PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 1: PRINCIPLES OF CHEMISTRY (PACK 7)

SCORE	PERCENTAGE
/202	%

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Q1.

This question is about the halogens.

(a) The table gives some information about the halogens.

Complete the table by predicting the physical state of astatine at room temperature and the colour of astatine.

(2)

Halogen	Physical state at room temperature	Colour
fluorine	gas	yellow
chlorine	gas	pale green
bromine	liquid	red-brown
iodine	solid	grey
astatine		

(b) Bromine has two isotopes with mass numbers 79 and 81

(i) The relative percentages of each isotope in a sample of bromine are

bromine-79 = 51.0% bromine-81 = 49.0%

Calculate the relative atomic mass of this sample of bromine.

Give your answer to one decimal place.

(3)

relative atomic mass = ...

(ii) Give a reason why both isotopes of bromine have the same chemical properties.

(1)

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(c) A student investigates the reactivity of some halogens.

She uses these solutions of halogens and their halides.

- bromine, chlorine and iodine
- sodium bromide, sodium chloride and sodium iodide

She adds each halogen solution to each halide solution.

The table shows her results.

	Sodium bromide	Sodium chloride	Sodium iodide
Bromine	no reaction	no reaction	reaction occurs
Chlorine	reaction occurs	no reaction	reaction occurs
Iodine	no reaction	no reaction	no reaction

(i) Explain how these results show the order of reactivity of bromine, chlorine and iodine.

(3)

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(ii) Suggest why the student does not need to add bromine solution to sodium bromide solution.

(1)

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(iii) The ionic equation for the reaction between bromine and sodium iodide is

$$Br_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Br^-(aq)$$

Explain why this is a redox reaction.

(2)

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(Total for question = 12 marks)

Q2.

(a) Table 1 shows the formulae of some ions.

It also shows the formulae of some compounds containing these ions.

	Ca^{2+}	Al^{3+}	NH_4^+
F^-		AlF_3	NH_4F
NO_3^-	$Ca(NO_3)_2$		NH_4NO_3
SO_4^{2-}	$CaSO_4$	$Al_2(SO_4)_3$	

Table 1

Complete Table 1 by giving the missing information.

(3)

(b) Table 2 gives information about aluminium fluoride and aluminium bromide.

	Bonding	Structure	Melting point in °C
Aluminium fluoride	ionic	giant lattice	1290
Aluminium bromide	covalent	simple molecular	98

Table 2

Explain the difference between the melting points of aluminium fluoride and aluminium bromide. Refer to bonding and structure in your answer.

(5)

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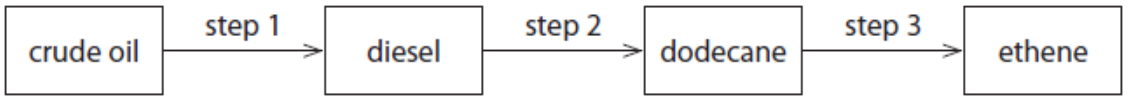
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(Total for question = 8 marks)

Q3.

The flow chart shows how ethene can be obtained industrially from crude oil.



(a) Step 1 involves the use of a tall column.

Describe how the diesel fraction is obtained from the crude oil in step 1.

(5)

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(b) In step 2, saturated compounds such as dodecane are obtained from the mixture of hydrocarbons in the diesel fraction.

Explain why dodecane is described as a **saturated hydrocarbon**.

(3)

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(c) Which of these formulae is that of an alkane?

(1)

☒ **A** C_7H_{12}

☒ **B** C_9H_{18}

☒ **C** $C_{11}H_{24}$

☒ **D** $C_{13}H_{30}$

(d) In step 3, cracking is used to convert alkanes into alkenes.

Complete the equation to show the reaction in which one molecule of dodecane is converted into two molecules of ethene and one molecule of another hydrocarbon.

(1)

$$C_{12}H_{26} \rightarrow 2C_2H_4 + ...$$

(e) Alkanes and alkenes both react with halogens, but in different ways.

The equations for two examples of these different reactions are shown.

equation 1 $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl$ + compound X

equation 2 $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

(i) State the condition needed for the reaction in equation 1 to occur.

(1)

.....

(ii) Deduce the formula of compound X.

(1)

.....

(iii) Draw a dot-and-cross diagram to represent a molecule of C_2H_5Cl

Show only the outer electrons of each atom.

(2)

(iv) Equation 2 shows an example of an addition reaction.

State the type of reaction shown by equation 1.

(1)

.....

(f) Alkenes can be distinguished from alkanes using bromine water.

(i) What colour change occurs in the reaction between propene and bromine water?

(1)

☒ **A** colourless to orange

☒ **B** colourless to green

☒ **C** green to colourless

☒ **D** orange to colourless

(ii) A compound formed in the reaction between propene and bromine water has the percentage composition by mass

C = 25.9%, H = 5.0%, Br = 57.6% and O = 11.5%

Calculate the empirical formula of this compound.

