Geylang Methodist School (Secondary)

Preliminary Examination 2024

CHEMISTRY — **Sec 4 Express**

Paper 1 Multiple Choice — **6092/01**

Additional Materials: Multiple Choice Answer Sheet — **1 hour**

14 August 2024

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

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

There are **forty** questions on this paper. Answer **all** questions.

For each question there are four possible answers **A**, **B**, **C** and **D**.

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark.

A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

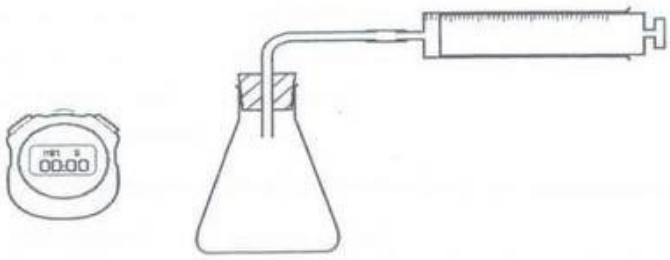
A copy of the Periodic Table is printed on page 19.

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

This document consists of **19** printed pages and **1** blank page.

[Turn over

1 The apparatus shown can be used to find the rate of some chemical reactions.

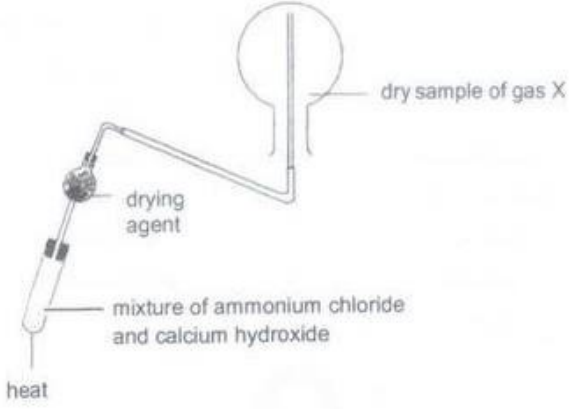


Which set of reagents does the student use?

A $Mg + HCl$ **B** $AgNO_3 + KI$

C $NaOH + HCl$ **D** $NaOH + CuSO_4$

2 A student set up the apparatus as shown below to collect a sample of clean, dry gas X. Predict the identity of gas X and identify a suitable drying agent to be used.



	gas X	drying agent
A	ammonia	calcium oxide
B	ammonia	concentrated sulfuric acid
C	hydrogen chloride	calcium oxide
D	hydrogen chloride	concentrated sulfuric acid

3 Compound W is soluble in hot water, but not in cold water while Compound V is soluble in both hot and cold water. Compound W has a boiling point of 2670 °C while compound V has a boiling point of 1430 °C.

Which is the most suitable method in obtaining a pure, dry sample of Compound W crystals from a hot solution of Compound W and V?

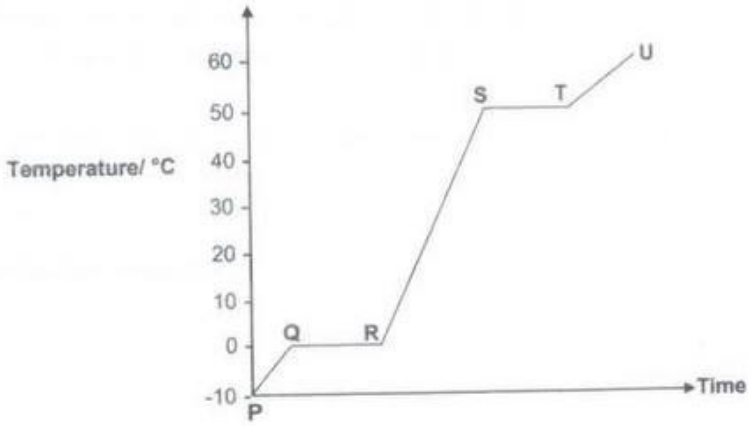
A Cool the mixture, filter, rinse and collect the residue.

B Cool the mixture, filter and evaporate the filtrate.

C Simple distillation of the mixture.

D Heat the mixture to dryness

4 The graph shows the change in the temperature of a substance with time when it is heated from −10 °C to 60 °C.



Which of the following correctly describes the change taking place between the points?

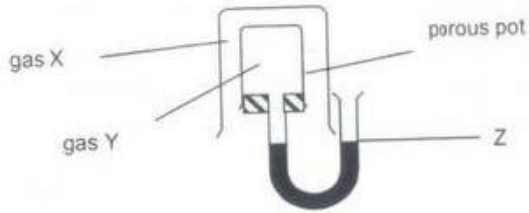
A Energy is released from points P to Q.

B Kinetic energy of the particles remains constant from points P to U.

C Particles gain energy to weaken the forces of attraction from points S to T.

D There is a large increase in the volume of the substance from points R to S.

5 Which pair of gases will cause a decrease in the water level at Z?



	gas X	gas Y
A	carbon monoxide	nitrogen
B	neon	methane
C	methane	carbon monoxide
D	nitrogen	carbon dioxide

6 An ion X^{2-} has m nucleons and n electrons.

What does the nucleus of an atom X contain?

	number of protons	number of neutrons
A	n – 2	m – n
B	n – 2	m – (n – 2)
C	n + 2	m – (n – 2)
D	n + 2	m – (n + 2)

7 Naturally-occuring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative atomic masses 79 and 81.

What can be deduced about naturally occurring bromine from this information only?

A Bromine is radioactive.

B Bromine has different oxidation states.

C Bromine isotopes have different number of protons

D Bromine contains the two isotopes in equal proporions.

8 The table shows four elements W, X, Y and Z with their atomic numbers.

element	W	X	Y	Z
atomic number	6	8	11	17

Which row shows the formula of the compounds formed from the four elements?

	formula of ionic compound formed	formula of covalent compound formed
A	WX	YZ
B	YW	WZ_4
C	YZ	ZW
D	Y_2X	WX_2

9 Which statement about metals is correct?

A Layers of electrons can slide over another making metals malleable.

B Metals consist of a lattice of positive ions in a sea of delocalised electrons.

C Metals consist of a lattice of positive ions in a sea of delocalised negative ions.

D Metals conduct electricity because positive ions are free to move.

10 The physical properties of three substances are shown in the table below.

substance	melting point / °C	boiling point / °C	electrical conductivity		
			solid	liquid	aqueous
X	–114	–85	poor	poor	good
Y	3550	3825	good	good	insoluble
Z	501	950	poor	good	insoluble

Which row correct identifies X, Y and Z?

	X	Y	Z
A	nitrogen dioxide	potassium iodide	silicon dioxide
B	sodium chloride	silicon chloride	zinc
C	hydrogen chloride	graphite	lead(II) chloride
D	sodium	diamond	calcium sulfate

11 Selenium is in the same group as oxygen in the Periodic Table.

Which of the following chemical formulae involving selenium is **wrong**?

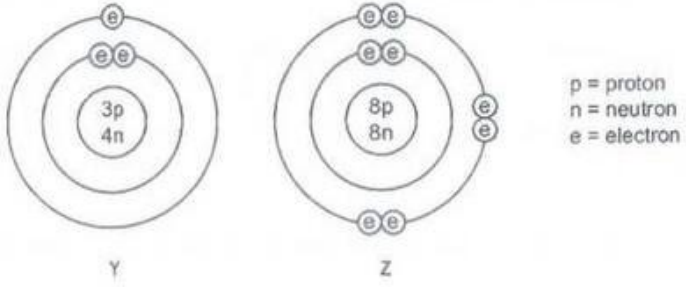
A $CaSe_2$

B H_2Se

C K_2Se

D SeO_3

12 The diagram shows the structures of the atoms of elements Y and Z.



Y Z

Elements Y and Z react to form a compound.

What is the mass of one mole of this compound?

A 11g B 12g

C 23g D 30g

13 What is the volume of hydrogen gas produced at room temperature and pressure when 1.3g of zinc reacts with $20cm^3$ of 0.8mol / dm^3 nitric acid?

$$Zn + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2$$

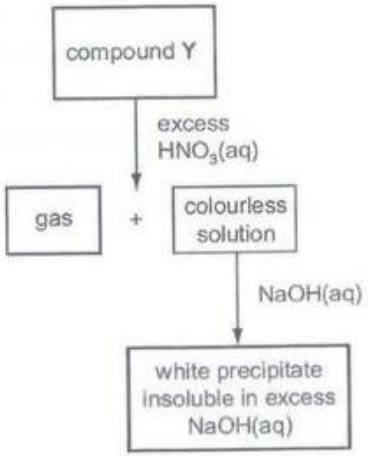
A $192cm^3$

B $288cm^3$

C $384cm^3$

D $480cm^3$

24 The scheme shows a sequence of reactions starting from compound Y.



What could compound Y be?

