



Answer ALL questions. Write your answers in the spaces provided.

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 (a) The two most common gases in today's atmosphere are nitrogen and oxygen.

(i) What is the third most common gas in today's atmosphere? (1)

- A argon
- B butane
- C chlorine
- D hydrogen

(ii) What is the percentage of oxygen in today's atmosphere? (1)

- A 0.04
- B 1
- C 21
- D 78

(b) Give the name of the most common gas in the Earth's **early** atmosphere. (1)

.....

(c) This early atmosphere was hot and contained water vapour.  
The atmosphere today contains less water vapour.

Explain what caused the amount of water vapour in the atmosphere to decrease. (2)

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- (d) The concentration of carbon dioxide in the atmosphere can be measured in parts per million (ppm).

Figure 1 shows the measurements in January 2018 and January 2019.

	concentration of carbon dioxide in ppm
January 2018	407.96
January 2019	410.83

**Figure 1**

- (i) Calculate the increase in the concentration, in ppm, of carbon dioxide from January 2018 to January 2019.

Give your answer to the nearest whole number.

(2)

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.....

.....

increase in concentration of carbon dioxide = ..... ppm

- (ii) Give a possible cause for this increase in the concentration of carbon dioxide.

(1)

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**(Total for Question 1 = 8 marks)**



- 2 (a) Figure 2 shows information about three different materials, a composite, a glass and a metal.

	a composite	a glass	a metal
density	low	high	high
ability to conduct electricity	poor	poor	good
resistance to corrosion	good	good	poor

Figure 2

Explain which material in Figure 2 is the most suitable material to use in electrical circuits.

(2)

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- (b) (i) Nanoparticles are very small.

Some nanoparticles have a radius of 17 nm.  
The radius of a magnesium atom is 0.16 nm.

Approximately how many times larger is the radius of these nanoparticles than the radius of the magnesium atom?

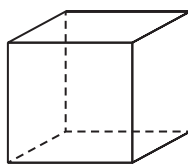
(1)

- A 0.01
- B 0.10
- C 10
- D 100



- (ii) A catalyst contains cube-shaped nanoparticles.  
Figure 3 shows a diagram of a cube-shaped nanoparticle.

The length of each side of the cube is 9 nm.



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**Figure 3**

Calculate the surface area of the cube, in  $\text{nm}^2$ .

(2)

.....

.....

.....

surface area = .....  $\text{nm}^2$

- (iii) Nanoparticles have many uses.  
Some scientists are concerned about the possible risks of using nanoparticles.

Give **one** possible risk of using nanoparticles.

(1)

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**(Total for Question 2 = 6 marks)**

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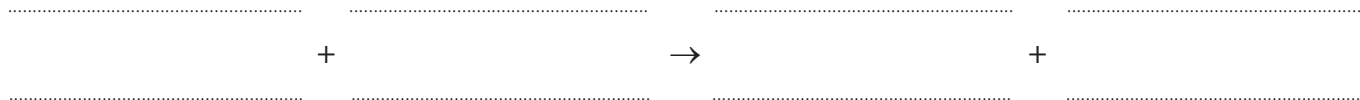


3 (a) A student investigated the reaction between potassium iodide and lead nitrate.

- (i) Solutions of potassium iodide and lead nitrate were mixed together. Lead iodide and potassium nitrate were formed.

Complete the word equation.

(2)



- (ii) The student recorded the total mass of the reactants and the total mass of the products.

The results are shown in Figure 4.

	reactants	products
total mass in g	21.7	21.7

Figure 4

State how the results in Figure 4 show that mass is conserved in this reaction.

(1)

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.....



- (b) In another experiment, a student investigated the temperature decrease when different amounts of ammonium nitrate crystals were dissolved in  $100\text{ cm}^3$  of water.

The apparatus used is shown in Figure 5.

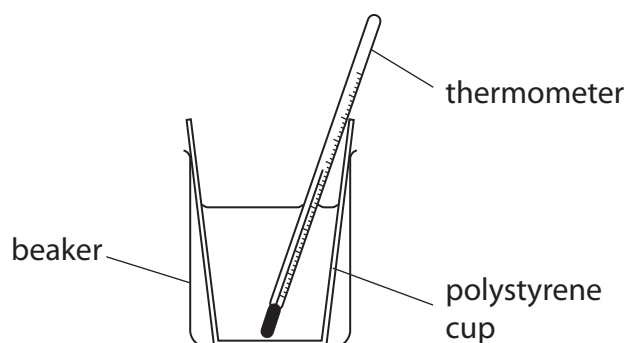


Figure 5

The student used the following method.

