Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Monday 22 May 2023

Morning (Time: 2 hours)

Paper reference 4CH1/1CR 4SD0/1CR

Chemistry

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

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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N:1/1/1/1/1/

P 7 1 9 5 1 A 0 1 3 2

Pearson

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.

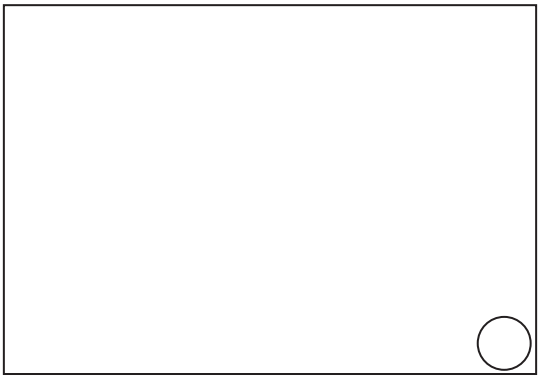
Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 This question is about oxygen.

(a) Oxygen can be stored in tanks as a liquid or as a gas.

(i) Complete the diagram to show the arrangement of six more particles in a gas.

(1)



(ii) Give a reason why a tank can store much more oxygen as a liquid.

(1)

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.....

(iii) Identify a hazard when storing oxygen as a gas.

(1)

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(b) Sulfur burns in oxygen to form sulfur dioxide.

(i) Give one observation that can be made when sulfur burns in oxygen.

(1)

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(ii) Some universal indicator is added to sulfur dioxide.

Explain the final colour of the universal indicator.

(2)

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(Total for Question 1 = 6 marks)

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2 This question is about mixtures and compounds.

(a) The box gives some techniques used to separate mixtures.

crystallisation	filtration
fractional distillation	simple distillation

The table lists some substances and mixtures.

Complete the table using words from the box to show the best technique to obtain the named substance from each mixture.

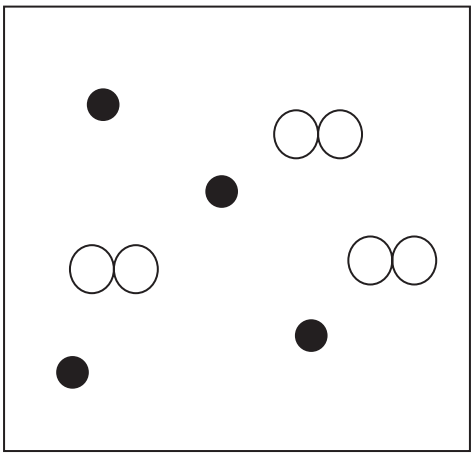
Each technique may be used once, more than once or not at all.

(3)

Substance	Mixture	Technique
solid sodium chloride	aqueous sodium chloride	
water	aqueous copper(II) sulfate	
sand	sand and water	

(b) State how the box represents a mixture.

(1)



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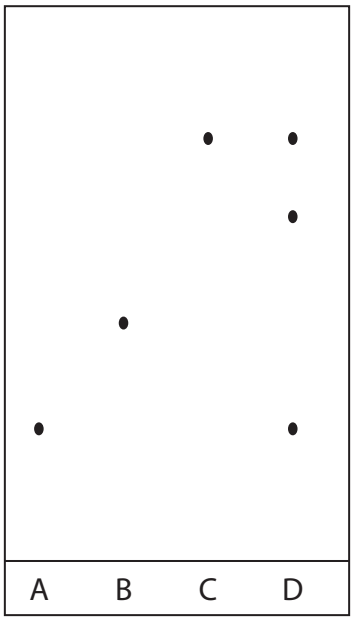
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(c) Food colourings are mixtures of food dyes.

A student uses paper chromatography to separate the food dyes contained in food colouring D.

The student places spots of three food dyes A, B and C and food colouring D on chromatography paper.

The diagram shows the appearance of the paper after the experiment.



Describe the composition of food colouring D.

