



TANJONG KATONG SECONDARY SCHOOL
Preliminary Examination 2026
Secondary 4

NAME

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CLASS

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Index Number

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CHEMISTRY

6092/02

Paper 2

20 August 2026

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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 24.

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

My Predicted Grade	
Before doing assessment:	After doing assessment:

For Examiner's Use	
Section A	
Section B	
Total	80

This document consists of **24** printed pages, including the cover page and **2** blank pages.

Chemistry 6092/Sec 4/Prelim Exam/P2/2026

[Turn over

Section A

Answer **all** questions.

- 1 Choose from the following list of elements to answer the questions below.

iron

chlorine

hydrogen

iodine

nickel

sodium

palladium

zinc

Each element can be used once, more than once, or not at all.

- (a) Which element forms an oxide which can react with both acids and alkalis?
..... [1]
- (b) Which element is a catalyst in the hydrogenation of alkenes?
..... [1]
- (c) Which element oxidises bromide ions to bromine?
..... [1]
- (d) Which element is formed at the cathode when concentrated aqueous solution of sodium chloride is electrolysed?
..... [1]
- (e) Which element is used to galvanise steel?
..... [1]

[Total: 5]

- 2 Argon forms 1% of the air and is unreactive.

Argon is used as a replacement for nitrogen when nitrogen is too reactive.

- (a) State one use of argon.

.....
 [1]

- (b) Chlorine is very reactive. Argon is unreactive.

Explain how the reactivity of these two elements are related to the arrangement of electrons in their atoms.

.....

 [2]

- (c) An element **R** has two electron shells with one electron in its outer shell.

- (i) Put ticks (✓) in the boxes to show which statements about element **R** are true and which are false.

	true	false
R forms basic oxide.		
R forms R ⁻ ions.		
R loses one electron when it reacts.		
R is in the first period of the Periodic Table.		

[2]

- (ii) Name one element that is more reactive than element **R**.

..... [1]

[Total: 6]

3 A key is made from the alloy brass, made of copper and zinc.

(a) Fig. 3.1 shows a diagram to represent the bonding in copper metal.

(i) Complete the diagram by identifying particle **X** and **Y**.

[1]

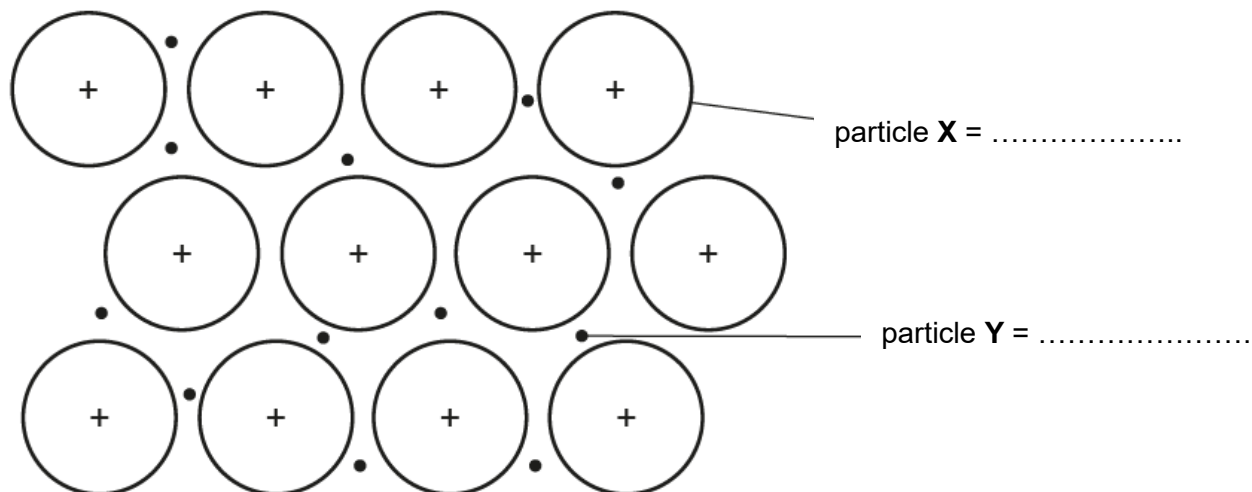


Fig. 3.1

(ii) Describe what happens to particle **X** and particle **Y** in the structure when a metal conducts electricity.