**step 1** pour  $100\text{ cm}^3$  of water into the polystyrene cup

**step 2** add one spatula of ammonium nitrate crystals to the water

**step 3** stir the mixture

**step 4** use the thermometer to record the lowest temperature reached by the mixture

**step 5** repeat steps 1 to 4 using different amounts of ammonium nitrate

- (i) Name a piece of apparatus that should be used to measure the  $100\text{ cm}^3$  of water in **step 1**.

(1)

- (ii) The student cannot work out the temperature decrease using the method described.

State what the student must do before **step 2** to be able to work out the temperature decrease.

(1)

- (iii) State why a polystyrene cup is used in this experiment.

(1)



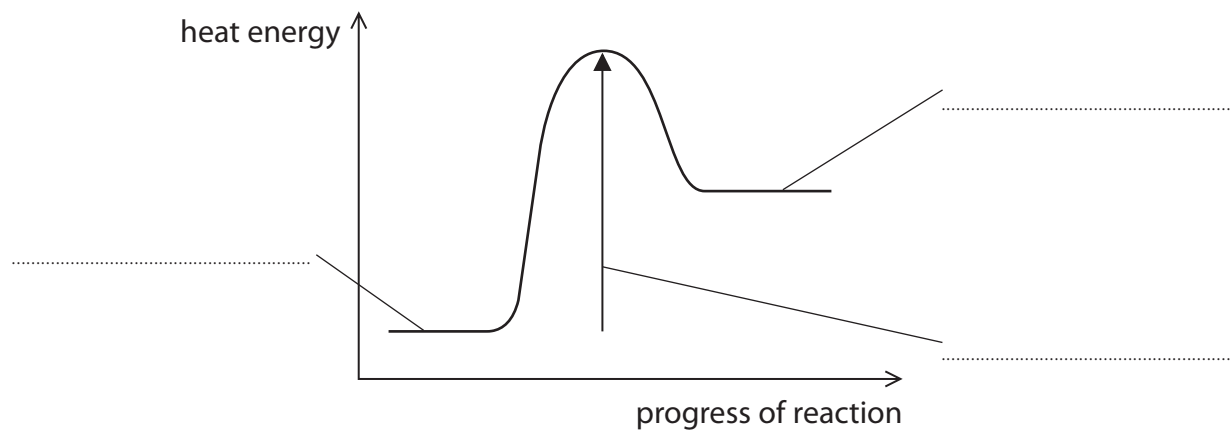


(iv) Figure 6 shows the reaction profile for this reaction.

Use the words from the box to complete the labels on Figure 6.

activation energy	products	reactants
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(2)



**Figure 6**

**(Total for Question 3 = 8 marks)**

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4 Tests are carried out to identify the ions in two solids, **P** and **Q**.

(a) A flame test is used to identify the metal ions in each of these solids.

(i) Describe how to do a flame test.

(2)

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.....

.....

.....

(ii) Different metal ions produce different coloured flames.

Draw one straight line from each metal ion to its flame colour.

(2)

**metal ion**

**flame colour**

	● green
calcium ●	● yellow
	● lilac
potassium ●	● orange-red
	● blue-green



(b) **P** and **Q** dissolve in water to form colourless solutions.

Figure 7 shows the results of tests on these solutions.

test	results	
	solution of P	solution of Q
dilute hydrochloric acid added, then barium chloride solution	a white precipitate	remains colourless
dilute nitric acid added, then silver nitrate solution	remains colourless	a yellow precipitate

**Figure 7**

(i) The anions in solutions of **P** and **Q** can be identified from the results of the tests shown in Figure 7.

Draw one straight line from each solution to the anion present.

(2)

solution	anion
	● bromide
● solution of <b>P</b>	● carbonate
	● chloride
● solution of <b>Q</b>	● iodide
	● sulfate

(ii) The formula of barium chloride is  $\text{BaCl}_2$ .

Give the total number of ions in the formula  $\text{BaCl}_2$ .

(1)

.....



(c) A few drops of sodium hydroxide solution are added to a solution of iron(II) sulfate. Iron(II) hydroxide is formed.

(i) State what would be **seen**.

(2)

(ii) One other product is formed in this reaction.

What is the name of this other product?

(1)

- A iron(II) chloride
- B sodium chloride
- C sodium sulfate
- D water

**(Total for Question 4 = 10 marks)**



5 Chlorine, bromine and iodine are elements in group 7 of the periodic table.

(a) Chlorine is toxic.

State **one** safety precaution that should be taken when using chlorine in the laboratory. (1)

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.....

(b) Chlorine reacts with hydrogen to form hydrogen chloride.

