions takes place in the presence of an ion of the element **X**.

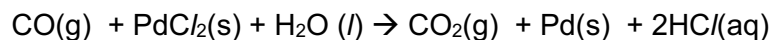


In which of the following position could element **X** be found in the Periodic Table?

A simplified periodic table grid is shown. The grid consists of several rows and columns of squares. The elements are marked as follows:

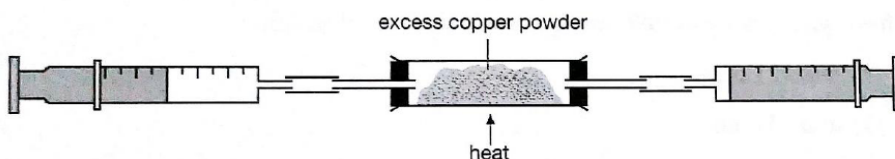
- A** is located in the second row from the bottom, second column from the left.
- B** is located in the fourth row from the bottom, eighth column from the left.
- C** is located in the third row from the bottom, tenth column from the left.
- D** is located in the fifth row from the bottom, thirteenth column from the left.

- 24** A cheap carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals. When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.



Which is the element whose oxidation state decreases in this reaction?

- A** carbon
- B** chloride
- C** hydrogen
- D** palladium
- 25** The set-up of an experiment is shown below. At room temperature, the system initially contains 80 cm³ of nitrogen, 60 cm³ of oxygen and 20 cm³ of argon.

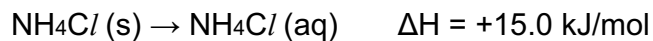


The plungers of the gas syringes are moved to and fro until there is no further change in the system. The system is then allowed to cool to room temperature.

Which of the following statements concerning the experiment are correct?

- 1** Black solids would be formed in the glass tube.
 - 2** The total volume of the gases in the system would decrease by 60 cm^3 .
 - 3** The same change in total volume of gases would be observed if excess copper is replaced with excess zinc powder.
- A** 1 and 2 **B** 1 and 3
C 2 and 3 **D** 1, 2 and 3

- 26** Ammonium chloride dissolves in water according to the equation below.



When 0.2 moles of ammonium chloride dissolves in 50 cm³ of water,

- 1 The concentration of the solution is 4.00 mol/dm³.
- 2 The temperature of the water decreases.
- 3 Some heat energy is lost to the surroundings.
- 4 The heat change is 3.0 kJ.

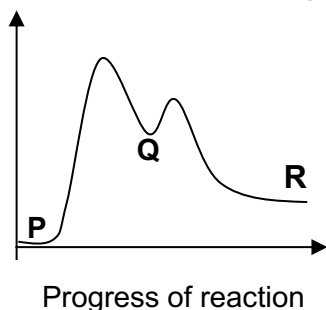
Which of the above statements are true?

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

- 27** In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by way of compound **Q**.

The following graph shows the energy profile diagram for the reactions.

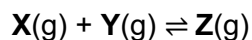
What can be deduced from the diagram?



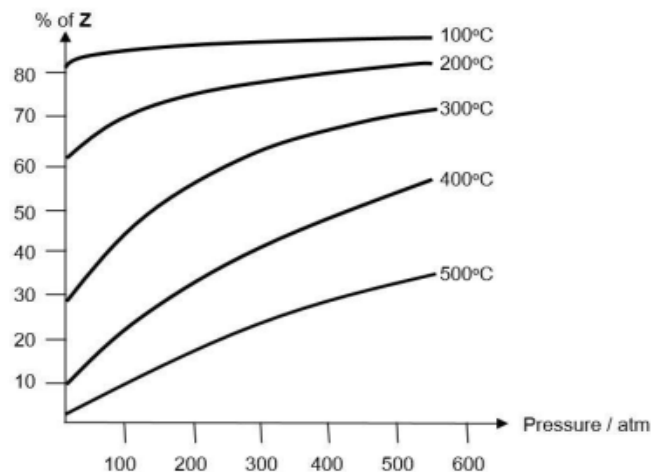
step 1: **P** → **Q**
step 2: **Q** → **R**

- A** Both steps are endothermic.
- B** The overall reaction to convert **P** to **R** is exothermic.
- C** Step 2 involves breaking of stronger bonds than step 1 because **Q** is at higher energy level.
- D** Step 1 is harder to take place than step 2 because more energy is needed for bond breaking.