(2)

(d) A compound has the formula $Ca(HCO_3)_2$

(i) Determine the number of different elements in $Ca(HCO_3)_2$

(1)

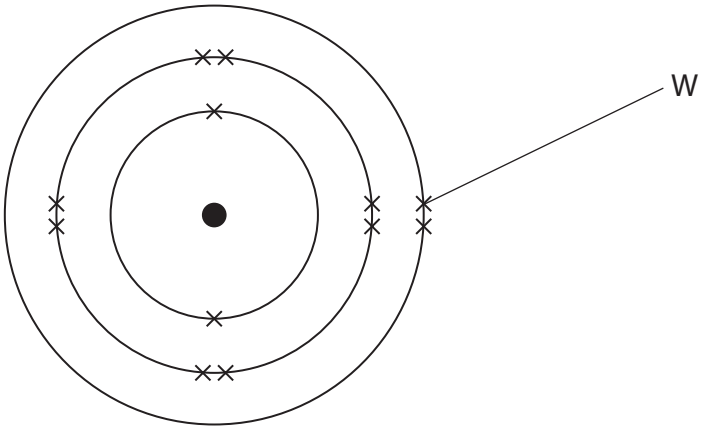
(ii) Determine the number of atoms in the formula of $Ca(HCO_3)_2$

(1)

(Total for Question 2 = 8 marks)

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3 (a) The diagram represents an atom of an element.



(i) What is the particle labelled W?

(1)

- ☒ **A** electron
- ☒ **B** neutron
- ☒ **C** nucleus
- ☒ **D** proton

(ii) An atom of this element contains 13 neutrons.

What is the mass number of this element?

(1)

- ☒ **A** 12
- ☒ **B** 13
- ☒ **C** 25
- ☒ **D** 49

(iii) State why atoms have no overall charge.

(1)

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(iv) What is the charge on the ion usually formed from this element?

(1)

- ☒ **A** 1+
- ☒ **B** 2+
- ☒ **C** 1–
- ☒ **D** 2–

(b) There are two isotopes of the element lithium.

$^{6}_{3}Li$ $^{7}_{3}Li$

(i) State why both isotopes react in the same way.

(1)

.....

.....

(ii) A sample of lithium contains 7.60% $^{6}_{3}Li$ and 92.4% $^{7}_{3}Li$

Calculate the relative atomic mass, A_r, of this sample of lithium.

Give your answer to two decimal places.

(3)

A_r = ...

(Total for Question 3 = 8 marks)

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4 This question is about gases.

(a) The table gives information about some gases.

Complete the table by choosing a gas from the box that matches the information.

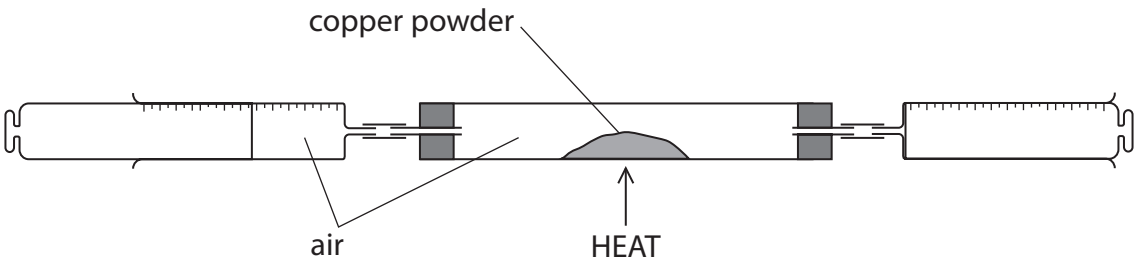
carbon dioxide	carbon monoxide	helium
methane	nitrogen	oxygen

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

(4)

Information	Gas
the most abundant gas in air	
a toxic gas that is a product of incomplete combustion of hydrocarbons	
an unreactive gas that exists as atoms	
a gas produced by the fractional distillation of crude oil	

(b) A teacher uses this apparatus to determine the percentage of oxygen in a sample of air.



This is the teacher's method.

- record the total volume of air in the apparatus
- heat the copper powder
- use the syringes to pass air over the heated copper powder several times
- allow the remaining gas to cool and record its volume

The copper powder turns black.

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(i) State why the copper powder turns black.

(1)

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(ii) Give a reason why the remaining gas is allowed to cool before its volume is recorded.

(1)

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(iii) At the start of the experiment, the total volume of air in the apparatus is 138 cm^3.

At the end of the experiment, the volume of gas remaining is 108 cm^3.

Calculate the percentage of oxygen in the sample of air.