.....
 [1]

- (b) Brass contains copper atoms and zinc atoms, as shown in Fig. 3.2.

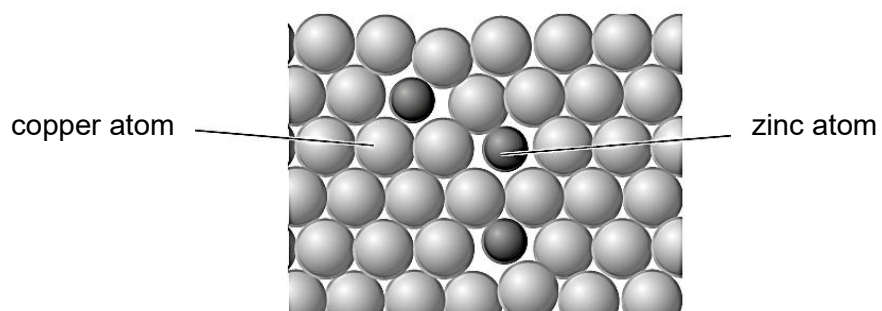


Fig. 3.2

Table 3.1 shows some information about brass. It contains some errors.

Table 3.1

	percentage of element in brass	relative size of atom
copper	56	1.0
zinc	37	1.1

- (i) Describe how the information in Table 3.1 shows that there are more than two elements in brass.

.....
 [1]

- (ii) Using Table 3.1, state another reason why Fig. 3.2 is not an accurate representation of atoms in brass.

.....
 [1]

- (iii) Explain why is brass stronger than pure zinc or copper.

.....

 [2]

- (c) A student investigates the reactivity of copper and zinc.

The student places a zinc rod into a solution containing aqueous copper(II) ions and leaves it for 5 minutes, as shown in Fig. 3.3.

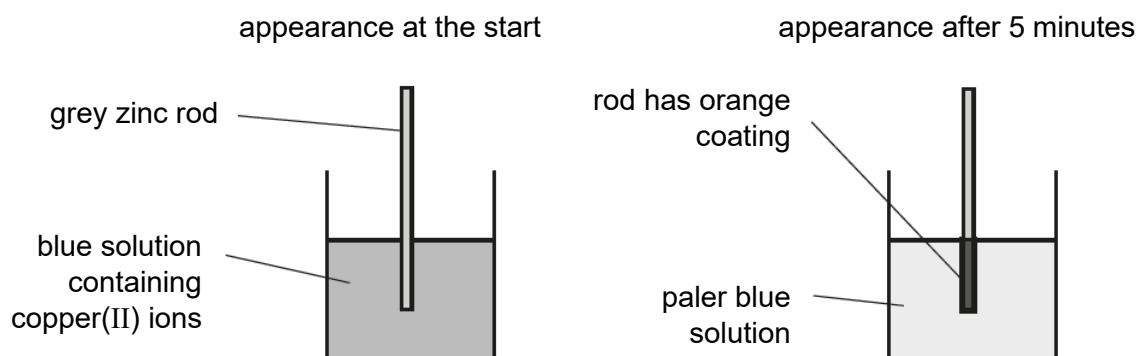


Fig. 3.3

With the aid of an ionic equation, explain the changes that occurred.

.....

.....

.....

.....

..... [3]

- (d) Explain why the electrolysis of aqueous copper(II) solution gives copper metal but the electrolysis of aqueous zinc solution does **not** give zinc metal.

.....

.....