(3)

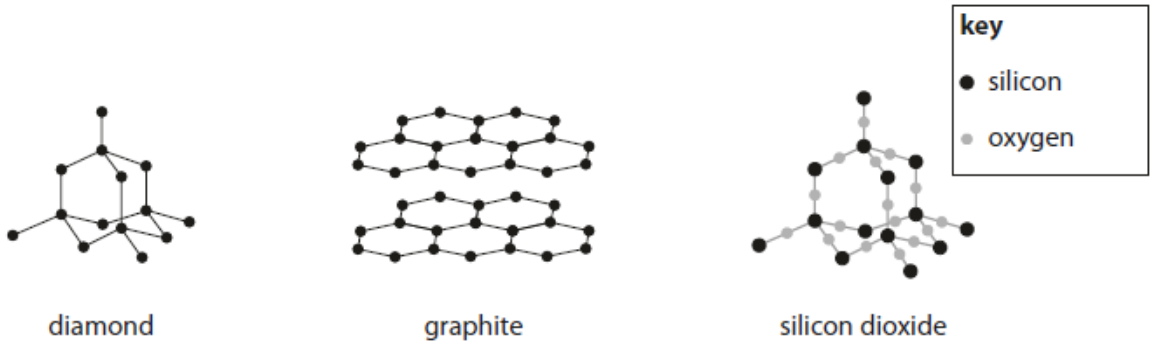
empirical formula = ...

(Total for question = 19 marks)

Q4.

Diamond, graphite and silicon dioxide all have giant covalent structures.

The diagram shows the structures of these three substances.



(a) Explain why silicon dioxide has a high melting point.

(2)

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(b) Explain why graphite conducts electricity.

(2)

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(c) State why diamond is hard but graphite is soft.

(2)

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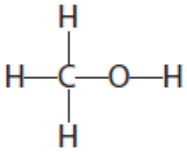
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(Total for question = 6 marks)

Q5.

(a) The diagram shows the displayed formula of the organic compound methanol, CH_3OH



(i) Determine the number of atoms in one molecule of methanol.

(1)

.....

(ii) State why methanol is not a hydrocarbon.

(1)

.....

.....

(b) The atoms in methanol are held together by covalent bonds.

(i) State what is meant by the term **covalent bond**.

(2)

.....

.....

.....

.....

(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of methanol.

Show only the outer electrons of each atom.

(2)

(c) Another organic compound has the percentage composition by mass

C = 38.7% H = 9.7% O = 51.6%

(i) Calculate the empirical formula of this compound.

(3)

empirical formula = ...

(ii) The relative molecular mass (M_r) of the compound is 62

Determine the molecular formula of the compound.

(2)

molecular formula = ...

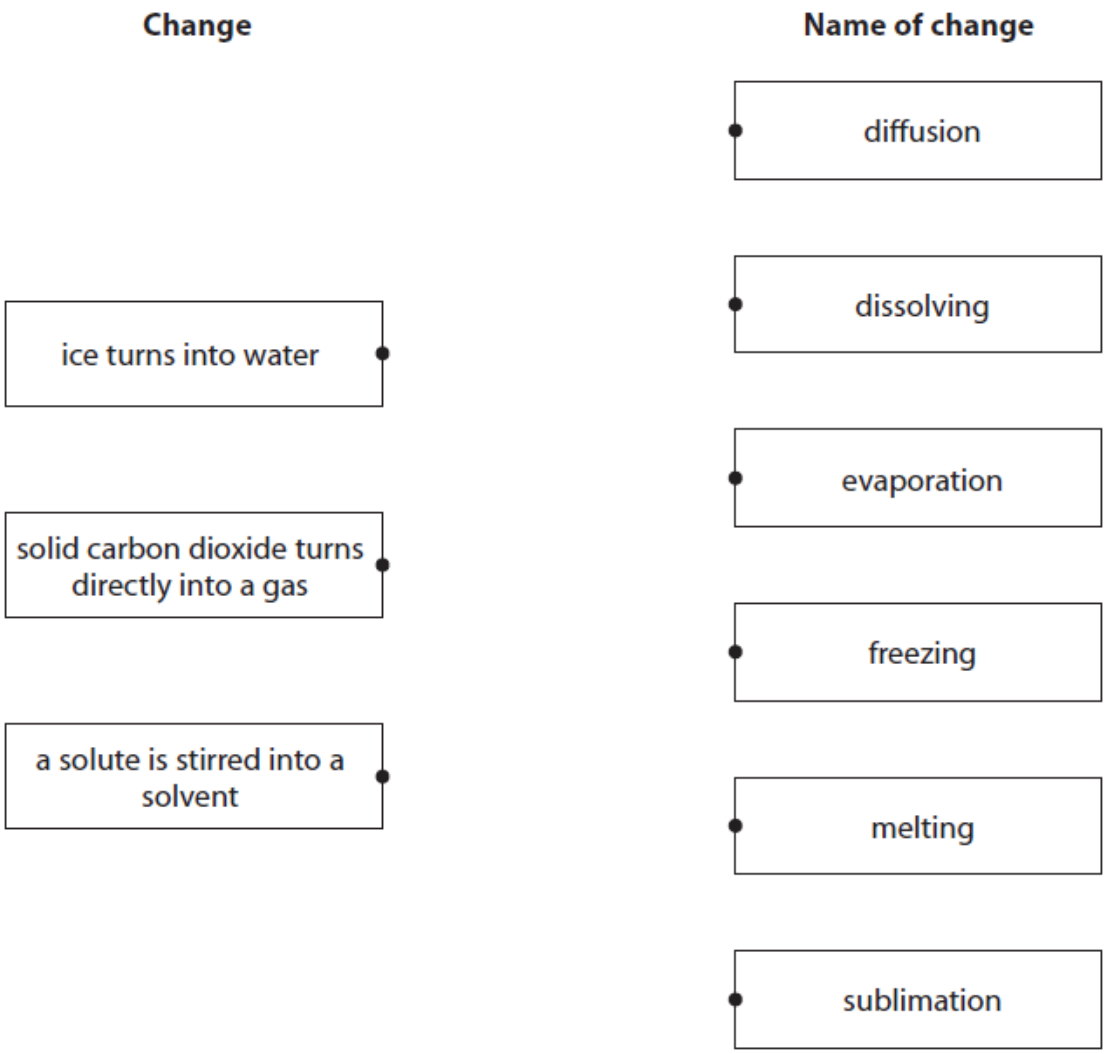
(Total for question = 11 marks)