- 28 In an industrial process, two gases **X** and **Y** react together to form a single gaseous product **Z**.

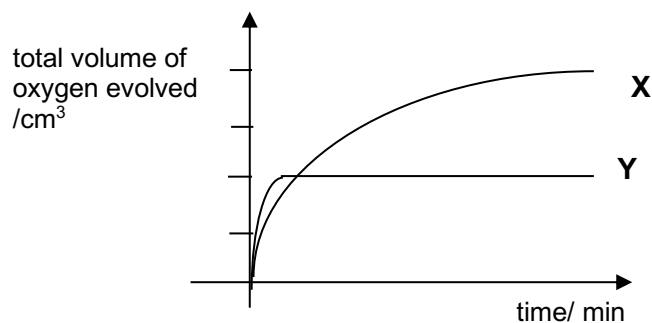


The percentage yield of product **Z** varies according to the pressure and the temperature as shown in the graph.



Which change decreases both the speed of reaction and the volume of **Z** produced?

- A** decreasing the pressure **B** decreasing the temperature
C increasing the pressure **D** increasing the temperature
- 29 The result of an experiment involving the decomposition of 20.0 cm³ of hydrogen peroxide of 1.5 mol/dm³ is represented by graph **X** below.



Which one of the following produces graph **Y**?

	volume of hydrogen peroxide used / cm ³	concentration of hydrogen peroxide used / mol/dm ³
A	10.0	1.5
B	5.0	2.5
C	20.0	0.75
D	7.5	2.0

- 30** Dilute hydrochloric acid reacts with an aqueous solution of sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, according to the chemical equation below:



10.0 cm³ portions of 2.00 mol/dm³ dilute hydrochloric acid were added to four separate conical flasks. Each flask contains 90.0 cm³ sodium thiosulfate solution which was prepared by dilution with different volumes of water as shown in the table.

conical flask	sodium thiosulfate solution		volume of water added/cm ³
	initial concentration/ mol/dm ³	volume/cm ³	
W	1.00	80.0	10.0
X	1.50	60.0	30.0
Y	2.50	30.0	60.0
Z	3.00	20.0	70.0

In which conical flask would the reaction proceed at the fastest rate?

- | | | | |
|---|---|---|---|
| A | W | B | X |
| C | Y | D | Z |

- 31** The volume ratio of unknown gases produced at the positive electrode and negative electrode during the electrolysis of unknown electrolyte solution **M** is 1:2 respectively.

Which row correctly identifies electrolyte solution **M** and the positive and negative electrodes?

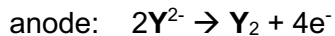
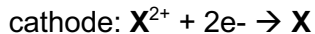
	electrolyte solution M	positive electrode	negative electrode
A	concentrated zinc chloride	platinum	graphite
B	aqueous sodium nitrate	graphite	platinum
C	aqueous silver nitrate	silver	silver
D	aqueous silver nitrate	platinum	platinum

- 32** During the electrolysis of an aqueous solution of a molybdenum salt, 19.2 g of molybdenum is deposited at the cathode by the same amount of charge that deposits 12.8 g of copper.

What is the formula of the molybdenum ion?
[Ar Mo, 96]

- A** Mo^+ **B** Mo^{2+}
C Mo^{3+} **D** Mo^{4+}

- 33** Element **X** is extracted by the electrolysis of a molten compound of elements **X** and **Y**. The electrode reactions are shown below.



Which substance could be the molten compound?

- A** aluminium oxide **B** calcium chloride
C magnesium oxide **D** potassium chloride

- 34** To reduce atmospheric pollution, the following waste gases from a coal-burning power station are passed through aqueous calcium hydroxide.

carbon monoxide	carbon dioxide	nitrogen dioxide
sulfur dioxide	phosphorus(V) oxide	ethene

How many waste gases will not be removed by the above process?

- | | | | |
|----------|---|----------|---|
| A | 2 | B | 3 |
| C | 4 | D | 5 |

- 35** The reaction of different vegetable oils with hydrogen was investigated.

