PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 2: INORGANIC CHEMISTRY (PACK 4)

SCORE	PERCENTAGE
/201	%

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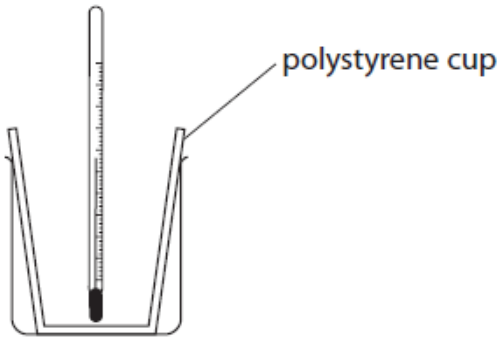
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Q1.

A student uses this apparatus to find the temperature change when sodium hydroxide solution reacts with dilute hydrochloric acid.



This is the student's method.

- pour 20 cm^3 of sodium hydroxide solution into a polystyrene cup
- record the temperature of the sodium hydroxide solution
- add 20 cm^3 of dilute hydrochloric acid and stir the mixture
- record the highest temperature of the mixture

(a) (i) Give the formula of the ion that causes sodium hydroxide solution to be alkaline.

(1)

.....

(ii) Suggest a pH value for the dilute hydrochloric acid.

(1)

.....

(b) Explain why a polystyrene cup is used in this experiment.

(2)

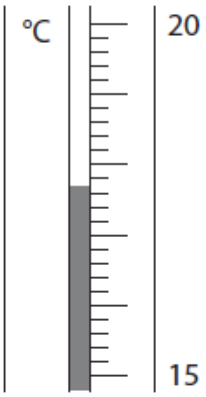
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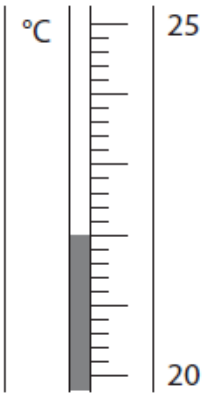
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(c) The diagram shows the thermometer readings at the start and at the end of the experiment.



start



end

Use the readings to complete the table, giving all values to the nearest 0.1 °C.

(3)

temperature in °C at end	
temperature in °C at start	
temperature change in °C	

(d) Another student does the experiment, but uses 25 cm^3 of sodium hydroxide solution and 25 cm^3 of dilute hydrochloric acid.

She records a temperature change of 5.2 °C.

Calculate the heat energy (Q) in kilojoules (kJ) released in this reaction.

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

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

(4)

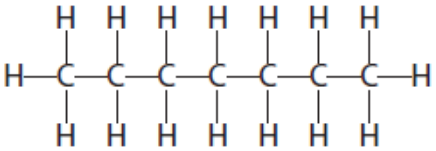
Q = ... kJ

(Total for question = 11 marks)

Q2.

(a) Two of the fractions obtained from crude oil are gasoline and bitumen.

(i) This is the displayed formula for one of the alkanes in the gasoline fraction.



Determine the molecular formula of this alkane.

(1)

.....

(ii) Give a use of bitumen.

(1)

.....

(iii) Describe the differences between the gasoline and bitumen fractions, in terms of colour, boiling point
and viscosity.

(3)

colour .....

.....

boiling point .....

.....

viscosity .....

.....

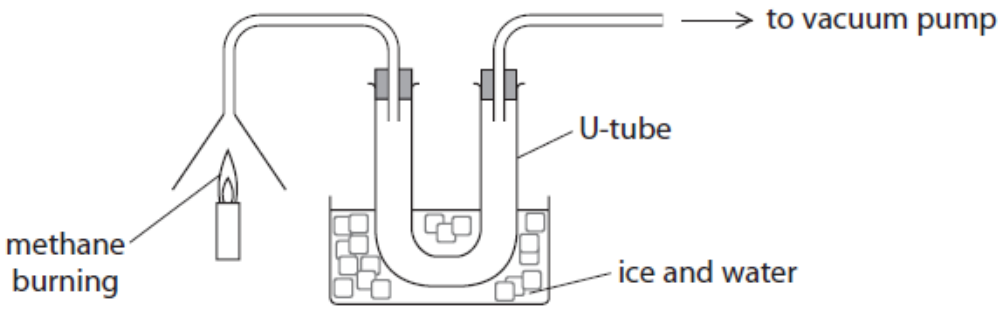
(b) Methane is an alkane used as a fuel.

