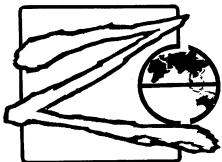


Candidate Name: _____ Index No: _____ Class: _____



**ZHENGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS
CHEMISTRY**

6092/01

Paper 1 Multiple Choice

27 August 2024

1 hour

Additional Materials: Multiple Choice Answer Sheet

*Zhenghua Secondary School Zhenghua Secondary School Zhenghua Secondary School Zhenghua Secondary School
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READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, Centre number 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.

A copy of the Periodic Table is printed on page 18.

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

Name of Setter: Ms Tan Li Er Natalie

- 1** Aqueous sodium hydroxide is neutralised by dilute hydrochloric acid in a titration. 25.0 cm³ of aqueous sodium hydroxide is measured into a conical flask using a ...1... and a few drops of methyl orange indicator is added to the solution.

The dilute hydrochloric acid is added to the conical flask using a ...2... .

The end-point is reached when the methyl orange indicator turns ...3... .

Which words correctly complete blanks 1, 2 and 3?

	1	2	3
A	burette	pipette	red
B	burette	pipette	orange
C	pipette	burette	orange
D	pipette	burette	red

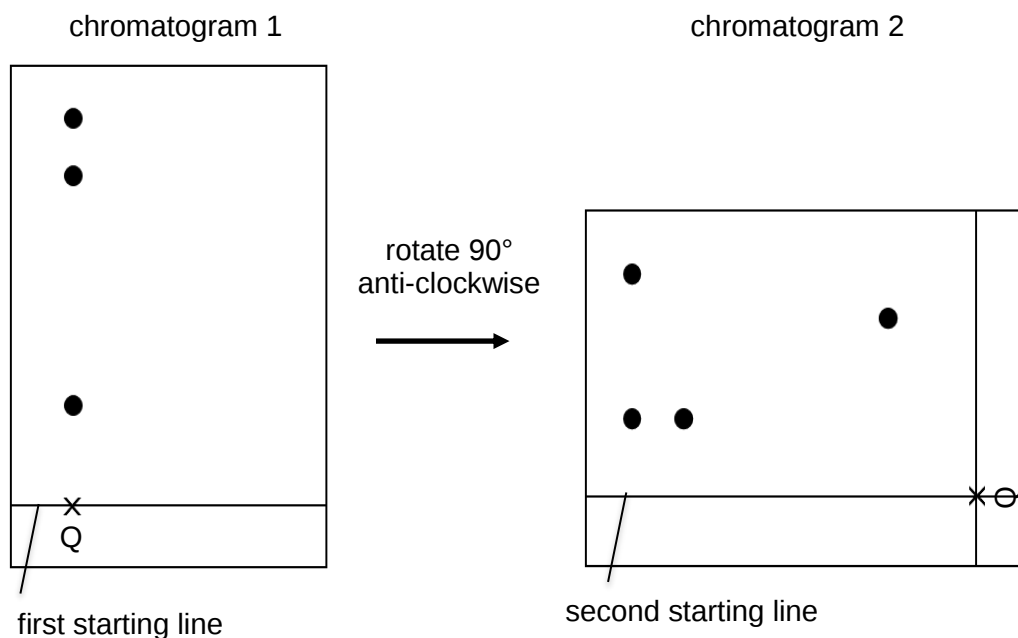
25.0 cm³ of sodium hydroxide is measured using a pipette. Note the precision of the value. Value would have been recorded to 2dp if the instrument was a burette.

Sodium hydroxide was present in the conical flask originally. The addition of methyl orange indicator would have turned the solution yellow in colour due to the high pH.

Upon the addition hydrochloric acid, sodium hydroxide is neutralized and the end point is reached when the last drop of hydrochloric acid causes the solution to change colour from yellow to orange permanently.

- 2 Chromatogram 1 shows the separation of coloured inks in mixture Q, using solvent A.

