NAME:		( )	CLASS:	

YISHUN TOWN SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2024

SEC 4 EXPRESS

CHEMISTRY

(6092/1)

DATE : 28 Aug 2024 **DAY : Wednesday**

DURATION: 1 hour **MARKS: 40 marks**

ADDITIONAL MATERIALS

Multiple Choice Answer Sheet (OMS)

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided at the top of this page.

There are forty questions. 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. Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

INFORMATION FOR CANDIDATES

Any rough working should be done in this booklet.

You may use an approved calculator.

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

This question paper consists of **12** printed pages.

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1 Peter added 25.00 cm^3 of hydrochloric acid into a styrofoam cup and then added 75.0 cm^3 of aqueous sodium hydroxide to investigate the temperature change of the reaction.

Which apparatus did he use?

I beaker II pipette III burette IV measuring cylinder

A I and II **B** I and IV **C** II and III **D** III and IV

2 Which property increases when a substance is being cooled?

A energy of particles
B distance between particles
C speed of movement of particles
D strength of attractive force between particles

3 The diagram shows the result of dropping a purple crystal into water.



Which processes have taken place?

	chemical reaction	*diffusing*	*dissolving*
A	√	√	x
B	√	x	x
C	x	x	√
D	x	√	√

4 The number of electrons, neutrons and protons of four particles, W, X, Y and Z, are shown.

	electrons	*neutrons*	*protons*
W	2	2	2
X	2	2	3
Y	2	3	2
Z	3	2	3

Which particles are isotopes?

A W and X **B** W and Y **C** X and Y **D** X and Z

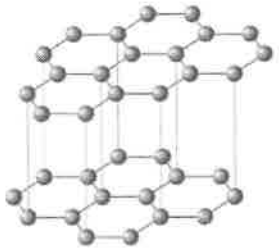
5 Which ion contains more protons than electrons and more neutrons than protons?

A $^{6}Li^{+}$ **B** $^{25}Mg^{2+}$ **C** $^{18}F^{-}$ **D** $^{31}P^{3-}$

6 Diagrams representing substances **E** and **F** are shown.



E



F

Which particles are responsible for how the substances conduct electricity in the solid state?

	E	F
A	cannot conduct	delocalised electrons within each layer
B	ions	delocalised electrons between layers
C	cannot conduct	delocalised electrons between layers
D	ions	delocalised electrons within each layer

7 Element J, K, L and M have four, five, six and seven valence electrons respectively. Which molecule is likely to be formed?

I JL_2 II JM_4 III KM_3 IV LM_2

A I, II and III only
B II, III and IV only
C II and III only
D I, II, III and IV

8 When substance **G** is dissolved in a water and filtered, a grey solid **H** is obtained as the residue and a green solution is obtained as the filtrate. When liquid **H** is electrolysed, it remains unchanged.

What type of substances are **G** and **H** most likely to be?

	G	H
A	mixture	element
B	compound	compound
C	mixture	compound
D	compound	element

9 How is the term *mole* defined?

A It is the average mass of 6.0×10^{23} atoms of carbon-12.
B It is the number of atoms present in 24 dm^3 of carbon-12.
C It is the number of atoms present in 12.0 g of carbon-12.
D It is the average mass of an atom when compared against that of carbon-12.

10 A sample of 10 cm^3 of ethene is completely burned in 100 cm^3 of oxygen. What is the final volume of gas in the resulting mixture when measured under room conditions?

A 20 cm^3 **B** 40 cm^3 **C** 70 cm^3 **D** 90 cm^3

11 When a sample of 3.4 g of hydrogen peroxide is decomposed, 480 cm^3 of oxygen is obtained. What is the percentage yield of the decomposition?

A 20% **B** 40% **C** 60% **D** 80%

12 The same volume of 1.0 mol/dm^3 of acid **P** and **Q** both turn red in the presence of Universal Indicator. Which statement is true?

A Acid **P** and **Q** have the same basicity and strength.
B Acid **P** and **Q** have the same basicity but no conclusion about their strength can be made.
C Acid **P** and **Q** have the same strength but no conclusion about their basicity can be made.
D No conclusion can be made about both the strength and basicity of acid **P** and **Q**.

13 Acidity of soil is usually controlled using calcium hydroxide. Why is sodium hydroxide **not** used?

A Sodium is a more reactive metal than calcium.
B Sodium hydroxide is more soluble than calcium hydroxide.
C Sodium hydroxide is more expensive than calcium hydroxide.
D Sodium hydroxide is monobasic while calcium hydroxide is dibasic.

14 Copper (II) sulfate is formed by reacting excess solid copper (II) carbonate with dilute sulfuric acid. Which processes are part of the preparation of solid copper (II) sulfate?

I crystallisation II distillation III filtration IV titration

A I and III **B** I and IV **C** II and III **D** II and IV

15 Which element forms an oxide that reacts with an aqueous solution of a base?

A sulfur
B magnesium
C copper
D argon

16 Which reaction is reversible?

A an iron nail rusting in moist air
B limestone reacting with acid to form carbon dioxide gas
C magnesium burning in air to produce a white ash
D white anhydrous copper (II) sulfate turning blue in water

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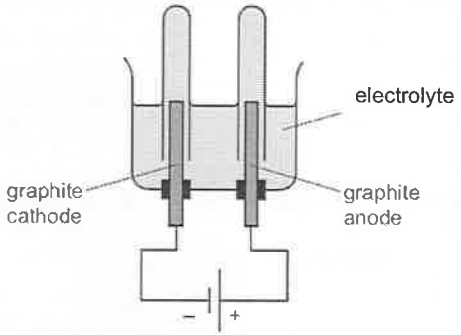
17 A student wants to test for the presence of chloride in an aqueous solution. What should the student do to a sample of the aqueous solution?

A add dilute nitric acid followed by aqueous silver nitrate
B add dilute nitric acid followed by aqueous barium nitrate
C add dilute hydrochloric acid followed by aqueous silver nitrate
D add dilute hydrochloric acid followed by aqueous barium nitrate

18 When chlorine dissolves in water, hypochlorous acid, HC*l*O, is formed. Which statement most accurately describes this reaction?

A Chlorine is reduced because chlorine gains oxygen.
B Chlorine is oxidised because chlorine gains hydrogen.
C The oxidation number of chlorine changes from 0 to +1.
D The oxidation number of chlorine changes from 0 to –1.