(i) Write the word equation for this reaction. (1)

..... → .....

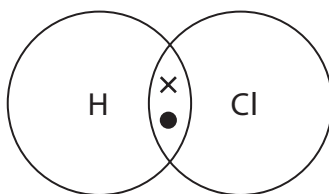
(ii) Hydrogen chloride dissolves in water to form an acidic solution.

State what is **seen** when blue litmus paper is placed into this solution. (1)

.....

(iii) A chlorine atom has seven electrons in its outer shell.  
A hydrogen atom has one electron in its outer shell.

Complete the dot and cross diagram of a molecule of hydrogen chloride. Show outer shell electrons only. (1)

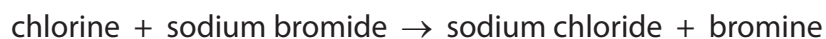


(iv) Name the type of bonding in a molecule of hydrogen chloride. (1)

.....



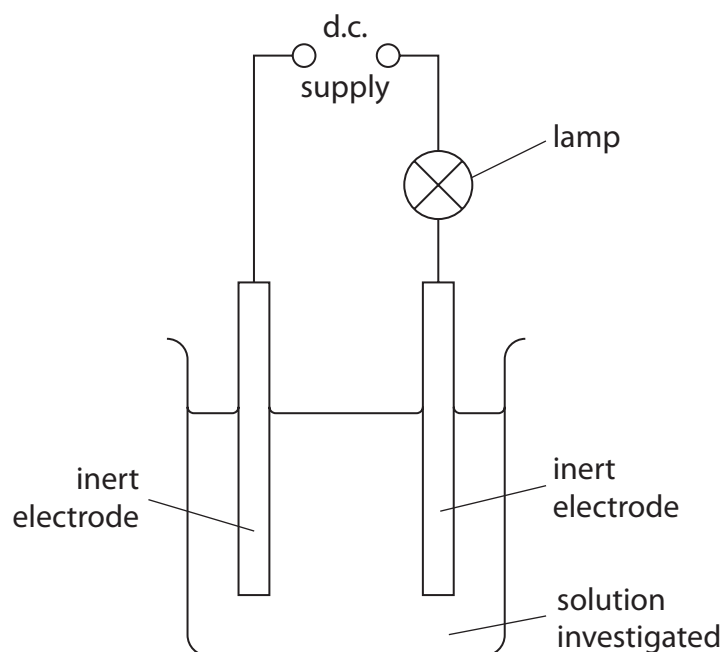
(c) If chlorine solution is added to sodium bromide solution a reaction occurs.



Give a reason why this reaction occurs.

(1)

(d) Figure 8 shows apparatus used to find out if a solution conducts electricity.



**Figure 8**

Glucose solution and sodium chloride solution are tested.  
Glucose is a typical simple molecular covalent compound.  
Sodium chloride is an ionic compound.

(i) State what would happen to the lamp when glucose solution is tested.

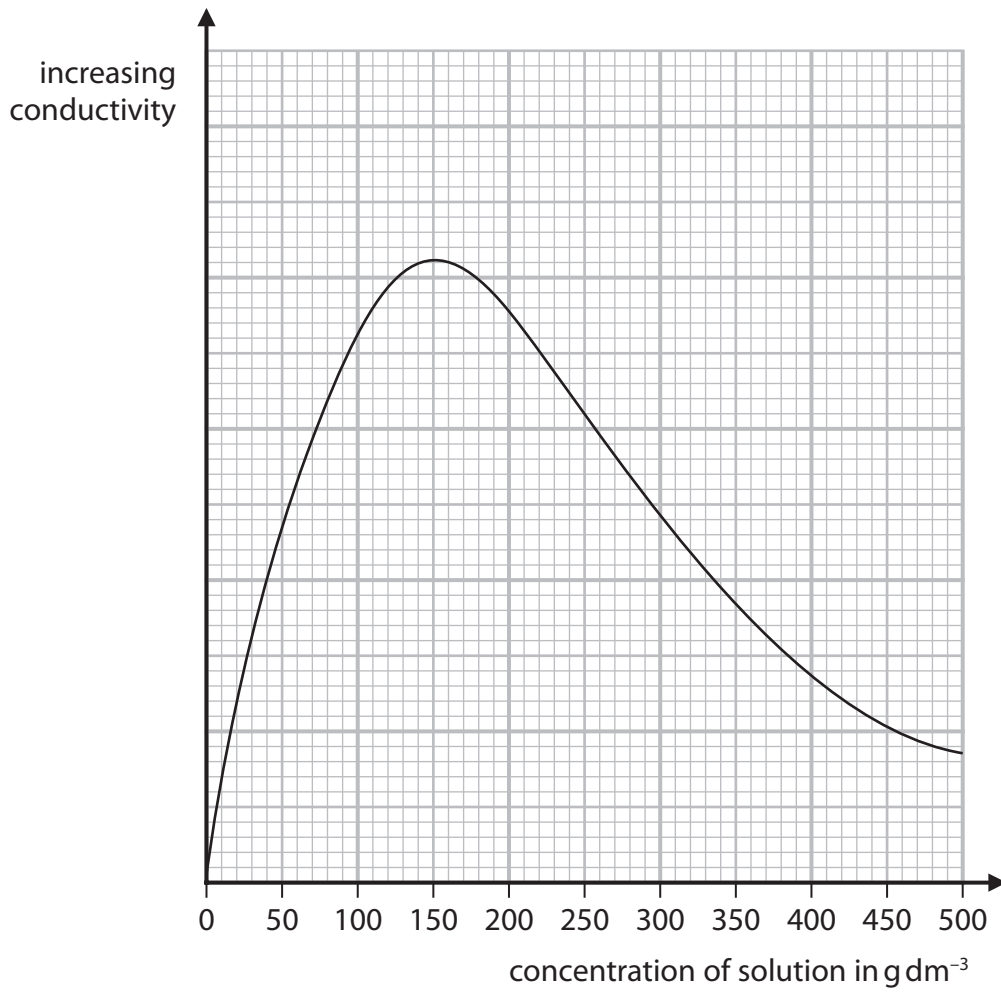
(1)

