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Answer ALL questions.

Some questions must be answered with a cross \boxtimes . If you change your mind about an answer, put a line through the box \boxtimes and then mark your new answer with a cross \boxtimes .

1 The three states of matter are solid, liquid and gas.

(a) Substances can change from one state to another.

The box gives some words about changes of state.

condensing	cooling	evaporation	
freezing	heating	melting	sublimation

Complete the table by giving the correct word from the box for each change of state.

You may use each word once, more than once or not at all.

(3)

Change of state	Name of change
from liquid to solid	
from gas to liquid	
from solid to gas	

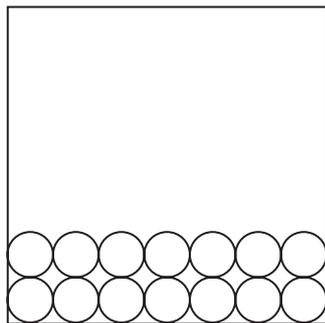
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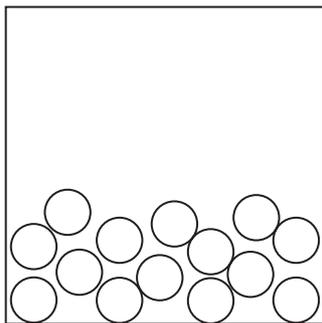
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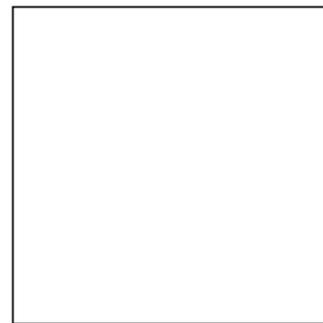
(b) The diagram shows two states of matter for a substance.



solid



liquid



gas

Each circle represents an atom of the substance.

(i) Complete the diagram by drawing six circles to represent atoms in the gas state.

(1)

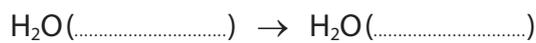
(ii) Which statement is correct about this substance?

(1)

- A the atoms move randomly in the gas state
- B the atoms move randomly in the solid state
- C the atoms are in fixed positions in the gas state
- D the atoms are in fixed positions in the liquid state

(c) Complete the equation, by adding the state symbols, for the conversion of water into ice.

(1)



(Total for Question 1 = 6 marks)

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2 The table gives some information about five gases.

Name	Formula	Boiling point in °C
chlorine	Cl ₂	-35
hydrogen chloride	HCl	-114
oxygen	O ₂	-183
nitrogen	N ₂	-196
hydrogen	H ₂	-253

(a) Use gases from the table to answer these questions.

You may use each gas once, more than once or not at all.

(i) Name the gas needed for combustion.

(1)

(ii) Name the gas that is most abundant in air.

(1)

(iii) Name the gas that can bleach damp litmus paper.

(1)

(b) Explain why hydrogen chloride is classified as a compound.

(2)

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(c) Why does chlorine have the highest boiling point of the gases in the table?

(1)

- A** chlorine has the strongest covalent bonds between its atoms
- B** chlorine has the strongest covalent bonds between its molecules
- C** chlorine has the strongest ionic bonds between its atoms
- D** chlorine has the strongest forces of attraction between its molecules

(Total for Question 2 = 6 marks)

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3 This question is about the rusting of iron.

(a) (i) Name the two substances needed for iron to rust.

(2)

1

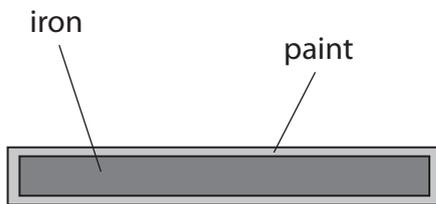
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(ii) Give the chemical name for rust.

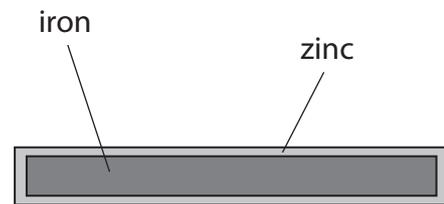
(1)

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(b) The diagram shows two methods used to prevent iron from rusting.



Method A



Method B

Method A will work only if the paint coating is **not** scratched.