Chromatogram 2 shows the separation using the same piece of paper in another solvent B after it has been rotated 90° anti-clockwise.



How many different types of ink are present in mixture Q?

- A 3 B 4
C 6 D 7

4 spots were found after immersing the paper in both solvents.

- 3 An element, Z, has p protons and n neutrons in the nucleus of its atoms.

Z reacts with oxygen to form a basic oxide.

Which list gives the correct information about the ion of an isotope of Z?

	number of protons	number of neutrons	number of electrons
A	p	$n + 1$	$p + 1$
B	p	$n + 1$	$p - 1$
C	$p + 1$	n	$p + 1$
D	$p + 1$	n	$p - 1$

Isotopes have different number of neutrons but same number of protons.

Z is likely a metal as it forms a basic oxide. Hence, it has the tendency to lose electrons to form an ion.

- 4 A solution contains barium ions and sodium ions and one type of anion.

What could the anion be?

- A chloride only
- B nitrate only
- C sulfate only
- D chloride or nitrate

Barium sulfate is highly insoluble in water. A precipitate would have been observed if sulfate ion was present.

- 5 Solid P conducts electricity and has a high melting point. – likely a metal

When solid P is warmed with excess dilute hydrochloric acid, it partially dissolves leaving behind a residue. – likely one component of P does not react with the acid

What is P?

- A brass
 - made up of copper (no reaction with acid) and zinc (reacts with acid)
- B copper(II) oxide
- C graphite
- D iron

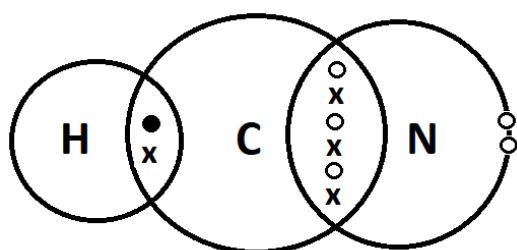
- 6 In a molecule of hydrogen cyanide, HCN, what is the total number of electrons present and how many of them are involved in bonding?

	total number of electrons	number of electrons involved in bonding
A	14	4
B	14	8
C	26	4
D	26	8

H: 1 e- and 1 valence e- , C: 6 e- and 4 valence e-, N: 7 e- and 5 valence e-

Total number of e- = 1 + 6 + 7 = 14

Note: only valence e- might be involved in bonding.



Total number of valence electrons shared = 2 + 6 = 8 e-

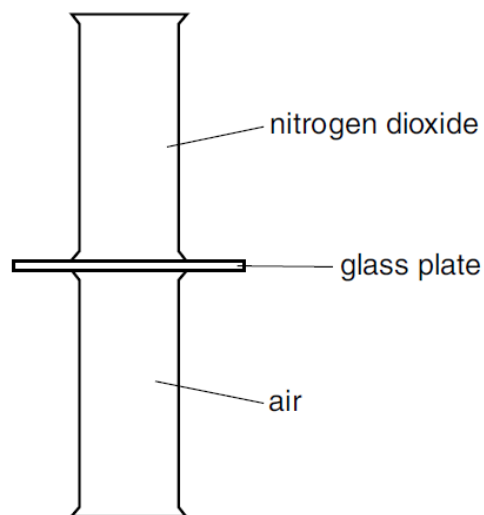
- 7 Nitrogen dioxide is a dark brown gas and is denser than air.

A gas jar containing nitrogen dioxide is sealed with a glass plate and is then inverted on top of a gas jar containing air.

nitrogen dioxide

glass plate

air



The glass plate is removed.

Which row correctly describes the colours inside the gas jars after a long period of time?
The gases are at room temperature and pressure.

	upper gas jar	lower gas jar
A	brown	brown
B	colourless	dark brown
C	dark brown	light brown
D	light brown	dark brown

Diffusion occurs.