(ii) State what would happen to the lamp when sodium chloride solution is tested.

(1)



(e) Figure 9 shows how the conductivity of one solution changes as its concentration increases.



**Figure 9**

Describe how the conductivity of this solution changes as its concentration increases from 0 to 500 g dm<sup>-3</sup>.

(2)

.....

.....

.....

.....

**(Total for Question 5 = 10 marks)**



6 (a) Methane is a hydrocarbon fuel.

- (i) Complete the word equation for the **complete** combustion of methane in oxygen.

(2)

methane + ..... → water + .....

- (ii) The **incomplete** combustion of methane can produce carbon and carbon monoxide.

Give the reason why carbon and carbon monoxide are produced in the **incomplete** combustion of methane.

(1)

(b) Crude oil is a complex mixture of hydrocarbons.

Crude oil can be separated into useful fractions by fractional distillation.

Figure 10 shows a fractional distillation column and the fractions produced when crude oil is distilled.

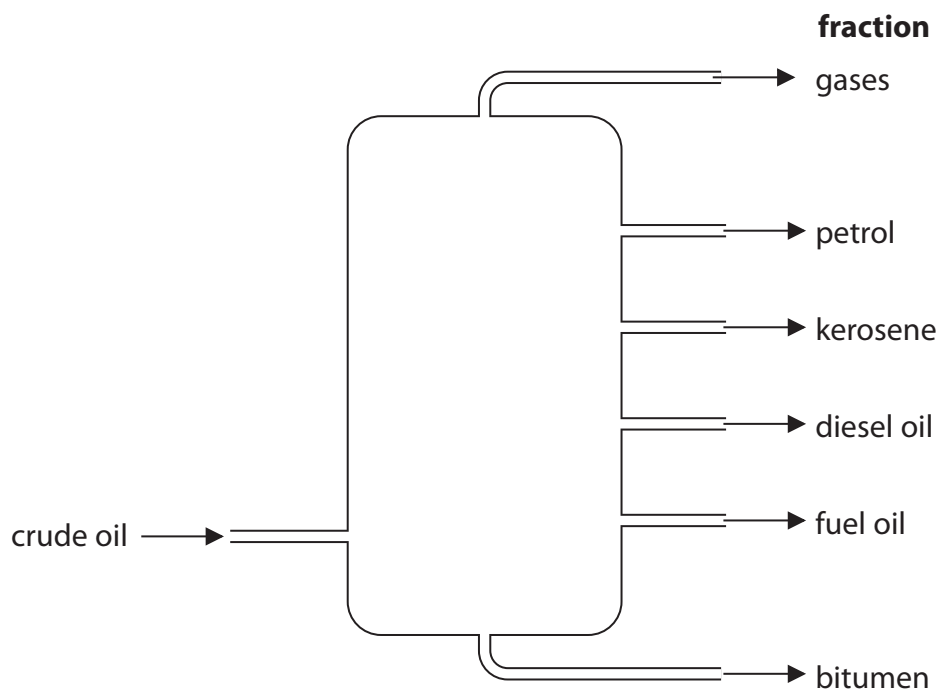


Figure 10

- (i) Name the fraction in Figure 10 that is used to surface roads.