Q6.

(a) The boxes list changes that may happen in a laboratory and the names of some changes.

Draw one straight line from each change to its correct name.

(3)



(b) A student has two solids, X and Y.

One of these solids is a pure substance and the other is a mixture.

Describe how the student could identify which solid is pure and which is a mixture by measuring a physical property of each solid.

(3)

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(Total for question = 6 marks)

Q7.

This question is about chemical elements.

Use the Periodic Table to help you answer this question.

(a) (i) Identify the element with atomic number 5

(1)

.....

(ii) Give the symbol of a metallic element in Period 3

(1)

.....

(iii) Identify the element whose atoms contain 14 protons.

(1)

.....

(iv) Identify the element whose atoms have the electronic configuration 2.5

(1)

.....

(v) Give the name of the compound formed between oxygen and the element with atomic number 13

(1)

.....

(b) The position of an element in the Periodic Table can be used to predict its properties.

(i) Which group contains elements that are all unreactive?

(1)

☒ **A** Group 2

☒ **B** Group 5

☒ **C** Group 6

☒ **D** Group 0

(ii) Which of these is the least reactive element in Group 1?

(1)

☒ **A** caesium

☒ **B** lithium

☒ **C** potassium

☒ **D** sodium

(Total for question = 7 marks)

Q8.

The box lists some substances.

air	bromine	carbon	copper	glucose
nitrogen	oxygen	sulfur	water	

Choose substances from the box to answer these questions.

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

(a) Name a metallic element.

(1)

.....

(b) Name a compound.

(1)

.....

(c) Name a mixture.

(1)

.....

(d) Name an element that is a gas at room temperature.

(1)

.....

(e) Name an element that forms a basic oxide.

(1)

.....

(f) Name two elements that are in the same group of the Periodic Table.

(1)

.....

(Total for question = 6 marks)

Q9.

Sodium hydrogencarbonate ($NaHCO_3$) is also known as baking soda.

Baking soda can be used to make cakes increase in size in an oven.

This is the equation for the reaction that takes place when baking soda is heated.

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

(a) (i) What type of reaction is this?

(1)

☒ **A** combustion

☒ **B** decomposition

☒ **C** oxidation

☒ **D** reduction

(ii) Suggest why the reaction makes the cakes increase in size.

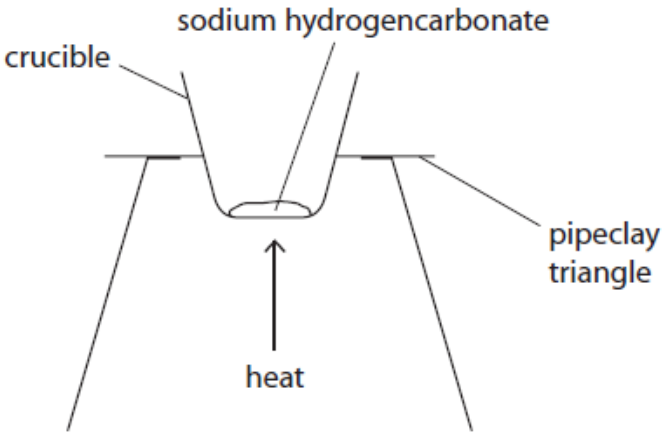
(1)

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(b) A student uses this apparatus to investigate the reaction that takes place when sodium hydrogencarbonate is heated.



This is the student's method.

- weigh a crucible and record the mass
- add some sodium hydrogencarbonate to the crucible, reweigh it and record the mass
- heat the crucible and contents for five minutes, then allow to cool before weighing and recording the mass
- heat the crucible and contents again for a further three minutes, then allow to cool before weighing and recording the mass

(i) Give a reason why the crucible and contents are heated for a further three minutes.

(1)

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(ii) The student considered using a lid on the crucible in the experiment.

Suggest an advantage and a disadvantage of using a lid on the crucible.

(2)

advantage

.....

.....

.....

disadvantage

.....

.....

.....

(c) The table shows some of the student's results.

mass of crucible and sodium hydrogencarbonate in g	29.75
mass of empty crucible in g	26.50

(i) Calculate the mass of sodium hydrogencarbonate that the student uses.