19 An electrolysis is carried out using graphite electrodes.



Which electrolyte will **not** produce gases at both electrodes?

A dilute sulfuric acid
B dilute zinc chloride
C dilute sodium sulfate
D dilute silver nitrate

20 A cell is set up using zinc and metal **W** to convert chemical energy to electrical energy. What should be used for metal **W** so that **W** is the negative electrode producing the largest voltage?

A calcium **B** magnesium **C** iron **D** copper

21 Which is correct regarding the differences between hydrogen fuel cell and ethanol fuel cell?

	hydrogen fuel cell	*ethanol fuel cell*
I	only water is produced as the product	carbon dioxide is produced as one of the products
II	reaction is endothermic	reaction is exothermic
III	fuel is obtained from cracking of crude oil	fuel is obtained from fermentation

A I and II only **B** I and III only **C** II and III only **D** I, II and III

22 Which is correct regarding the trend of metallic character of the elements of the Periodic Table?

	going across the period from left to right	*going down the group*
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

23 Aqueous bromine is mixed with aqueous potassium chloride. Which statement is true about this mixture?

A There is a reaction because bromine is more reactive than chlorine.
B There is a reaction because bromine is more reactive than chloride.
C There is no reaction because bromine is less reactive than chlorine.
D There is no reaction because bromine is less reactive than chloride.

24 Which statement gives a correct use of noble gases?

A Helium is used as an anaesthetic (inducing insensitivity to pain).
B Neon is used as a disinfectant.
C Argon is used in the manufacture of steel.
D Krypton is used to fill weather balloons.

25 Which statements about brass are correct?

I It is a compound of zinc and copper.
II It is a mixture of zinc and copper.
III It is stronger than zinc.

A I and II only **B** I and III only **C** II and III only **D** I, II and III

26 What are the products produced when calcium is reacted with steam and water?

	react with steam	*react with water*
A	calcium oxide	calcium hydroxide
B	calcium hydroxide	calcium oxide
C	no reaction	calcium oxide
D	no reaction	calcium hydroxide

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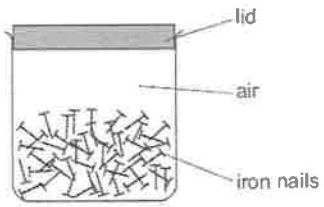
27 Information about some metals P, Q, R and S are listed below.

- Metal P reacts slowly with water.
- Metal Q does not react with acid.
- Metal R is usually extracted by reaction with carbon.
- Metal S is usually extracted using electrolysis of its molten ore.

Which is the most likely arrangement of the metals in order of decreasing reactivity?

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

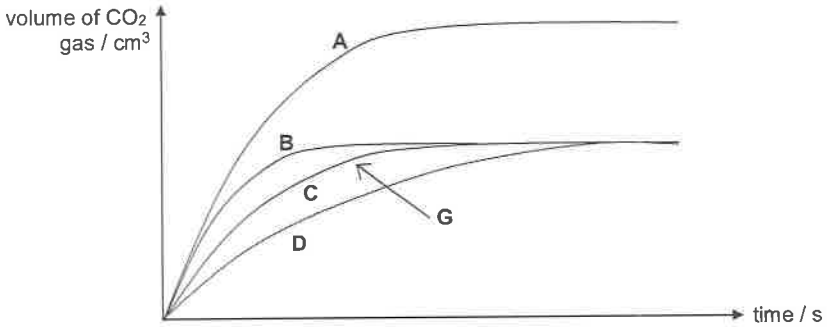
28 Iron nails are stored in an airtight container.



The nails begin to rust after a few days. How can the rusting of nails be prevented?

A Leave the lid off.
B Replace the air with argon.
C Put the container in a warm place.
D Seal the container in a bag.

29 When 1.0 g of calcium carbonate is reacted with 100 cm^3 of 1.0 mol/dm^3 of hydrochloric acid (an excess), graph labelled **G** is obtained for the volume of carbon dioxide gas produced over time.



Which graph is obtained when the experiment is repeated at a higher pressure?

30 When a mixture of a colourless solution of thiosulfate ions reacts with an acid, sulfur dioxide gas, yellow sulfur solid and water are produced.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(g) + S(s) + H_2O(l)$$

Which measurement can be used to determine the rate of the reaction?

I change in concentration of acid
II change in mass of mixture
III change in volume of sulfur dioxide gas

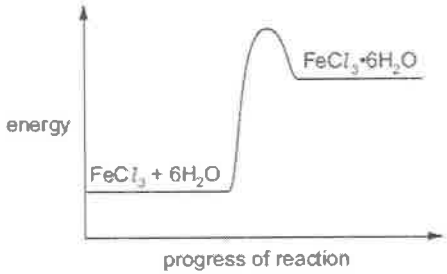
A I and II only **B** I and III only **C** II and III only **D** I, II and III

31 When water is added to anhydrous iron (III) chloride, hydrated iron (III) chloride is formed and energy is given out.

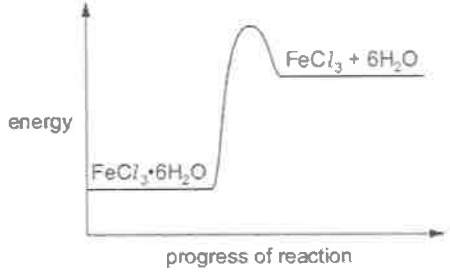
$$FeCl_3 + 6H_2O \rightleftharpoons FeCl_3 \cdot 6H_2O$$

Which reaction pathway diagram represents the formation of anhydrous iron (III) chloride in the **reverse** reaction?