(1)





(ii) Name the fraction in Figure 10 that contains hydrocarbons with the lowest boiling point.

(1)

(c) When crude oil is fractionally distilled, the demand for some fractions is more than the amount produced.

Figure 11 shows the relative amounts of each fraction in a crude oil and the relative demand for each of these fractions.

fraction	relative amount	relative demand
gases	2	6
petrol	12	29
kerosene	16	11
diesel oil	24	29
fuel oil	37	21
bitumen	9	4

**Figure 11**

Which of the following shows the fractions where the relative demand is greater than the relative amount in the crude oil?

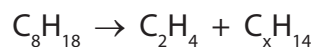
(1)

- A kerosene, diesel oil, bitumen
- B gases, petrol, diesel oil
- C gases, petrol, kerosene
- D petrol, diesel oil, fuel oil



(d) Cracking involves the breaking down of large hydrocarbon molecules into smaller hydrocarbon molecules.

- (i) Octane,  $C_8H_{18}$ , can be cracked to produce one molecule of ethene,  $C_2H_4$ , and one molecule of  $C_xH_{14}$ .



Determine the value of x in the molecule of  $C_xH_{14}$ .

(1)

x = .....

- (ii) Dodecane is a large hydrocarbon molecule.  
When one molecule of dodecane is cracked the products are one molecule of octane and one molecule of butene.



Calculate the maximum mass of octane that could be produced when 340 g of dodecane is cracked in this reaction.

(relative formula masses: dodecane = 170, octane = 114)

(2)

mass of octane = ..... g

**(Total for Question 6 = 9 marks)**



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7 (a) Ethanol can be produced by the fermentation of glucose solution.

Which of these shows the word equation for the fermentation of glucose solution?

(1)

- A glucose  $\rightarrow$  ethanol + water
- B glucose  $\rightarrow$  ethanol + carbon dioxide
- C glucose  $\rightarrow$  ethanol + hydrogen
- D glucose  $\rightarrow$  ethanol + water + carbon dioxide

(b) The names and formulae of the first four alcohols in the homologous series of alcohols are given in Figure 12.

name of alcohol	formula
methanol	CH <sub>3</sub> OH
ethanol	C <sub>2</sub> H <sub>5</sub> OH
propanol	C <sub>3</sub> H <sub>7</sub> OH
butanol	C <sub>4</sub> H <sub>9</sub> OH

Figure 12

(i) Pentanol is the next member of this series.  
A molecule of pentanol contains five carbon atoms.

Suggest the formula of a molecule of pentanol.

(1)

(ii) Draw the structure of a molecule of ethanol.  
Show all bonds.

(2)

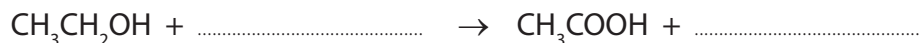


(c) Ethanol is present in alcoholic drinks, such as wine.

When a bottle of wine is left open some of the ethanol reacts with the oxygen in the air to form ethanoic acid,  $\text{CH}_3\text{COOH}$ , and water.

(i) Complete the equation for this reaction.

(2)



(ii) Which calculation shows the percentage by mass of hydrogen in ethanoic acid?

(relative atomic mass of hydrogen,  $\text{H} = 1$ ,  
relative formula mass of ethanoic acid,  $\text{CH}_3\text{COOH} = 60$ )

(1)

**A**  $\frac{1}{60} \times 100$

**B**  $\frac{3}{60} \times 100$

**C**  $\frac{4}{60} \times 100$

**D**  $\frac{60}{1} \times 100$





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(Total for Question 7 = 13 marks)



P 6 2 0 8 4 A 0 2 3 3 2

8 (a) An atom of potassium has atomic number 19 and mass number 39.

(i) Give the electronic configuration of this potassium atom.

(1)

(ii) This potassium atom forms the ion  $K^+$ .

Which row shows the number of protons and the number of neutrons in this potassium ion,  $K^+$ ?

(1)

	number of protons	number of neutrons
<input type="checkbox"/> A	19	19
<input type="checkbox"/> B	19	20
<input type="checkbox"/> C	20	19
<input type="checkbox"/> D	20	20

(b) Potassium and caesium are in the same group of the periodic table.

Explain, in terms of electrons, why potassium and caesium are in the same group.

(2)

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(c) Fluorine boils at  $-188^\circ\text{C}$ .

There are forces between fluorine molecules.