(1)

mass = ... g

(ii) Using this equation, calculate the maximum mass of sodium carbonate (Na_2CO_3) that could form in the student's reaction.

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

[M_r of $NaHCO_3$ = 84 M_r of Na_2CO_3 = 106]

(3)

maximum mass = ... g

(d) In a second experiment, the student uses a larger mass of sodium hydrogencarbonate.

She calculates that she should obtain 4.8 g of sodium carbonate.

She actually obtains 4.2 g of sodium carbonate.

(i) Calculate the percentage yield from the student's experiment.

(2)

percentage yield = ... %

(ii) Other than spillages, suggest a possible reason why the student's actual yield is less than expected.

(1)

.....

.....

.....

(Total for question = 12 marks)

Q10.

A student investigates the reaction between magnesium and hydrochloric acid.

He uses this method.

Step 1 add 25 cm^3 of dilute hydrochloric acid to a polystyrene cup

Step 2 record the temperature of the acid

Step 3 find the mass of a 10 cm strip of magnesium ribbon

Step 4 add the magnesium ribbon to the hydrochloric acid

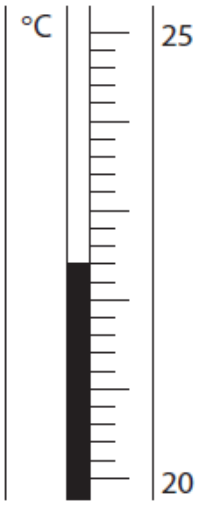
Step 5 when all the magnesium has reacted, record the highest temperature reached

(a) Complete the word equation for the reaction.

(1)

magnesium + hydrochloric acid → ..... + ...

(b) The thermometer shows the temperature of the acid at the start of the experiment.



(i) Complete the table by giving the temperatures to the nearest 0.1 °C.

(2)

temperature of the acid at the start in °C	
highest temperature reached in °C	
temperature rise in °C	20.8

(ii) Show that the heat energy change (Q) for this reaction is about 2200 J.

[mass of 1.0 cm^3 of solution = 1.0 g]

[for the solution, c = 4.2 J/g/°C]

(2)

(iii) The mass of magnesium used by the student was 0.12 g.

Calculate the value of the enthalpy change (ΔH), in kilojoules per mole of magnesium, for the reaction between magnesium and hydrochloric acid.

Include a sign in your answer.

(4)

ΔH = ... kJ/mol

(Total for question = 9 marks)

Q11.

A student investigates the reaction between solid hydrated sodium carbonate and dilute hydrochloric acid.

(a) She uses this method to investigate the temperature change during the reaction.

Step 1 pour 25.0 cm^3 of dilute hydrochloric acid into a polystyrene cup

Step 2 record the temperature of the dilute hydrochloric acid

Step 3 add 0.5 g of sodium carbonate and stir the mixture

Step 4 record the lowest temperature of the mixture

Step 5 add further 0.5 g portions of sodium carbonate, one portion at a time, stir the mixture and record the lowest temperature each time

The table shows the student's results.

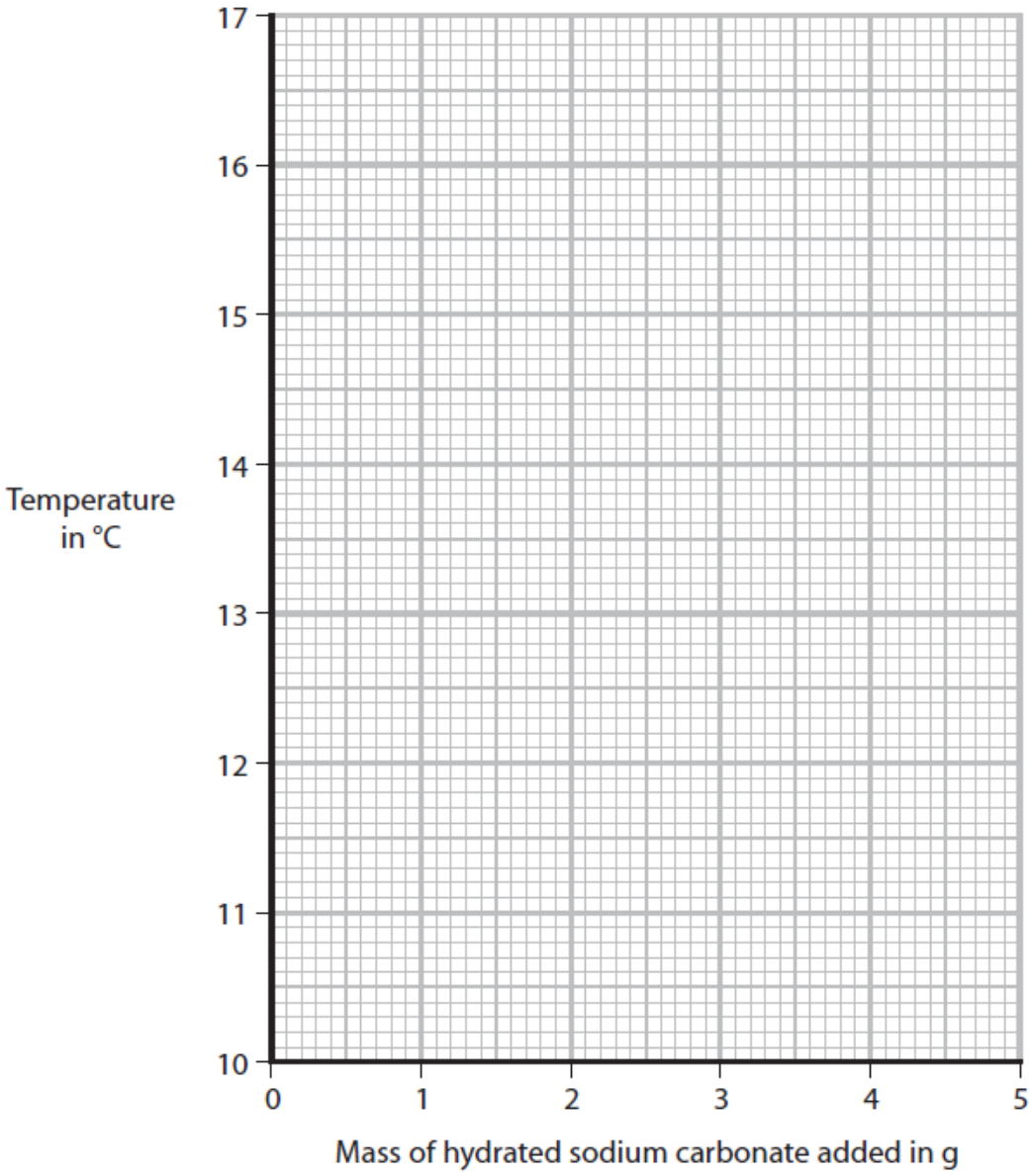
Mass of sodium carbonate added in g	Temperature in °C
0.0	17.0
0.5	15.6
1.0	14.1
1.5	13.0
2.0	12.9
2.5	12.2
3.0	11.8
3.5	11.5
4.0	11.2
4.5	11.0
5.0	11.0

