Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE

Tuesday 12 November 2024

Morning (Time: 2 hours)

Paper reference 4CH1/1C 4SD0/1C

Chemistry

UNIT: 4CH1
Science (Double Award) 4SD0
PAPER: 1C

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 7 5 9 4 6 A 0 1 3 2

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

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Answer ALL questions.

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

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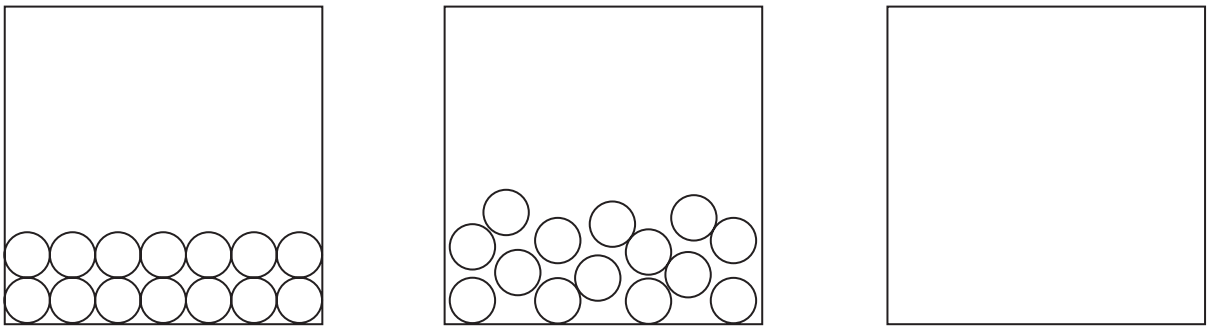
(b) The diagram shows two states of matter for a substance.



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)

H_2O(.....) → H_2O(.....)

(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)

3 This question is about the rusting of iron.

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

(2)

1 .....

2 .....

(ii) Give the chemical name for rust.

(1)

.....

(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)

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(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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4 A student does an experiment to identify the dyes in inks A, B, C, D and E.

The student uses this apparatus.

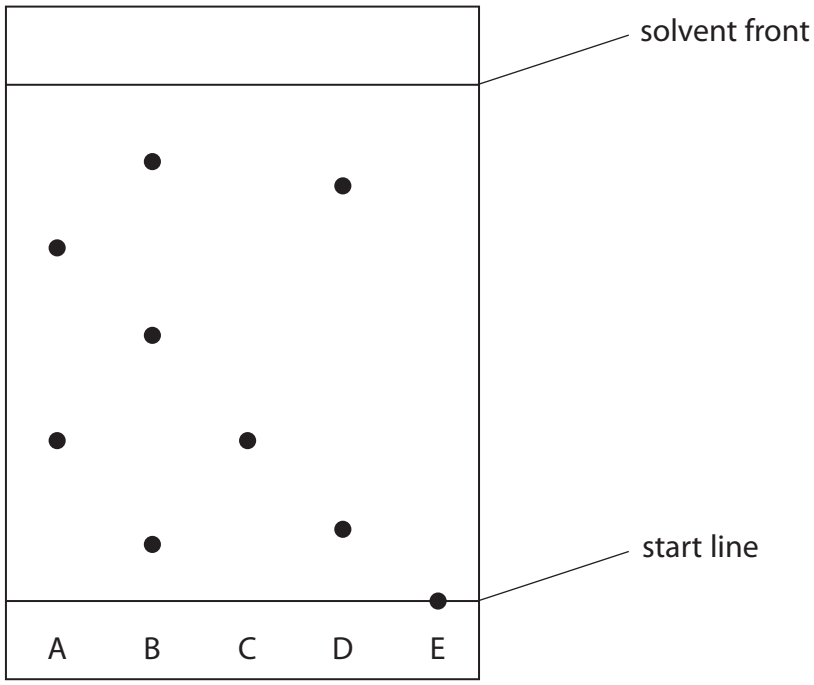
- a piece of chromatography paper
- a beaker
- a solvent
- inks A, B, C, D and E

(a) Describe how the student should set up the apparatus and do the experiment.

You may use a diagram to help your answer.