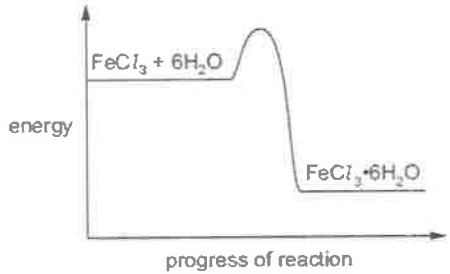
A



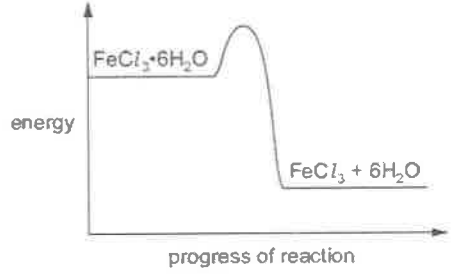
B



C

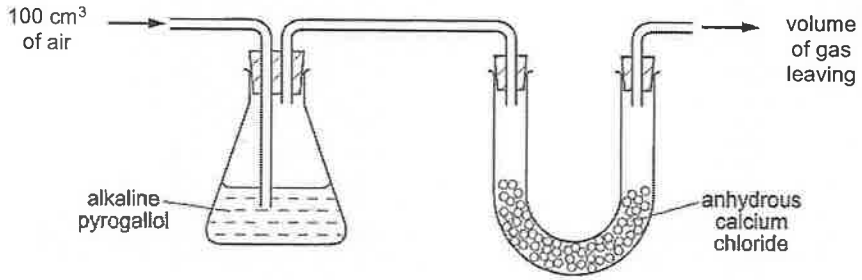


D



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32 Air is passed through an apparatus set up as shown. A solution of alkaline pyrogallol absorbs oxygen and carbon dioxide.



What is the approximate volume of gas leaving the apparatus?

A 20 cm^3 **B** 40 cm^3 **C** 60 cm^3 **D** 80 cm^3

33 Gas **T** is less dense than air and contributes towards global warming. What is gas **T**?

A methane
B sulfur dioxide
C carbon dioxide
D nitrogen monoxide

34 Which row shows the correct use for the fractions of petroleum after separation?

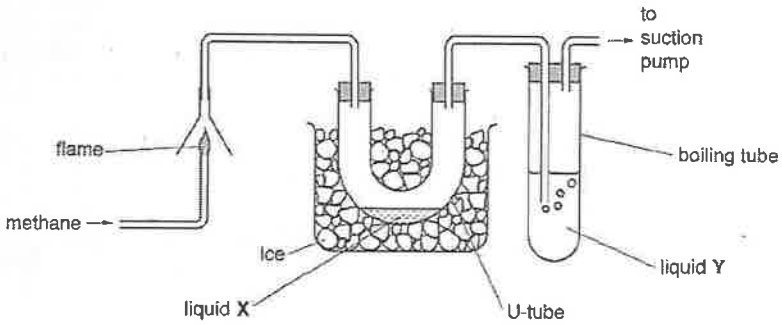
	fraction	*use*
A	bitumen	wax making
B	petrol	jet fuel
C	kerosene	road making
D	naphtha	making chemicals

35 Which reactions take place only in the presence of sunlight?

I $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
II $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$
III $C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$

A I only **B** I and III only **C** II only **D** II and III only

36 The substances formed when methane is burnt in air is investigated.



What is the identity of liquid **X** and **Y**?

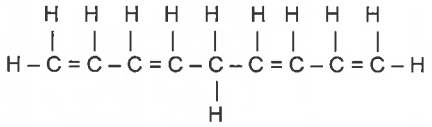
	liquid X	*liquid Y*
A	carbon dioxide	limewater
B	carbon dioxide	concentrated sulfuric acid
C	water	limewater
D	water	concentrated sulfuric acid

37 Hydrocarbon **D** reacts with steam to produce molecule **E**, which is then reacted with acidified potassium manganate (VII) to form molecule **F**.

What is the homologous series of hydrocarbon **D** and molecule **F**?

	hydrocarbon D	*molecule F*
A	alkane	alcohol
B	alkane	carboxylic acid
C	alkene	alcohol
D	alkene	carboxylic acid

38 An unsaturated molecule contains four carbon-carbon double bonds.



The molecule reacts exactly with two bromine molecules. How many possible products can be formed?

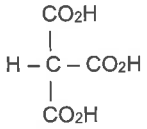
A 3 **B** 4 **C** 5 **D** 6

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39 Ethanoic acid reacts with sodium carbonate in a similar manner as hydrochloric acid.

$$2CH_3CO_2H + Na_2CO_3 \rightarrow 2CH_3CO_2Na + CO_2 + H_2O$$

How many moles of carbon dioxide gas will be produced when two moles of the following substance are completely reacted with sodium carbonate?



A 1 **B** 2 **C** 3 **D** 6

40 Poly(ethene) is formed from petroleum using three separate processes. Which shows the correct order of the processes?

A cracking → fractional distillation → addition polymerisation
B cracking → fractional distillation → condensation polymerisation
C fractional distillation → cracking → addition polymerisation
D fractional distillation → cracking → condensation polymerisation

The Periodic Table of Elements

Group																	
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 –		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
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^3 at room temperature and pressure (r.t.p.).

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NAME:		( )	CLASS:	

YISHUN TOWN SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2024

SEC 4 EXPRESS

CHEMISTRY

(6092/2)

DATE : 20 Aug 2024 **DAY : Tuesday**

DURATION : 1 h 45 min **MARKS : 80 marks**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided at the top of this page.

Section A

Answer **all** questions.
Write your answers in the spaces provided.

Section B

Answer **one** question.
Write your answers in the spaces provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an approved calculator.

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

Section A	
Section B	
TOTAL	

This question paper consists of **21** printed pages, including the cover page.

SECTION A

Answer **all** questions.

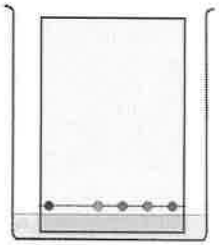
1 The diagrams of some methods for separation and purification of substances are shown below. They are labelled from **A** to **F**.



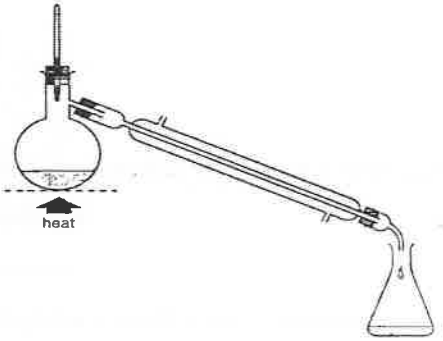
A



B



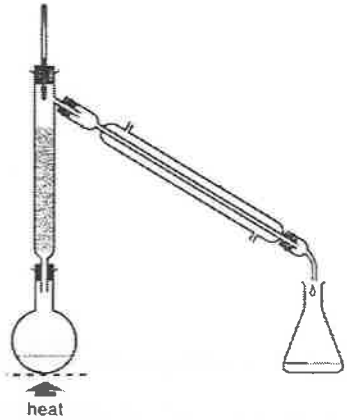
C



D



E



F

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(a) Use the alphabets **A** to **F** to answer the following questions. You may use the alphabets once, more than once or not at all.