When methane burns in a plentiful supply of air, carbon dioxide and water vapour form.

The equation for the reaction is

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The diagram shows how water can be collected when methane burns in the air.



(i) Water freezes at 0 °C and boils at 100 °C.

Carbon dioxide sublimes at −78 °C.

Explain why water collects in the U-tube, but carbon dioxide does not.

(4)

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(ii) Describe how anhydrous copper(II) sulfate can be used to show that the U-tube contains water.

(2)

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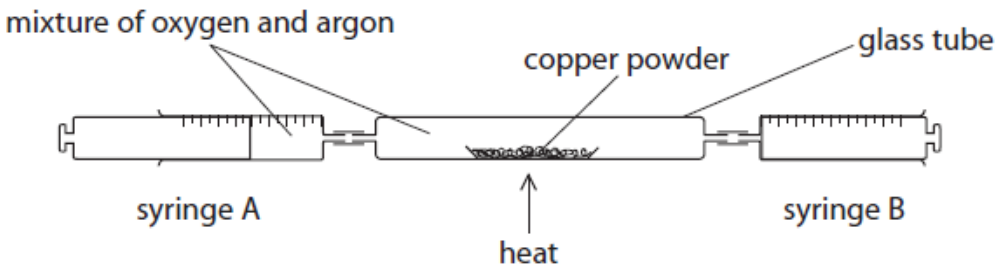
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(Total for question = 11 marks)

Q3.

A teacher uses this apparatus to find the percentage of oxygen in a gaseous mixture of oxygen and argon.



This is the teacher's method.

Step 1 heat the copper powder

Step 2 push the plunger on syringe A to pass the mixture of oxygen and argon over the hot copper so that the mixture moves into syringe B

Step 3 push the plunger on syringe B to pass the mixture of oxygen and argon over the hot copper so that the mixture moves into syringe A

Step 4 record the reading on syringe A

Step 5 repeat Steps 2, 3 and 4 a number of times

The volume of gas decreases as the oxygen reacts with the copper.

Argon is unreactive so does not react with the copper.

The copper powder turns black.

(a) (i) Give a reason why the copper powder is heated.

(1)

.....

.....

(ii) State why argon is unreactive.

(1)

.....

.....

(iii) Give the name of the black powder that forms when the oxygen reacts with the copper.

(1)

.....

(b) The table shows the teacher's results.

Reading number	Reading on syringe A in cm^3
Start	78
1	70
2	67
3	65
4	63
5	61
6	60
7	59
8	58
9	58
10	58

(i) State how the results show that all the oxygen has reacted.

(1)

.....

.....

(ii) The volume of gas in the glass tube and connecting tubes is 175 cm^3.

Use this value and the results table to calculate the percentage of oxygen in the mixture of oxygen and argon.

(3)

percentage of oxygen = ... %

(iii) Suggest one reason why the calculated percentage of oxygen in the mixture may not be accurate.

(1)

.....

.....

(Total for question = 8 marks)

Q4.

This question is about gases in the atmosphere.

(a) A student adds a piece of burning magnesium ribbon to a gas jar containing oxygen.

(i) State an observation that the student could make.

(1)

.....