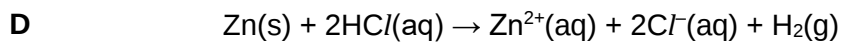
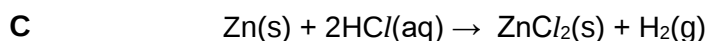
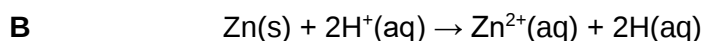
- 8** Sodium is a grey solid. Chlorine is yellowish-green gas.

When sodium is heated and mixed with chlorine, a reaction takes place and a white crystalline substance called sodium chloride is formed.

Which statement about sodium chloride is correct?

- A** It is a compound of sodium and chlorine.
- B** It is a mixture of sodium and chlorine.
- C** It is a new element.
- D** It is an alloy of sodium and chlorine. – alloys are mixtures, not compounds

- 9** Which equation represents the ionic equation of the reaction between zinc and dilute hydrochloric acid?



Cancel out spectator ions on both sides of the equation.

10 The formula for hydrated copper(II) nitrate is $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$.

It contains 36.5% of water of crystallisation by mass.

What is the value of x ?

A 4

B 5

C 6

D 7

Percentage by mass = mass of water / molar mass $\times 100\%$

$$36.5 = (18x) / (64 + 2 \times 14 + 16 \times 3 \times 2 + 18x) \times 100$$

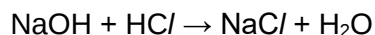
$$36.5 = 18x / (188 + 18x) \times 100$$

$$188 + 18x = (18x) \times 100 / 36.5$$

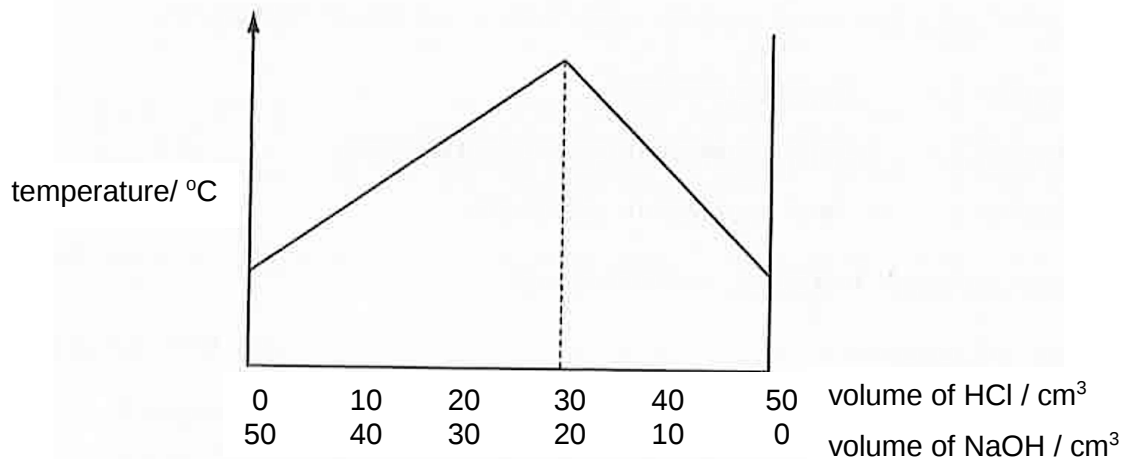
$$188 + 18x = 49.315x$$

$$x = 6$$

- 11 An aqueous solution of hydrochloric acid has a concentration of 2.0 mol / dm^3 . Different volumes of the acid are added to different volumes of aqueous sodium hydroxide.



The maximum temperature of each mixture is measured. The graph shows the results.



What is the concentration of the aqueous sodium hydroxide?

- A 0.67 mol/dm^3
 B 1.3 mol/dm^3
 C 1.5 mol/dm^3
D 3.0 mol/dm^3

As neutralization is an exothermic reaction, the maximum temperature would be the highest when exact amounts of both chemicals react with each other (i.e. at 30 cm^3 of HCl and 20 cm^3 of NaOH).