(5)

(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)

(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)

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(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.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(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)

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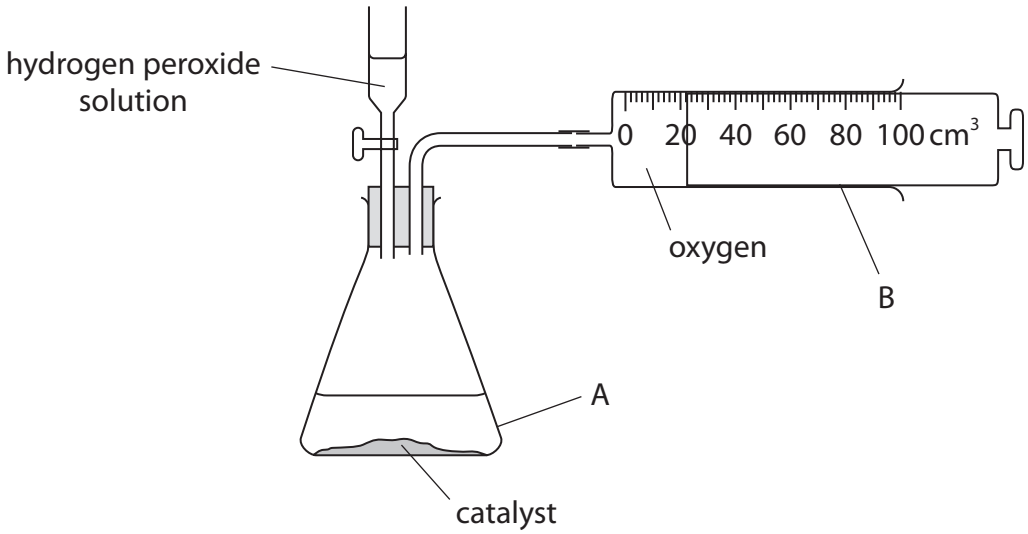
.....

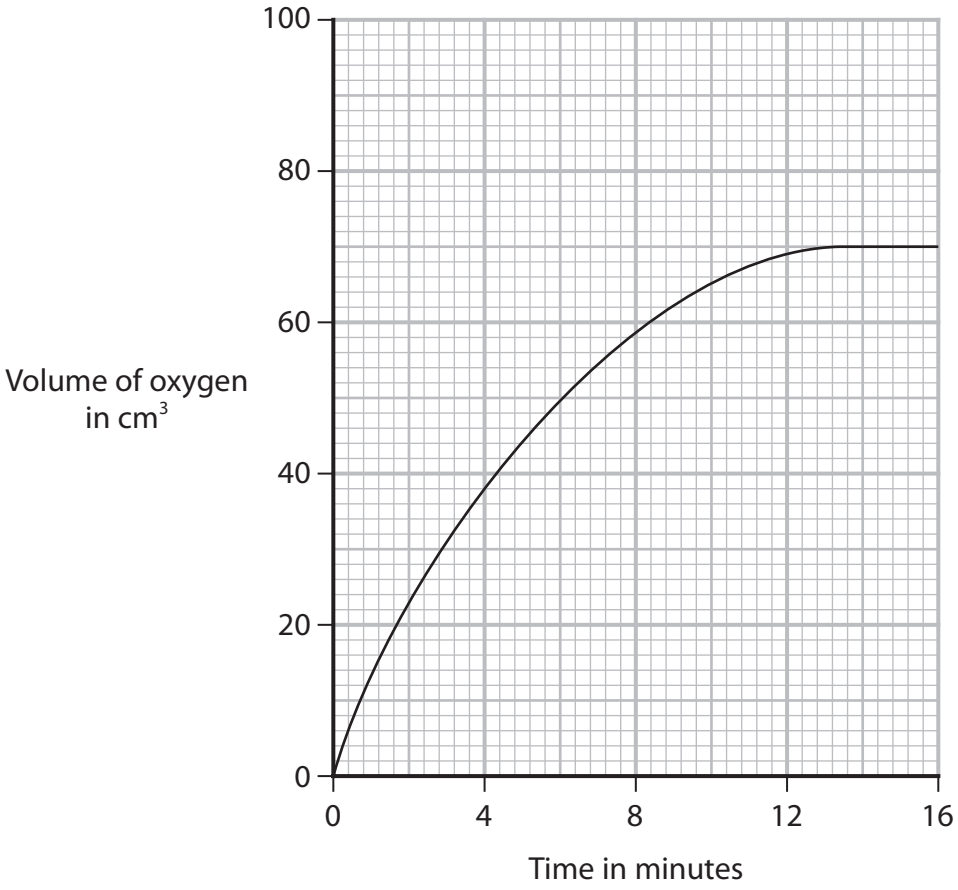
(c) A student uses this apparatus to investigate the rate of decomposition of hydrogen peroxide solution.