A aluminium hydrogencarbonate
B calcium carbonate
C copper(II) carbonate
D zinc carbonate

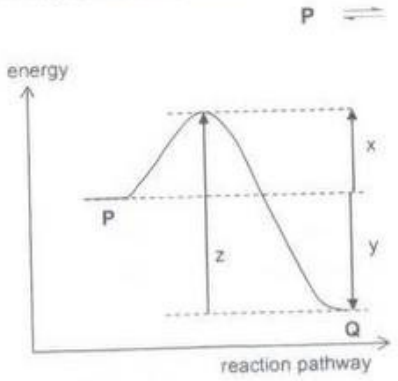
25 The formation of hydrogen iodide from hydrogen and iodine is an exothermic reaction. The equation for the reaction is shown below.

$$H_2 + I_2 \longrightarrow 2HI$$

Which of the following statements can be deduced from the above information?

A Energy is absorbed when H–I bonds are formed.
B The reaction between H_2 and I_2 releases heat to the surroundings.
C The number of bonds broken is greater than the number of bonds formed.
D The products possess more energy compared to the reactants.

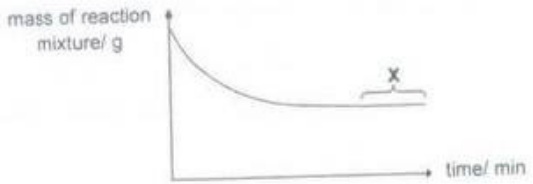
26 The energy profile for a reversible reaction is shown below.



Which of the following statements is correct?

A The reaction from **Q** to **P** is endothermic.
B The enthalpy change for the reaction from **P** to **Q** is *x*.
C The activation energy of the reaction from **P** to **Q** is *z*.
D The activation energy of the reaction from **Q** to **P** is *z* - *y*.

27 A small amount of powdered magnesium carbonate was added to excess hydrochloric acid in an open conical flask. The mass of the reaction mixture was recorded at regular time intervals. The graph below shows the results.

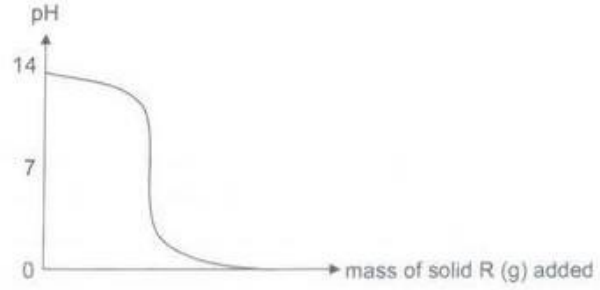


Which of the following statements about the section of the graph labelled **X** is correct?

A Half of the magnesium carbonate has been used up.
B All the hydrochloric acid has been used up.
C The rate of the reaction is at its maximum.
D The reaction has been completed.

18 Solid R is gradually added to aqueous solution S.

The changes in pH are shown on the graph below.



What are substances R and S?

	substance R	substance S
A	insoluble non-metal oxide	sodium hydroxide
B	soluble metal oxide	aqueous ammonia
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

19 Which of the following oxides can react with aqueous potassium hydroxide?

A CO_2 and BaO

B CO_2 and H_2O

C CO_2 and PbO

D CO_2 only

20 Which of the following reactants could be used to prepare a pure sample of potassium sulfate safely?

A potassium carbonate and sulfuric acid

B potassium and zinc sulfate

C potassium and sulfuric acid

D potassium nitrate and magnesium sulfate

21 Which method of preparation would be suitable for making these salts?

	titration	metal + acid	metal carbonate + acid	precipitation
A	potassium nitrate	silver chloride	copper(II) sulfate	zinc sulfate
B	zinc sulfate	copper(II) sulfate	potassium nitrate	silver chloride
C	zinc sulfate	sodium nitrate	silver chloride	copper(II) sulfate
D	potassium nitrate	zinc sulfate	copper(II) sulfate	silver chloride

22 Industrial ammonia is obtained by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ / mol}$$

Which of the following is an **incorrect** statement about the process?

A The industrial catalyst used is finely divided iron.

B The reaction is endothermic, hence a temperature of 450 °C is used.

C The hydrogen needed is obtained mainly by cracking of petroleum oil.

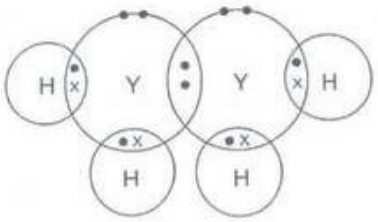
D 250 atm favours the production of ammonia but is difficult to maintain.

23 A student adds aqueous sodium hydroxide or aqueous ammonia to aqueous solutions of four different metal compounds.

Which solution contains Zn^{2+} ions?

solution	add a few drops of NaOH(aq)	add excess NaOH(aq)	add a few drops of NH_3(aq)	add excess NH_3(aq)
A	ppt	ppt dissolves	ppt	ppt dissolves
B	ppt	ppt dissolves	ppt	ppt
C	ppt	ppt	no ppt	no ppt
D	no ppt	no ppt	no ppt	no ppt

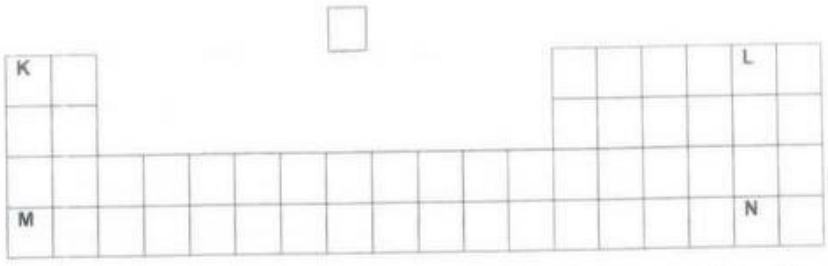
14 Compound Y has the chemical formula Y_2H_4. The dot-and-cross diagram is shown.



Which group of the Periodic Table does element Y belong?

A 15 B 17
C 16 D 18

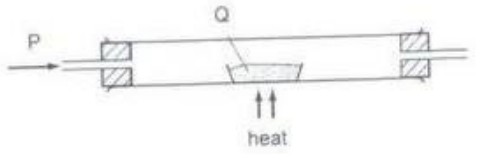
15 Part of the Periodic Table is shown below.



Which of the following pairs of elements would react together the **most** violently?

A K and L
B K and N
C L and M
D M and N

16 In the apparatus shown, gas P is passed over solid Q. No visible reaction occurs.



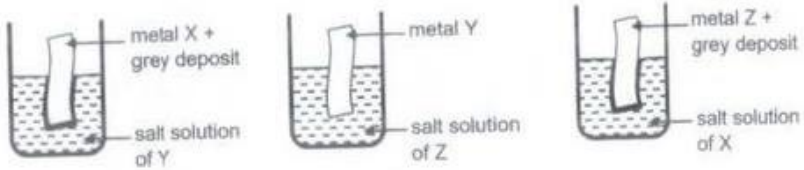
Identify gas P and solid Q.

	P	Q
A	hydrogen	zinc oxide
B	hydrogen	iron(II) oxide
C	oxygen	sulfur
D	oxygen	carbon

17 Pieces of metal X, Y and Z are dipped into three salt solutions.

The results after half an hour are shown in the diagrams below.

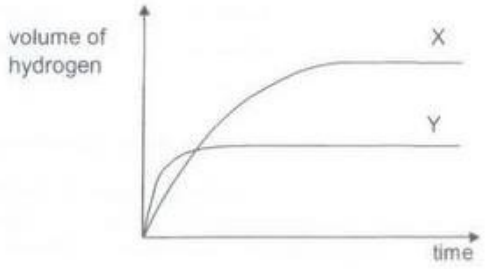
Metals X and Z are coated with a layer of shiny grey deposit but metal Y stays the same.



Which of the following lists the metals in order of decreasing reactivity?