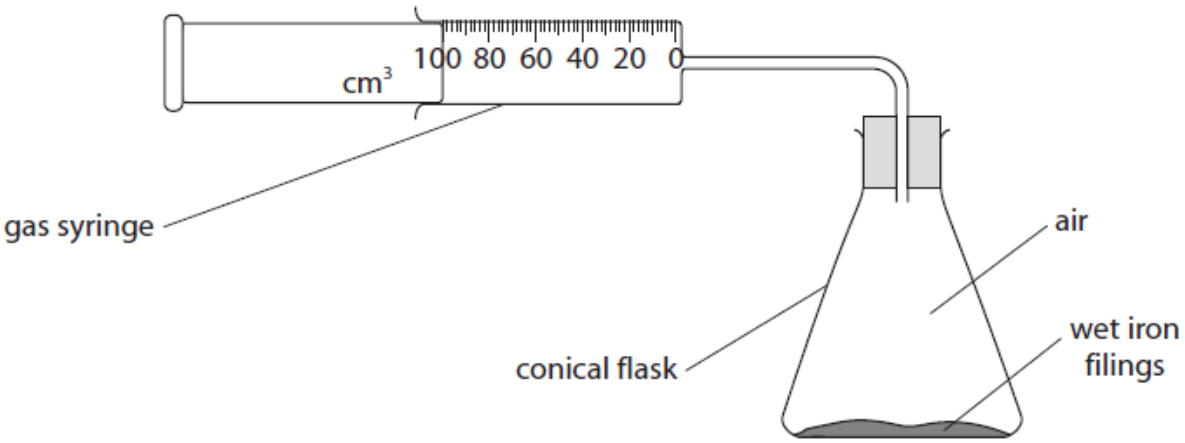
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(ii) Write a chemical equation for the reaction of magnesium with oxygen.

(1)

.....

(b) The student uses this apparatus to find the percentage by volume of oxygen in a sample of air.



The student leaves the apparatus until there is no further decrease in the volume of gas in the syringe.

These are the student's results.

volume of gas in conical flask and connecting tube	275 cm^3
volume of gas in syringe at start	100 cm^3
volume of gas in syringe at end	28 cm^3

Calculate the percentage by volume of oxygen in the sample of air.

Give your answer to two significant figures.

(4)

percentage of oxygen = ... %

(c) Carbon dioxide is another gas in the atmosphere.

(i) Describe a test for carbon dioxide.

(2)

.....

.....

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.....

(ii) Explain why an increase in the percentage of carbon dioxide in the atmosphere may cause an environmental problem.

(2)

.....

.....

.....

.....

(Total for question = 10 marks)

Q5.

This question is about gases in the atmosphere.

(a) The box gives the names of some gases in the atmosphere.

argon	carbon dioxide	helium	nitrogen	oxygen

Choose gases from the box to answer these questions.

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

(i) Identify a noble gas.

(1)

.....

(ii) Identify a gas that makes up about 78% of the atmosphere.

(1)

.....

(iii) Identify a greenhouse gas.

(1)

.....

(iv) Identify a gas produced by the thermal decomposition of calcium carbonate.

(1)

.....

(b) Sulfur reacts with oxygen to produce sulfur dioxide gas.

(i) Write a chemical equation for this reaction.

(1)

.....

(ii) State an environmental problem caused when sulfur dioxide gas dissolves in water in the atmosphere.

(1)

.....

.....

(Total for question = 6 marks)

Q6.

This question is about the elements in Group 1 of the Periodic Table and their reactions with water.

(a) State why sodium and potassium are in Group 1 of the Periodic Table.

(1)

.....

.....

(b) A reaction occurs when a small piece of sodium is added to a large volume of water in a trough.

(i) Give **two** observations that you would make during this reaction.

(2)

1 .....

.....

2 .....

.....

(ii) After the reaction has finished, a few drops of universal indicator are added to the solution in the trough.

Explain the final colour of the universal indicator.

(2)

.....

.....

.....

(iii) What is the most likely pH value of the solution in the trough after the reaction is complete?

(1)

☒ **A** 2

☒ **B** 5

☒ **C** 8

☒ **D** 12

(c) Give the name of a Group 1 metal that is less reactive than sodium.

(1)

.....