Number of moles of HCl = $2 \times 30 / 1000 = 0.06 \text{ mol}$

Number of moles of NaOH = 0.06 mol

Concentration of NaOH = $0.06 / (20 / 1000) = 3 \text{ mol / dm}^3$

- 12 8 g of X_2O_3 , an oxide of element X, contains 5.6 g of X.

How many moles of X does 5.6 g of the element contain?

- A** $\frac{2.4}{16} \times \frac{2}{3}$ B $\frac{2.4}{16} \times \frac{3}{2}$
 C $\frac{8}{16} \times \frac{2}{3}$ D $\frac{8}{16} \times \frac{3}{2}$

Mass of oxygen in 8 g of $\text{X}_2\text{O}_3 = 8 - 5.6 = 2.4 \text{ g}$

Number of moles of oxygen = $2.4 / 16 \text{ mol}$

Number of moles of X = $2.4 / 16 \times (2/3)$

*In each mole of X_2O_3 , there are 2 moles of X and 3 moles of O.

13 In which reaction does the smallest percentage change in volume occur?

- A $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$ change in number of moles of gases = - 3
- B $4\text{NH}_3(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$ change in number of moles of gases = - 5
- C $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ change in number of moles of gases = - 2
- D $2\text{H}_2\text{S}(\text{g}) + \text{SO}_2(\text{g}) \rightarrow 3\text{S}(\text{s}) + 2\text{H}_2\text{O}(\text{l})$ change in number of moles of gases = - 3

14 One mole of compound X gives three moles of ions in aqueous solution. X reacts with ammonium carbonate to give an acidic gas.

What is X?

- A barium hydroxide $\text{Ba}(\text{OH})_2$ (3 moles of ions but reacts with ammonium compounds to form NH_3 , an alkaline gas)
- B ethanoic acid CH_3COOH
- C potassium hydroxide KOH
- D sulfuric acid H_2SO_4 (3 moles of ions + reacts with carbonates to form CO_2 , an acidic oxide)

15 The scheme shows four stages, 1 to 4, in the conversion of solid candlewax, $\text{C}_{30}\text{H}_{62}$, into carbon dioxide and water.

- 1 $\text{C}_{30}\text{H}_{62}(\text{s}) \rightarrow \text{C}_{30}\text{H}_{62}(\text{l})$
- 2 $\text{C}_{30}\text{H}_{62}(\text{l}) \rightarrow \text{C}_{30}\text{H}_{62}(\text{g})$
- 3 $\text{C}_{30}\text{H}_{62}(\text{g}) + 45.5\text{O}_2(\text{g}) \rightarrow 30\text{CO}_2(\text{g}) + 31\text{H}_2\text{O}(\text{g})$
- 4 $30\text{CO}_2(\text{g}) + 31\text{H}_2\text{O}(\text{g}) \rightarrow 30\text{CO}_2(\text{g}) + 31\text{H}_2\text{O}(\text{l})$

Which stages are exothermic?

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

Combustion and condensation of water release energy (exothermic).

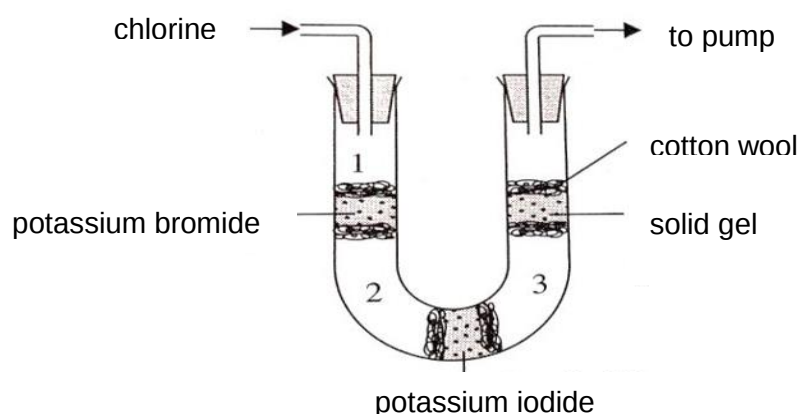
16 These statements are about the activation energy of a chemical reaction.

