

Please check the examination details below before entering your candidate information

Candidates 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
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Chemistry

UNIT: 4CH1

Science (Double Award) 4SD0

PAPER: 1CR

You must have: Calculator, ruler	Total Marks
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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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The Periodic Table of the Elements

1	2	3	4	5	6	7	0																								
7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18																						
19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36														
37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	43 Tc technetium 43	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54	55 Cs caesium 55													
55 Fr francium 87	56 Ba barium 56	57 La* lanthanum 57	58 Ce cerium 58	59 Pr praseodymium 59	60 Nd neodymium 60	61 Pm promethium 61	62 Sm samarium 62	63 Eu europium 63	64 Gd gadolinium 64	65 Tb terbium 65	66 Dy dysprosium 66	67 Ho holmium 67	68 Er erbium 68	69 Tm thulium 69	70 Yb ytterbium 70	71 Lu lutetium 71	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 Rn radon 86
87 Fr francium 87	88 Ra radium 88	89 Ac* actinium 89	90 Th thorium 90	91 Pa protactinium 91	92 U uranium 92	93 Np neptunium 93	94 Pu plutonium 94	95 Am americium 95	96 Cm curium 96	97 Bk berkelium 97	98 Cf californium 98	99 Es einsteinium 99	100 Fm fermium 100	101 Md mendelevium 101	102 No nobelium 102	103 Lr lawrencium 103	104 Rf rutherfordium 104	105 Db dubnium 105	106 Sg seaborgium 106	107 Bh bohrium 107	108 Hs hassium 108	109 Mt meitnerium 109	110 Ds darmstadtium 110	111 Rg roentgenium 111	112 Cn copernicium 112	113 Nh nihonium 113	114 Fl flerovium 114	115 Mc moscovium 115	116 Lv livermorium 116	117 Ts tennessine 117	118 Og oganesson 118
119 Fr francium 119	120 Ra radium 120	121 Ac actinium 121	122 Th thorium 122	123 Pa protactinium 123	124 U uranium 124	125 Np neptunium 125	126 Pu plutonium 126	127 Am americium 127	128 Cm curium 128	129 Bk berkelium 129	130 Cf californium 130	131 Es einsteinium 131	132 Fm fermium 132	133 Md mendelevium 133	134 No nobelium 134	135 Lr lawrencium 135	136 Rf rutherfordium 136	137 Db dubnium 137	138 Sg seaborgium 138	139 Bh bohrium 139	140 Hs hassium 140	141 Mt meitnerium 141	142 Ds darmstadtium 142	143 Rg roentgenium 143	144 Cn copernicium 144	145 Nh nihonium 145	146 Fl flerovium 146	147 Mc moscovium 147	148 Lv livermorium 148	149 Ts tennessine 149	150 Og oganesson 150
151 Fr francium 151	152 Ra radium 152	153 Ac actinium 153	154 Th thorium 154	155 Pa protactinium 155	156 U uranium 156	157 Np neptunium 157	158 Pu plutonium 158	159 Am americium 159	160 Cm curium 160	161 Bk berkelium 161	162 Cf californium 162	163 Es einsteinium 163	164 Fm fermium 164	165 Md mendelevium 165	166 No nobelium 166	167 Lr lawrencium 167	168 Rf rutherfordium 168	169 Db dubnium 169	170 Sg seaborgium 170	171 Bh bohrium 171	172 Hs hassium 172	173 Mt meitnerium 173	174 Ds darmstadtium 174	175 Rg roentgenium 175	176 Cn copernicium 176	177 Nh nihonium 177	178 Fl flerovium 178	179 Mc moscovium 179	180 Lv livermorium 180	181 Ts tennessine 181	182 Og oganesson 182
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247 Fr francium 247	248 Ra radium 248	249 Ac actinium 249	250 Th thorium 250	251 Pa protactinium 251	252 U uranium 252	253 Np neptunium 253	254 Pu plutonium 254	255 Am americium 255	256 Cm curium 256	257 Bk berkelium 257	258 Cf californium 258	259 Es einsteinium 259	260 Fm fermium 260	261 Md mendelevium 261	262 No nobelium 262	263 Lr lawrencium 263	264 Rf rutherfordium 264	265 Db dubnium 265	266 Sg seaborgium 266	267 Bh bohrium 267	268 Hs hassium 268	269 Mt meitnerium 269	270 Ds darmstadtium 270	271 Rg roentgenium 271	272 Cn copernicium 272	273 Nh nihonium 273	274 Fl flerovium 274	275 Mc moscovium 275	276 Lv livermorium 276	277 Ts tennessine 277	278 Og oganesson 278
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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)

(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)

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

Explain the final colour of the universal indicator.