Method B will work even if the zinc coating is scratched.

(i) Explain how method A prevents iron from rusting.

(2)

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(ii) Give the name of method B.

(1)

.....



(iii) Explain how method B prevents iron from rusting even when the zinc coating is scratched.

(2)

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(Total for Question 3 = 8 marks)



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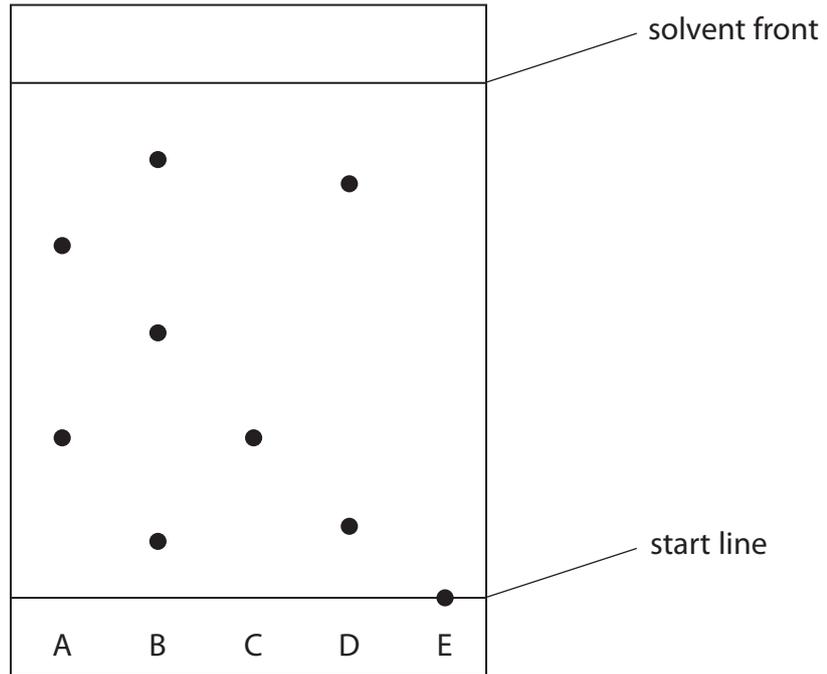
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(b) The chromatogram shows the results for inks A, B, C, D and E.



(i) Explain which ink contains a dye that is insoluble in the solvent.

(2)

(ii) Explain which inks contain the same dye.

(2)

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- (iii) Describe how the student can use the chromatogram to determine the R_f value for the dye in ink C.

You do **not** need to calculate the R_f value.

(2)

(Total for Question 4 = 11 marks)

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5 Hydrogen peroxide decomposes to form water and oxygen.

This decomposition is shown in the equation.



(a) Give the test for oxygen gas.

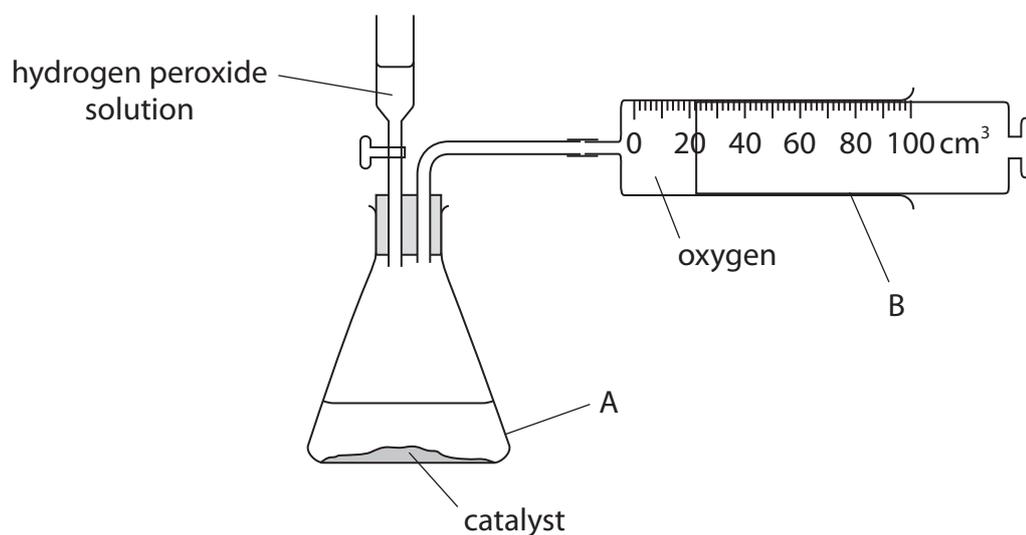
(1)

(b) The rate of reaction is increased by adding a suitable catalyst.