..... [1]

[Total: 10]

4 Oxygen is a non-metal.

- (a) There are two main isotopes of oxygen, ^{16}O and ^{18}O .
Table 4.1 shows information about the atomic structure of ^{16}O .

Table 4.1

	^{16}O
number of protons	8
number of neutrons	8
number of electrons	8

- (i) Why do atoms of each isotope have the same number of electrons?

.....
 [1]

- (ii) Complete the diagram for an ^{18}O atom shown in Fig. 4.1.
Use crosses (x) to represent electrons.

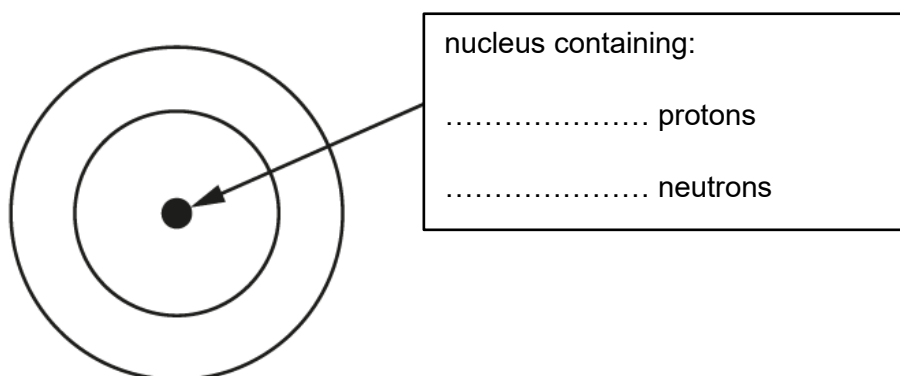


Fig. 4.1

[2]

- (b) Oxygen can bond with magnesium or carbon.
Discuss the differences between the way that the bonds are formed in MgO and CO_2 .

.....

 [2]

- (c) An element reacts with oxygen gas, O_2 , to make an oxide. The number of moles of the element that react with different numbers of moles of oxygen gas is calculated and the results are shown in Fig. 4.2.

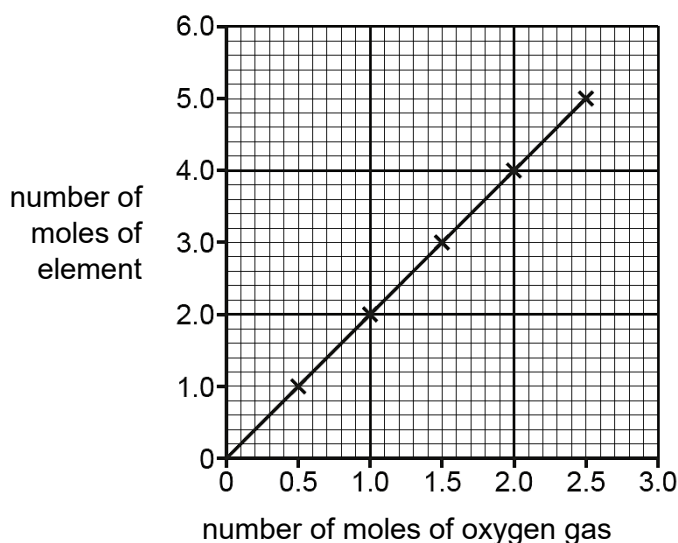


Fig. 4.2

- (i) The student concludes that the graph shows this relationship:

$$\text{number of moles of element} \propto \text{number of moles of oxygen}$$

Explain, using Fig. 4.2, why the student is correct.

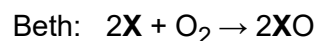
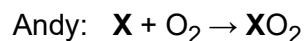
.....

 [2]

- (ii) Calculate the mass of oxygen gas that reacts with 1.8 moles of the element.

mass of oxygen = ... g [1]

- (iii) Two students suggest an equation for the reaction. They use **X** to represent the symbol of the element.