(2)

(Total for Question 1 = 6 marks)



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.

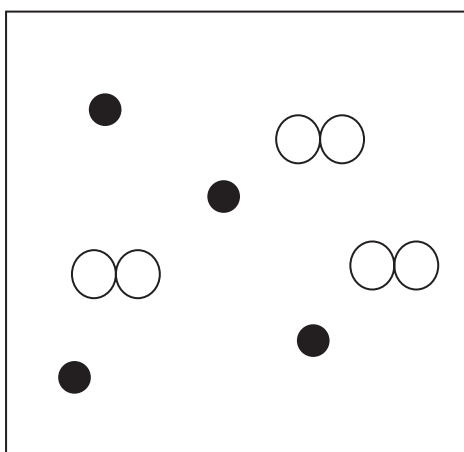
Each technique may be used once, more than once or not at all.

(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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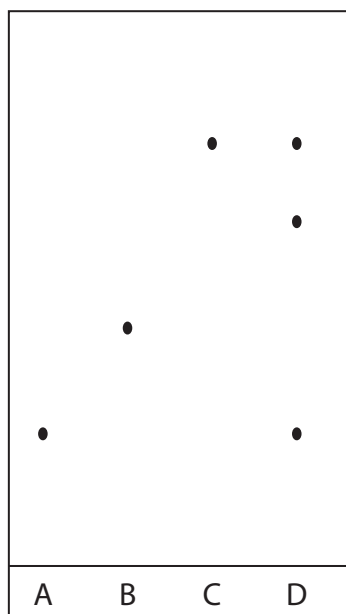
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(c) Food colourings are mixtures of food dyes.

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 $\text{Ca}(\text{HCO}_3)_2$

(i) Determine the number of different elements in $\text{Ca}(\text{HCO}_3)_2$

(1)

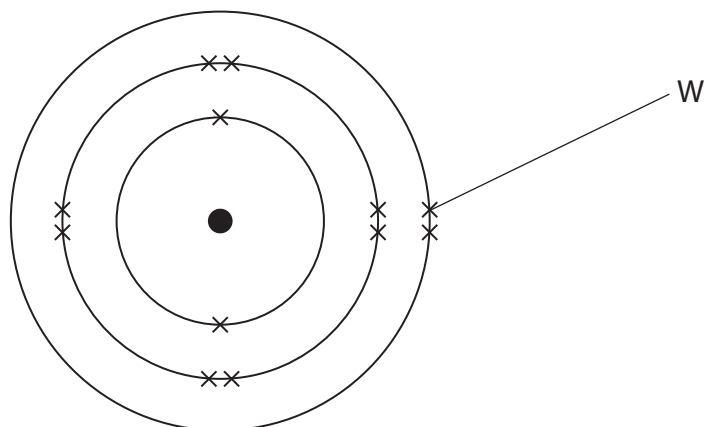
(ii) Determine the number of atoms in the formula of $\text{Ca}(\text{HCO}_3)_2$

(1)

(Total for Question 2 = 8 marks)



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)

.....

.....

.....



(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.



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

(1)

(ii) A sample of lithium contains 7.60% ${}^6_3\text{Li}$ and 92.4% ${}^7_3\text{Li}$

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)



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.