- 1 Chemical reactions in gases and liquids take place when molecules collide with sufficient energy to overcome the activation energy.
- 2 If the activation energy for a reaction is high, many of the collisions have enough energy to be successful and the reaction is fast. – less particles would have sufficient energy to overcome the activation energy and rate of reaction would be slower
- 3 A catalyst reduces the activation energy for a reaction and therefore the overall enthalpy change of the reaction is lower. – a catalyst does not lower the enthalpy change of reaction

Which statements are correct?

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

17 Gaseous chlorine was passed through the following apparatus. The apparatus was continuously heated.



What observations would be made at regions 1, 2 and 3?

	region 1	region 2	region 3
A	yellow-green gas	violet gas	black solid
B	yellow-green gas	reddish-brown gas	violet gas
C	red-brown gas	violet gas	violet gas
D	red-brown gas	black solid	black solid

Reactivity of halogens decrease down group 17. The more reactive halogen will undergo reduction, displacing the less reactive halogen from its halide.

- 18** P is a Group 1 element. What would happen when a small piece of P is put into a bowl that contains water and a few drops of litmus solution?

- 1 Heat is released.
- 2 An electrolyte is formed.
- 3 The solution turns blue.
- 4 A gas is given off.

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

Group 1 metals react vigorously with water to form metal hydroxides (alkaline and suitable as an electrolyte as group 1 hydroxides are soluble) and hydrogen gas.

- 19** X, Y, and Z are elements in the same period of the Periodic Table.

X forms an amphoteric oxide, Y forms an acidic oxide and Z forms a basic oxide.

If X, Y and Z are placed in order of increasing atomic number, which order is correct?

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

Z is likely a metal (forms a basic oxide)

Y is likely a non-metal (forms an acidic oxide)

X is likely Aluminium/ zinc/ lead.

Nature of oxides vary from basic to amphoteric to acidic across the period from left to right as the metallic character decreases.

- 20** 216 g of silver is deposited when an electric current is passed through a solution of silver nitrate using graphite electrodes.

What is the mass of magnesium formed when the same amount of current is passed through molten magnesium chloride using graphite electrodes?

- A** 24 g **B** 48 g
C 72 g **D** 96 g



Number of moles of silver = number of moles of electrons = $216 / 108 = 2$ moles



Number of moles of Mg = $2 / 2 = 1$ mole

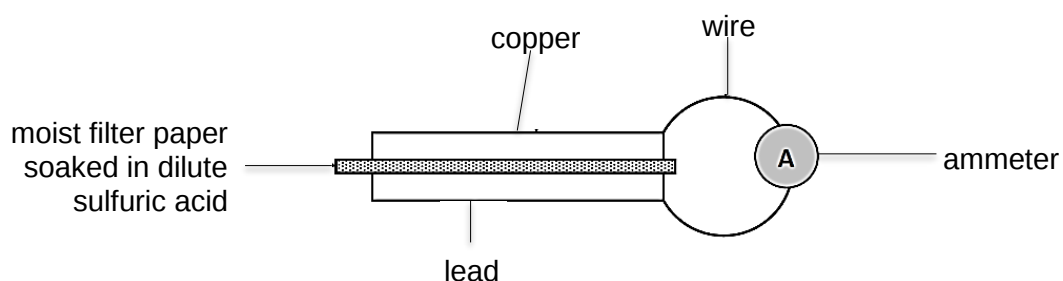
Mass of Mg = $1 \times 24 = 24$ g

- 21 Which pair of electrolyte and electrodes will not result in a change in the concentration of the solution during electrolysis?

	electrolyte	electrodes
A	copper(II) nitrate	carbon
B	copper(II) nitrate	copper
C	sodium nitrate	carbon
D	sodium nitrate	copper

Copper anode dissolves to form Cu^{2+} , which is converted to Cu at the cathode.