Describe how a catalyst increases the rate of a reaction.

(2)

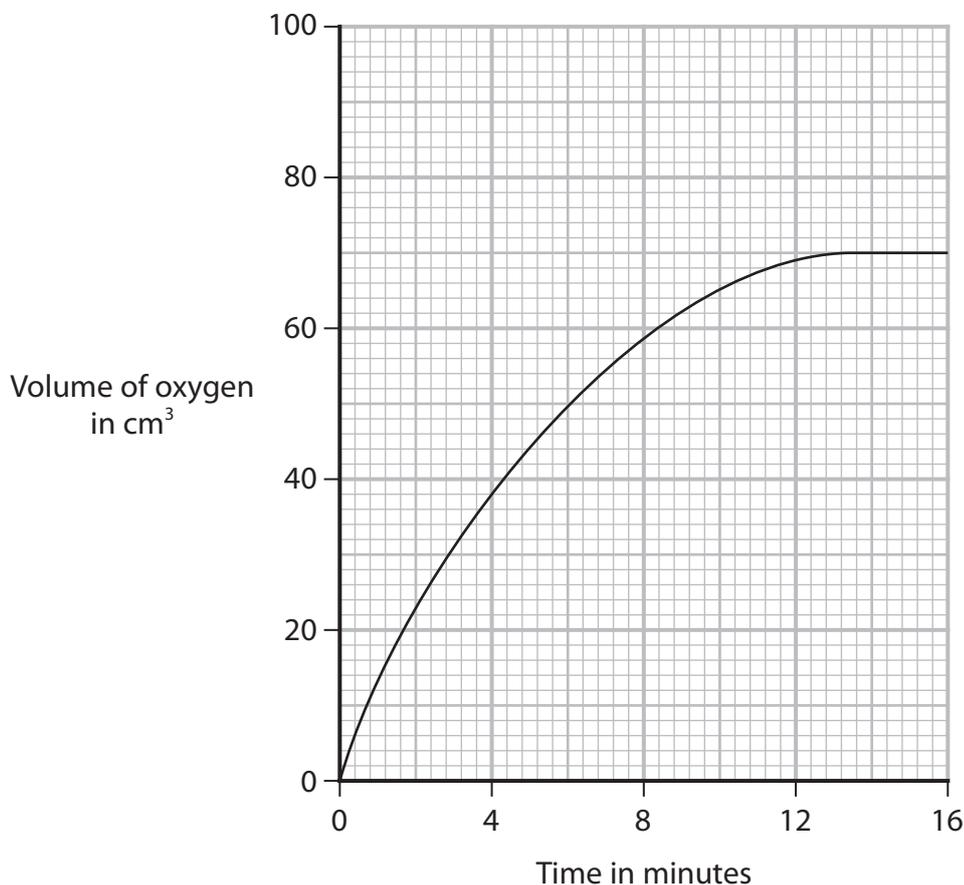
(c) A student uses this apparatus to investigate the rate of decomposition of hydrogen peroxide solution.



The student adds 100 cm^3 of hydrogen peroxide solution at 20°C to the apparatus labelled A.

The student records the volume of oxygen gas collected every minute for 16 minutes.

The graph shows the student's results.



(i) Name the pieces of apparatus labelled A and B.

(2)

A

B

(ii) Determine the volume of oxygen gas produced in the first 4 minutes.

Show on the graph how you obtain your answer.

(2)

volume of oxygen = cm^3



- (iii) Determine the rate of reaction at 8 minutes by drawing a suitable tangent to the curve.

Include the units for the rate of reaction.

(4)

rate of reaction = units

(Total for Question 5 = 11 marks)

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6 This question is about ionic and covalent compounds.

(a) The table gives the formulae of some positive ions, some negative ions and some compounds containing these ions.