Explain, by means of words or calculation, which student has the correct equation.

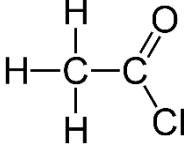
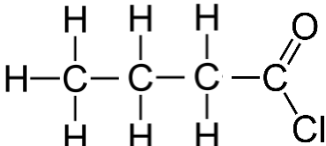
.....

 [1]

[Total: 9]

- 5 Table 5.1 shows some information about the homologous series of a class of organic compounds called acyl chlorides.

Table 5.1

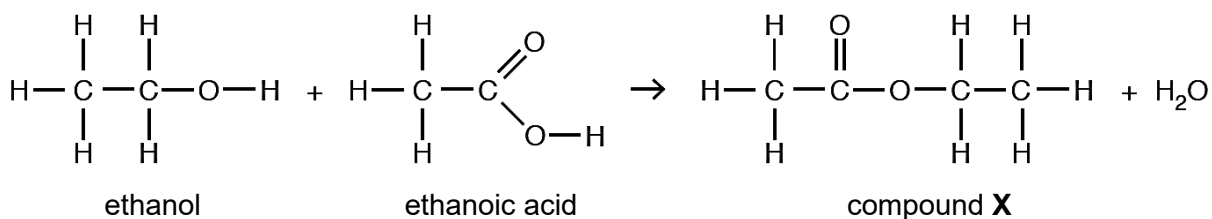
name	condensed formula	displayed formula
ethanoyl chloride	CH_3COCl	
butanoyl chloride	$\text{C}_3\text{H}_7\text{COCl}$	

- (a) (i) Fill in Table 5.1 to show the name, condensed formula and displayed formula of the acyl chloride that occurs between ethanoyl chloride and butanoyl chloride in the homologous series. [2]
- (ii) Explain how you can tell these molecules are from the same homologous series.

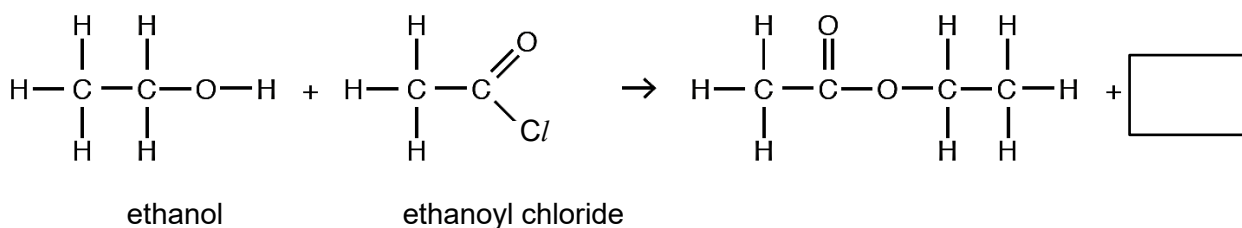
 [1]
- (iii) Predict the condensed formula for the acyl chloride that contains 9 carbon atoms.
 condensed formula [1]

- (b) Acyl chlorides can react with alcohols like how carboxylic acids react with alcohols. Two reactions are shown below.

reaction 1



reaction 2



- (i) Name compound X.
 [1]
- (ii) Deduce the chemical formula of the second product formed in reaction 2.
 [1]
- (c) Table 5.2 shows the number of bonds in the reactants and the number of bonds in the products for reaction 1 shown in part (b).

Table 5.2

bond	C – H	C – C	C – O	C = O	O – H
number of bonds in reactants	6	1	2	1	2
number of bonds in products	6	1	2	1	2

- (i) State which two bonds are broken in the reactants during reaction 1.
 [1]
- (ii) Explain why the enthalpy change in this reaction is approximately 0 kJ/mol.

 [3]

[Total: 10]

6 Polymers are made by either an addition reaction or a condensation reaction.

- (a) Fig. 6.1 shows the equation for the reaction used to prepare a polymer. The monomer is both an alcohol and a carboxylic acid.