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

(2)

(ii) Draw a curve of best fit, ignoring the anomalous result.

(1)



(iii) Explain why it is better to use a polystyrene cup instead of a glass beaker in this experiment.

(2)

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(iv) Suggest a reason for the anomalous result.

(1)

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(v) State how the results show that all the dilute hydrochloric acid has reacted.

(1)

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(vi) Use the results of the experiment to explain the type of reaction that occurs when sodium carbonate is added to dilute hydrochloric acid.

(2)

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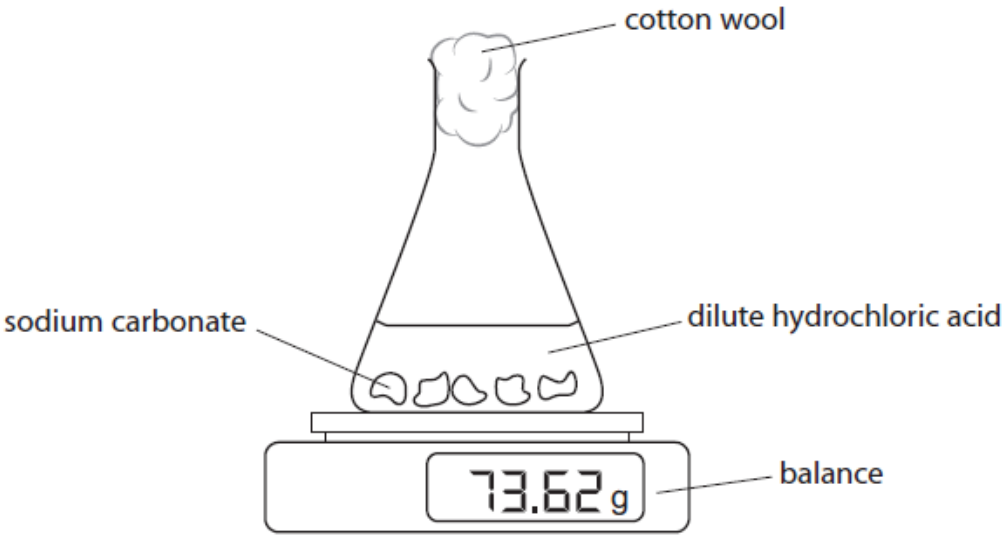
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(b) The student does another experiment using the same reaction.

The diagram shows the student's apparatus.



The mass on the balance decreases as carbon dioxide gas escapes.

(i) Give a reason for the cotton wool plug in the conical flask.

(1)

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.....

(ii) The student adds 2.12 g of sodium carbonate to an excess of dilute hydrochloric acid.

The chemical equation for the reaction is

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Calculate the maximum mass, in g, of carbon dioxide formed in the reaction.

(3)

mass = ... g

(iii) Suggest why the mass of carbon dioxide produced is less than the calculated maximum mass.

(1)

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(Total for question = 14 marks)

Q12.

(a) (i) Organic compounds can exist as isomers.

Explain what is meant by the term **isomers**.

(2)

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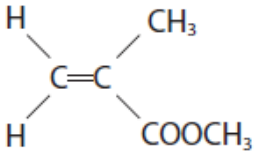
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(ii) Organic compound Q reacts with bromine, without the presence of ultraviolet radiation, to form the
compound $C_4H_8Br_2$

Draw the displayed formulae of two isomers of Q.