Explain, in terms of these forces, why the boiling point of fluorine is low.

(2)

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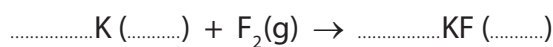




- (d) Potassium reacts with fluorine to form potassium fluoride.  
Potassium fluoride is a solid.

Complete the balanced equation for this reaction and add the state symbols.

(3)



- (e) What are the elements in group 1 of the periodic table called?

(1)

- A alkali metals  
 B fullerenes  
 C halogens  
 D noble gases

- (f) Figure 14 shows the melting points and boiling points of elements in group 7 of the periodic table.

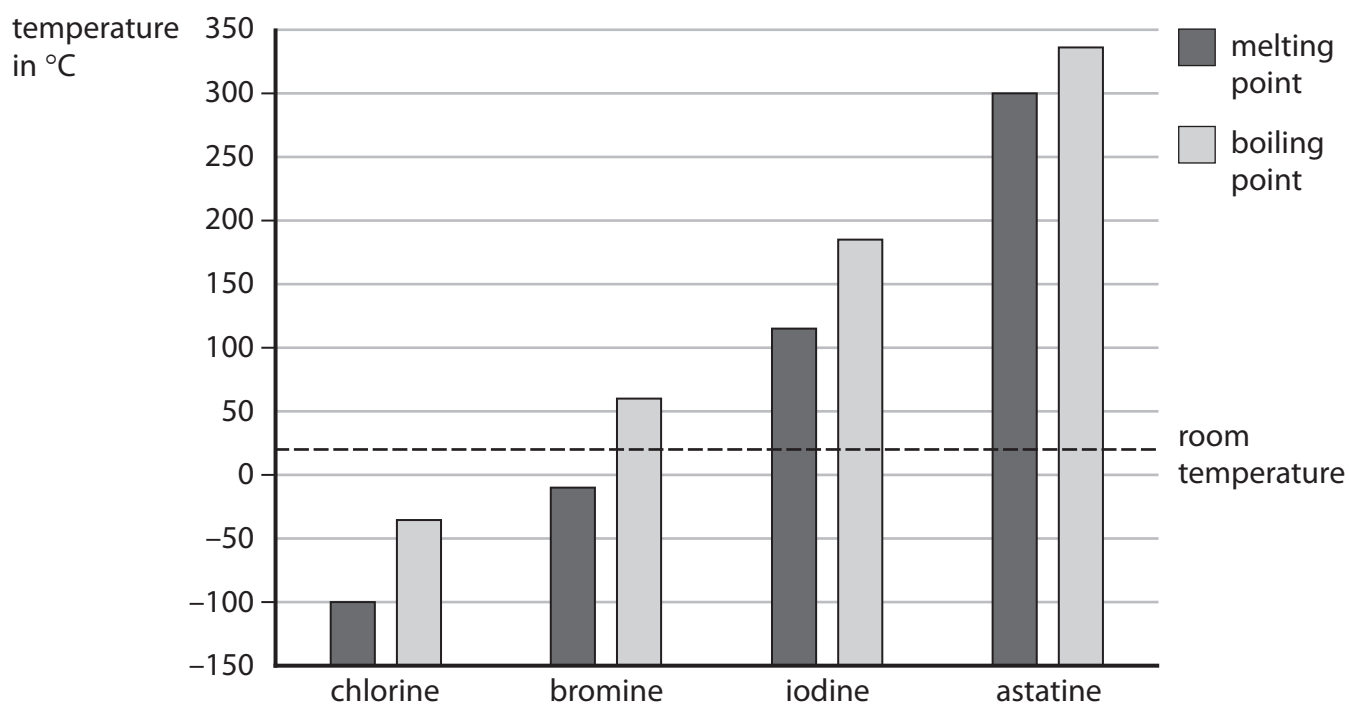


Figure 14

- (i) Give, using Figure 14, the boiling point of bromine.

(1)

boiling point of bromine = ..... °C

- (ii) State which **two** elements from Figure 14 are solids at room temperature.

(1)

(Total for Question 8 = 12 marks)



- 9 (a) Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The rate of reaction between calcium carbonate and dilute hydrochloric acid at room temperature was investigated.

- (i) The investigation was carried out with different sized calcium carbonate pieces.

The mass of calcium carbonate and all other conditions were kept the same.

The results are shown in Figure 15.

size of calcium carbonate pieces used	volume of carbon dioxide gas produced in five minutes in $\text{cm}^3$
large	16
small	48
powder	90

Figure 15

State, using the information in Figure 15, the effect of the surface area of the calcium carbonate on the rate of this reaction.