(d) A small piece of potassium is added to a large volume of water in a trough.

Give **one** observation that is made when potassium is added to water that is **not** made when sodium is added to water.

(1)

.....

.....

(e) Complete the equation for the reaction of rubidium with water.

State symbols are not required.

(1)

$$\text{.....}Rb + \text{.....}H_2O \rightarrow \text{.....}RbOH + \text{.....}H_2$$

(Total for question = 9 marks)

Q7.

This question is about some of the Group 1 elements and their compounds.

(a) A teacher adds a small piece of lithium to water in a trough.

(i) Give three observations that are made when lithium reacts with water.

(3)

1 .....

2 .....

3 .....

(ii) After the reaction has finished, the teacher adds a few drops of universal indicator to the solution in the trough.

Explain the colour of the universal indicator after it is added to the solution.

(2)

.....

.....

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.....

(iii) Write a chemical equation for the reaction of lithium with water.

(2)

.....

(b) A student does a flame test to see if a white solid contains sodium ions.

She cleans a platinum wire before using it for the flame test.

(i) Explain why the student needs to clean the platinum wire.

(2)

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.....

(ii) Which of these is the colour of the flame if the solid contains sodium ions?

(1)

☒ **A** green

☒ **B** lilac

☒ **C** red

☒ **D** yellow

(c) Potassium sulfate (K_2SO_4) is an ionic compound.

(i) Give the formula of each ion in potassium sulfate.

(1)

potassium ion ..... sulfate ion .....

(ii) The melting point of potassium sulfate is 1069 °C.

Explain why potassium sulfate has a high melting point.

Refer to structure and bonding in your answer.

(4)

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(Total for question = 15 marks)

Q8.

Lithium, sodium and potassium are the first three elements in Group 1 of the Periodic Table.

(a) Suggest why these three elements are all stored in paraffin oil.

(1)

.....

.....

.....

(b) Caesium, Cs, is below potassium in Group 1.

(i) Give a similarity and a difference between the reactions of potassium with water and caesium with water.

(2)

similarity.....

.....

difference.....

.....

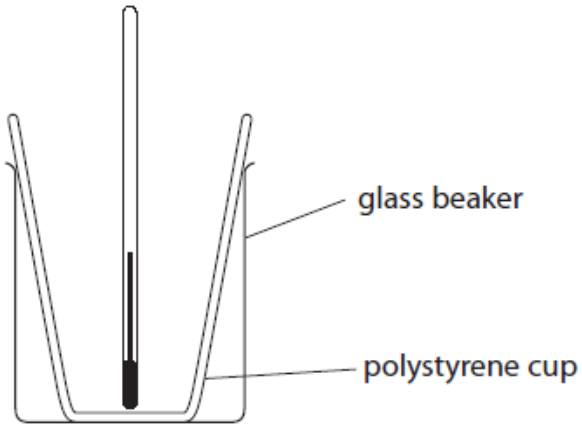
(ii) Give the chemical equation for the reaction between caesium and water.

(2)

.....

(c) A student investigates the temperature change in the reaction between dilute acids and solutions of Group 1 hydroxides.

He uses this apparatus.



This is the student's method.

- measure the temperature of 50 cm^3 of hydrochloric acid
- pour the acid into a polystyrene cup
- add 50 cm^3 of sodium hydroxide solution to the acid
- measure the maximum temperature of the mixture

(i) Suggest what could be added to the apparatus to improve the experiment.

(1)

.....

.....

(ii) Explain a change to the method that would improve the accuracy of the experiment.

(2)

.....

.....

.....

.....

(d) These are the student's results.

temperature of hydrochloric acid = 19.9 °C

maximum temperature of mixture = 26.5 °C

(i) Calculate the energy change, Q, in joules for this reaction.

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

[for the mixture, c = 4.2 J/g/°C]

(3)

Q = ... J

(ii) In the student's reaction between hydrochloric acid and sodium hydroxide, 0.050 mol of water forms.