(i) Which method can be used to test for purity of a substance?

..... [1]

(ii) Which **three** methods can be used to obtain a solid from a mixture?

..... [1]

(iii) Which method is used to separate diesel, kerosene and naphtha?

..... [1]

(iv) Which method is used in the preparation of lead (II) chloride?

..... [1]

(v) Which method works due to the non-miscibility of liquids?

..... [1]

(b) Sulfur is soluble in ethanol.

Explain why method **B** is **not** suitable for a mixture of sulfur dissolved in ethanol. Suggest an improvement to this method.

.....

..... [2]

[Total: 7]

2 Naphthalene, or mothball, are white solid spheres used in enclosed spaces to keep insects away. Naphthalene has the molecular formula of $C_{10}H_8$. It melts at 78 °C and boils at 218 °C.

(a) On the axes below, sketch a well-labelled diagram to show what happens when naphthalene is heated from 25 °C to 225 °C.



[2]

(b) Describe the movement and arrangement of the particles in naphthalene at 125 °C.

movement: .....

arrangement: ..... [2]

(c) Predict the solubility of naphthalene in water. Briefly explain your answer.

.....

..... [1]

[Total: 5]

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3 **(a)** Hydrogen reacts with magnesium to form magnesium hydride, MgH_2. Hydrogen reacts with oxygen to form water.

(i) Magnesium hydride is an ionic compound. Draw the dot-and-cross diagram of magnesium hydride, showing only the outermost electrons.

[2]

(ii) Water can partially dissociate to produce hydrogen ions and hydroxide ions. Draw the dot-and-cross diagram of the ions produced, showing only the outermost electrons.

[2]

(iii) Hence, in terms of electrons, explain why hydrogen exhibits the behaviours of both metals as well as non-metals.

.....

.....

.....

..... [2]

(b) Besides the reasons given in **(a)(iii)**, state one other property of hydrogen that resembles:

(i) a metal.

.....

..... [1]

(ii) a non-metal.

.....

..... [1]

(c) Explain the difference in melting point between magnesium hydride and water.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

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4 There are three main elements found in fertilisers that plants need to grow well. Element 1 is nitrogen and element 3 is potassium. The identity of element 2 is to be determined.

(a) Nitrogen is important to maintain green colouration of plants and to produce chlorophyll.

Nitrogen can be provided by compounds such as ammonium chloride (NH_4Cl) and ammonium nitrate (NH_4NO_3).

Two students made some claims about these compounds.

Patrick: These compounds are less effective in alkaline soil.

Hafiz: 1.0 g of ammonium nitrate provides a higher nitrogen content for soil than 1.0 g of ammonium chloride.

(i) Write an ionic equation for the reaction that takes place when ammonium ion is in alkaline soil. Hence, comment on the validity of Patrick's claim, with reasoning.

.....

.....

..... [2]

(ii) Using calculations, comment on the validity of Hafiz's claims.

.....

.....

..... [3]

(iii) Some ammonium nitrate is fully dissolved in water. Describe how the presence of ammonium and nitrate ions can be verified. Your answer needs to include the precaution taken to exclude the possibility of the test of one ion interfering with the other.

.....

.....

.....

.....

.....

..... [3]

(b) Element 2 is responsible for the growth of roots and seeds. It is also responsible for the blooming of flowers and bearing of fruits in plants.

(i) In countries with four seasons (spring, summer, autumn and winter), state the season in which Element 2 is most needed.

..... [1]

(ii) Element 2 is represented as **X**. It is found in the form of its oxide in fertilizers. There is 0.44 g of element 2 in 1.00 g of its oxide. The empirical formula of this oxide is X_2O_5.

Deduce the identity of element 2.

[3]

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(c) Potassium helps plants to transport water and nutrients, as well as to resist diseases.

Potassium comes in two stable isotopes. They are potassium-39 which consists of 93.3% and potassium-41 which consists of 6.7%.

(i) Write the nuclide notation for potassium-41.

..... [1]

(ii) State the number of protons, neutrons and electrons in an atom of potassium-41.

number of protons	*number of neutrons*	*number of electrons*

[1]

(iii) Calculate the relative atomic mass of potassium to **two** decimal places.

[1]

(iv) Explain why potassium usually forms K^+ ions and not ions of other charges.

.....

..... [1]

[Total: 16]

5 Copper (II) carbonate is a green solid which dissolves in aqueous sulfuric acid to give a blue solution. When copper (II) carbonate is strongly heated at about 290 °C, a black solid is left behind. The black solid can also be produced when copper is heated with oxygen, which also forms some red solid of copper (I) oxide.

(a) (i) With reference to the substances given, explain two of the properties of copper as a transition element.

.....

.....

.....

..... [2]

(ii) Identify and state the chemical formula of the blue solution and black solid.

blue solution: ..... black solid: ..... [1]

(b) Lead (II) carbonate is a white solid. When heated strongly at 315 °C, lead (II) oxide is formed.

(i) Name the type of reaction taking place when copper (II) carbonate and lead (II) carbonate are strongly heated at 290 °C and 315 °C respectively.

..... [1]

(ii) Explain the difference between the temperatures required for copper (II) carbonate and lead (II) carbonate.

.....

.....

.....

..... [2]

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(c) Lead (II) oxide can react with aqueous acid.

When reacted with aqueous sodium hydroxide, lead (II) oxide forms sodium plumbite. When left to stand in air, sodium plumbite becomes sodium plumbate. Plumbite and plumbate are anions with the formula of PbO_2^{2-} and PbO_3^{2-} respectively.

(i) State the acid-base nature of lead (II) oxide.

.....[1]

(ii) Write equations for the reactions of:

- lead (II) oxide to sodium plumbite.

.....

- sodium plumbite to sodium plumbate.

.....[2]

(iii) Using oxidation states, describe the type of reaction taking place when plumbite ion becomes plumbate ion.

.....

.....[2]

[Total: 11]

6 The three main types of nutrients are carbohydrates, proteins and fats.

In very simplistic terms, carbohydrates can be thought of as glucose, proteins can be thought of as alanine and fats can be thought of as triglyceride.

Some information of these nutrients are shown in the table below.

nutrients	*molecular formula*	*molar mass / g/mol*	*energy content / kJ/g*
glucose	$C_6H_{12}O_6$	180	15.7
alanine	$C_3H_7NO_2$	89	16.7
triglyceride	$C_{55}H_{98}O_6$	854	37.7

The nutritional information of an egg is shown below.

food	*one egg*
mass of carbohydrate / g	0.5
mass of protein / g	6.5
mass of fat / g	5.5

(a) (i) The respiration process to produce energy when food is consumed can be thought of as a complete combustion process.