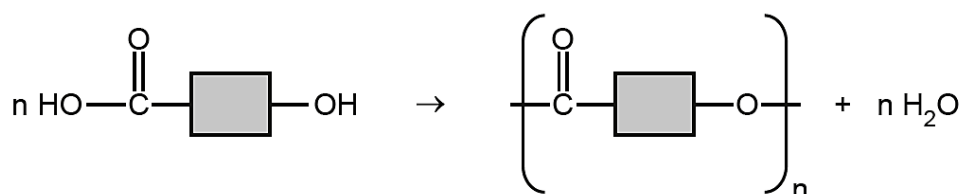


Fig. 6.1

- (i) Name the type of linkage that bonds the repeat units to one another in this polymer.
 [1]
- (ii) Explain how the equation shows that the polymer is made by a condensation reaction.

 [1]
- (b) Another polymer contains 10.8% carbon, 17.1% fluorine and 72.1% bromine by mass. Calculate the empirical formula of this polymer.

empirical formula [3]

- (c) Polybutene is an addition polymer. Fig. 6.2 shows the structure of butene.

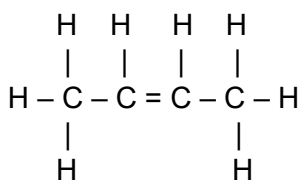


Fig. 6.2

- (i) Construct an equation for the reaction used to prepare polybutene from the monomer in Fig. 6.2, similar to the equation shown in Fig. 6.1.

[2]

- (ii) State one similarity and two differences between the addition polymerisation of butene and the condensation polymerisation shown in Fig. 6.1.

.....

.....

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.....

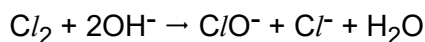
.....

..... [3]

[Total: 10]

7 Chlorine is used to make useful products.

- (a) Hypochlorite, ClO^- , is used for disinfection.
The ionic equation for the reaction of chlorine with cold dilute aqueous sodium hydroxide is shown.



- (i) State the oxidation state of chlorine in

ClO^-

Cl^- [2]

- (ii) Describe a chemical test to show that chlorine is an oxidising agent.

.....
..... [1]

- (b) Table 7.1 shows some information about three different compounds of chlorine.
Polyvinylchloride (PVC) is a polymer.

Table 7.1

compound	sodium chloride	phosphorus(V) chloride	polyvinylchloride (PVC)
formula	NaCl	PCl_5	$(\text{C}_2\text{H}_3\text{Cl})_n$
melting point / $^\circ\text{C}$	801	120	200 – 280

- (i) The 'dot-and-cross' diagram of bonding in PCl_5 is shown in Fig. 7.1.

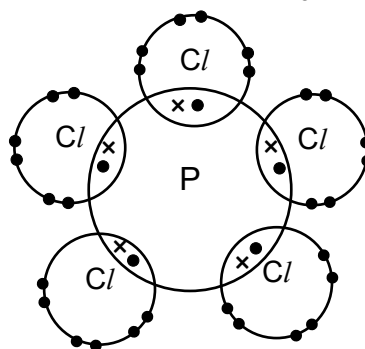


Fig. 7.1

Explain how the arrangement of electrons around the phosphorus atom is **not** usual compared to most covalent compounds.

.....
..... [1]

- (ii) Describe and explain the differences in the melting points of the three compounds.

Use ideas about their structures and bonding in your answer.

.....

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.....

..... [4]

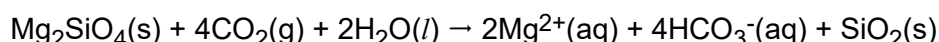
[Total: 8]

8 Enhanced Rock Weathering for Carbon Sequestration

As global atmospheric carbon dioxide levels continue to rise, scientists are exploring geoengineering techniques to accelerate Earth's natural carbon cycle. One such technique is Enhanced Rock Weathering (ERW).