Assume that all the oxygen has reacted.

(2)

percentage of oxygen = ... %

(Total for Question 4 = 8 marks)

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5 This question is about iron.

(a) One problem with iron is that it rusts.

(i) Name the two substances that iron reacts with when it rusts.

(2)

1 .....

2 .....

(ii) State what type of reaction occurs when iron rusts.

(1)

.....

(b) Iron can be prevented from rusting by painting or by coating with zinc.

(i) Explain how painting prevents iron from rusting.

(2)

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(ii) Name the process used to coat iron with zinc.

(1)

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(iii) Explain why a layer of zinc protects iron from rusting, even if the layer of zinc is scratched.

(2)

(c) Iron is formed when aluminium reacts with iron(III) oxide.

This is the equation for the reaction.

$$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$$

(i) Explain what this reaction shows about the relative reactivities of aluminium and iron.

(2)

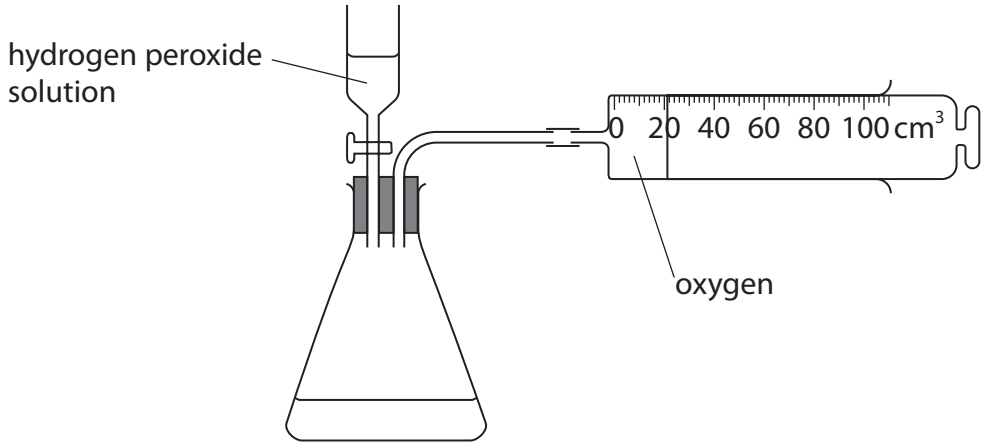
(ii) Explain which substance acts as an oxidising agent in this reaction.

(2)

(Total for Question 5 = 12 marks)

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6 A student uses this apparatus to investigate the rate of reaction when hydrogen peroxide solution decomposes.



This is the equation for the reaction.

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

(a) Give a reason why the gas that collects in the gas syringe is not pure oxygen.

(1)

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(b) The rate of reaction can be increased by adding a catalyst to the hydrogen peroxide solution.

Describe how a catalyst increases the rate of a reaction.

(2)

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(c) These solids catalyse the decomposition of hydrogen peroxide solution.

- lead(IV) oxide
- manganese(IV) oxide

Describe a method that the student could use to find out which solid is the more effective catalyst.

(5)

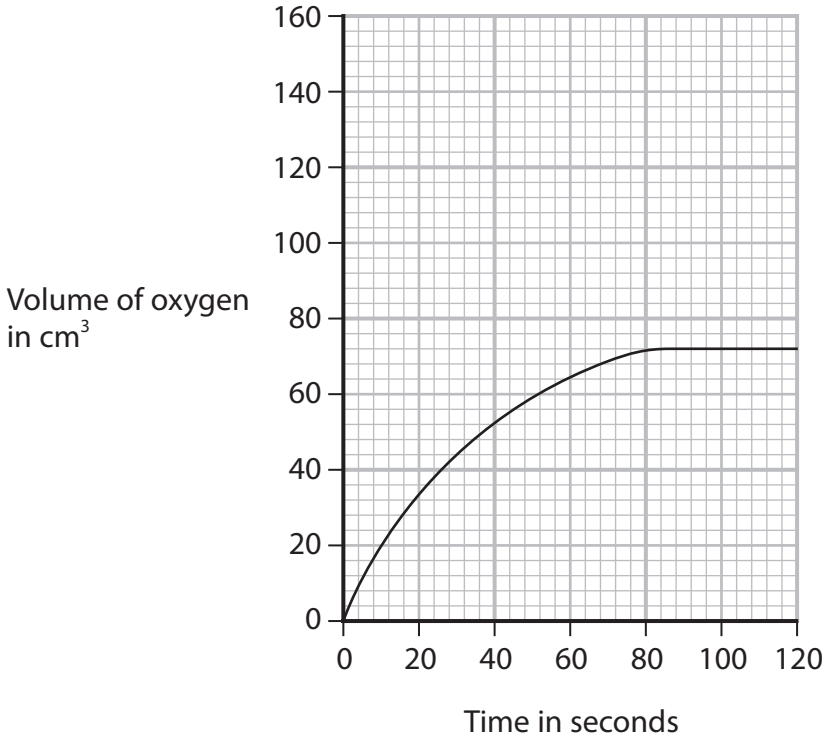
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(d) A student investigates the decomposition of a solution of hydrogen peroxide at different temperatures.