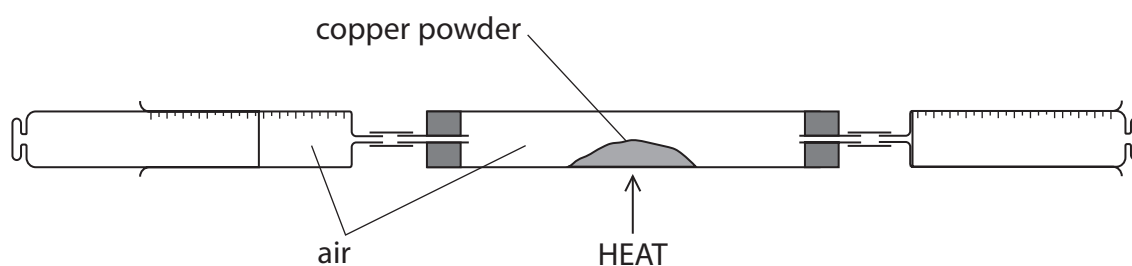
carbon dioxide	carbon monoxide	helium
methane	nitrogen	oxygen

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)

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

(1)

(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)



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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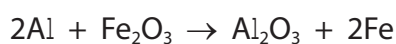
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(2)

This is the equation for the reaction.



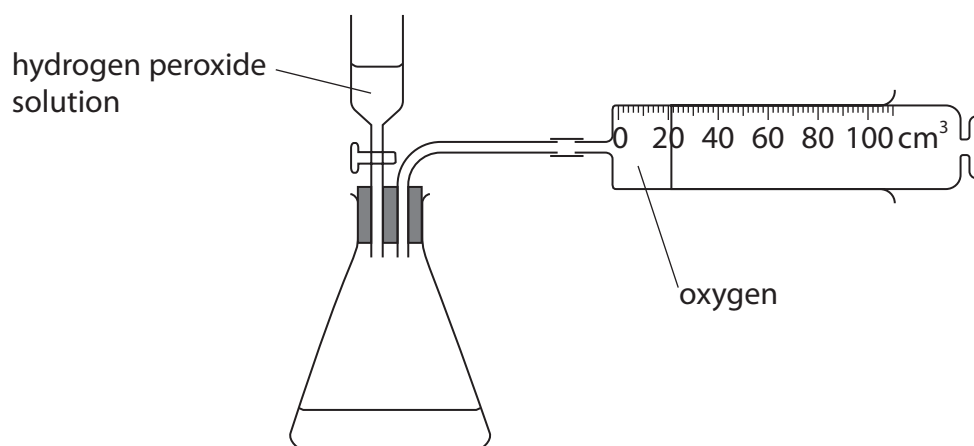
(2)

(2)

(Total for Question 5 = 12 marks)



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



This is the equation for the reaction.



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

(1)

- (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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(5)

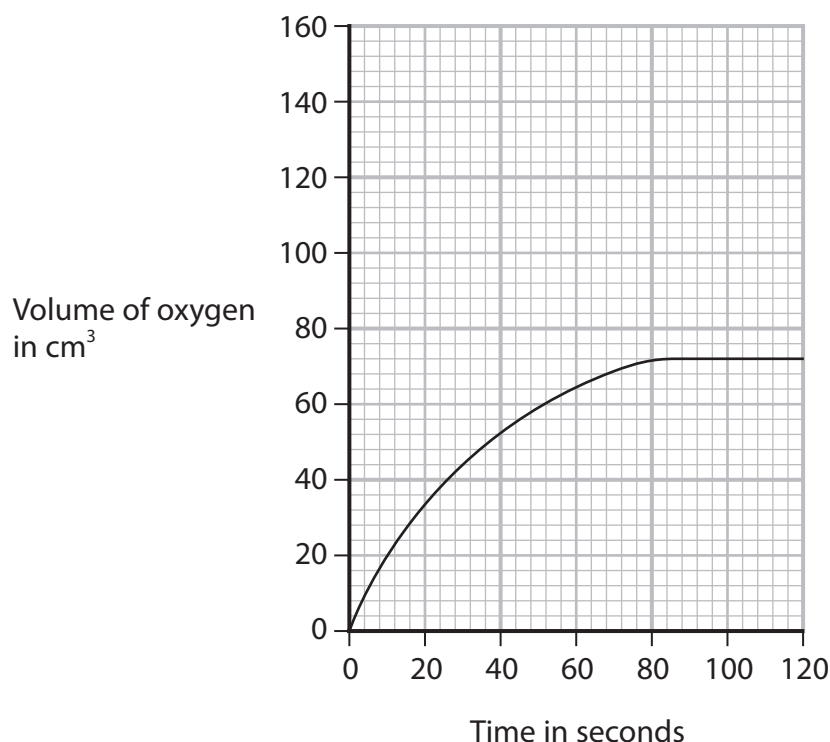
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- (d) A student investigates the decomposition of a solution of hydrogen peroxide at different temperatures.