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

28 Two experiments on the reaction between zinc and sulfuric acid are carried out and their results are given in the graph below.



If 4 g of zinc granules reacts with 100 cm^3 of 1.0 mol/dm^3 sulfuric acid to produce graph X, which of the following could give rise to graph Y?

A 2 g zinc granules in 100 cm^3 of 1.0 mol/dm^3 sulfuric acid

B 2 g zinc granules in 100 cm^3 of 2.0 mol/dm^3 sulfuric acid

C 4 g zinc granules in 50 cm^3 of 2.0 mol/dm^3 sulfuric acid

D 4 g zinc granules in 25 cm^3 of 2.0 mol/dm^3 sulfuric acid

29 The table below shows the colour changes when a few drops of aqueous potassium iodide and acidified potassium manganate(VII) were added separately into four different solutions.

solution	potassium iodide	potassium manganate(VII)
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

Which solution is/are oxidising agent(s)?

A 1 only

B 1 and 2

C 1 and 3

D 4 only

30 Which of the following is **not** a redox reaction?

A $2Ag + Br_2 \rightarrow 2AgBr$

B $2CO + O_2 \rightarrow 2CO_2$

C $Fe + 2HCl \rightarrow FeCl_2 + H_2$

D $Na_2CO_3 + CuCl_2 \rightarrow 2NaCl + CuCO_3$

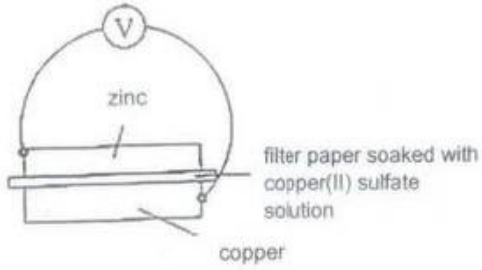
31 Three electrolytic cells are set up using inert electrodes. The electrolytes used are listed below.

cell 1: concentrated aqueous potassium chloride
cell 2: dilute sulfuric acid
cell 3: dilute copper(II) chloride

In which of these cell(s) is/are gases formed at both electrodes?

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

32 The diagram shows a simple cell experimental set-up.



Which of the following would take place?

I Electrons flow from copper to zinc.
II Oxidation is occurring at the zinc surface.
III Copper(II) ions in the filter paper are discharged on the copper surface.

A I only B II only

C II and III only D I and III only

Geylang Methodist School (Secondary)
Preliminary Examination 2024

Candidate Name			
Class		Index Number	

CHEMISTRY **6092/02**

Paper 2 **Sec 4 Express**

Additional materials: Nil **1 hour 45 minutes**

7 Aug 2024

READ THESE INSTRUCTIONS FIRST

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

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

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

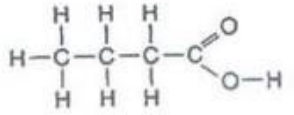
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 19.

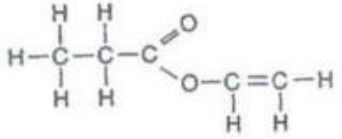
The use of an approved scientific calculator is expected, where appropriate.

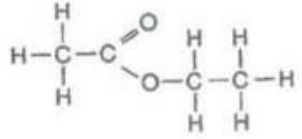
For Examiner's Use	
Section A	/70
Section B	/10
Total	80

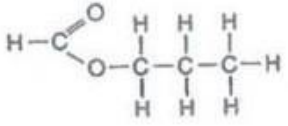
38 The table shows the results of tests carried out on compound P which has the molecular formula $C_4H_8O_2$.

test	observation
add bromine water	bromine water remains orange
add aqueous sodium carbonate	effervescence observed

1 

2 

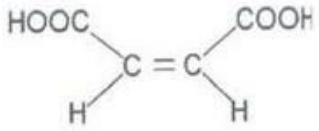
3 

4 

What could compound P be?

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

39 The structure shown below represents maleic acid, which is found in some fruits.



Which statement is true?

A It can undergo addition polymerisation with $HN_2CH_2CH_2NH_2$.

B It can undergo condensation polymerisation with CH_3CH_2OH.

C When maleic acid undergoes addition polymerisation, it loses water molecules.

D When maleic acid undergoes addition polymerisaton, the product can react with aqueous sodium carbonate.

40 A catalytic converter is installed at the exhaust of every vehicle to allow certain gases to react with each other. One of the reactions present in the catalytic converters is as follows.

$$4CO + 2NO_2 \rightarrow N_2 + 4CO_2$$

Which of the following is **not correct** about the catalytic converter?

A As the frequency of complete combustion in car engines increases, less nitrogen oxides are removed by catalytic converters.

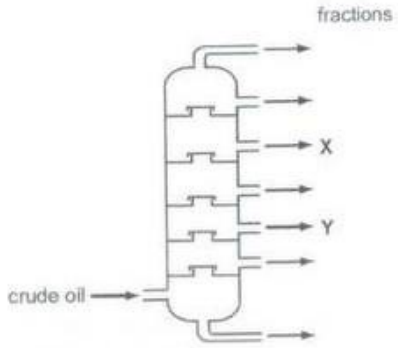
B Catalytic converters remove nitrogen oxides which can cause acid rain.

C Catalytic converters prevent global warming.

D Catalytic converters remove harmful pollutants before they are released into the atmosphere.

End of Paper

33 Crude oil is fractionally distilled in a fractionating column. The positions at which fractions X and Y are collected are shown.



Which statement is correct?

A X has a higher boiling point than Y.

B X has a longer chain molecule than Y.

C The temperature increases up the column.

D X condenses at a lower temperature than Y.

34 How many different isomers can be formed from this hydrocarbon of the molecular formula C_5H_{12}?

A 2 B 3 C 4 D 5

35 Compounds S and T both contain two elements only and have the following properties.

- They burn in air to form carbon dioxide and water only.
- They react with chlorine by substitution.
- S has a higher boiling point than T.

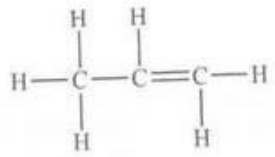
What could compounds S and T be?

	S	T
A	ethane	propane
B	ethene	propene
C	propane	ethane
D	propene	ethene

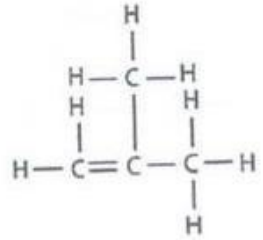
36 When reacted with steam and phosphoric acid at 300 °C and 65 atm pressure, an unknown alkene only forms one type of alcohol.

What is the unknown alkene?

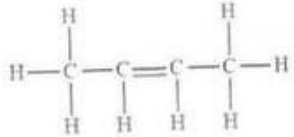
A



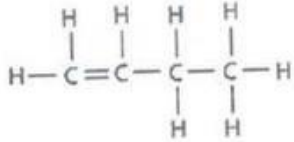
B



C



D



37 Propene reacts with steam at 300 °C and 65 atm in the presence of phosphoric acid as a catalyst to produce a colourless liquid P.

On warming, liquid P with acidified potassium manganate(VII) solution, a colourless liquid Q is produced.

Identify liquids P and Q.

	P	Q
A	propane	butanoic acid
B	propanol	butanoic acid
C	propanol	propanoic acid
D	propyl ethanoate	water

A3 Solid samples of calcium nitrate and sodium sulfate were dissolved in a water trough in the experimental set-in Fig. 3.1. After some time, a white solid, formed from the reaction of calcium nitrate and sodium sulfate, appeared along the line marked **X** as shown in Fig. 3.1.

Fig. 3.1

(a) Identify the white solid that appeared along the line marked **X**.

..... [1]

(b) Explain why the white solid appeared along the line marked **X** on Fig. 3.1.

.....

.....

.....

..... [3]

(c) Suggest how a student can confirm the presence of Ca^{2+} ions in the solution.

.....

..... [2]

[Total:6]

A2 Rubidium iodide is an ionic compound.

(a) Rubidium iodide is formed when rubidium reacts with iodine This is a redox reaction.

(i) Describe and explain this redox reaction in terms of gain and loss of electrons.

.....

.....

..... [2]

(ii) Write the ionic half equations for the reaction in **(a)(i)**.
State symbols are not required.

.....

..... [2]

(b) Draw a dot and cross diagram, showing only the valence electrons, to illustrate the bonding in rubidium iodide.