- 22 In the following set-up, lead and copper strips are pressed against a piece of wet filter paper soaked in dilute sulfuric acid and the amount of electric current flowing through can be detected by an ammeter, a device used to measure current.



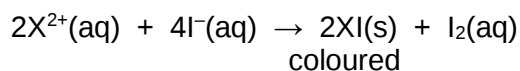
Which statement is correct?

- A Copper strip decreases in size.
- B Electrons flow from copper to lead through the wire. – electrons flow from anode to cathode
- C Lead strip is coated with a pink substance.
– there are no Cu^{2+} ions present in the filter paper
- D Oxidation occurs on the lead strip.

Lead: anode (oxidation)

Copper: cathode (reduction)

- 23 The ions of metal X react with aqueous potassium iodide.



From this information, it can be deduced that X is most likely a1..... metal and the $X^{2+}(aq)$ ions are2.....

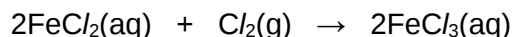
Which words correctly complete blanks 1 and 2?

	blank 1	blank 2
A	group 2	oxidised
B	group 2	reduced
C	transition	oxidised
D	transition	reduced

Transition metals form coloured ions.

Oxidation state of X decreases from +2 to +1.

- 24 Iron(II) chloride solution reacts with chlorine gas. The equation is shown.



Which statements about this reaction are correct?

- 1 Fe^{2+} ions are reduced to Fe^{3+} ions. – oxidation state increases (oxidation)
- 2 Chlorine acts as a reducing agent. – oxidizing agent (Fe^{2+} is oxidized to Fe^{3+})
- 3 Fe^{2+} ions each lose an electron. – each Fe^{2+} ion loses one mole of e^{-} to produce Fe^{3+}
- 4 Cl_2 molecules are reduced to Cl^{-} ions. – oxidation state decreases from 0 to -1.

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

- 25 When chlorine gas dissolves in concentrated sodium hydroxide a reaction occurs.



Which row correctly identify the oxidation state for chlorine in the chlorine-containing species?

	Cl_2	NaCl	NaOCl
A	-1	-1	-1
B	0	-1	+1
C	-1	+1	0
D	0	+1	-1

- 26 Gas X turns acidified potassium manganate(VII) from purple to colourless. Gas Y turns aqueous potassium iodide from colourless to brown.

What do these observations tell us about the role of gas X and gas Y?

	gas X	gas Y
A	oxidising agent	oxidising agent
B	oxidising agent	reducing agent
C	reducing agent	oxidising agent
D	reducing agent	reducing agent

Potassium manganate (VII) is used to test for a reducing agent.
 KI is used to test for an oxidizing agent.

- 27 The table shows the method of extraction of metals P, Q and R from their ores.

metal	method
P	reduction by hydrogen
Q	electrolysis
R	reduction by carbon

What is the the order of reactivity of the metals from least reactive to most reactive?

- A P, Q, R
B P, R, Q
 C Q, P, R
 D R, P, Q



- 28 Which statement about the Haber process is correct?

- A Increasing the temperature will increase yield but operating cost is high.
 - Higher temp leads to lower yield but slower rate of reaction.
- B One volume of hydrogen reacts with three volumes of nitrogen to form two volumes of ammonia.
 – 3 volumes of nitrogen react with 1 volume of nitrogen to form 2 volumes of ammonia
- C The raw materials are obtained from the air.
 - nitrogen is obtained from fractional distillation of air while hydrogen is obtained from cracking of petroleum.
- D The reaction does not go to completion.**
 - Reaction is reversible.