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)

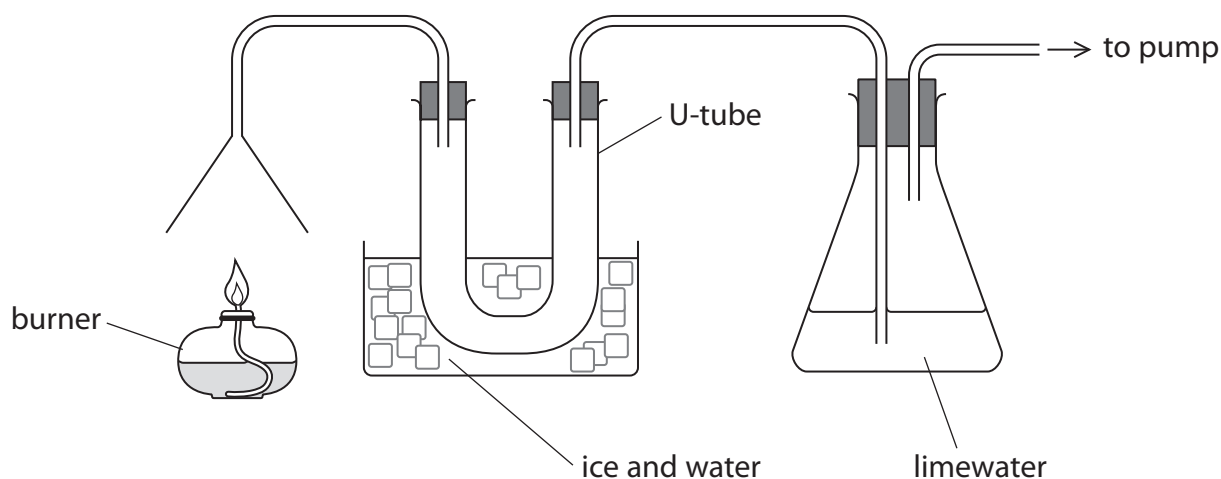
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- 7 A teacher uses this apparatus to test the products of the combustion of liquid hydrocarbons.



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

(2)

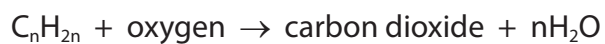
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- (b) The equation represents the complete combustion of an alkene.



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 =



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

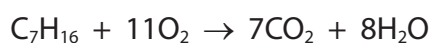
(1)

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

(2)

- (c) The teacher burns 30.0 g of heptane.

This is the equation for the complete combustion of heptane.



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)

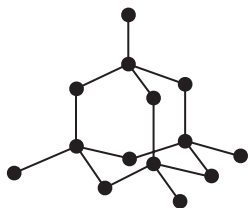
minimum mass of oxygen = g

(Total for Question 7 = 11 marks)

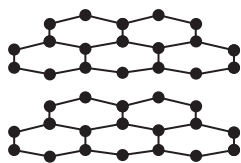


8 Diamond, graphite and C_{60} fullerene are all forms of the element carbon.

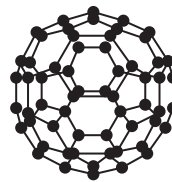
The diagram shows the structures of these three substances.



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)

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(Total for Question 8 = 5 marks)



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9 This question is about ionic compounds.

(a) Calcium nitrate has the formula $\text{Ca}(\text{NO}_3)_2$

(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)

(iii) Calcium nitrate decomposes when heated.

Complete the chemical equation for the decomposition of calcium nitrate.