In nature, rainwater reacts with atmospheric carbon dioxide to form a weak, dilute solution of carbonic acid, H_2CO_3 . When this acidic rain falls on rocks containing the mineral olivine, Mg_2SiO_4 , a slow neutralisation reaction occurs over thousands of years. ERW speeds up this process by mechanically crushing olivine into a fine powder and spreading it over vast agricultural fields, trapping carbon in the form of soluble bicarbonate ions HCO_3^- which eventually wash into the oceans.

The chemical equation for the weathering of olivine is shown below:



The enthalpy change for the above reaction is $\Delta H = -160 \text{ kJ/mol}$.

Scientists conducted a 12-month study on a farm to evaluate the effectiveness of ERW. They tracked how different rock particle sizes affected the rate of rock dissolution. Table 8.1 shows the time taken for olivine rock to dissolve based on particle radius.

Table 8.1

particle radius/ μm	time taken for dissolution / years
10	5
50	25
100	52
500	260

The scientist also monitored subsequent changes in soil properties over time. The changes in soil pH and magnesium ion concentration over 12 months is shown in Table 8.2.

Table 8.2

time after application / months	soil pH	concentration of dissolved Mg^{2+} / mol dm^{-3}
0	5.2	14
3	5.6	29
6	6.1	46
9	6.5	58
12	6.6	61

To further accelerate this process in automated facilities, engineers are experimenting with adding an enzyme extracted from soil-dwelling bacteria. The activation energy for the uncatalysed weathering reaction is $+180 \text{ kJ/mol}$, whereas the activation energy when using this bacterial enzyme is reduced to $+110 \text{ kJ/mol}$.

- (a) Using the data in Table 8.1, describe the relationship between the olivine particle radius and the time taken for the rock to dissolve. Use ideas about collisions between particles to explain this relationship.

.....

 [2]

- (b) Using the data in Table 8.2 and the provided chemical equation, describe and explain how the acidity of the soil changes over the 12-month period.

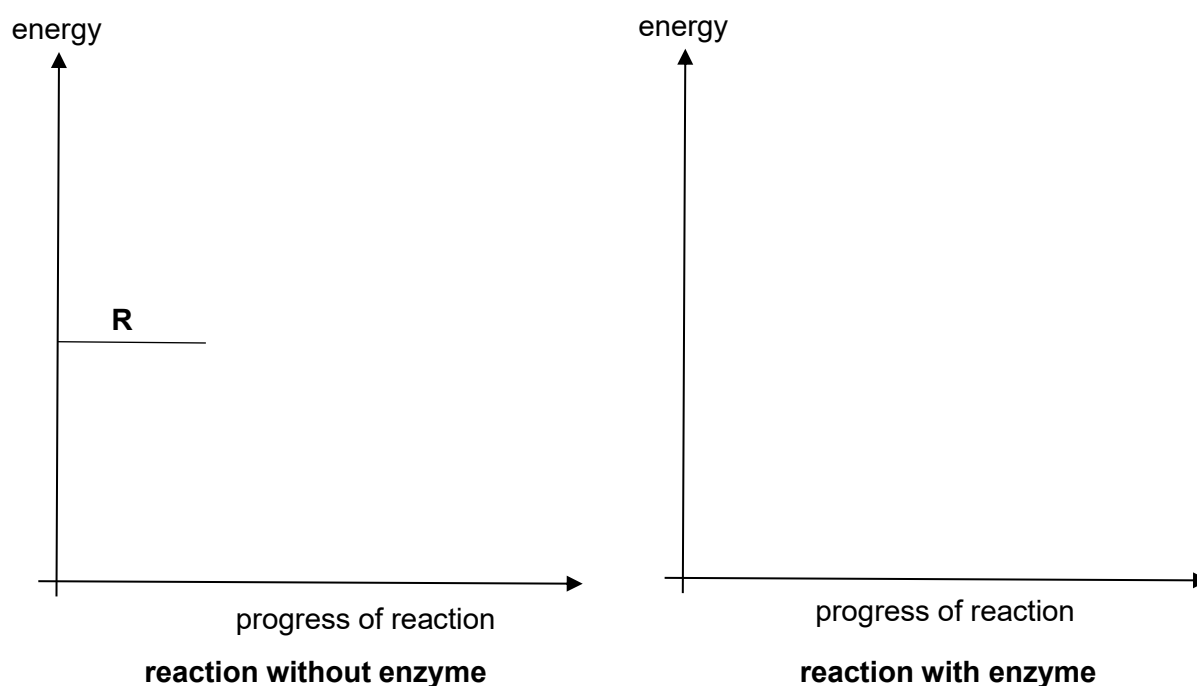
.....
 [1]