	NH_4^+	Zn^{2+}	Al^{3+}
Cl^-	NH_4Cl	ZnCl_2	
SO_4^{2-}	$(\text{NH}_4)_2\text{SO}_4$		$\text{Al}_2(\text{SO}_4)_3$
N^{3-}		Zn_3N_2	AlN

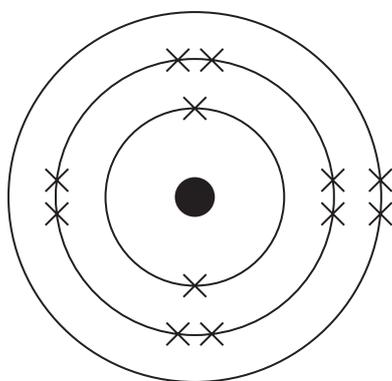
(i) Complete the table by giving the three missing formulae.

(3)

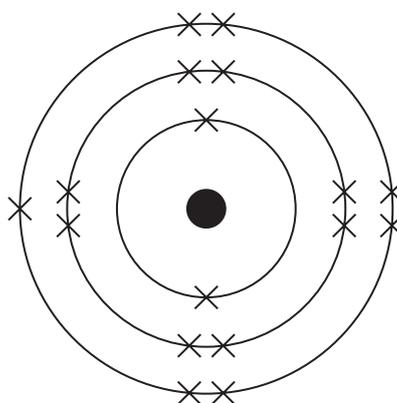
(ii) Give the name of the compound with the formula $\text{Al}_2(\text{SO}_4)_3$

(1)

(b) The diagram shows the arrangement of electrons in an atom of magnesium and an atom of chlorine.



Magnesium



Chlorine

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Describe, in terms of electrons, what happens when magnesium atoms and chlorine atoms form magnesium chloride.

(3)

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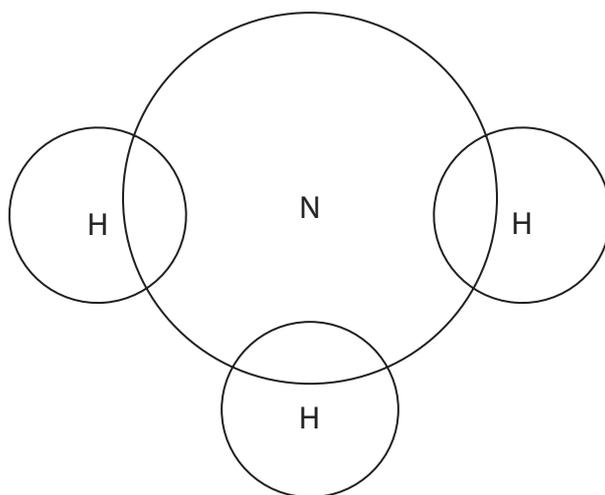
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(c) (i) Complete the dot-and-cross diagram to show the outer shell electrons in a molecule of ammonia.

(2)



(ii) Describe the forces of attraction in a covalent bond.

(2)

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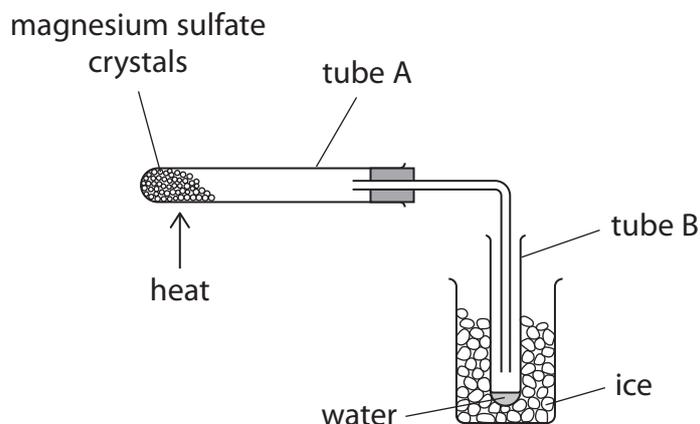
(Total for Question 6 = 11 marks)



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7 Magnesium sulfate crystals have the formula $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$

A student uses this apparatus to heat tube A and collect water of crystallisation in tube B.



The student records the mass of tube B at the start and every minute for 6 minutes.

The table gives the student's results.