(2)

(b) An acrylic polymer can be formed from molecules with this structure.



(i) A student describes the molecule as an unsaturated hydrocarbon.

Explain whether this is a correct description.

(2)

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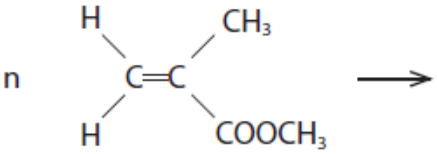
(ii) Name the type of polymerisation that occurs in the formation of the polymer.

(1)

.....

(iii) Complete the equation for the polymerisation reaction.

(2)



(c) Octane is a compound in petrol.

The equation for the complete combustion of octane is

$$C_8H_{18} + 12.5\ O_2 \rightarrow 8\ CO_2 + 9\ H_2O$$

(i) The fuel tank of a car contains 50.0 dm^3 of octane.

Calculate the mass, in kg, of carbon dioxide formed if all the octane in the fuel tank undergoes complete combustion.

[mass of 1 dm^3 of octane = 700 g]

(5)

mass = ... kg

(ii) State an environmental problem caused by carbon dioxide.

(1)

.....

.....

(Total for question = 15 marks)

Q13.

This question is about lithium carbonate.

(a) The formula of lithium carbonate is Li_2CO_3

Calculate the relative formula mass (M_r) of lithium carbonate.

(1)

M_r = ...

(b) (i) Give a test to show that lithium carbonate contains **lithium** ions.

(2)

test .....

.....

result .....

.....

(ii) Describe a test to show that lithium carbonate contains **carbonate** ions.

(3)

test .....

.....

.....

.....

result .....

.....

(c) Lithium carbonate decomposes when heated to produce lithium oxide and carbon dioxide.

Complete the chemical equation for this reaction.

(1)

Li_2CO_3 → ..... + ...

(Total for question = 7 marks)

Q14.

This question is about lithium oxide.

(a) The diagram shows the electron configurations of an atom of lithium and an atom of oxygen.



lithium oxygen

Describe the changes in electronic configuration when lithium and oxygen react to form lithium oxide, Li_2O

(3)

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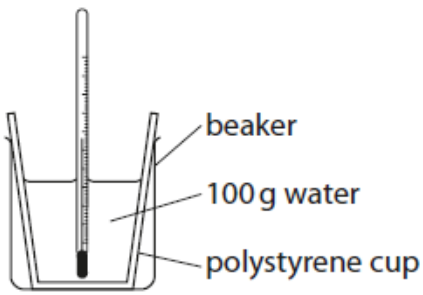
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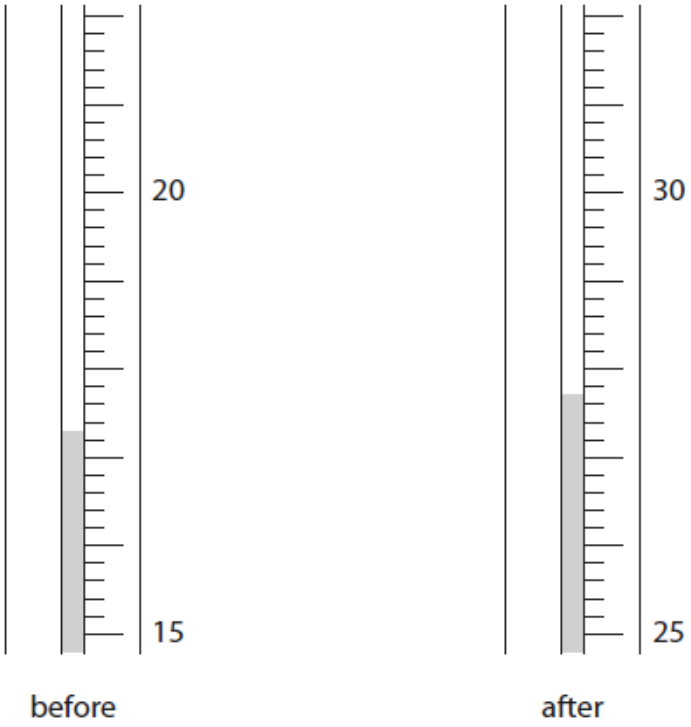
(b) Lithium oxide reacts with water to form lithium hydroxide as the only product.
A scientist uses this apparatus to measure the temperature change of the reaction.



This is the scientist's method.

- pour 100 g of water into a polystyrene cup
- record the temperature of the water
- add the lithium oxide and stir the mixture
- record the maximum temperature reached

The diagram shows the thermometer readings before and after adding the lithium oxide.



(i) Complete the table, giving all values to the nearest 0.1 °C.

(2)

temperature in °C after adding the lithium oxide	
temperature in °C before adding the lithium oxide	17.3
temperature rise in °C	

(ii) Calculate the heat energy change in the reaction.

Give your answer to two significant figures.

[c = 4.2 J / g / °C]

(4)

heat energy change = ... J

(iii) In another experiment the scientist obtains these results.

amount of lithium oxide in mol	0.0580
heat energy change in J	5210

Calculate the molar enthalpy change (ΔH) in kJ / mol.

Include a sign in your answer.