Calculate the molar enthalpy change, Δ*H*, in kJ/mol for this reaction.

(2)

Δ*H* = ... kJ/mol

(Total for question = 13 marks)

Q9.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross

This question is about the elements in Group 1 of the Periodic Table.

(a) State the name given to the elements in Group 1.

(1)

.....

(b) A scientist adds a small piece of potassium to a trough of water.

(i) Which observation is **not** correct when potassium is added to water?

(1)

☒ **A** a colourless solution forms

☒ **B** a lilac flame is seen

☒ **C** effervescence occurs

☒ **D** potassium sinks

(ii) Give a reason why the scientist does not use a large piece of potassium.

(1)

.....

.....

(iii) After the reaction stops, the scientist adds a few drops of universal indicator solution to the trough.

The universal indicator solution turns purple.

Give the formula of the ion that causes the universal indicator solution to turn purple.

(1)

.....

(iv) Complete the chemical equation for the reaction of potassium with water.

(2)

.....K + ...H2O → ..... + ...

(c) Sodium reacts with oxygen to form the ionic compound sodium oxide, Na_2O

Explain, in terms of structure and bonding, why sodium oxide has a high melting point.

(4)

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(Total for question = 10 marks)

Q10.

This question is about some compounds of the elements in Group 4 of the Periodic Table.

(a) When carbon dioxide dissolves in water, a weak acid forms.

(i) Which of these could be the pH of this weak acid?

(1)

☒ **A** 1

☒ **B** 5

☒ **C** 7

☒ **D** 9

(ii) Which of these is a correct statement about acids?

(1)

☒ **A** acids contain OH^- ions

☒ **B** acids are electron donors

☒ **C** acids are proton acceptors

☒ **D** acids are proton donors

(b) When lead(II) carbonate is heated, lead(II) oxide and carbon dioxide form.

(i) Give the name of this type of reaction.

(1)

.....

(ii) Complete the equation for this reaction.

(1)

$PbCO_3 \rightarrow$ ..... + ...

(c) Silicon dioxide, SiO_2, and silicon(IV) chloride, $SiCl_4$, are both covalently bonded compounds.

The table shows the melting and boiling points of these two compounds, and the physical state of silicon dioxide at room temperature.

Compound	Melting point in °C	Boiling point in °C	Physical state at room temperature
SiO_2	1710	2230	solid
$SiCl_4$	−69	58	

(i) Complete the table by giving the physical state of silicon(IV) chloride at room temperature.

(1)

(ii) Explain, in terms of structure and bonding, why silicon dioxide has a much higher melting point than
silicon(IV) chloride.

(6)

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(Total for question = 11 marks)

Q11.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question is about the elements in Group 7 of the Periodic Table.

(a) (i) State the name given to Group 7.

(1)

.....

(ii) Which element is a liquid at room temperature?

(1)

☒ **A** astatine

☒ **B** bromine

☒ **C** fluorine

☒ **D** iodine

(iii) What is the colour of chlorine gas?

(1)

☒ **A** brown

☒ **B** colourless

☒ **C** green

☒ **D** red

(iv) Describe a test for chlorine gas.

(2)

.....

.....

.....

.....

(b) Iron reacts with chlorine to form iron(III) chloride, $FeCl_3$

(i) Use information from the Periodic Table to calculate the relative formula mass (M_r) of iron(III) chloride.

(2)

M_r = ...

(ii) Complete the chemical equation for the reaction of iron with chlorine.

(1)

..... Fe + ... Cl_2 → ..... $FeCl_3$

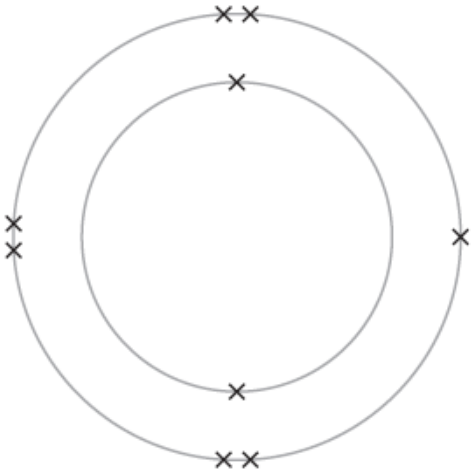
(Total for question = 8 marks)

Q12.