Time in minutes	Mass of tube B in g
0	15.8
1	16.5
2	17.6
3	19.2
4	20.4
5	22.1
6	22.1

(a) (i) Give a reason why the student surrounds tube B with ice.

(1)

(ii) State how the student knows when all the water of crystallisation has been given off.

(1)



- (b) Describe a chemical test the student can use to show that the liquid in tube B contains water.

(2)

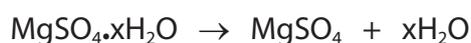
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- (c) The decomposition of hydrated magnesium sulfate is shown in the equation.



At the end of the reaction, the mass of MgSO_4 remaining in the tube is 6.0 g.

Use this mass and the results in the table to calculate x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$

[for MgSO_4 , $M_r = 120$ for H_2O , $M_r = 18$]

(4)

$x =$

(Total for Question 7 = 8 marks)

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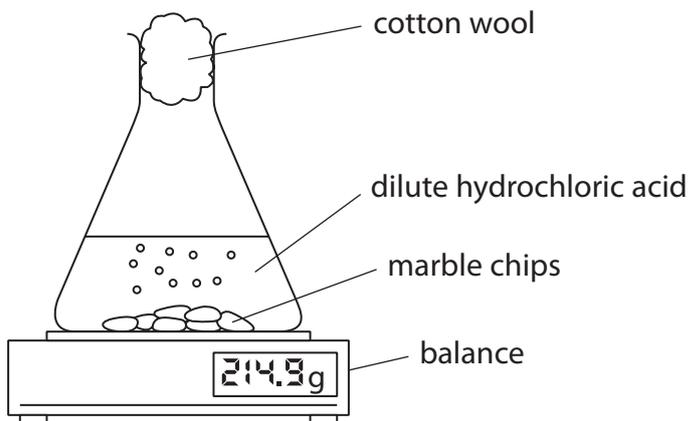
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- 8 A student uses this apparatus to investigate the rate of reaction between marble chips and dilute hydrochloric acid.



This is the equation for the reaction.



- (a) Give a reason why the reading on the balance decreases during the reaction.

(1)

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- (b) Explain why the rate of reaction is greatest at the start.

(2)

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- (c) After 10 minutes, the reaction stops even though there are marble chips remaining.

Give a reason why the reaction stops.

(1)

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(d) The student repeats the experiment with hydrochloric acid at a higher temperature to investigate the effect on the rate of reaction.

(i) Give two variables that should be controlled to make sure the results are valid.

(2)

1

2

(ii) Explain the effect of increasing the temperature of hydrochloric acid on the rate of reaction.

(3)

(Total for Question 8 = 9 marks)

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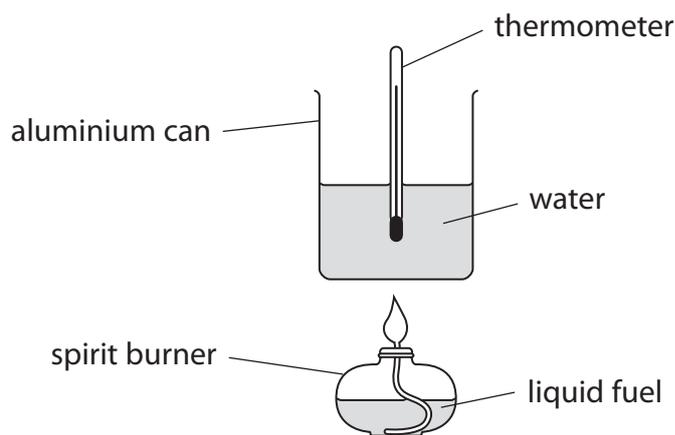
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- 9 A student uses this apparatus to investigate the heat energy released when a liquid fuel burns.



This is the student's method.

- measure the mass of the spirit burner and fuel
- add 100 g of water to the aluminium can
- measure the temperature of the water
- use the spirit burner to heat the water until the temperature rises by 50 °C
- measure the new mass of the spirit burner and fuel

- (a) Give a reason why the student uses an aluminium can rather than a glass beaker.

(1)

- (b) When the fuel burns, a black solid forms on the aluminium can.

- (i) Identify the black solid.

(1)

- (ii) Give a reason why the black solid forms.