The graph shows how the total volume of oxygen collected in the syringe changes with time when the solution is at a temperature of 20 °C.



On the grid, draw the curve the student would obtain at a temperature of 40 °C when all other conditions are kept the same.

(2)

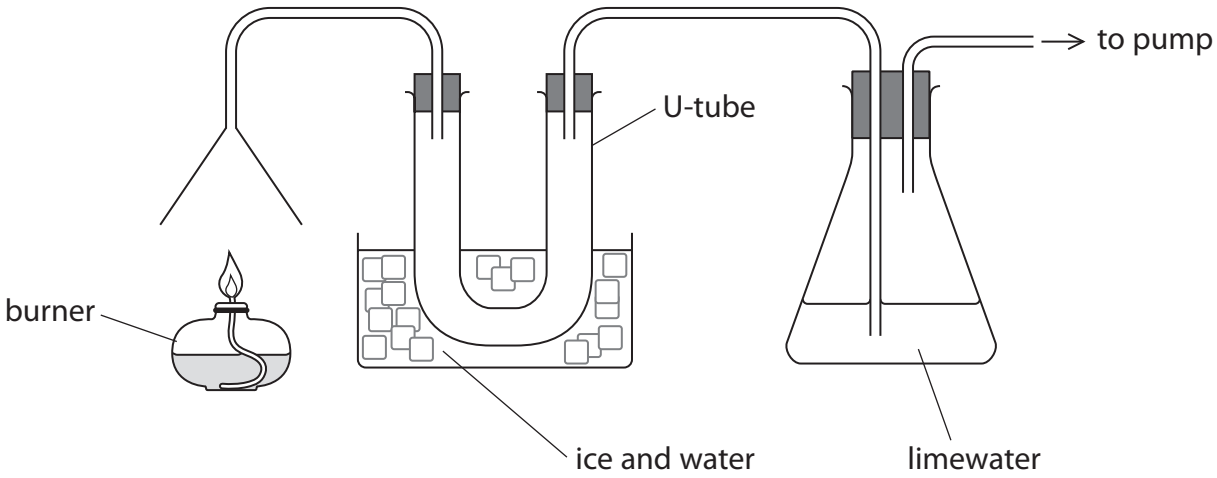
(Total for Question 6 = 10 marks)

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7 A teacher uses this apparatus to test the products of the combustion of liquid hydrocarbons.



(a) Explain the change in appearance that occurs in the limewater.

(2)

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(b) The equation represents the complete combustion of an alkene.

$$C_nH_{2n} + \text{oxygen} \rightarrow \text{carbon dioxide} + nH_2O$$

Complete combustion of 0.0100 mol of the alkene produces 2.16 g of water.

(i) Determine the molecular formula of this alkene.

[for H_2O, $M_r = 18$]

(3)

molecular formula = ...

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(ii) Give a reason why the mass of pure water that collects in the U-tube is less than 2.16 g.

(1)

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(iii) Give a physical test to show that the water that collects in the U-tube is pure.

(2)

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.....

.....

(c) The teacher burns 30.0 g of heptane.

This is the equation for the complete combustion of heptane.

$$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$$

Calculate the minimum mass of oxygen needed for the complete combustion of 30.0 g of heptane.