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)

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-}	$(NH_4)_2SO_4$		$Al_2(SO_4)_3$
N^{3-}		Zn_3N_2	AlN

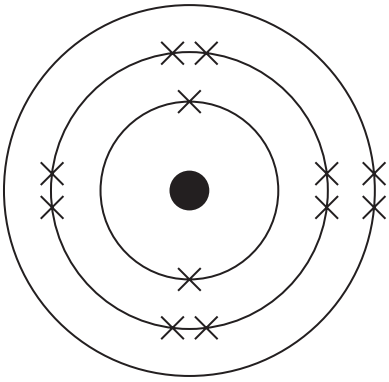
(i) Complete the table by giving the three missing formulae.

(3)

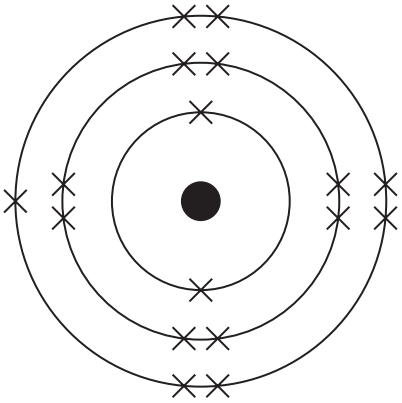
(ii) Give the name of the compound with the formula $Al_2(SO_4)_3$

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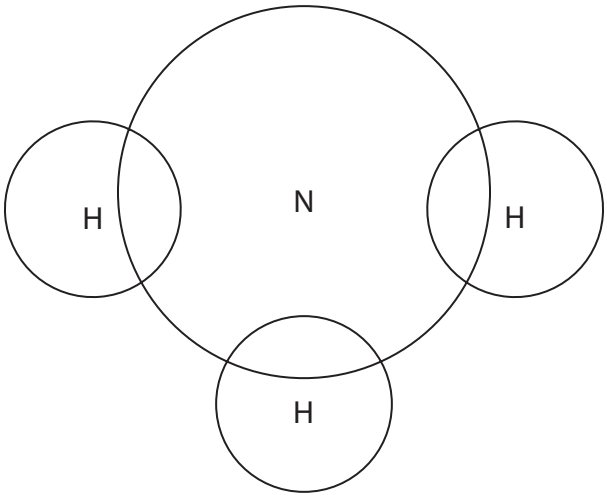
Describe, in terms of electrons, what happens when magnesium atoms and chlorine atoms form magnesium chloride.

(3)

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

(2)



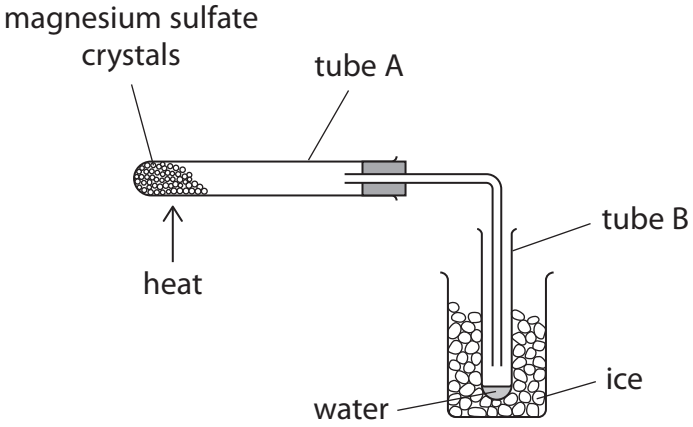
(ii) Describe the forces of attraction in a covalent bond.

(2)

(Total for Question 6 = 11 marks)

7 Magnesium sulfate crystals have the formula $MgSO_4.xH_2O$

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.