- (c) Olivine, Mg_2SiO_4 , is an ionic compound with one silicate oxyanion as the only anion. Deduce the chemical formula showing the overall charge of the silicate oxyanion.

..... [1]

- (d) Complete and label the energy profile diagrams to show the effect of the enzyme on the energy changes in the weathering of olivine reaction.

Use the symbol **R** to represent reactants and **P** to represent the products.



[3]

- (e) A local environmental agency calculates that a farm needs to capture $48,000 \text{ dm}^3$ of atmospheric carbon dioxide gas (measured at r.t.p.) to meet its annual net-zero carbon target

Calculate the minimum mass of olivine powder (Mg_2SiO_4), in grams, that must completely react to capture this volume of gas.

mass of olivine powder = ... [3]

- (f) Enzymes lower the activation energy.

- (i) Use ideas of collision between particles to explain why this speeds up the reaction.

.....
..... [1]

- (ii) Suggest why engineers designing the automated ERW facility are advised **not** to operate the system at high temperatures when enzymes are used.

.....
..... [1]

[Total: 12]

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Section B

Answer **one** question from this section.

- 9 Hydrogen fuel cells can be used in cars, but many cars use fossil fuels, such as diesel or petrol. Table 9.1 shows information about hydrogen and diesel.

Table 9.1

fuel	product(s) formed during complete combustion	source	melting point / °C	boiling point / °C	density at r.t.p / g cm ⁻³
hydrogen	water	water	-259	-253	0.09
diesel	carbon dioxide and water	crude oil	-80 to 0	200 to 350	0.85

- (a) Explain how you can tell from the data from Table 9.1 that diesel is a mixture.

.....
 [1]

- (b) Describe, briefly, how diesel is obtained from the fractional distillation of crude oil.

.....

 [3]

- (c) Use data from the table to explain why the density of hydrogen and diesel are very different.

.....

 [2]

- (d) (i) Hydrogen for fuel cells can be obtained from water by electrolysis.
Write the overall equation for the electrolysis of water.

..... [1]

- (ii) Evaluate the use of hydrogen as a fuel compared to diesel.

.....
.....
.....
.....
.....
..... [3]

[Total: 10]

- 10 A student sets up two different experiments for electroplating an object with silver. Figure 10.1 shows the two experiments.