This question is about Group 7 elements and their reactions.

(a) Fluorine has the smallest atoms in Group 7.

The diagram shows the electronic configuration of a fluorine atom.



(i) State why fluorine has the smallest atoms in Group 7.

(1)

.....

.....

(ii) Which row gives the correct number of occupied electron shells and the correct number of outer shell electrons in an atom of iodine?

Use the Periodic Table on page 2 to help you.

(1)

	Number of occupied electron shells	Number of outer shell electrons
☒ **A**	4	5
☒ **B**	5	6
☒ **C**	5	7
☒ **D**	7	5

(b) (i) The table gives descriptions of the reactions of some Group 7 elements with iron wool.

Complete the table by giving a description of the reaction of fluorine with iron wool.

(2)

Element	Description of reaction with iron wool
fluorine	
chlorine	• does not need heating • reacts quickly
bromine	• needs heating • reacts slowly
iodine	• needs heating • reacts very slowly

(ii) State the relationship between the reactivity of the Group 7 elements and the size of their atoms.

(2)

.....

.....

.....

.....

(Total for question = 6 marks)

Q13.

A student is given a mixture of two white solid compounds, and a colourless solution containing the same two compounds.

The student is told that one of the compounds is a halide and that the other compound is a carbonate.

(a) Give two reasons why the student should know, without doing any tests, that one of the compounds **cannot** be copper(II) carbonate.

(2)

1 .....

.....

2 .....

.....

(b) Describe tests the student could do to show that the mixture contains potassium carbonate and potassium iodide.

(6)

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(Total for question = 8 marks)

Q14.

This question is about some of the halogens and their compounds.

(a) (i) Which element is a liquid at room temperature?

(1)

☒ **A** astatine

☒ **B** bromine

☒ **C** chlorine

☒ **D** iodine

(ii) Which element has the palest colour?

(1)

☒ **A** astatine

☒ **B** bromine

☒ **C** chlorine

☒ **D** iodine

(iii) Which element is the least reactive?

(1)

☒ **A** astatine

☒ **B** bromine

☒ **C** chlorine

☒ **D** iodine

(b) A teacher uses displacement reactions to demonstrate the reactivities of some halogens.

She adds solutions of chlorine, bromine and iodine separately to three different sodium halide solutions.

The table shows some of the teacher's results.

	sodium chloride	sodium bromide	sodium iodide
chlorine solution	not done	solution turns orange	
bromine solution	solution stays orange	not done	solution turns brown
iodine solution		solution stays brown	not done

A change in colour of the solution indicates that a reaction has occurred.

(i) Complete the table by predicting the missing results.

(2)

(ii) State why the teacher does not add bromine solution to sodium bromide solution.

(1)

.....

.....

(iii) The word equation for the reaction of bromine with sodium iodide is

bromine + sodium iodide → iodine + sodium bromide

Write a chemical equation for this reaction.

(1)

.....

(c) A technician sees an unlabelled bottle containing a liquid.

He knows that the liquid is a solution of one of these compounds.

- copper(II) chloride
- copper(II) bromide
- iron(II) chloride
- iron(II) bromide

Describe chemical tests that the technician could use to identify the compound in the solution.

(6)

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(Total for question = 13 marks)

Q15.

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)

.....

.....

(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)

.....

.....

.....

.....

.....

.....

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

(1)

.....

.....

.....

(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)

.....

.....

.....

.....

(Total for question = 12 marks)

Q16.