$$MgSO_4.xH_2O \rightarrow MgSO_4 + xH_2O$$

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 $MgSO_4.xH_2O$

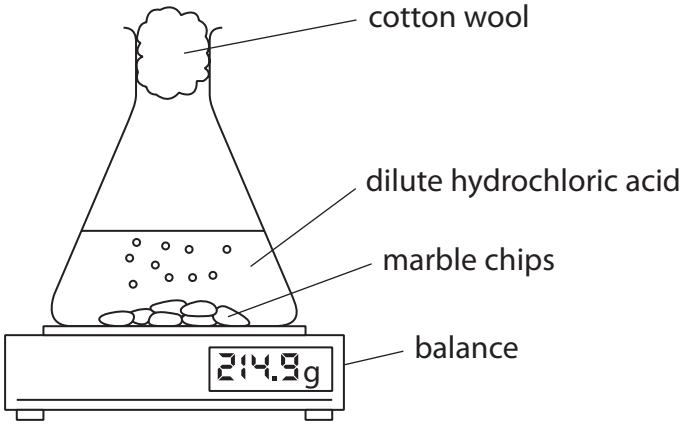
[for $MgSO_4$, $M_r = 120$ for H_2O, $M_r = 18$]

(4)

x = ...

(Total for Question 7 = 8 marks)

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.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

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

(1)

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

(2)

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

Give a reason why the reaction stops.

(1)

(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)

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(Total for Question 8 = 9 marks)

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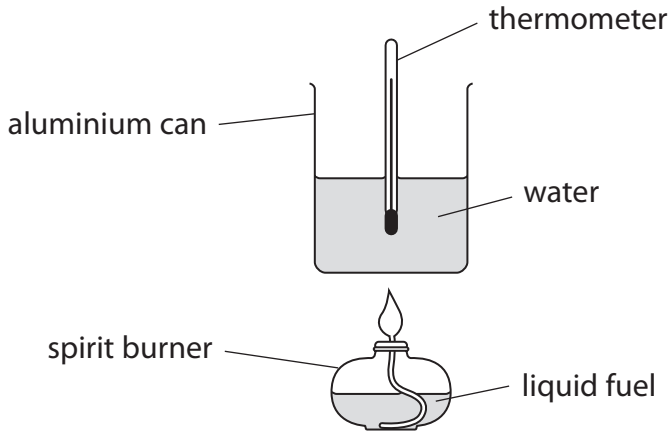
9 A student uses this apparatus to investigate the heat energy released when a liquid fuel burns.



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)

.....

.....

(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 J/g/°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)

ΔH = ... kJ/mol

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

This is an equation for the incomplete combustion of butanol.

$$C_4H_9OH(l) + \ldots\ldots O_2(g) \rightarrow 2CO_2(g) + 2CO(g) + 5H_2O(g)$$

(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)

$C_2H_6 + Br_2 \rightarrow$ ..... + ...

condition

.....

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

(1)

.....

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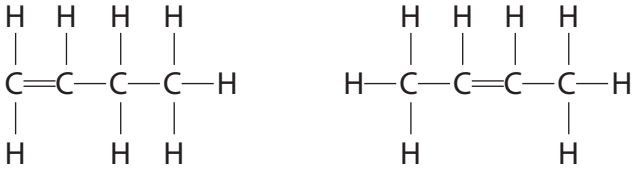
(b) The diagram shows the displayed formulae of two compounds in the homologous series of alkenes.



(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)

.....

.....

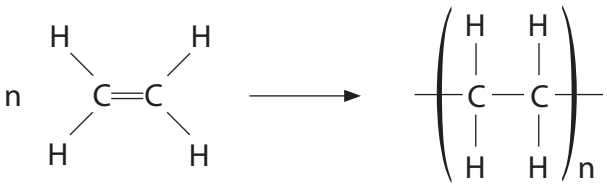
.....

.....

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

(1)

(c) The reaction used to make poly(ethene) can be represented by this equation.



Describe the differences between the reactant and the product in this reaction.

Refer to carbon chain length, type of bond and state of matter in your answer.

(3)

(Total for Question 10 = 12 marks)

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.

$$2PbO + C \rightarrow 2Pb + CO_2$$

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.

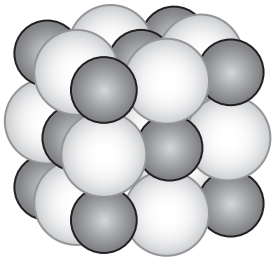
[1 tonne = 1×10^6 g]

[for PbO, $M_r = 223$ for CO_2, $M_r = 44$]

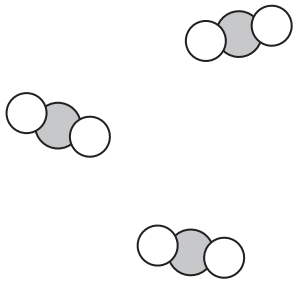
(3)

mass = ... tonnes

(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.

(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