[2]

(c) When aqueous chlorine is added to an aqueous solution of rubidium iodide, a reaction takes place.

(i) Construct an ionic equation to illustrate the above reaction.
Include state symbols.

..... [1]

(ii) State the colour change expected in this reaction.

..... [1]

[Total: 8]

Section A

Answer **all** questions.

A1 Use the list of substances to answer the questions **(a)** to **(e)**

Each substance can be used once, more than once or none at all.

calcium carbonate	chlorine	sulfur dioxide	iron(II) nitrate
lead(II) bromide	ammonia	sodium hydroxide	copper(II) oxide

Name a substance which,

(a) exists as a diatomic element,

..... [1]

(b) has a transition element in its compound,

..... [1]

(c) dissolves in water to give a pH value less than 7,

..... [1]

(d) decomposes upon heating to produce a gas that forms a white precipitate with limewater,

..... [1]

(e) when added together with another forms a green precipitate,

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

(f) when warmed with aqueous sodium hydroxide and aluminium foil produces a gas that turns damp red litmus blue.

..... [1]

[Total: 7]

A4 The world is trying to reduce the reliance of fossil fuel by exploring alternative fuels. The table below gives some information about the different fuels explored.

Table 4.1

fuel	physical state at room temperature and pressure	enthalpy change of combustion / kJ / mol	products of complete combustion
hydrogen	gas	- 256	H_2O only
methanol	liquid	- 715	CO_2 and H_2O
methane	gas	- 890	CO_2 and H_2O

(a) The complete combustion of methane is represented by the following equation.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

(i) Calculate the mass of methane that needs to be combusted to produce 3115 kJ of heat.

[2]

(ii) Using the ideas of bond breaking and bond forming, explain why the enthalpy change for the complete combustion of methane has a negative sign.

.....

.....

.....

..... [2]

(b) Using information from Table 4.1, state one advantage and one disadvantage of using methanol as a fuel compared to hydrogen apart from the amount of heat given out.

advantage: .....

.....

disadvantage: .....

..... [2]

(b) Experiment **A** is repeated using the same mass of calcium carbonate in place of lead(II) carbonate. All other conditions are kept constant.

Will the total volume of gas produced be more, less, or the same, as compared to Experiment **A**?

Explain your answer.

.....

.....

.....

..... [2]

(c) Experiment **A** is repeated using excess sulfuric acid in place of nitric acid. All other conditions are kept constant.

(i) Sketch on Fig. 6.1 the result you would expect to obtain. [1]

(ii) Explain the shape of your graph.

.....

.....

.....

..... [2]

[Total: 7]

A6 Lead(II) carbonate reacts with dilute nitric acid as shown by the equation below:

$$PbCO_3(s) + 2HNO_3(aq) \longrightarrow CO_2(g) + Pb(NO_3)_2(aq) + H_2O(l)$$

Two experiments are carried out using lumps or granules of lead(II) carbonate of the same mass, with other conditions kept the same.

The results are shown in Fig. 6.1 below.

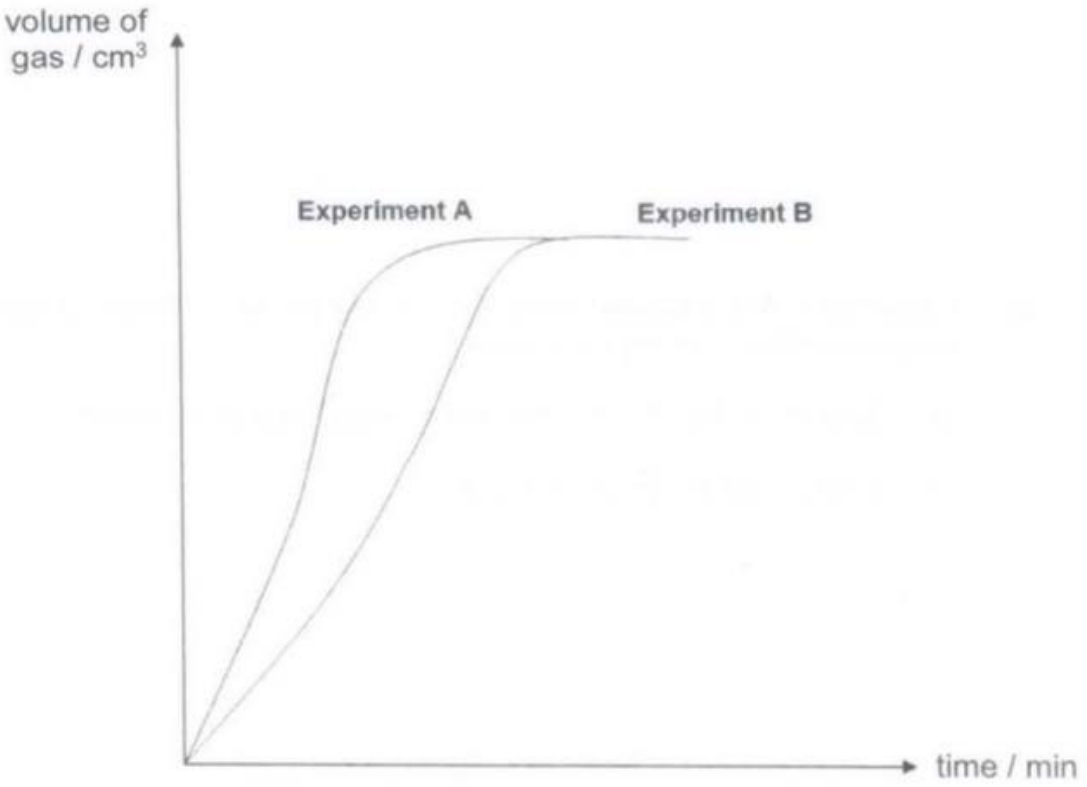


Fig. 6.1

(a) With reference to the graph, which experiment, **A** or **B**, was carried out using granules of lead(II) carbonate?

Explain your answer in terms of collisions between particles.

.....

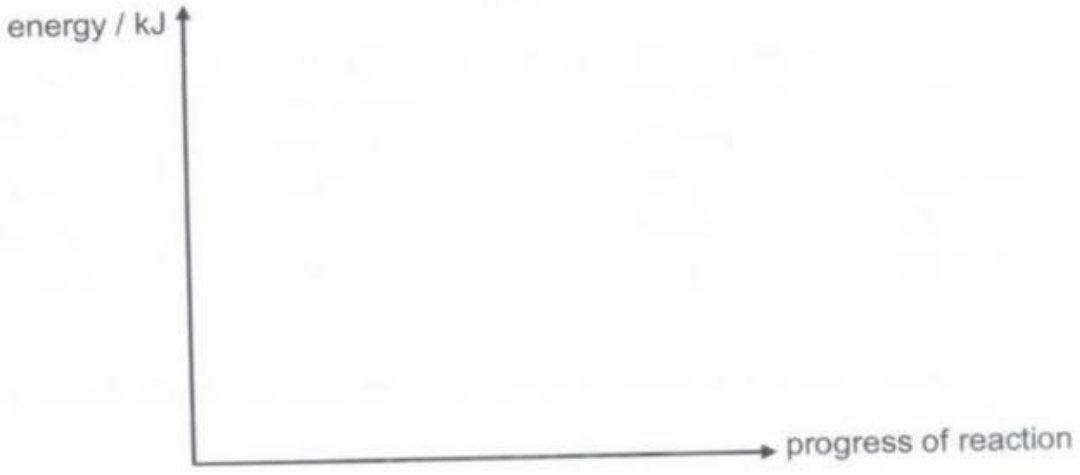
.....

.....

.....

..... [2]

(c) Draw an energy profile diagram for the complete combustion of hydrogen. Indicate the enthalpy change, ΔH and activation energy, E_a on the diagram clearly.



[3]

[Total: 9]

A5 Duralumin is a mixture of aluminium with copper. It is used mainly in machine parts due to its high strength and hardness compared to aluminium. However, duralumin is more susceptible to corrosion than aluminium.

(a) State the name given to mixtures such as duralumin.

..... [1]

(b) Explain why duralumin is harder than aluminium.

.....

.....

.....

..... [2]

(c) Explain why duralumin corrodes more easily than aluminium.

.....

.....

..... [2]

[Total: 5]

A7 A chemical company makes salts for many uses.

Table 7.1 shows some names, formulae of salts and the preparation of pure sample of solid salts.

Complete the table by filling in the missing information. Include state symbols for any formulae.