[for C_7H_{16}, $M_r = 100$ for O_2, $M_r = 32$]

(3)

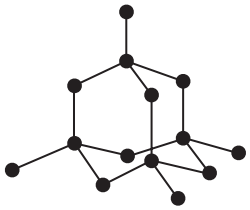
minimum mass of oxygen = ... g

(Total for Question 7 = 11 marks)

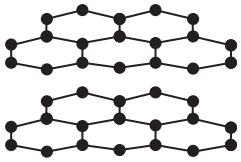
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8 Diamond, graphite and C_{60} fullerene are all forms of the element carbon.

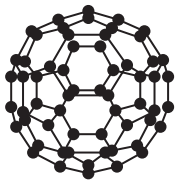
The diagram shows the structures of these three substances.



diamond



graphite



C_{60} fullerene

(a) Explain why graphite conducts electricity.

(2)

(b) Explain why diamond is hard but graphite is soft.

(2)

(c) Doctors use C_{60} fullerene to deliver medicines to certain parts of the body, so that the medicine does not damage other parts of the body.

Suggest why C_{60} fullerene is suitable for this purpose.

(1)

(Total for Question 8 = 5 marks)

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9 This question is about ionic compounds.

(a) Calcium nitrate has the formula $Ca(NO_3)_2$

(i) Give the formula of each ion in calcium nitrate.

(2)

calcium ion

.....

nitrate ion

.....

(ii) Explain why calcium nitrate has a high melting point.

Refer to structure and bonding in your answer.

(4)

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(iii) Calcium nitrate decomposes when heated.

Complete the chemical equation for the decomposition of calcium nitrate.

(1)

.....$Ca(NO_3)_2$ → .....CaO + ...NO_2 + ...O_2

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(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

These are the four salt solutions.

- calcium bromide
- calcium chloride
- sodium chloride
- sodium sulfate

Describe a series of tests to identify each solution.

Do not refer to safety precautions in your answer.

(6)

(Total for Question 9 = 13 marks)

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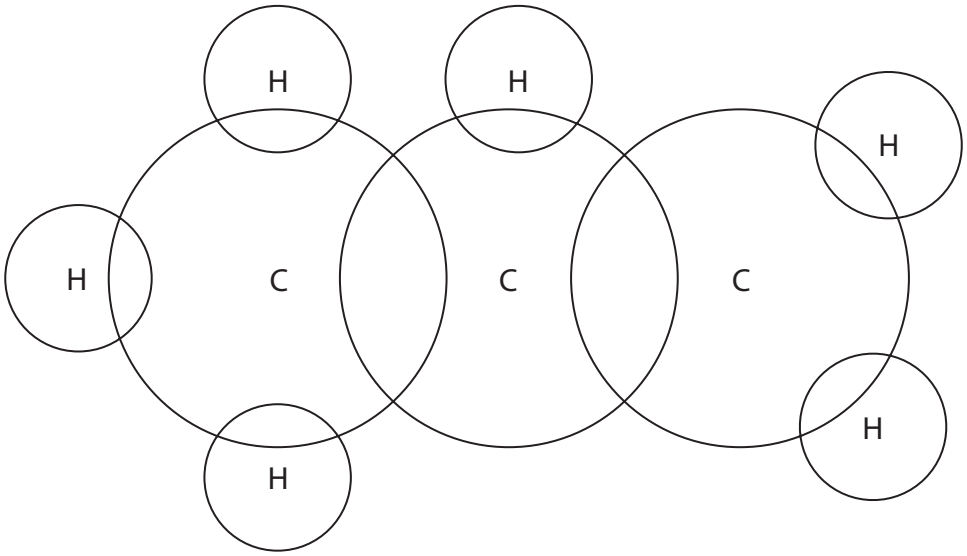
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10 This question is about propene.

(a) (i) The structural formula of propene is $CH_3CH{=}CH_2$

Complete the dot-and-cross diagram for a molecule of propene.

(2)



(ii) Describe the forces of attraction that hold the atoms together in a molecule of propene.

(2)

(b) The alkane pentadecane has the formula $C_{15}H_{32}$

Describe how propene can be produced from pentadecane.

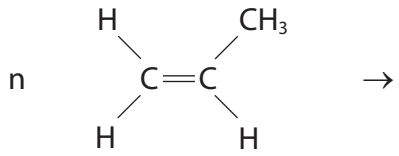
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(c) Propene is used to make poly(propene).