(3)

ΔH = ... kJ / mol

(iv) Give a reason why the scientist does the experiment in a polystyrene cup.

(1)

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(Total for question = 13 marks)

Q15.

The table gives the melting and boiling points of four pure substances, W, X, Y and Z.

	Melting point in °C	Boiling point in °C
W	–7	60
X	660	2500
Y	180	1330
Z	115	445

Use data from the table to answer the questions.

(a) (i) Which substance is a gas at 100 °C?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(ii) Which substance is a liquid for the largest range of temperature?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(iii) Which substance is a liquid at 1000 °C and a gas at 2000 °C?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(b) Substance Y does not conduct electricity when solid but does conduct electricity when molten.

Give the type of bonding in substance Y.

(1)

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(c) Suggest how the melting point of a pure substance changes when an impurity is added.

(1)

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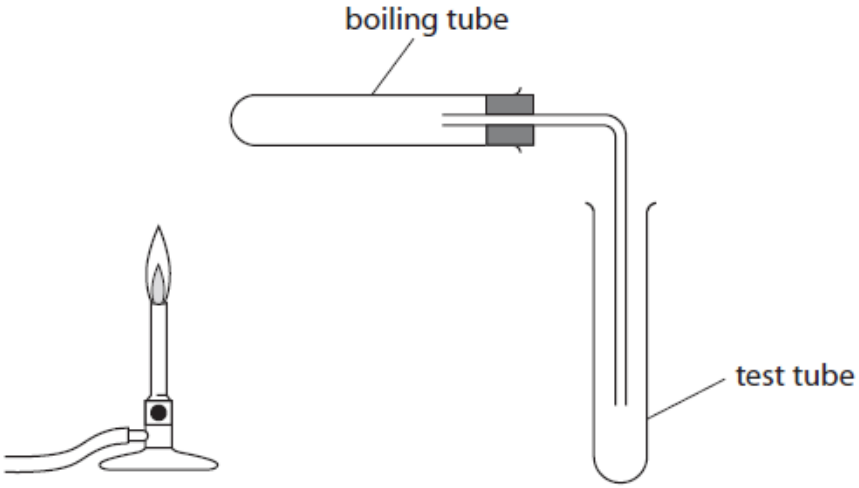
(Total for question = 5 marks)

Q16.

This question is about metal carbonates.

When heated, some metal carbonates decompose to form a metal oxide and carbon dioxide gas.

(a) A student is given three solid metal carbonates, a timer, some limewater and this apparatus.



Describe a method the student can use to find out which metal carbonate decomposes fastest when heated.

(4)

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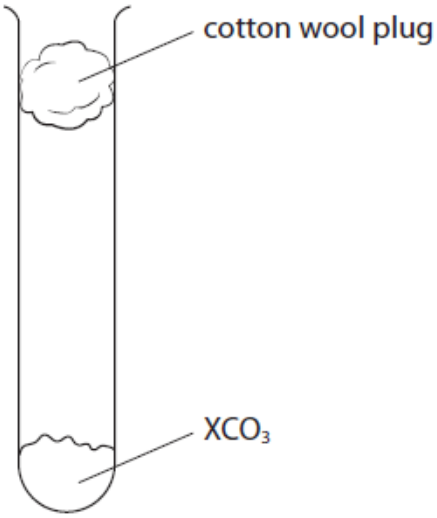
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(b) A student is given a solid metal carbonate with the formula XCO_3

X represents the symbol of a Group 2 metal.

A student uses this apparatus to heat a sample of XCO_3 until it all decomposes.



The equation for the decomposition of XCO_3 is

$$XCO_3 \rightarrow XO + CO_2$$

The student records the mass of XCO^3 and the mass of carbon dioxide that escapes through the cotton wool plug.

These are the student's results.

mass of XCO_3 = 7.40 g

mass of CO_2 = 2.20 g

(i) Give a reason why the student uses a cotton wool plug.

(1)

.....

.....

(ii) Calculate the amount, in mol, of carbon dioxide produced.

[for carbon dioxide M_r = 44]

(1)

amount of carbon dioxide = ... mol

(iii) Use the equation to determine the amount, in mol, of XCO_3 that decomposed.

(1)

amount of XCO_3 = ... mol

(iv) Use the mass of XCO_3 and your answer to (b)(iii) to calculate the relative formula mass (M_r) of XCO_3

(2)

M_r of XCO_3 = ...

(v) Use your answer to (b)(iv) and the Periodic Table on page 2 to determine the identity of the Group 2 metal X.

Show your working.

(2)

identity of X = ...

(Total for question = 11 marks)

Q17.

This is a question about metals and their compounds.

(a) State one property of metals.

(1)

.....

(b) Mercury is the only metal that is liquid at room temperature.

Describe the difference in the movement of particles in liquid mercury and in a solid metal.

(2)

.....

.....

.....

(c) Magnesium is a metal that burns in air.

(i) State one observation made during the combustion of magnesium metal.

(1)

.....

.....

(ii) State one chemical property of the product of combustion that can be used to classify magnesium as a metal.

(1)

.....

.....

(d) In the absence of air, magnesium reacts with sulfur to form the ionic compound magnesium sulfide, MgS

(i) Give a reason why the reaction needs to be done in the absence of air.