(1)

.....

.....

.....

- (ii) The calcium carbonate powder produced  $90 \text{ cm}^3$  of carbon dioxide in five minutes.

Calculate the average rate of reaction in  $\text{cm}^3 \text{ s}^{-1}$ .

(3)

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.....

average rate of reaction = .....  $\text{cm}^3 \text{ s}^{-1}$



(iii) The experiments were repeated at a higher temperature.  
The rate of reaction for each experiment increased.

Explain, in terms of particles, why the rate of reaction increased when the temperature was increased.

(3)

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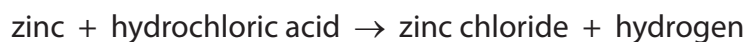
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P 6 2 0 8 4 A 0 2 7 3 2

\*(b) Zinc metal reacts with dilute hydrochloric acid to produce hydrogen gas.



A student investigated the effect of doubling the concentration of the hydrochloric acid on this reaction.

The student made the following prediction.

When the concentration of the hydrochloric acid is doubled the rate of reaction will double and the reaction will be more exothermic.

Devise a plan, including the apparatus you would use, to test the student's prediction.

You are provided with pieces of zinc and two bottles of dilute hydrochloric acid. One bottle of hydrochloric acid is double the concentration of the other.

(6)



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**(Total for Question 9 = 13 marks)**



P 6 2 0 8 4 A 0 2 9 3 2

10 Figure 16 shows the structure of a molecule of dichloroethene.

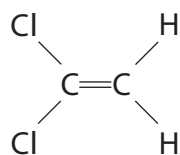


Figure 16

(a) (i) Describe how dichloroethene monomers form a polymer.

(2)

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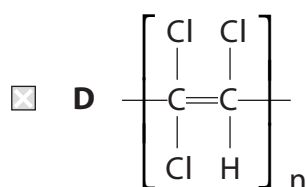
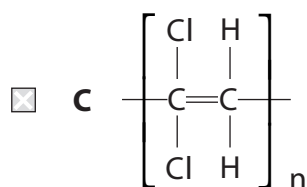
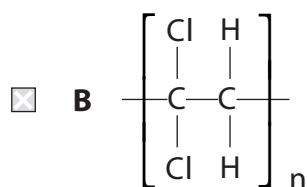
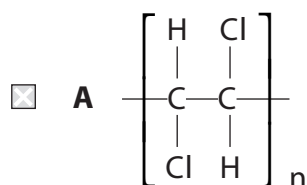
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(ii) Which of these represents the structure of the polymer formed from the monomer in Figure 16?

(1)



(iii) Separate samples of dichloroethene and poly(dichloroethene) are shaken with a few drops of bromine water.

What would be **seen**? (1)

- A both mixtures remain orange
- B only the dichloroethene and bromine water goes colourless
- C only the poly(dichloroethene) and bromine water goes colourless
- D both mixtures go colourless

(b) Dichloroethene is produced from ethene and chlorine.

In the overall reaction, ethene reacts with chlorine and forms dichloroethene and hydrogen chloride.

Complete the balanced equation for the overall reaction. (2)



(c) Poly(dichloroethene) was used to wrap food to keep it fresh.

Explain **one** property that a plastic food wrapping must have. (2)

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(d) An industrial process uses 500 tonnes of dichloroethene.  
In the process only 96.5% of the dichloroethene molecules react.

Calculate the mass of dichloroethene that has **not** reacted.

Give your answer to two significant figures. (3)

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mass = ..... tonnes

**(Total for Question 10 = 11 marks)**

**TOTAL FOR PAPER = 100 MARKS**

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# The periodic table of the elements