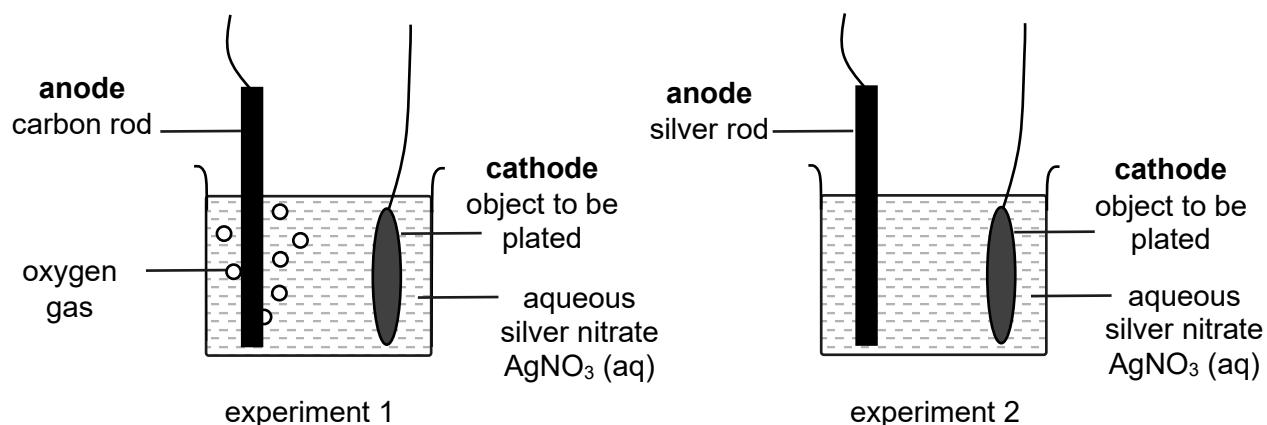


Fig. 10.1

- (a) Write half-equation, with state symbols, to show the reactions that happen at the anode and cathode during each experiment.

.....

.....

.....

.....

.....

.....

..... [4]

- (b) At the beginning of each experiment the student removes a sample of the electrolyte, aqueous silver nitrate, and puts it in a test-tube.

The student then adds a few drops of aqueous sodium chloride to the sample.

- (i) Describe and explain what the student sees.

Include an equation in your answer.

.....

..... [2]

- (ii) After some time, the student observes that no more silver is being deposited on the object in experiment 1 but more silver is still being deposited on the object in experiment 2.

Suggest a reason for this observation and describe how he could use aqueous sodium chloride to find out if his reasoning is correct.

.....

 [2]

- (c) Another student sets up the following electric cell shown in Fig. 10.2 using aqueous silver nitrate

This reaction can be used to generate electricity in a cell.

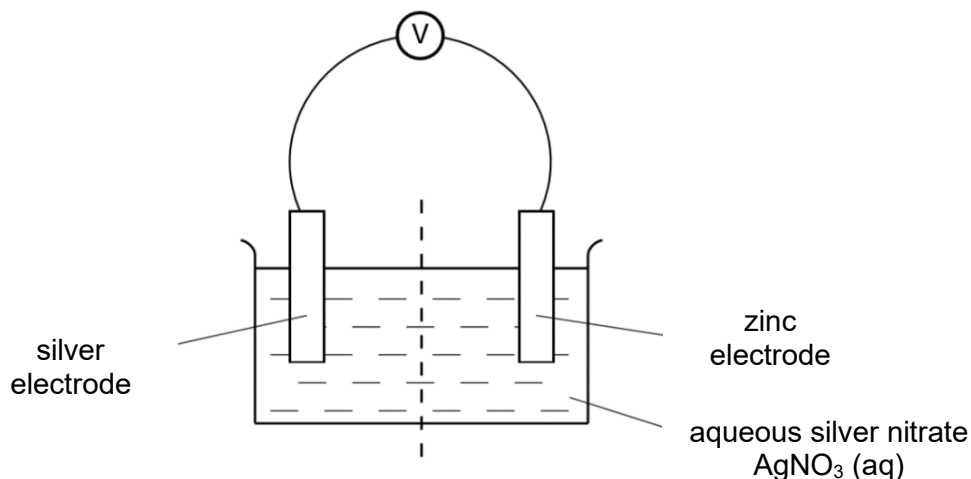


Fig. 10.2

- (i) Draw an arrow on Fig.10.2 to show the direction of the flow of electrons in the wire. [1]
- (ii) When **metal M** was used instead of zinc, it produced a higher voltage than zinc. Suggest a name for **metal M**.

..... [1]

[Total: 10]

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