(1)

.....

.....

(ii) Describe, in terms of electrons, the formation of the ions in magnesium sulfide.

Give the charges on the ions.

(3)

.....

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.....

(iii) Explain why magnesium sulfide has a very high melting point.

(3)

.....

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.....

.....

(iv) Magnesium sulfide reacts with hydrochloric acid to form magnesium chloride and hydrogen sulfide gas, H_2S

Give the chemical equation for this reaction.

(2)

.....

(Total for question = 14 marks)

Q18.

This question is about metals.

(a) Metals can be arranged in a reactivity series based on their reactions with water and their reactions with dilute hydrochloric acid.

The table shows how four metals, P, Q, R and S, react with water and with dilute hydrochloric acid.

Metal	Reaction with water	Reaction with dilute hydrochloric acid
P	no reaction	hydrogen gas forms very slowly
Q	no reaction	no reaction
R	hydrogen gas forms very quickly	not done
S	hydrogen gas forms quickly	hydrogen gas forms very quickly

(i) Identify which of the metals P, Q, R or S could be gold.

(1)

.....

(ii) Suggest why the reaction between metal R and dilute hydrochloric acid was not done.

(1)

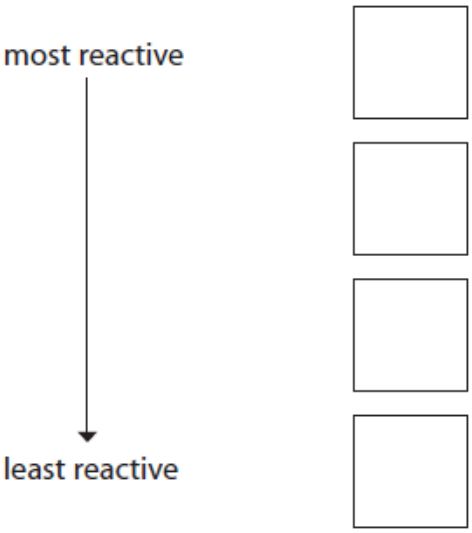
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(iii) Use the information in the table to place the metals in order of reactivity from most reactive to least reactive.

(1)



(b) Zinc is used to coat iron gates to prevent the iron from rusting.

(i) State the name of this method of preventing iron from rusting.

(1)

.....

(ii) State another method of preventing iron from rusting.

(1)

.....

(c) A mixture of zinc powder and copper(II) oxide is heated.

The chemical equation for the reaction that takes place is

$$Zn + CuO \rightarrow ZnO + Cu$$

(i) State how the reaction shows that zinc is more reactive than copper.

(1)

.....

.....

(ii) Explain which substance is the oxidising agent.

(2)

.....

.....

.....

.....

(Total for question = 8 marks)

Q19.

(a) The box gives some methods used in the separation of mixtures.

chromatography	crystallisation	evaporation
filtration	fractional distillation	simple distillation

Use words from the box to answer these questions.

(i) Identify the method used to obtain pure water from sea water.

(1)

.....

(ii) Identify the method used to separate the dyes in a food colouring.

(1)

.....

(iii) Identify the method used to obtain ethanol from a mixture of ethanol and water.

(1)

.....

(b) Complete the sentences by writing a suitable word in each blank space.

(3)

When salt is added to water and stirred until no more will ..... , a saturated solution forms.

The salt is the ..... .

The water is the ..... .

(Total for question = 6 marks)

Q20.

Ocimene is an organic compound that gives some plants their particular smell.

The molecular formula of ocimene is $C_{10}H_{16}$

(a) Calculate the relative formula mass (M_r) of ocimene.

(1)

M_r = ...

(b) Using ocimene as an example, explain what is meant by the term **empirical formula**.

(2)

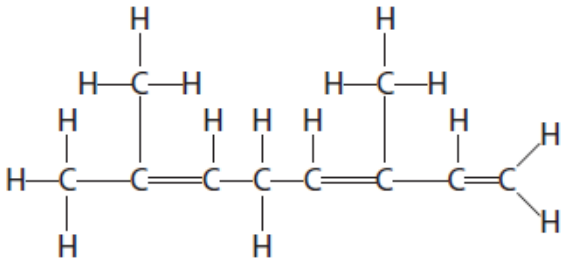
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(c) The displayed formula of ocimene is



Explain why ocimene is described as an unsaturated hydrocarbon.

(3)

.....

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.....

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.....

(d) Ocimene is an alkene.

(i) Which of these types of reaction occurs between ocimene and bromine?

(1)

☒ **A** addition

☒ **B** polymerisation

☒ **C** precipitation

☒ **D** substitution

(ii) Many alkenes have the general formula C_nH_{2n}

Suggest why ocimene does not have this general formula.

(1)

.....

.....

.....

(e) Ocimene can take part in combustion reactions.

Complete the equation for the complete combustion of ocimene.

(2)

$C_{10}H_{16}$ + ... O_2 → ..... + ...

(f) Two different products can form during the incomplete combustion of ocimene. One product is a solid and the other is a poisonous gas.

(i) Identify these two products.

(2)

.....

.....

(ii) State why the gas produced is poisonous.

(1)

.....

.....

.....

.....

(Total for question = 13 marks)