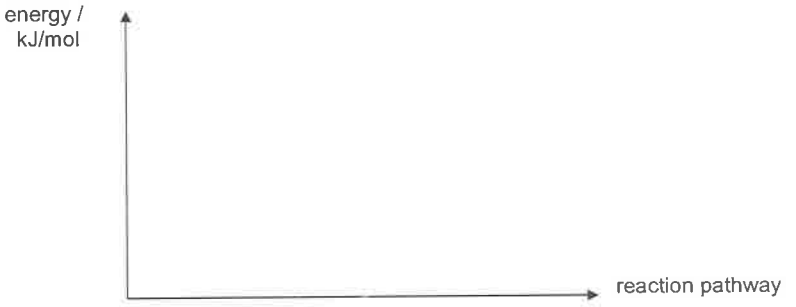
Write an equation for the respiration process for glucose.

.....[1]

(ii) Calculate enthalpy change, in kJ/mol, for the respiration of glucose.

[1]

(iii) Hence, draw a well-labelled energy level diagram on the axes below for the respiration of glucose.



[2]

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(b) Some people claim that if the molar mass of triglyceride is to be halved, its energy content in kJ/g would be halved as well, since the mass for each mole of triglyceride is now half of the original.

Explain the accuracy of this claim.

.....

.....

..... [1]

(c) The recommended daily energy requirement of an adult male is 9300 kJ.

An adult male tries to achieve this by eating eggs. Calculate the number of eggs, to the nearest whole number, that he needs to eat to achieve this.

Comment on one advantage and one disadvantage of his diet.

comment: .....

.....

.....

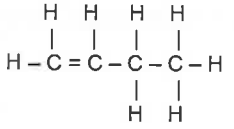
..... [3]

[Total: 8]

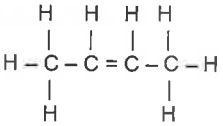
7 Organic Molecules with Four Carbon Atoms

Different Molecules of Butene

Butene is commonly produced from long chain hydrocarbons in the petrochemical industries. The term "butene" can refer to either but-1-ene or but-2-ene.



but-1-ene

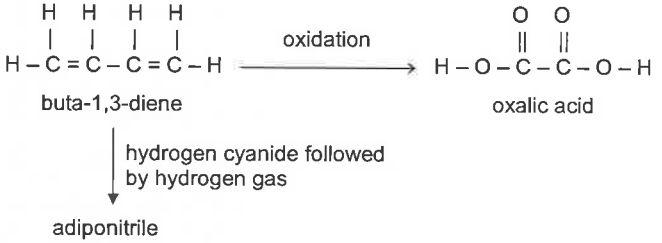


but-2-ene

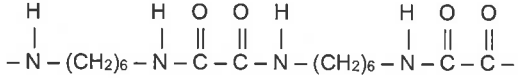
Buta-1,3-diene

When butene undergoes catalytic dehydrogenation, buta-1,3-diene can be produced. When buta-1,3-diene is oxidised, oxalic acid is produced. In this reaction, buta-1,3-diene and the oxidising agent are the only reactants while carbon dioxide and water are the only other products.

When buta-1,3-diene is reacted with hydrogen cyanide followed by hydrogen gas, adiponitrile is formed.

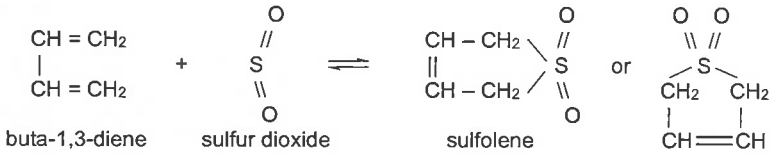


When oxalic acid is reacted with adiponitrile, a polymer with the following partial structure is obtained.



Sulfolene and sulfur dioxide

At room temperature, buta-1,3-diene is usually stored and kept in the form of sulfolene. Sulfolene is formed when buta-1,3-diene is reacted with sulfur dioxide. When sulfolene is heated, buta-1,3-diene and sulfur dioxide are obtained again.



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As with most organic substances, all these three compounds are flammable. Some physical properties of buta-1,3-diene, sulfur dioxide and sulfolene are shown below.

substance	*relative molecular mass, M_r*	*boiling point / °C*	*melting point / °C*	*density / kg/m³*
buta-1,3-diene	54	– 4	– 109	615
sulfur dioxide	64	– 10	– 72	2.6
sulfolene	118	191	65	1300

Sulfur dioxide and acid rain

Sulfur dioxide can cause acid rain. This takes place in two steps.

- Step 1: Sulfur dioxide is oxidised by atmospheric oxygen to sulfur trioxide.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

In this step, the enthalpy change of reaction for the formation of one mole of sulfur trioxide is –99 kJ/mol. Sulfur dioxide can also dissolve in water to form sulfurous acid, H_2SO_3, a weak acid, which also contributes towards acid rain.

- Step 2: Sulfur trioxide dissolves in water to become sulfuric acid.

$$SO_3 + H_2O \rightarrow H_2SO_4$$

In this step, the enthalpy change of reaction for the formation of one mole of sulfuric acid is –132 kJ/mol.

(a) (i) State the relationship between but-1-ene and but-2-ene.

..... [1]

(ii) Draw the structural formula of the **same** alcohol that can be produced from both but-1-ene and but-2-ene.

[1]

(b) (i) Using the **molecular** formula of the respective substances, write a balanced equation to produce oxalic acid from buta-1,3-diene. In your equation, use [O] to represent the oxidising agent.

..... [2]

(ii) Draw the structure of adiponitrile.

[1]

(c) Draw the addition polymer formed from sulfolene. The – SO_2 – group in sulfolene does **not** take part in this reaction.

[1]

(d) (i) Using the data provided, explain why the boiling point of sulfolene is higher than that of sulfur dioxide.

.....

.....

..... [1]

(ii) Using the data provided, explain why buta-1,3-diene is stored and kept as sulfolene at room temperature, only to be re-obtained again when required.

.....

.....

.....

.....

..... [2]

(e) (i) Write the overall equation for the conversion of sulfur dioxide into sulfuric acid. Calculate the enthalpy change for this overall reaction.

overall equation: .....

enthalpy change:

[2]

(ii) Suggest why sulfuric acid is a more major contributor of acid rain than sulfurous acid.