29 The solid carbonates of three metals, P, Q and R are heated.

action of heat on carbonates of	results
P	carbon dioxide produced solid changes colour from green to black
Q	carbon dioxide produced solid does not change colour
R	no carbon dioxide produced solid does not change colour

Which statements are correct?

- 1 Metal R is more reactive than metal Q.
- more reactive metals have carbonates which are more resistant to thermal decomposition.
- 2 Metal P is a transition metal.
- change in colour indicates the presence of a transition metal.
- 3 If dilute nitric acid is added to all three carbonates, carbon dioxide is given off from the carbonates of P and Q but not from the carbonate of R.
– no information from the question on this.

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

30 Which metal is mined commercially in its elemental state rather than as a compound?

- A copper
- B lead
- C silver – least reactive metal**
- D sodium



31 Which of the following sentences about the fractional distillation of crude oil is true?

- A Plastic is collected at the bottom of the fractionating column.
- B Shorter hydrocarbons are collected near the top of the fractional distillation.**
- lower bp, vaporizes first and is collected near the top
- C The fractions are collected one after the other during the process of fractional distillation.
- D The hydrocarbon with the lowest boiling point remains in the furnace.

32 Two statements about substances X, Y and Z are given.

- 1 A hydrocarbon X is cracked to make Y and hydrogen gas.
- 2 Compound Z is formed by the addition polymerisation of Y.

Based on the two statements above, which statement is true?

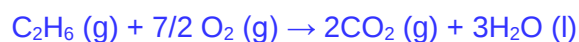
- A X is an unsaturated compound. - insufficient info in the question to tell if this is true
- B Y is a saturated compound. – unsaturated as it is able to undergo addition polymerization
- C Y can react with steam to form an alcohol.**
-unsaturated, able to undergo addition with steam
- D Z has a lower melting point than Y.
- a polymer would have a higher melting point

33 In which reaction does the product have less carbon atoms than the underlined reactant?

- A** a carboxylic acid produced from an alcohol and an oxidising agent
same number of C atoms
- B** an alcohol produced from an alkene and steam
same number of carbon atoms
- C** carbon dioxide produced from the combustion of ethanol (2 carbons)
- D** calcium ethanoate produced from ethanoic acid and calcium carbonate
 $(\text{CH}_3\text{COO})_2\text{Ca}$ CH_3COOH

34 100 cm³ of ethane is burnt in 200 cm³ of oxygen.

When cooled to room temperature, what could be the resulting mixture of gases?



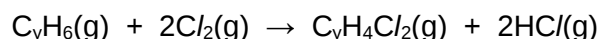
Since mole ratio of ethane: oxygen = 1 : 7/2

Volume of oxygen required for 100 cm³ of ethane = 100 x 7/2 = 350 cm³

Thus, incomplete combustion has taken place.

- A** ethane, carbon monoxide, water vapour
- B** ethane, carbon monoxide, carbon dioxide
- C** ethane, carbon dioxide, oxygen
- D** oxygen, carbon monoxide, carbon dioxide

35 The reaction between a hydrocarbon C_yH₆ and chlorine is shown.



Which statement is correct?

- A** It is an addition reaction. – addition reactions only produce one product
- B** The molecular formula of the hydrocarbon is C₃H₆.
- C** The presence of UV light is essential for the reaction to take place.
Essential for substitution to take place.
- D** High temperature, high pressure and a catalyst are required in the reaction.

36 Carbohydrates can be converted to poly(ethene) in different stages as shown.



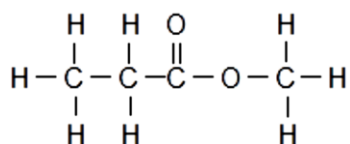
Which row correctly labels the processes X and Y?