Table 7.1

name of salt	formula of salt	formulae of reagents used	method used
potassium nitrate	.....	HNO_3(aq) KOH(aq)	..... evaporation and crystallisation
lead(II) sulfate	$PbSO_4$(s)	H_2SO_4(aq) and	..... followed by filtration
zinc chloride	.....	HC*l*(aq) and	addition of excess solid with acid; filtration; evaporation and crystallisation

[Total: 6]

A9 Chemical batteries

A simple cell can be made by connecting two different metals in contact with an electrolyte. Fig 9.1 shows the electrolytic set-up of two different metals.

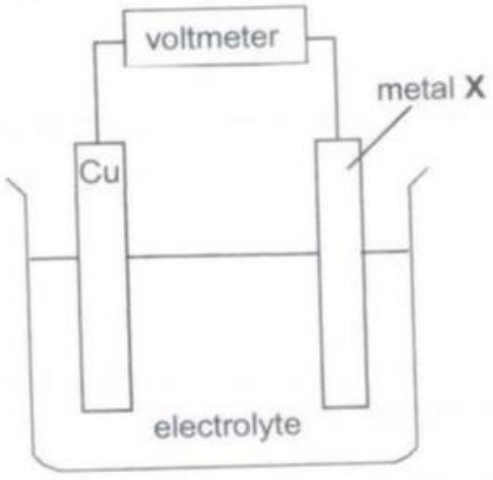


Fig. 9.1

A scientist makes a simple cell by connecting an electrode made from copper to an electrode made from a different metal **X**.

Table 9.1 shows the voltage the different metals produced when combined with copper in a cell and the density of the metals.

Table 9.1

metal x	voltage produced by combining metal Z and copper / V	density of metal in g/cm^3
iron	0.78	7.86
lithium	3.37	0.53
lead	0.47	11.34
magnesium	2.71	1.74

Lithium-ion battery chemistry

As the name suggests, lithium ions are involved in the reactions driving the battery. Lithium-ion batteries power much of our modern lives, from our mobile phones to laptops. To use a rechargeable battery, it needs to be charged first. Once charged, electrons from the lithium atoms will flow through an external wire, providing the electric current that we used to do work.

As lithium is reactive, the electrolyte used in lithium ion cells does not contain water. The electrolyte will contain lithium cation in molten state. The lithium ions and its electrons are also encased in graphite as shown in Fig 9.2 to reduce exposure to air.

However, the repeated removal of electrons during the recharging of the battery will eventually break apart the graphite. This reduces the battery's performance and the graphite will eventually break down, and the battery will stop working.

(i) State the reagent and conditions necessary for reaction **I**.

.....

..... [2]

(ii) Describe a test to differentiate between isobutylene and compound **X**.

.....

..... [2]

(c) Once the bladder has been formed into a sphere, it is wound with several thousand metres of nylon thread.

(i) Draw the structural formula of the linkage present in nylon in the space below and state its name.

[2]

(ii) Describe one environmental problem associated with using plastics like nylon.

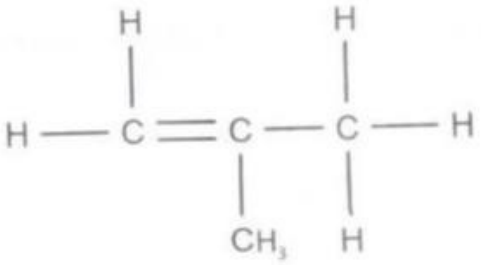
.....

..... [1]

[Total: 10]

A8 The World Cup soccer ball's innermost layer is a spherical bladder formed from butyl rubber. Butyl rubber is composed mostly of isobutylene.

The structure of isobutylene is shown below.



isobutylene

(a) **(i)** Name the homologous series that isobutylene belongs to and state its general formula.

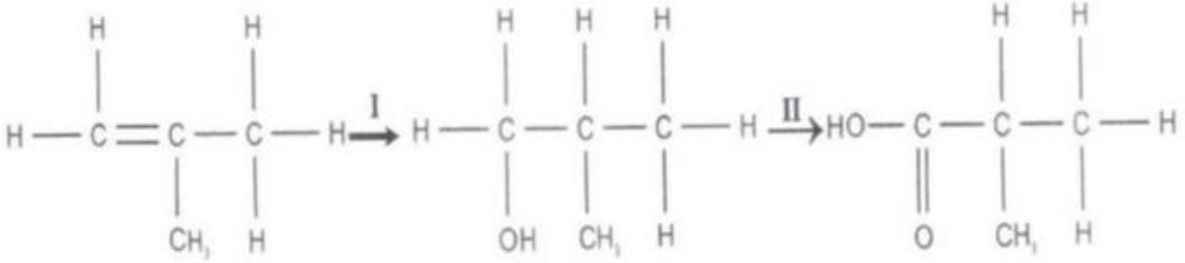
homologous series .....

general formula ..... [2]

(ii) Draw an isomer of isobutylene.

[1]

(b) Fig. 8 shows a reaction scheme to obtain the final product, compound **X**.



isobutylene compound **X**

Fig. 8

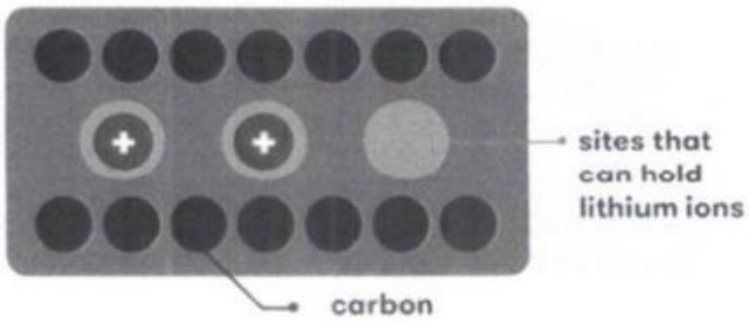


Figure 9.2

To overcome this challenge, researchers are working on developing options to use graphene (single-atom thick sheets of carbon) rather than graphite. Fig. 10.3 shows a sample of graphene layer.

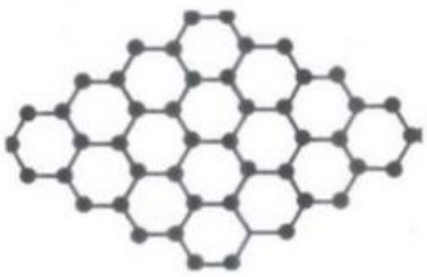


Fig. 9.3

(a) Using information from Table 9.1, suggest two reasons why lithium is used to make mobile phone batteries.

.....

..... [2]

(b) Explain why different combinations of metals produce different voltages

.....

..... [2]

(c) Suggest, with the aid of a chemical equation, why the electrolyte used in lithium ion cells must not contain water.

.....

..... [2]

(c) On warming **Z** with ethanol and a few drops of concentrated sulfuric acid, a sweet-smelling substance was formed.

Draw the full structural formula of the compound formed.

Circle the functional group that gave the compound the sweet smell.

[2]

(d) Under suitable conditions, compound **Z** undergoes addition polymerisation.

(i) State the conditions necessary for compound **Z** to undergo addition polymerisation.

..... [1]

(ii) Draw the structural formula of the polymer formed, showing three repeating units.

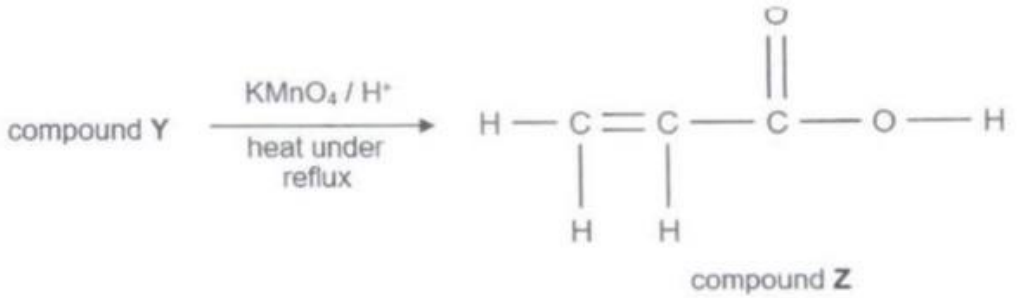
[1]

[Total: 10]

Section B

Answer **one** question from this section.