(i) Complete the equation for the formation of poly(propene).

(2)



(ii) Explain why the disposal of poly(propene) in landfill sites is a problem.

(2)

.....

.....

.....

.....

(d) Propene can be converted into compound X.

(i) Compound X contains these percentages by mass.

- carbon 60%
- hydrogen 13.3%
- oxygen 26.7%

Compound X has an M_r of 60

Determine the molecular formula of compound X.

(3)

molecular formula = ...

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(ii) Propene and compound X both have simple molecular structures.

Explain why compound X has a higher boiling point than propene.

(2)

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(Total for Question 10 = 15 marks)

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11 A student uses this method to investigate the temperature change when solid sodium hydrogencarbonate is added to ethanoic acid solution.

- pour 100 cm^3 of ethanoic acid solution into a polystyrene cup
- record the temperature of the ethanoic acid solution
- add a 1 g portion of sodium hydrogencarbonate to the ethanoic acid solution and stir
- record the new temperature
- add further 1 g portions of sodium hydrogencarbonate, stirring and recording the temperature after each portion is added

The table shows the student's results.

Mass of sodium hydrogencarbonate added in g	Temperature in °C
0	20.8
1	19.4
2	18.1
3	18.0
4	16.4
5	15.8
6	15.3
7	15.3
8	15.3

(a) (i) Plot the student's results on the grid.

(1)

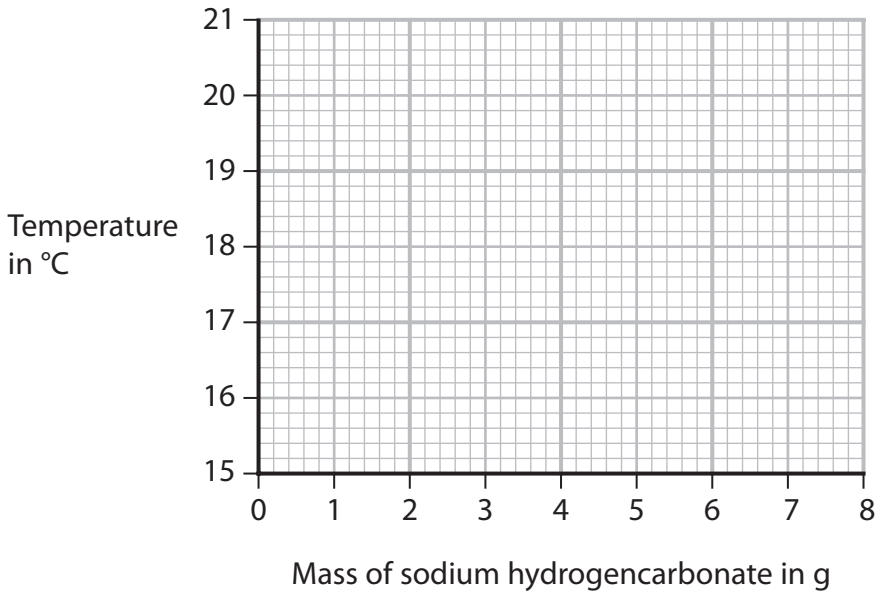
(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a curve of best fit.

(1)

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(b) (i) Explain why using a polystyrene cup makes the results more accurate.

(2)

(ii) Suggest a mistake the student might have made to cause the anomalous result.

(1)

(iii) State how the results show the reaction is complete.

(1)

(iv) State how the results show that the reaction is endothermic.

(1)

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(c) Use the results to calculate the heat energy change, Q, in joules.

[for 1.0 cm^3 of ethanoic acid solution, mass = 1.0 g]

[for ethanoic acid solution, c = 4.2 J / g / °C]

(2)

Q = ... J

(d) The student repeats the experiment starting with a different volume of ethanoic acid solution.

The student uses 7.0 g of sodium hydrogencarbonate to neutralise the ethanoic acid solution.

The heat energy change, Q, is 3200 J.

Calculate the molar enthalpy change, ΔH, in kJ / mol.

Include a sign with your answer.

[for sodium hydrogencarbonate, M_r = 84]

(4)

ΔH = ... kJ / mol

(Total for Question 11 = 14 marks)

TOTAL FOR PAPER = 110 MARKS

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