(1)



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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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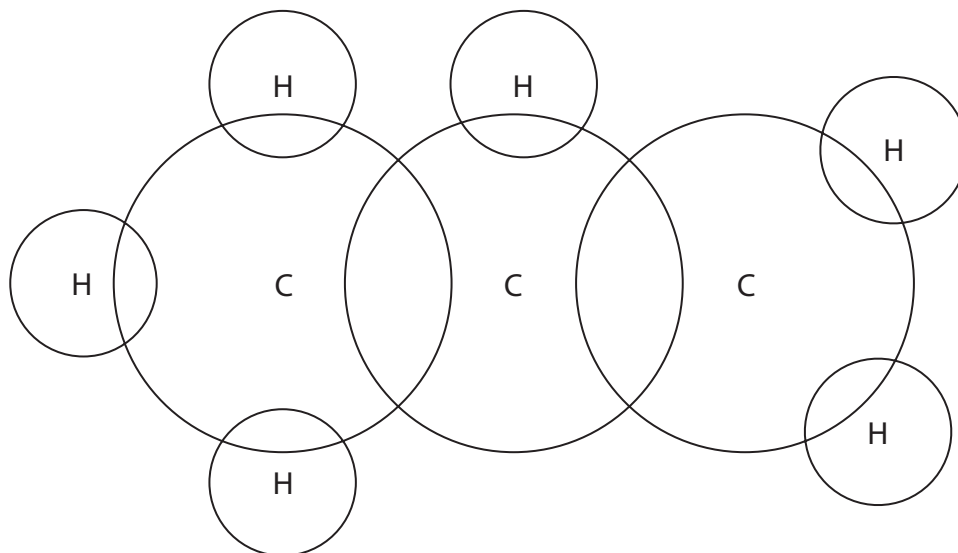
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10 This question is about propene.

- (a) (i) The structural formula of propene is $\text{CH}_3\text{CH}=\text{CH}_2$

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)

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- (b) The alkane pentadecane has the formula $\text{C}_{15}\text{H}_{32}$

Describe how propene can be produced from pentadecane.

(2)

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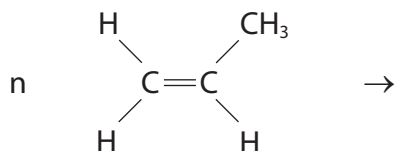
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(c) Propene is used to make poly(propene).

(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)

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.....

(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 =



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

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

(2)

(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 $^{\circ}\text{C}$
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.

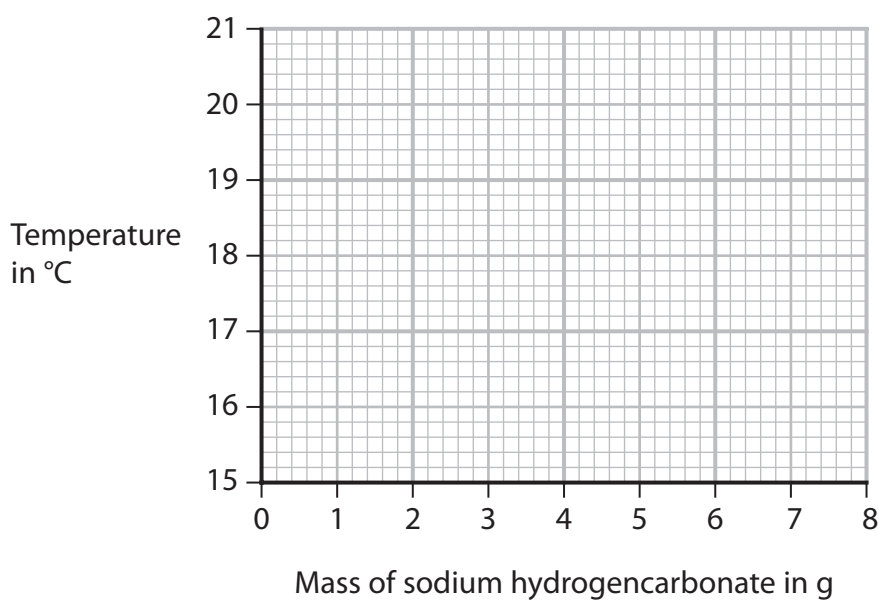
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(b) (i) Explain why using a polystyrene cup makes the results more accurate.

(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)



P 7 1 9 5 1 A 0 2 9 3 2

- (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, $c = 4.2\text{ J/g/}^\circ\text{C}$]

(2)

$Q = \dots\dots\dots\text{ J}$

- (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)

$\Delta H = \dots\dots\dots\text{ kJ/mol}$

(Total for Question 11 = 14 marks)

TOTAL FOR PAPER = 110 MARKS



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