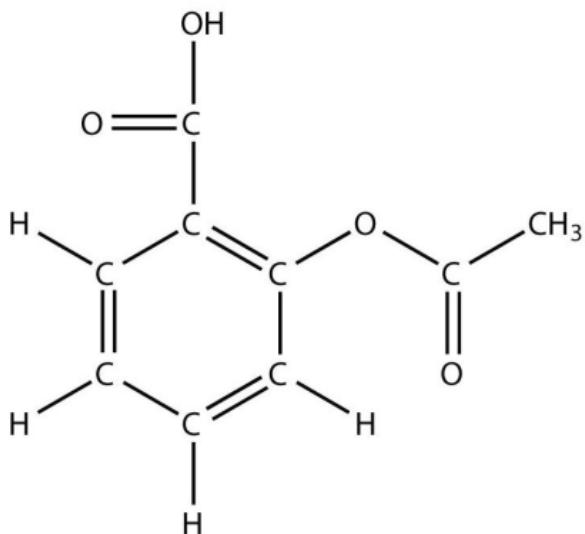
100 cm³ of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst. The volume of hydrogen gas that remained after each reaction was recorded in the table below.

vegetable oil	volume of hydrogen gas that remained after the reaction / cm ³
P	100
Q	87
R	63
S	0

Which vegetable oil(s) is/ are unsaturated?

- A** P only
B S only
C P, Q and R
D Q, R and S

- 36** Aspirin is a drug which is used as a general painkiller. The structural formula of aspirin is shown below.



Which statement is incorrect about aspirin?

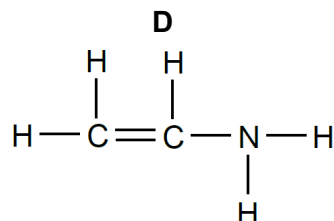
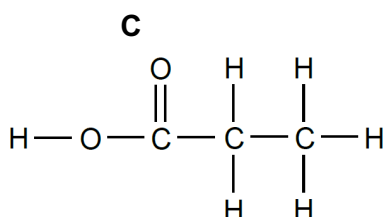
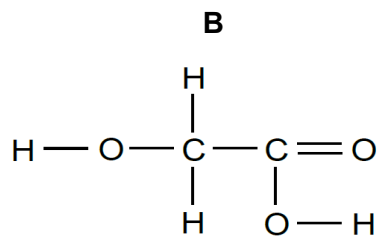
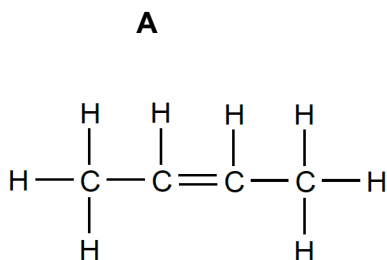
- A** It is not a hydrocarbon.
 - B** It decolourises acidified aqueous potassium manganate(VII).
 - C** It can be formed from an alcohol and a carboxylic acid
 - D** Effervescence is observed when its aqueous solution is added to sodium carbonate.
- 37** The table gives some information about some esters and the fragrance they produce.

ester	fragrance
$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3 \end{array}$	rum
$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C}-\text{O}-\text{CH}_3 \end{array}$	apple
$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3 \end{array}$	pineapple
$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \end{array}$	pear

An ester is made from ethanol and butanoic acid. What fragrance would the ester have?

- A** apple
- B** pear
- C** pineapple
- D** rum

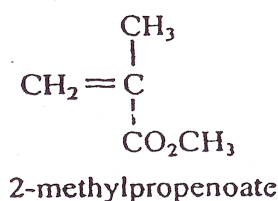
38 Which of the molecules shown cannot be polymerised?



39 Which statement about fractional distillation of petroleum is correct?

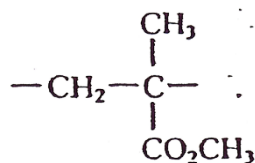
- A** At each level in the column, only one compound is collected.
- B** The higher up the column, the greater the temperature.
- C** The molecules collected at the bottom of the column are the most flammable.
- D** The molecules reaching the top of the column have the smallest relative molecular mass

40 In an artificial hip joint, bone cement is used to attach the poly(ethene) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of 2-methylpropenoate and the process is highly exothermic.



Which statements about this polymerisation of 2 methylpropenoate are correct?

- 1 The repeat unit of the polymer is



- 2 The formation of cement occurs by addition polymerisation.
 3 The energy given out in making the two C-C bonds is greater than the energy taken in to break a C=C bond.

- A** 1 and 2
C 2 and 3

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

The Periodic Table of Elements

Group																	
I	II																0
	1 H hydrogen 1																2 He helium 4
	Key proton (atomic) number atomic symbol name relative atomic mass																
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24																
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 -		114 Fl flerovium -		116 Lv livermorium -		
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 -			
actinoids																	

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).