.....

..... [1]

[Total: 12]

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SECTION B

Answer **one** question from this section.

8 Bromoalkanes are organic molecules produced when one or more of the hydrogen atoms of alkanes are replaced by bromine atoms.

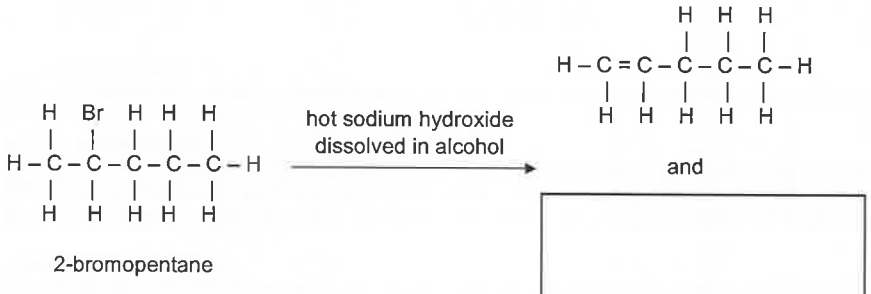
The table below shows the structures and names of some bromoalkanes formed from $CH_3CH_2CH_2CH_2CH_3$ (pentane) and $CH_3CH_2CH_2CH_3$. The bromine atoms are in **bold** for ease of reference.

structures of bromoalkanes	*names*
$CH_2\mathbf{Br}CH_2CH_2CH_2CH_3$	1-bromopentane
$CH_3CH\mathbf{Br}CH_2CH_2CH_3$	2-bromopentane
$CH_3CH_2CH\mathbf{Br}CH_2CH_3$	3-bromopentane
$CH_3CH\mathbf{Br}CH_2CH_3$	

(a) Study the patterns of the names of the given bromoalkanes. Complete the table with the name of the bromoalkane not given. [1]

(b) When bromoalkane is reacted with hot sodium hydroxide dissolved in alcohol, one or more alkenes can be produced by removing the bromine atom and a hydrogen atom to form a carbon-carbon double bond. The bromine atom and hydrogen atom removed needs to be on carbon atoms which are side by side in the bromoalkene.

Hence, 2-bromopentane can produce two types of pentene molecules.



2-bromopentane

two types of pentene molecules

(i) In the box provided, draw the full structural formula of the other pentene molecule which is produced. [1]

(ii) Describe a chemical test to distinguish between pentane and pentene molecules.

.....

.....

..... [2]

(iii) In terms of energy and collisions, explain why the sodium hydroxide dissolved in alcohol needs to be hot.

.....

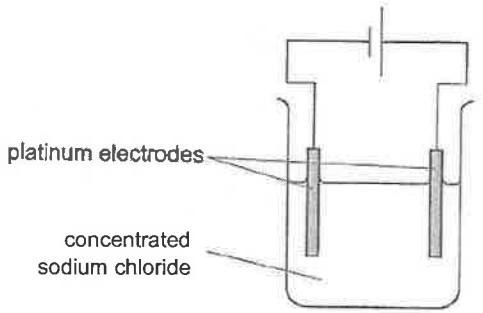
.....

.....

.....

..... [3]

(c) Sodium hydroxide can be produced by electrolysis of brine (concentrated sodium chloride).



Explain how aqueous sodium hydroxide is produced by this electrolysis after some time. In your answers, you need to make references to the ions and reaction taking place at each electrode.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

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9 Aldehydes are organic molecules with the group –CHO located at the end of the molecules.

The table below shows the structures and names of some aldehydes.

structures of aldehydes	*names*
HCHO	methanal
CH_3CHO	ethanal
CH_3CH_2CHO	propanal
$CH_3CH_2CH_2CHO$	

(a) Study the patterns of the names of the given aldehydes. Complete the table for the name of the aldehyde not given. [1]

(b) Aldehydes can be reduced to form alcohols and be oxidised to form carboxylic acids. For example, an aldehyde molecule with one carbon atom will be reduced into an alcohol molecule with one carbon atom and be oxidised into a carboxylic acid molecule with one carbon atom as well.

(i) Name the alcohol and carboxylic acid formed when propanal is reduced and oxidised respectively.

alcohol: ..... carboxylic acid: ..... [1]

(ii) Both the alcohol and carboxylic acid can react with reactive metals like sodium. Hence, reactive metals cannot be used as a chemical test to distinguish between alcohols and carboxylic acids.

Describe a chemical test that can distinguish between the alcohol and carboxylic acid produced from propanal.

.....

.....

..... [2]

(c) To convert an aldehyde into its corresponding carboxylic acid, the oxidising agent used can be either acidified potassium manganate (VII) or Tollens' reagent. The acid added when aqueous potassium manganate (VII) is used as the oxidising agent acts as a catalyst.

In terms of energy and collisions, explain how the acid acts as a catalyst and why it is used.

.....

.....

.....

.....

..... [3]

(d) The preparation of Tollens' reagent involves the use of aqueous silver nitrate. Aqueous silver nitrate can also be used as an electrolyte during electroplating.

Describe the electroplating process when an ornament (decorative item) is to be plated with silver. In your answer, you need to:

- state the anode and cathode used.
- fully explain the reactions taking place at the anode and cathode, making references to the ions and electrodes involved, as necessary.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

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The Periodic Table of Elements

Group 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 –		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
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 –

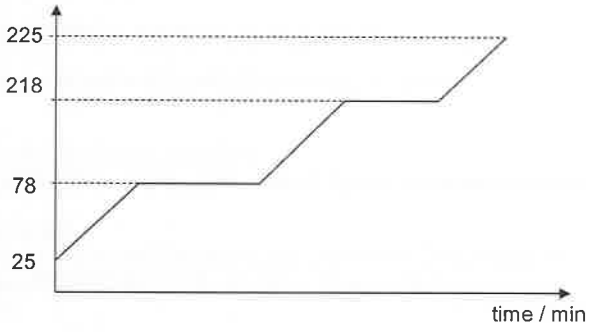
The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