B10 Organic compound **Y** was heated under reflux with acidified potassium manganate(VII) solution to form compound **Z**. The reaction is show below.



compound **Z**

(a) **(i)** Name the reaction above.

..... [1]

(ii) Describe the observation seen.

..... [1]

(iii) Draw the full structural formula of compound **Y**.

[1]

(b) A few drops of liquid bromine were added to compound **Z**.

(i) Name the reaction that takes place and describe the observation seen.

.....

.....

..... [2]

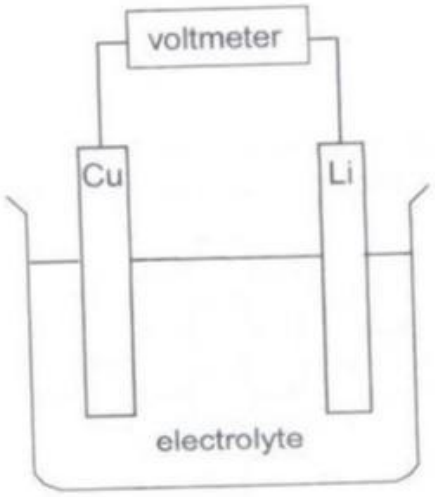
(ii) Draw the full structural formula of the product formed.

[1]

(d) Suggest the voltages that will be produced when the following metals are used.

metal 1	metal 2	predicted voltage / V
sodium	copper	
zinc	copper	

(e) **(i)** Early lithium-ion cells used lithium as one of the electrodes.
Use an **arrow** to show the flow of electrons in the set-up shown below. [1]



(ii) State and explain whether the lithium metal is an anode or a cathode.

.....

..... [1]

(f) Graphite and graphene have some similarities between the bonding and structures.

Explain, in terms of **structure** and **bonding**, why graphene can be used as an electrode in place of graphite.

.....

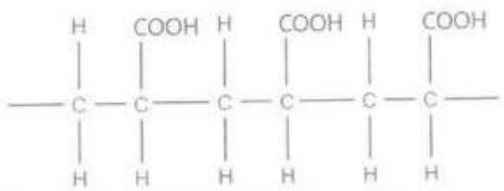
.....

.....

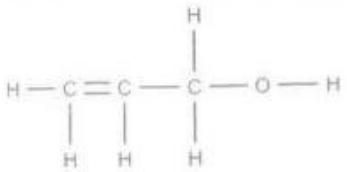
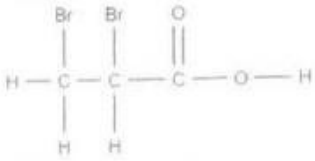
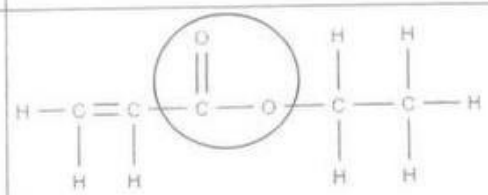
..... [2]

[Total: 12]

End of Section A

		(ii)		[1]
			Total	[10]
B11	(a)		Carbon monoxide binds irreversibly with haemoglobin in the red blood cells which lowers the ability of the haemoglobin to transport oxygen to the rest of our body. (This sentence is compulsory to score the 1m)	[1]
			Source: Sulfur dioxide is produced during **combustion of fossil fuels**. (Car exhaust – not accepted) Or, naturally during **volcanic eruptions**; **Harmful effect on aquatic life:** Sulfur dioxide **reacts with oxygen** in the air to form acidic compounds which **dissolve in water**, forming solutions of strong acids. **Lowering the pH** of the water bodies. **Acid rain kills aquatic life**	[1] [1] [1] [1] [1]
	(b)	(i)	Volume in $1000dm^3 = 0.0022 \times 5 = 0.011cm^3$ Mole of $SO_2 = 0.011/24000 = 0.00000045833$ mol Mass of $SO_2 = 0.00000045833 \times 64 = 0.000029333g = 29.3ug$. Hence exceed target of 15 ug.	[1] [1]
		(ii)	Carbon dioxide is a greenhouse gas and high amounts of it leads to global warming; Accept: leads to melting of polar ice caps/flooding/drying of water bodies/drought/famine.	[1] [1]
			Total	[10]

			OR Blue litmus turns red in **X** (but not in isobutylene). (Accept other pH tests)	[1] observation
	(c)	(i)	 Amide linkage	[1] [1]
		(ii)	1) Land pollution: Disposal of plastic waste in landfill sites leads to an increasing amount of built-up waste. 2) Air pollution: Some plastics (eg PVC) produce toxic fumes like HCl when burnt. 3) Water pollution: Improper disposal of plastics in the sea can endanger marine animals, which might mistake the plastics for food and choke on them. 4) Use of non-renewable resource: Plastics are made using petroleum/crude oil as a raw material, which are non- renewable.	Any one [1]
				Total [10]
A9	(a)		Lithium is used to make battery because it produced the **highest voltage of 3.37 V** [1] but it has the **lowest density of 0.53 g/cm^3**. [1]	[2]
	(b)		Metals with a **greater difference [1] in reactivity** will generate a **larger voltage.** [1] *Max [1] if students wrote difference in reactivity generates a voltage without mentioning the magnitude of the difference.*	[2]
	(c)		$2Li + 2H^2O \rightarrow 2LiOH + H_2$ [1] Lithium is **reactive** and can **react with water**. [1]	[2]
	(d)		metal 1 / metal 2 / predicted voltage / V sodium / copper / Accept more than 3.37V zinc / copper / Accept any value below 2.71 but greater than 0.78V	[1] [1]
	(e)	(i)	Electron flows from lithium to copper.	[1]
		(ii)	Lithium is an **anode** as it is **more reactive than copper** or It **undergoes oxidation** and **lose electrons.**	[1]
	(f)		Both graphite and graphene are **giant covalent structures** with **every carbon atom is covalently bonded to three other carbon atoms.**	[1] [1]
			One electron in each carbon atom is not involved in bonding. It can be **delocalised** and **act as mobile charge carriers** to conduct electricity.	
				Total [12]

B10	(a)	(i)	oxidation	[1]
		(ii)	purple $KMnO_4$ solution turns colourless	[1]
		(iii)		[1]
	(b)	(i)	addition reaction / addition of bromine / bromination reddish-brown solution turns colourless / decolourises	[1]
		(ii)		[1]
	(c)			[1] (str formula) [1] (circled func'nal gp) / write
	(d)	(i)	high temperature and pressure, catalyst (all 3 conditions must be present for 1m); missing anyone of the conditions, no marks)	[1]

A5

(a) Alloy [1]

(b) Aluminium consists of aluminiums atoms arranged in orderly layers. These layers can slide easily when a force is applied.

While duralumin contains **atoms of different sizes that disrupt** the **orderly arrangement of the atoms.** [1]
Hence the **atoms cannot slide over each other easily when a force** is **applied**. Hence it is harder. [1]

1m: describe correctly the arrangement of atoms in duralumin.
1m: describe correctly the ease of atoms sliding over each other when a force is applied.

(c) Aluminium is more reactive than copper. [1]

Hence it acts as a **sacrificial metal protection for copper** and corrode much easily. [1]

Total [5]

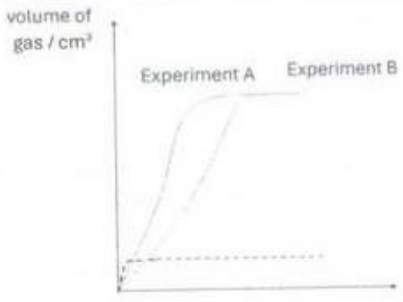
A6

(a) Experiment A *(must be accompanied by reason, no mark w/o reason given)*
Granules has a smaller particle size compared to lumps, thus they have **more surface area exposed** for collisions. [1]
Hence granules will have a **higher frequency of effective collisions between reactant particles** and thus have a greater rate of reaction. [1]

(b) Experiment using **$CaCO_3$ (x/100 mol) will have a larger amount of carbonate present compared to $PbCO_3$** (x/267 mol), as $CaCO_3$ has a smaller molar mass than $PbCO_3$. [1]

Thus, **greater volume CO_2** will be produced in the reaction that uses $CaCO_3$ [1]

(c) **(i)**



[1]

(ii) The rate of reaction is fast initially as sulfuric acid is a dibasic acid and hence has a twice the number of H^+ per unit volume / compared to HNO_3 in experiment A [1]