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)

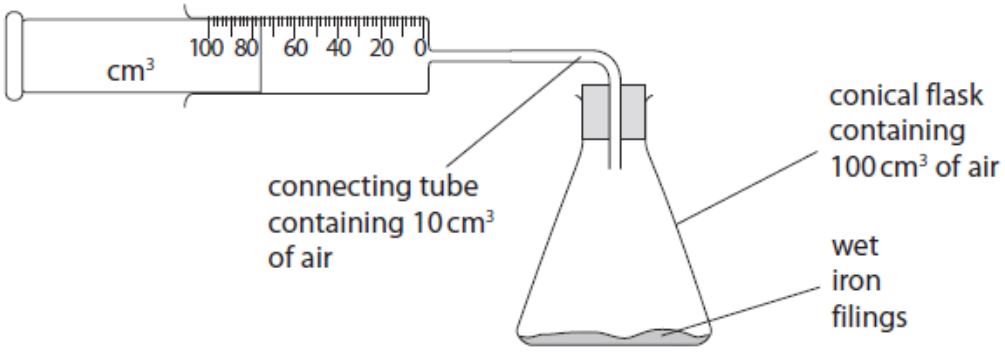
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(Total for question = 6 marks)

Q17.

The percentage by volume of oxygen in air can be found by using the rusting of iron.

A student sets up this apparatus to measure the volume of oxygen in a sample of air.

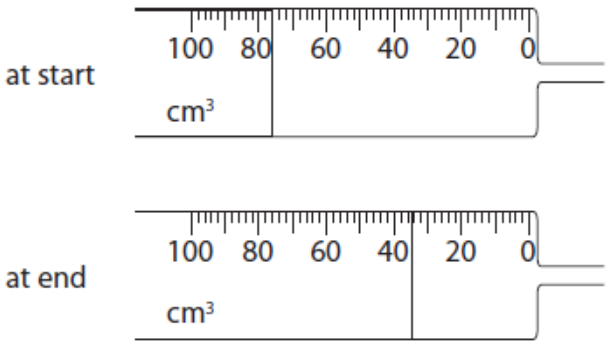


An excess of wet iron filings is used.

At the start of each experiment, the reading on the syringe is recorded and the apparatus is then left for a week so that the reaction is complete.

The reading on the syringe is then recorded again.

(a) The diagram shows the readings in one experiment.



Complete the table to show:

- the syringe reading at the end of this experiment
- the volume of oxygen used in the experiment.

(2)

syringe reading at start / cm³	76
syringe reading at end / cm³	
volume of oxygen used / cm³	

(b) The table shows the results recorded by a different student in her experiment.

volume of air in conical flask / cm^3	100
volume of air in connecting tube / cm^3	10
original volume of air in syringe / cm^3	80
final volume of air in syringe / cm^3	43

Calculate the percentage of oxygen in air using these results.

(3)

percentage of oxygen = ... %

(c) The table shows some possible causes of anomalous results in this experiment.

Use terms from the box to complete the table, showing possible causes and their effects on the volume of oxygen used in this experiment.

decreased	increased	no effect

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

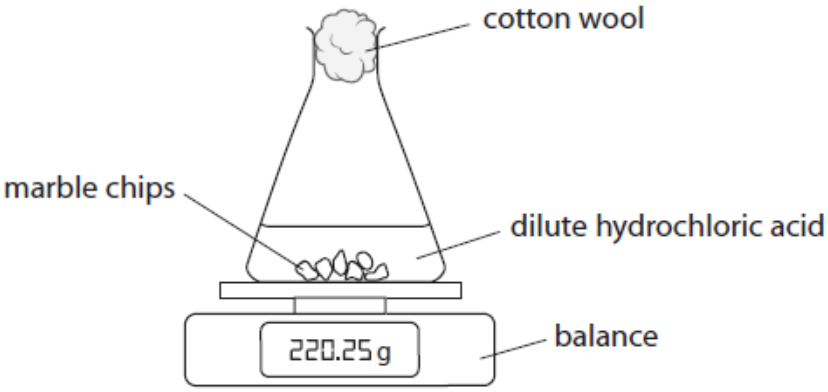
(3)

Possible cause	Effect on volume of oxygen used
wet iron filings not in excess	
apparatus left for 1 hour instead of 1 week	
apparatus left in a warmer place for 1 week	

(Total for question = 8 marks)

Q18.