YTSS 2024 Chem Prelim Marks Scheme

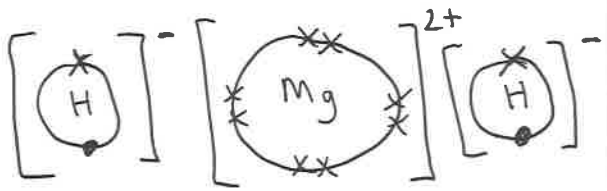
Paper 1

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

Paper 2

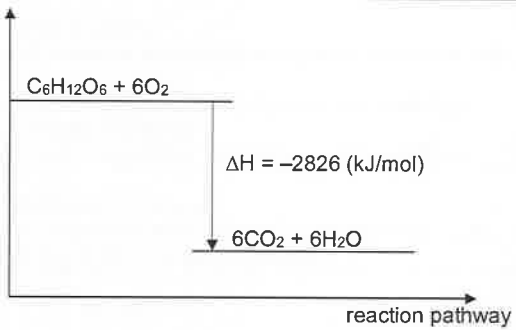
	Answers	Remarks
1(a)(i)	C	1
(a)(ii)	A, B, D	1
(a)(iii)	F	1
(a)(iv)	A	1
(a)(v)	E	1
(b)	Ethanol / Alcohol is (easily / highly) flammable. Change bunsen burner / naked flame to water bath (or other acceptable heating methods without naked flame, e.g. sand bath, etc).	1 1
2(a)	temperature / °C  	1 shape of graph (accept rounded or sharp corners, **two** horizontal parts must be clear, no horizontal at 225) 1 label temperatures (all 4 values)
(b)	movement: **role and slide** across one another arrangement: close-packed and disorderly	1 1
(c)	Not soluble because naphthalene is a (simple) covalent substance which is usually not.	1

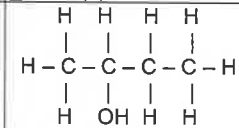
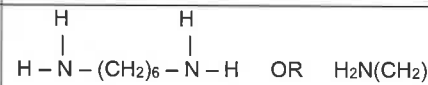
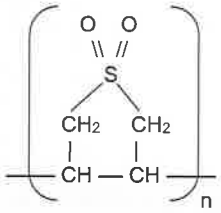
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3(a)(i)		1 for one Mg^{2+} showing only outermost electrons 1 for two H^- ions (with both dot and cross drawn) (dot and cross are interchangeable)
(a)(ii)		1 for H^+ ion (accept circle drawn with no electron) 1 for OH^- ion (with non-bonded foreign electron of O drawn using another symbol) (dot and cross are interchangeable)
(a)(iii)	Hydrogen **loses electron(s) which behaves as a metal** and **gains electron(s) which behave as a non-metal.** Hydrogen **shares electrons which behaves as a non-metal.**	1 1
(b)(i)	metal: Hydrogen has 1 valence electron / forms positive ion / forms 1+ charge ion / forms ionic bond.	1
(b)(ii)	non-metal: Hydrogen is a gas / cannot conduct electricity / forms negative ion / form 1– charge ion / forms covalent bond / has low melting (boiling) point / has low density.	1
(c)	Magnesium hydride has a **giant ionic (lattice)** structure with **strong electrostatic forces of attraction between (oppositely charged) ions**. This requires **a lot of energy** (*not "higher"*) to break and hence **high melting point** (*not "higher"*). Water has a **simple covalent / simple molecular** structure with **weak intermolecular forces** (between molecules). This requires **low energy** (*not "lower"*) to break and hence **low melting point** (*not "lower"*).	1 (structure + bonding) 1 (structure + bonding) 1 (energy + mp, award independently)
4(a)(i)	$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ *(not NH_4OH)* Patrick's claim is valid because nitrogen is lost to atmosphere / lost as ammonia.	1 1
(a)(ii)	% N content in NH_4Cl = 14 / 53.5 x 100% = 26.2% % N content in NH_4NO_3 = 2(14) / 80 x 100% = 35.0% Or Mass of N in 1 g of NH_4Cl = 1/53.5 x 14 = 0.262 g Mass of N in 1 g of $NH4NO_3$ = 1/80 x 2(14) = 0.350 g OR No. of mole of N in NH_4Cl = 1 / 53.5 = 0.018692 mol No. of mole of N in $NH4NO_3$ = (1 / 80) x 2 = 0.0250 mol	1 1 (ignore sf)

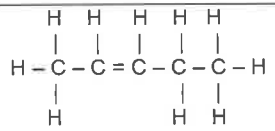
	Hence, Hafiz's claim is valid because % N content of NH_4NO_3 is higher than that in NH_4Cl / mass of nitrogen in 1 g of NH_4NO_3 is higher than that in NH_4Cl.	1 (ecf from cal, must state higher/lower and not just figures)
(a)(iii)	Add NaOH(aq) and heat. **Damp (wet / moist)** red litmus turns blue means that NH_4^+ is present (since NH_3 gas is evolved). Then add NaOH(aq) in **excess** (to remove all NH_4^+ ions as precaution), Al and heat. Damp red litmus turns blue means that NO_3^- is present. OR Add **excess** NaOH(aq) and heat. **Damp (wet / moist)** red litmus turns blue means that NH_4^+ is present (since NH_3 gas is evolved). Then add Al and continue heating. Damp red litmus turns blue means that NO_3^- is present.	1 (penalise if not "damp") 1 (for method, do not penalise "damp" again) 1 for "excess" when testing for nitrate
(b)(i)	spring (season of flowering and bearing of fruits)	1
(b)(ii)	No. of mole of O = 0.56 / 16 = 0.035 mol No. of mole of X = 0.035 / 5 x 2 = 0.014 mol A_r of X = 0.44 / 0.014 = 31.4 Hence, X is phosphorus / P.	1 (for oxygen) 1 (for A_r) 1 (for element)
(c)(i)	$^{41}_{19}K$	1
(c)(ii)	number of protons = 19 number of neutrons = 22 number of electrons = 19	1 (all three correct)
(c)(iii)	A_r = (93.3/100 x 39) + (6.7/100 x 41) = **39.13**	1 (must be 2 dp)
(c)(iv)	K (not K^+) loses its one valence electron (to form K^+) with fully filled outermost (complete valence electron) shell.	1
5(a)(i)	Ions / Compounds of copper (***not copper itself***) have different colours. For example, copper (II) carbonate is light green while copper (I) oxide is red. (Accept blue for copper (II) sulfate and black for copper (II) oxide.) Ions (or oxidation states) of copper have different charges, Cu^{2+} and Cu^+ / +2 and +1.	1 (at least 2 examples given) 1 (award 1 overall for both properties without eg given)
(a)(ii)	blue solution: $CuSO_4$ black solid: CuO	1 (formula required, not name)
(b)(i)	(thermal) decomposition	1