The small **volume of gas produced quickly remains constant** as $PbCO_3$ reacts with sulfuric acid to form **insoluble $PbSO_4$** which forms a protective layer around the carbonate and **prevents further reaction** from taking place. [1]

Total [7]

A7

name of salt	formula of salt	formulae of reagents used	method used
potassium nitrate	**KNO_3(aq)** [1]	HNO_3(aq) KOH(aq)	**titration between acid and base** [1] evaporation and crystallisation
lead(II) sulfate	$PbSO_4$(s)	H_2SO_4(aq) and **$Pb(NO_3)_2$(aq)** [1]	**mix both reagents together** [1] followed by filtration
zinc chloride	**$ZnCl_2$(aq)** [1]	HCl(aq) and **Zn(s) / ZnO(s) / $ZnCO_3$(s)** [1]	addition of excess solid wth acid; filtration; evaporation and crystallisation

Total [6]

A8

(a) **(i)** alkene [1]
C_nH_{2n} [1]

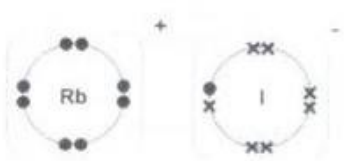
(ii)

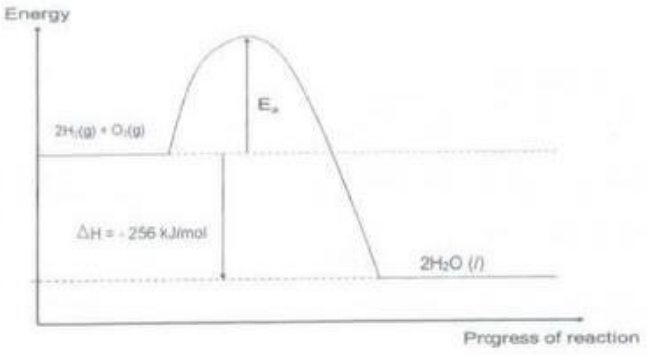
[1] (any one)

(b) **(i)** steam / 300°C, 60 atm (all 3 conditions must be present for 1m) [1]
H_3PO_4 catalyst [1]

(ii) Reddish-brown bromine decolourises in isobutylene but not in **X**. [1] reagent

GMS(S)
Secondary 4 Chemistry 6092 Preliminary Examination 2024 P2

A1	(a)	chlorine	[1]
	(b)	iron(II) nitrate / copper(II) oxide	[1]
	(c)	sulfur dioxide	[1]
	(d)	calcium carbonate	[1]
	(e)	iron(II) nitrate and sodium hydroxide (both must be correct for 2m)	[2]
	(f)	Iron(II) nitrate	[1]
		Total	[7]
A2	(a) (i)	Rubidium atom loses 1 valence electron to form rubidium ion, Rb^+. Rb is oxidized. Iodine gains 1 valence electron to form iodide ion, I^-. Iodine is reduced. Hence, the reaction is a redox reaction as oxidation and reduction occurs simultaneously. [this mark is awarded only if the above 2 points are were not mentioned].	[1] [1]
	(ii)	$Rb \longrightarrow Rb^+ + e^-$ $I_2 + 2e^- \longrightarrow 2I^-$	[1] [1]
	(b)	 Key: X: electron for Rb ●: electron for I	[1] for each ion
	(c) (i)	$Cl_2(aq) + 2I^-(aq) \longrightarrow 2Cl^-(aq) + I_2(aq)$ [1] for ionic equation [1] for state symbols	[2]
	(ii)	Solution changes from colourless to brown *(I_2 in aqueous state is brown)*	[1]
		Total	[8]
A3	(a)	Calcium sulfate or $CaSO_4$	[1]
	(b)	M_r of calcium nitrate, $Ca(NO_3)_2 = 40 + 2(14) + 6(16) = \mathbf{164}$ M_r of sodium sulfate $= 2(23) + 32 + 4(16) = \mathbf{142}$ Relative molecular **mass** of **calcium nitrate is greater / heavier**, the ions will **diffuse slower** and the reaction with sodium sulfate to form **insoluble calcium sulfate will take place nearer** to its starting point of **calcium nitrate.**	[1] [1] [1]
	(c)	Add dilute sodium hydroxide solution to the solution. A **white ppt formed and it is insoluble in excess sodium hydroxide**. The cation is Ca^{2+}	[1] [1]
		Total	[6]

A4	(a) (i)	No of moles of methane = 3115/890 = 3.5 mol Mass of methane = 3.5 X 16 = 56.0 g	[1] [1]
	(ii)	The energy **taken in to break** 4 mol C-H bond and 2 mol O=O bond is **less** than the **energy give out in the bond formation** of 2 mol C=O bond and 4 mol O-H bond. Hence the reaction is exothermic and has a negative sign for enthalpy change. C-H, O=O, C=O, O-H are not mentioned in the answer, minus 1m *1m: compare energy taken in and given out* *1m: relate energy taken in to that of bond breaking of the reactants and energy given out as bond forming of products*	[1] [1]
	(b)	**advantage**: Methanol is a liquid while hydrogen is a gas at r.t.p. Easier to transport methanol as transporting hydrogen would require use of pressurized tanks. [accepted "store" instead of transport] **disadvantage**: Burning methanol releases carbon dioxide which is a greenhouse gas. While burning hydrogen produces only water which is non-pollutive	[1] [1]
	(c)	 *[1 mark for correct shape of graph, 1 mark for correc labelling of reactant and product, 1 mark for correct labelling of enthalpy charge and activation energy]* **Single** arrow head must be used to show E_a and ΔH If **double arrow** heads are used for E_a, no 1 mark is awarded If **double arrow** heads are used for ΔH, no 1 mark is awarded	[3]
		Total	[9]

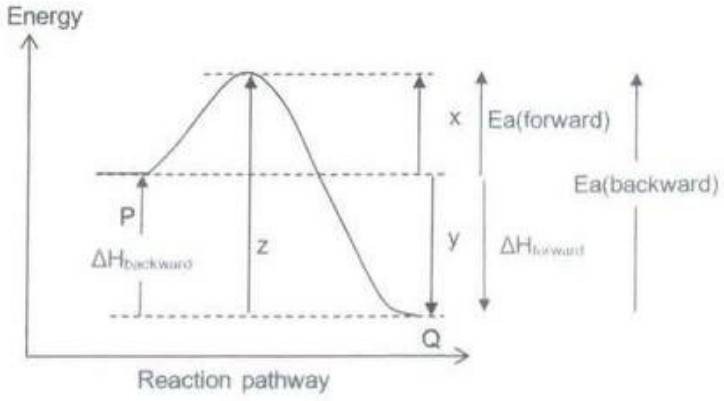
Q40) Solution: A

When the frequency of complete combustion increases, rate of complete combustion increases, less carbon monoxide is produced and there will be less hydrocarbons unburnt.

This means that less nitrogen dioxide is removed by catalytic converters.

Hydrocarbons + oxides of nitrogen → carbon dioxide + water + nitrogen
Carbon monoxide + oxides of nitrogen → nitrogen + carbon dioxide

Q26) Solution: A
The reaction from P to Q is exothermic, so the reaction from Q to P is endothermic.
The enthalpy change for the reaction from P to Q is y.
The activation energy of the reaction P to Q is x.
The activation energy of the reaction Q to P is z.



Q27) Solution: D

A and B are wrong because hydrochloric acid is in excess and hence it is the magnesium carbonate that is used up. C is wrong because the rate of reaction (represented by gradient) is zero, as X represents the completion of the reaction.

Q28) Solution: B

No. of moles of zinc = 4/65 = 0.061538 mol.
No. of moles of sulfuric acid = 0.1 x 1 = 0.100 mol.
$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
0.0615 mol. of zinc reacts with 0.0615 mol. of acid. As there is 0.100 mol. of acid, zinc is the limiting reactant. To produce half the volume of gas in Y, mass of zinc used is halved to 2 g. Initial rate of reaction for graph Y is faster than X, hence acid used has a higher concentration than 1.0 mol/dm^3.

Q29) Solution: B
Solution 1 and 2 are oxidising agents because they can react with the reducing agent, potassium iodide to gie a colour change.
Solution 1 is both an oxidising agent and a reducing agent, like hydrogen peroxide.