	X	Y
A	photosynthesis	oxidation
B	fermentation	addition polymerisation
C	fermentation	condensation polymerisation
D	photosynthesis	addition polymerisation

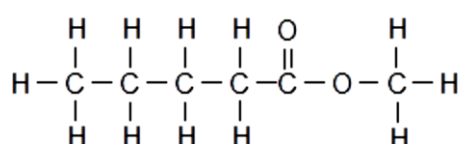
37 An ester was produced by the condensation reaction of methanol and butanoic acid.

Which structure represents the ester compound?

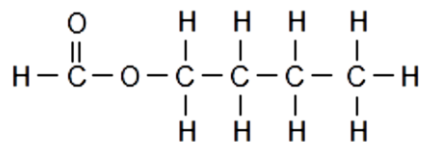
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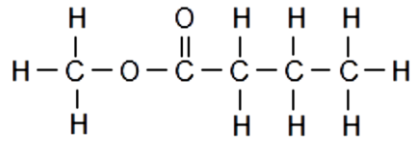
B



C

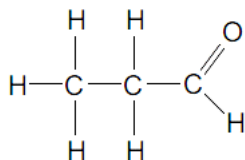


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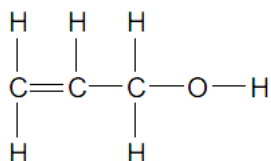


38 Which compound is an isomer of propanol? – same chemical formula as $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

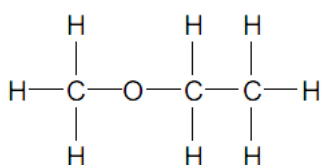
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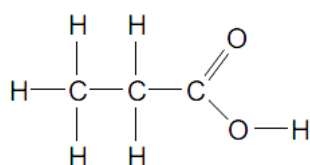
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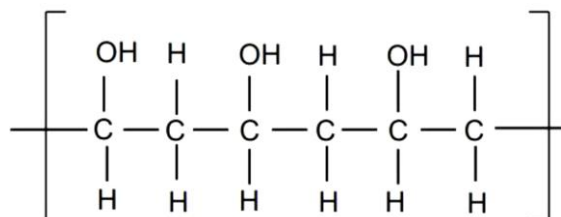
C



D

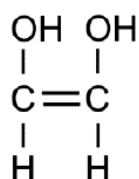


39 The structure of a polymer is shown below.

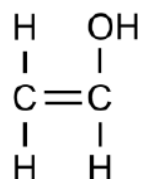


What is the monomer unit for this polymer?

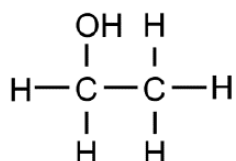
A



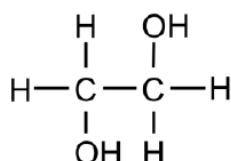
B



C



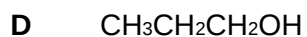
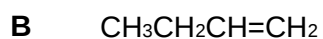
D



40 X is an organic compound containing four carbon atoms. It gives negative results with the following tests.

- reacting X with aqueous bromine – not unsaturated
- reacting X with acidified potassium manganate (VII) solution – absence of hydroxyl group
- reacting X with sodium carbonate solution – absence of -COOH group

Which of the following could be the structural formula of X?



Qn	Answer	Qn	Answer
1	C	21	B
2	B	22	D
3	B	23	D
4	D	24	D
5	A	25	B
6	B	26	C
7	A	27	B
8	A	28	D
9	A	29	A
10	C	30	C
11	D	31	B
12	A	32	C
13	C	33	C
14	D	34	B
15	C	35	C
16	A	36	B
17	B	37	D
18	D	38	C
19	C	39	B
20	A	40	A

The Periodic Table of Elements

Periodic Table of Elements																	
Group												13	14	15	16	17	18
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9	Key proton (atomic) number atomic symbol name relative atomic mass										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	17 Cl chlorine 35.5	18 Ar argon 40
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 oganeson —

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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 dm³ at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$