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(b)(ii)	**<u>Lead</u> is more reactive** than copper and **<u>lead (II) carbonate</u> is more (thermally) stable / less easily decomposed** than copper (II) carbonate. Hence, more energy is required to decompose lead (II) carbonate and (thermal decomposition) **<u>temperature</u> (required) for lead (II) carbonate is higher.**	1 1
(c)(i)	amphoteric	1
(c)(ii)	$PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$ (or: $PbO + 2OH^- \rightarrow PbO_2^{2-} + H_2O$) $2Na_2PbO_2 + O_2 \rightarrow 2Na_2PbO_3$ (or: $2PbO_2^{2-} + O_2 \rightarrow 2PbO_3^{2-}$)	1 1
(c)(iii)	**Oxidation.** Lead is oxidised because **oxidation state of lead <u>increased</u> from +2** in PbO_2^{2-} **to +4** in PbO_3^{2-}.	1 1
6(a)(i)	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	1
(a)(ii)	enthalpy change = –15.7 x 180 = –2826 kJ/mol (or –2830 kJ/mol)	1 (sign required, accept if sign is missing from workings but given in answer)
(a)(iii)		1 for exo shape [ecf endo if + sign written in part (a)(ii)] 1 for all labels with value (reactants, products, labelled arrow pointing down with value, units <u>not</u> required since already given on y-axis) ecf from (a)(i) and (a)(ii), ignore E_a if "profile" is drawn
(b)	No / This is not true. Although the molar mass (or mass) has halved, the energy per unit mass (or per gram) is still the same. *<u>Further explanation (not required):</u>* *energy content = enthalpy change ÷ molar mass* in kJ/g in kJ/mol in g/mol If molar mass if halved, enthalpy change would halve too because each mole would contain half the original mass and hence the energy given by each mole (with half the original mass) would half too. Hence, energy content remains unchanged.	1

(c)	Energy content of one egg = (0.5 x 15.7) + (6.5 x 16.7) + (5.5 x 37.7) = 323.75 kJ Number of eggs = 9300 / 323.75 = 28.7 = 29 eggs Advantage: He managed to achieve his daily energy requirement / Eggs are good source of proteins / etc. Disadvantage: Other nutrients are not balanced / Lack of carbohydrates / etc.	1 1 (whole number) 1 (for both advantage & disadvantage)
7(a)(i)	isomer(s) / isomerism	1
(a)(ii)	 OR $CH_3CH(OH)CH_2CH_3$	1
(b)(i)	$C_4H_6 + 10[O] \rightarrow C_2H_2O_4 + 2CO_2 + 2H_2O$ (or $C_2O_4H_2$)	1 for the four **molecular** formula (except [O]) 1 balanced with [O]
(b)(ii)	 OR $H_2N(CH_2)_6NH_2$	1
(c)		1
(d)(i)	Boiling point of sulfolene (191 °C) is higher than that of sulfur dioxide (–10 °C) because the **size of molecule / relative molecular mass of sulfolene is larger (M_r 118) than that of sulfur dioxide (M_r 64).**	1 (need to quote data)
(d)(ii)	At room temperature, buta-1,3-diene is a **gas** and sulfolene is a **solid**. Hence, sulfolene takes up less space to be stored or kept (density = 1300 kg/m^3) compared to buta-1,3-diene (density = 615 kg/m^3) **<u>OR</u>** sulfolene does not need to be stored or kept under high pressure whereas needed for buta-1,3-diene.	1 1

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(e)(i)	Workings: $2SO_2 + O_2 \rightarrow 2SO_3$ $\Delta H = -198$ kJ/mol $2SO_3 + 2H_2O \rightarrow 2H_2SO_4$ $\Delta H = -264$ kJ/mol Overall: $2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$ $\Delta H = -462$ kJ/mol	(Workings not required) 1 balanced eqn + 1 value (with sign and units)
(e)(ii)	Sulfuric acid is a strong acid and sulfurous acid is a weak acid. / Sulfuric acid is a stronger acid than sulfurous acid.	1
8(a)	2-bromobutane	1
(b)(i)		1 (must draw FULL structural formula)
(b)(ii)	Test with aqueous bromine (bromine water). For pentene, **reddish-brown** colour will turn colourless. For pentane, reddish-brown remains.	1 1 (not brown)
(b)(iii)	When temperature increased, (average kinetic) energy of (reactant) particles increased. **More** (reactant) particles achieved the minimum activation energy. Frequency of collisions and effective collisions increased and rate of reaction increased.	1 1 1
(c)	At the anode (positive electrode), chloride ions are (preferentially) discharged / oxidised / lose electrons (than hydroxide ions to give chlorine). At the cathode, (negative electrode), hydrogen ions are (preferentially) discharged / reduced / gain electrons (than sodium ions to give hydrogen gas). Hence, sodium ions and hydroxide ions are unreacted / left behind / still remaining in electrolyte to give aqueous sodium hydroxide. *(not just "aqueous sodium hydroxide is produced" which is copying back the same phrase as the question.)*	1 1 1
9(a)	butanal	1
(b)(i)	propanol, propanoic acid	1
(b)(ii)	Either Test with acidified potassium manganate (VII). For propanol, purple $KMnO_4$ will turn colourless. For propanoic acid, purple $KMnO_4$ remains. Or Test with sodium carbonate (or any other solid or aqueous metal carbonates). For propanol, no effervescence (bubbles of gas) would be produced. For propanoic acid, effervescence (bubbles of gas) will be produced. *(Not: "Aqueous NaOH reacts with carboxylic acid" because no change can be seen although there is a reaction.)*	1 1

(c)	A catalyst provides an alternative reaction pathway with a lower activation energy (while itself remains unchanged and regenerated at the end of the reaction). (When the activation energy is lowered) **More** (reactant) particles can achieve the minimum activation energy. Hence, frequency of effective collisions increased and rate of reaction increased.	1 1 1 (frequency of collisions didn't increase, but ignore)
(d)	The anode used is silver and the cathode used is the ornament. At the anode, silver is (preferentially) oxidised (not discharged) / lose electrons (than nitrate and hydroxide ions to give silver ions). At the cathode, silver ions are (preferentially) discharged / reduced / gain electrons (than hydrogen ions to give silver / to be coated onto the ornament).	1 1 1

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