A student uses this apparatus to investigate the rate of reaction between marble chips and dilute hydrochloric acid.



The equation for the reaction is

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

(a) During the reaction the mass of the contents of the flask decreases.

(i) State why the mass of the contents of the flask decreases.

(1)

.....

.....

(ii) State the purpose of the cotton wool.

(1)

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(iii) Explain why sulfuric acid is not a suitable acid to use in this investigation.

(2)

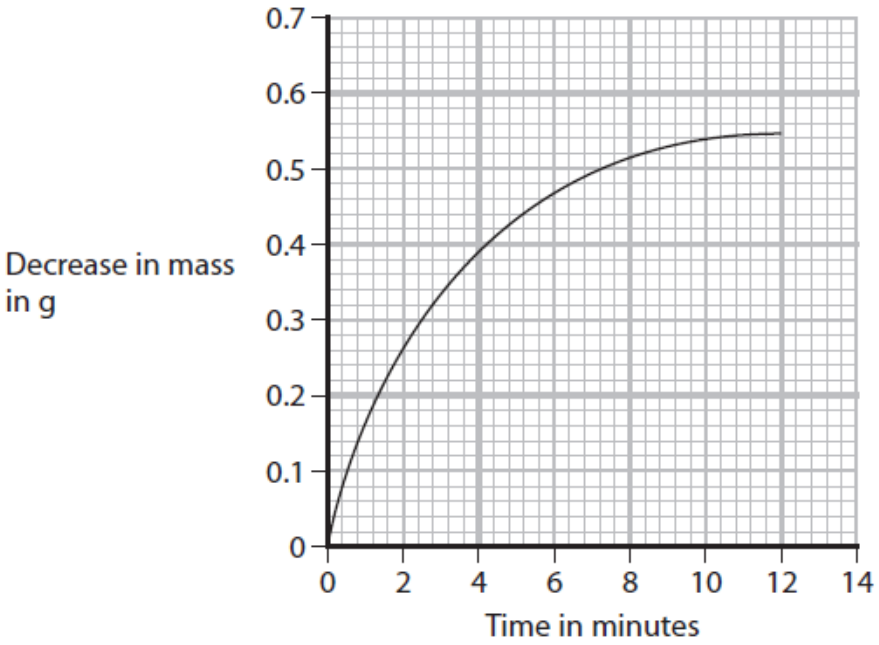
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(b) The graph shows the student's results.



(i) In the investigation the marble chips are in excess.

Explain the shape of the graph.

(4)

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(ii) The student repeats the experiment using the same volume of hydrochloric acid but of half the concentration of
the original acid. All other conditions are kept the same.

On the grid, draw the curve the student would obtain.

(2)

(c) Explain, using particle collision theory, how increasing the temperature affects the rate of a reaction.

(4)

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(Total for question = 14 marks)

Q19.

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

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

(2)

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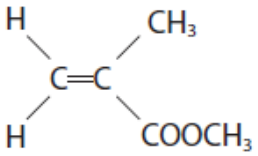
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(ii) Organic compound Q reacts with bromine, without the presence of ultraviolet radiation, to form the
compound $C_4H_8Br_2$

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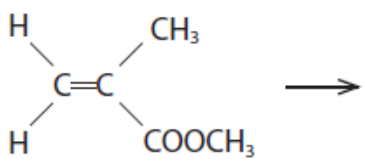
(ii) Name the type of polymerisation that occurs in the formation of the polymer.

(1)

.....

(iii) Complete the equation for the polymerisation reaction.

(2)

n 

(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)

Q20.

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)

$Li_2CO_3 \rightarrow$ ..... + ...

(Total for question = 7 marks)