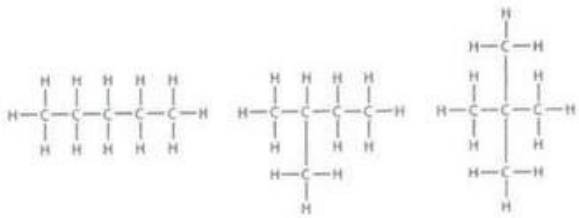
Q30) Solution: D
There is no change in oxidation states in any element in the substances before and after the reactions.

Q31) Solution: C
Cell 1: chloride and hydrogen ions are discharged to form chlorine and hydrogen gas.
Cell 2: hydroxide and hydrogen ions are discharged to form oxygen and hydrogen gas.
Cell 3: hydroxide and copper ions are discharged to form copper solid and oxygen gas.

Q32) Solution: C
The more reactive metal undergoes oxidation.
Hence, zinc will lose electrons and electrons will flow from zinc to copper.

Q33) Solution: D
X has a lower boiling point than Y.
X has a shorter chain molecule than Y.
The temperature decreases up the column.

Q34) Solution: B
C_5H_{12} is fully saturated based on 2n+2 rule, so only the strucural isomers need to be considered. There are only 3 possible unique structures.



Q35) Solution: C
S and T are both alkanes, hydrocarbon molecules.
Since S has a higher boiling point than T, the hydrocarbon chain in S is lonegr than T.

Q36) Solution: C
To form only one type of alcohol, the alkene should be symmetrical, having an internal plane of symmetry within the molecule.

Q37) Solution: C
Propanol is oxidised to propanoic acid, Q.

Q38) Solution: A
There is no C=C but there is carboxylic acid functional group in P.

Q39) Solution: D
The product still have carboxylic acid functional group after maleic acid undergoes addition polymerisation since mass is conserved.

Q13) Solution: A

number of moles of Zn = 1.3 / 65 = 0.0200 mol
Number of moles of HNO_3 = 20 / 1000 x 0.8 = 0.0160 mol
From the equation, Zn : HNO_3
1 : 2 (mole ratio)
0.0200mol: 0.0400mol required
Since number of moles of HNO_3 available is less than required, hence HNO_3 is limiting.

HNO_3 : H_2
2 : 1 (mole ratio)
0.0160mol: 0.00800mol

Volume of H_2 produced = 0.00800 x 24 = 0.192 dm^3 = 192 cm^3

Q14) Solution: A
Y has 5 valence electrons, so it belongs to group 15.

Q15) Solution: C
L is most reactive in group 17. M is most reactive in group 1.

Q16) Solution: A

Hydrogen will reduce oxide of metals from iron and below.
Since zinc is above hydrogen in the reactivity series, hydrogen will not be able to reduce zinc oxide. Hence, no visible reaction occurs.

Q17) Solution: C
X is more reactive than Y. Z is more reactive than X. Y is less reactive than Z. Hence, the metals in order of decreasing reactivity is from Z to X to Y.

Q18) Solution: D
When solid R is gradually added to solution S, neutralisation happens, as indicated by the sharp change in pH.

Solution S is alkaline as the starting pH is 14.
Solid R dissolves in water to give an acidic solution. This means that R is an acidic oxide that can dissolve in water.
As more R is added to alkaline solution S, neutralisation happens. The pH of solution decreases.
When excess R is added to S, the solution becomes more acidic.

Q19) Solution: C

Carbon dioxide (CO_2) is an acidic oxide, and lead(II) oxide (PbO), an amphoteric oxide, can react with potassium hydroxide, an alkali.
Barium oxide (BaO), an alkaline oxide, and water (H_2O), a neutral oxide, cannot react with potassium hydroxide.

Q20) Solution: A
To prepare potassium sulfate safely, titration method using potassium carbonate and sulfuric acid (both starting materials are soluble).

Q21) Solution D
Group 1 and ammonium salts are prepared by titration.
Other soluble salts are prepared by adding in excess of insoluble solids such as metal or metal carbonate with acids.
Insoluble salts are prepared by precipitation.

Q22) Solution: B
Since ΔH is negative, the reaction is exothermic.

Q23) Solution: A
Zinc cations will form a soluble complex that can dissolve in excess sodium hydroxide and excess aqueous ammonia.

Q24) Solution: B
Since compound Y reacts with acid to produce a gas, it is likely to be a metal carbonate.
A white ppt is obtained when sodium hydroxide is added to the colourless solution. This white ppt is insoluble in excess of NaOH. The cation is Ca^{2+}.
Hence, compound Y is calcium carbonate.

Q25) Solution: B
As HI is a product of the reaction, energy is released during its formation.
As the reaction is exothermic, heat is released to the surrourdings during the reaction.
The number of bonds broken and bonds formed are similar.
Since this is an exothermic reaction, the products have less energy than the reactants.

Geylang Methodist School (Secondary)
Preliminary Exam 2024 (6092/01)

Chemistry Paper 1

Answers

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

Workings:

Q1) Solution: A
To find the rate of chemical reactions, using stop watch and gas syringe, the reaction must produce gas.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

Q2) Solution: A
This method of collecting gas X is upward delivery method, for gases that are less dense than air (ammonia).

Ammonia is an alkaline gas, which will not react with basic oxide like calcium oxide.

Q3) Solution: A
After cooling the mixture, W will not dissolve in cold water, while C will dissolve in cold water.

Hence, filter the mixture to obtain W as the residue and V in the filtrate.

To the residue, rinse with cold water and dry to collect the residue.

Q4) Solution: C
Particles gain kinetic energy to weaken the forces of attractions from poitns S to T (liquid + gaseous state). That is why the temperature remaisn constant as the heat energy is converted to kinetic energy.

Q5) Solution: B
Gas Y diffuses faster than X.
Y is lighter than X. Hence, relative molecular mass of Y is smaller than X.
Relative molecular mass of Y, methane, is 16.
Relative moelcular mass of X, Neon, is 20.

Q6) Solution: B
Anion has more electrons than protons.
Nucleons = number of protons and neutrons
X has n electrons, n–2 protons.

Hence, the number of neutrons = m – (n – 2) = m – n + 2

Q7) Solution: D
Bromine contains two isotopes in equal proportions.

A_r(Bromine) = (50/100 x 79) + (50/100 x 81) = 80

Q8) Solution: D

element	W	X	Y	Z
atomic number	6	8	11	17
Identity	C	O	Na	Cl

Ionic compound: Na_2O or Y_2X; covalent compound: CO_2 or WX_2

Q9) Solution: B
Metals consists of a lattice of positive ions in a sea of delocalised electrons.

Q10) Solution: C
Hydrogen chloride is a simple covalent molecule, which can dissolve in water to become hydrochloric acid.

In aqueous solutions, the H^+ and Cl^- ions are able to conduct electricity.

Q11) Solution: A
CaO and CaS is correct.
$CaSe_2$ is wrong

Q12) Solution: D
Y is Li; Z is O.
$Mr(Li_2O) = 2(7) + 16 = 30$

BLANK PAGE

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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

GMS(S)/Chem/P2/PRELIM/2024/4E

(c) A researcher working with the NEA takes a 200 dm^3 sample of gaseous emissions from a factory. The composition of this sample of air is shown below.

gas	volume/ cm^3
sulfur dioxide	0.0022
nitrogen dioxide	0.0031
nitrogen	157000
oxygen	42900
carbon dioxide	99.9

(i) Show, by calculation, that the factory has exceeded the sulfur dioxide target set by NEA.

[2]

(ii) Activists have pushed for NEA to also monitor carbon dioxide emissions by factories.

Explain the impact high levels of carbon dioxide has on the global climate and describe one possible effect on the environment.

.....

.....

..... [2]

[Total: 10]

End of Paper

B11 Singapore maintains its air quality by strict laws and enforcement measures. The following shows the ambient air quality targets set by the National Environmental Agency (NEA) of three air pollutants. (1 μg = 10^{-6}g)

pollutant	sulfur dioxide	nitrogen dioxide	carbon monoxide
target (μg/1000 dm^3 sample of air)	15	40	30 000

(a) Explain why carbon monoxide is considered an air pollutant.

.....

..... [1]

(b) Sulfur dioxide and nitrogen dioxide are air pollutants that can affect aquatic life.

Describe the harmful effect of **sulfur dioxide** on aquatic life. Include in your answer a **source** for this air pollutant.

Sulfur dioxide:
Source:

..... [1]

Harmful effect on aquatic life:

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]