(1)

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- (c) (i) Show that the heat energy needed to raise the temperature of 100 g of water by 50 °C is approximately 20 000 J.

[for water, $c = 4.2 \text{ J/g}^\circ\text{C}$]

(2)

- (ii) The student burns 1.84 g of ethanol.

Calculate the molar enthalpy change, ΔH , in kJ/mol, for the combustion of ethanol.

Include a sign in your answer.

[for ethanol, $M_r = 46$]

(4)

$\Delta H = \dots\dots\dots$ kJ/mol

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(d) In a different experiment, the student burns 3.7 g of butanol.

This is an equation for the incomplete combustion of butanol.



(i) Complete the equation for the incomplete combustion of butanol. (1)

(ii) Calculate the total amount, in moles, of gas produced by the incomplete combustion of 3.7 g of butanol. (3)

amount of gas = mol

(Total for Question 9 = 13 marks)



10 This question is about alkanes and alkenes.

(a) Ethane and ethene each react with bromine, but under different conditions.

(i) Give a reason why **ethane** does not undergo an addition reaction with bromine.

(1)

(ii) Complete the equation for the substitution reaction between **ethane** and bromine, including an essential condition for the reaction.

(2)



condition

(iii) Give the colour change that occurs when **ethene** reacts with bromine water.

(1)

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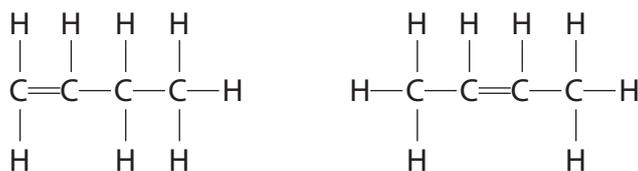
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- (b) The diagram shows the displayed formulae of two compounds in the homologous series of alkenes.



- (i) Compounds in the same homologous series have the same general formula.
Give two other characteristics of compounds in the same homologous series.

(2)

1

.....

2

.....

- (ii) Explain why the alkenes in the diagram are isomers.

(2)

.....

.....

.....

.....

- (iii) Draw the displayed formula of another alkene that is an isomer of these two alkenes.

(1)



11 This question is about the reactions of some compounds of lead.

(a) Lead can be extracted from lead(II) sulfide, PbS, in two stages.

Stage 1 lead(II) sulfide is heated in air and reacts with oxygen to produce lead(II) oxide, PbO, and sulfur dioxide

Stage 2 lead(II) oxide is heated with carbon in a furnace

(i) Write a chemical equation for the reaction in stage 1.

(2)

(ii) Give a reason why sulfur dioxide should not be released into the atmosphere.

(1)

(iii) This is the equation for stage 2.



A mass of 892 tonnes of lead(II) oxide is heated in a furnace with an excess of carbon.

Calculate the maximum mass, in tonnes, of carbon dioxide that could be released into the atmosphere.

[1 tonne = 1×10^6 g]

[for PbO, $M_r = 223$ for CO₂, $M_r = 44$]

(3)

mass = tonnes

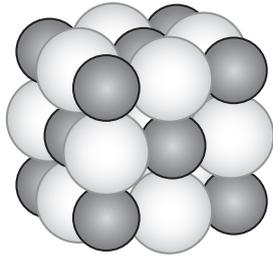
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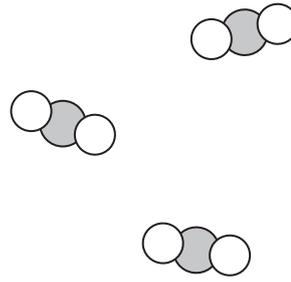
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(iv) The diagram shows the structures of lead(II) sulfide and sulfur dioxide.



Lead(II) sulfide



Sulfur dioxide

Explain, in terms of bonding and structure, why lead(II) sulfide is a solid with a very high melting point at room temperature and why sulfur dioxide is a gas at room temperature.

(5)

lead(II) sulfide

sulfur dioxide

QUESTION 11 CONTINUES ON NEXT / BACK PAGE.



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- (b) A different oxide of lead contains 90.7% by mass of lead and 9.3% by mass of oxygen.

Determine the empirical formula of this oxide of lead.

(4)

empirical formula =

(Total for Question 11 = 15 marks)

TOTAL FOR PAPER = 110 MARKS

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