1	2	3	4	5	6	7	0
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	85 <b>Rb</b> rubidium 37	133 <b>Cs</b> caesium 55
45 <b>Sc</b> scandium 21	48 <b>Ti</b> titanium 22	51 <b>V</b> vanadium 23	52 <b>Cr</b> chromium 24	55 <b>Mn</b> manganese 25	56 <b>Fe</b> iron 26	59 <b>Co</b> cobalt 27	59 <b>Ni</b> nickel 28
89 <b>Y</b> yttrium 39	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	96 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46
139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78
88 <b>Sr</b> strontium 38	90 <b>Zr</b> zirconium 40	92 <b>U</b> uranium 92	94 <b>Pu</b> plutonium 94	96 <b>Am</b> americium 96	98 <b>Cm</b> curium 98	100 <b>Fm</b> fermium 100	102 <b>No</b> nobelium 102
137 <b>Ba</b> barium 56	138 <b>La</b> lanthanum 57	139 <b>Ce</b> cerium 58	140 <b>Pr</b> praseodymium 59	141 <b>Nd</b> neodymium 60	142 <b>Pm</b> promethium 61	144 <b>Sm</b> samarium 62	146 <b>Eu</b> europium 63
87 <b>Fr</b> francium 87	88 <b>Ra</b> radium 88	89 <b>Ac</b> actinium 89	90 <b>Th</b> thorium 90	91 <b>Pa</b> protactinium 91	92 <b>U</b> uranium 92	93 <b>Np</b> neptunium 93	94 <b>Pu</b> plutonium 94
105 <b>Db</b> dubnium 105	106 <b>Sg</b> seaborgium 106	107 <b>Bh</b> bohrium 107	108 <b>Hs</b> hassium 108	109 <b>Mt</b> meitnerium 109	110 <b>Ds</b> darmstadtium 110	111 <b>Rg</b> roentgenium 111	112 <b>Cn</b> copernicium 112
113 <b>Nh</b> nihonium 113	114 <b>Fl</b> flerovium 114	115 <b>Mc</b> moscovium 115	116 <b>Lv</b> livermorium 116	117 <b>Ts</b> tennessine 117	118 <b>Og</b> oganesson 118	119 <b>Uu</b> ununoctium 119	120 <b>Uub</b> unubium 120
121 <b>Uut</b> ununtrium 121	122 <b>Uuq</b> ununquadium 122	123 <b>Uuq</b> ununquadium 123	124 <b>Uuq</b> ununquadium 124	125 <b>Uuq</b> ununquadium 125	126 <b>Uuq</b> ununquadium 126	127 <b>Uuq</b> ununquadium 127	128 <b>Uuq</b> ununquadium 128
129 <b>Uuq</b> ununquadium 129	130 <b>Uuq</b> ununquadium 130	131 <b>Uuq</b> ununquadium 131	132 <b>Uuq</b> ununquadium 132	133 <b>Uuq</b> ununquadium 133	134 <b>Uuq</b> ununquadium 134	135 <b>Uuq</b> ununquadium 135	136 <b>Uuq</b> ununquadium 136
137 <b>Uuq</b> ununquadium 137	138 <b>Uuq</b> ununquadium 138	139 <b>Uuq</b> ununquadium 139	140 <b>Uuq</b> ununquadium 140	141 <b>Uuq</b> ununquadium 141	142 <b>Uuq</b> ununquadium 142	143 <b>Uuq</b> ununquadium 143	144 <b>Uuq</b> ununquadium 144
145 <b>Uuq</b> ununquadium 145	146 <b>Uuq</b> ununquadium 146	147 <b>Uuq</b> ununquadium 147	148 <b>Uuq</b> ununquadium 148	149 <b>Uuq</b> ununquadium 149	150 <b>Uuq</b> ununquadium 150	151 <b>Uuq</b> ununquadium 151	152 <b>Uuq</b> ununquadium 152
153 <b>Uuq</b> ununquadium 153	154 <b>Uuq</b> ununquadium 154	155 <b>Uuq</b> ununquadium 155	156 <b>Uuq</b> ununquadium 156	157 <b>Uuq</b> ununquadium 157	158 <b>Uuq</b> ununquadium 158	159 <b>Uuq</b> ununquadium 159	160 <b>Uuq</b> ununquadium 160
161 <b>Uuq</b> ununquadium 161	162 <b>Uuq</b> ununquadium 162	163 <b>Uuq</b> ununquadium 163	164 <b>Uuq</b> ununquadium 164	165 <b>Uuq</b> ununquadium 165	166 <b>Uuq</b> ununquadium 166	167 <b>Uuq</b> ununquadium 167	168 <b>Uuq</b> ununquadium 168
169 <b>Uuq</b> ununquadium 169	170 <b>Uuq</b> ununquadium 170	171 <b>Uuq</b> ununquadium 171	172 <b>Uuq</b> ununquadium 172	173 <b>Uuq</b> ununquadium 173	174 <b>Uuq</b> ununquadium 174	175 <b>Uuq</b> ununquadium 175	176 <b>Uuq</b> ununquadium 176
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457 <b>Uuq</b> ununquadium 457	458 <b>Uuq</b> ununquadium 458	459 <b>Uuq</b> ununquadium 459	460 <b>Uuq</b> ununquadium 460	461 <b>Uuq</b> ununquadium 461	462 <b>Uuq</b> ununquadium 462	463 <b>Uuq</b> ununquadium 463	464 <b>Uuq</b> ununquadium 464
465 <b>Uuq</b> ununquadium 							