PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

CHEMISTRY



EXAM QUESTION PACK

SECTION 2: INORGANIC CHEMISTRY (PACK 6)

SCORE	PERCENTAGE
/195	%

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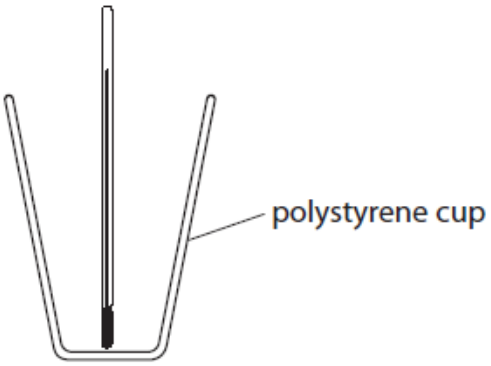
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Q1.

A student investigates the temperature change during the reaction between zinc metal and copper(II) sulfate solution.

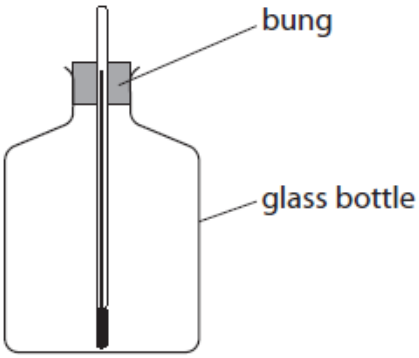
The student considers two different methods.

Method 1



- pour 50 cm^3 of copper(II) sulfate solution into the polystyrene cup
- record the temperature of the solution
- add 3 g of zinc powder
- stir using the thermometer and record the highest temperature reached

Method 2



- record the temperature of 50 cm^3 of copper(II) sulfate solution
- pour the 50 cm^3 of copper(II) sulfate solution into the glass bottle
- add 3 g of zinc powder
- push the bung and thermometer into the bottle and record the highest temperature reached

(a) Discuss the advantages and disadvantages of each method.

(6)

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(b) The equation for the reaction is

$$Zn\ (s) + CuSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Cu\ (s)$$

50 cm^3 of copper(II) sulfate solution contains 0.025 mol $CuSO_4$

A mass of 3 g of zinc is used.

Show that the zinc is in excess.

[A_r of zinc = 65]

(2)

(c) The student reacts a solution containing 0.025 mol $CuSO_4$ with an excess of zinc.

These are the student's results.

temperature of 50 cm^3 of copper(II) sulfate solution = 21.1 °C

highest temperature reached = 40.6 °C

(i) Show that the energy change Q for this reaction is about 4000 J

[mass of 1 cm^3 of solution = 1.0 g]

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

(3)

(ii) Calculate the molar enthalpy change (ΔH), in kJ / mol, for the reaction.

(3)

(ΔH) = ... kJ / mol

(d) The ionic equation for the reaction is

$$Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Zn^{2+}\ (aq) + Cu\ (s)$$

Explain what is oxidised and what is reduced in this reaction.

(2)

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(Total for question = 16 marks)

Q2.

(a) Carbon dioxide changes directly from a solid to a gas without becoming a liquid.

(i) Give the name of the change of state from solid to gas.

(1)

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(ii) Describe the test for carbon dioxide gas.

(2)

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(b) Carbon dioxide is a simple molecular covalent substance.

Explain why carbon dioxide turns from a solid to a gas at a very low temperature.

(2)

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(c) Diamond and graphite are both giant covalent substances made up of carbon atoms.

- diamonds are used in cutting tools
- graphite is used in pencils to make marks on paper

Explain, with reference to structure and bonding, why each substance is suitable for its particular use.

(6)

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(Total for question = 11 marks)

Q3.

The gas burned in a Bunsen burner is methane.

The equation for the complete combustion of methane is

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

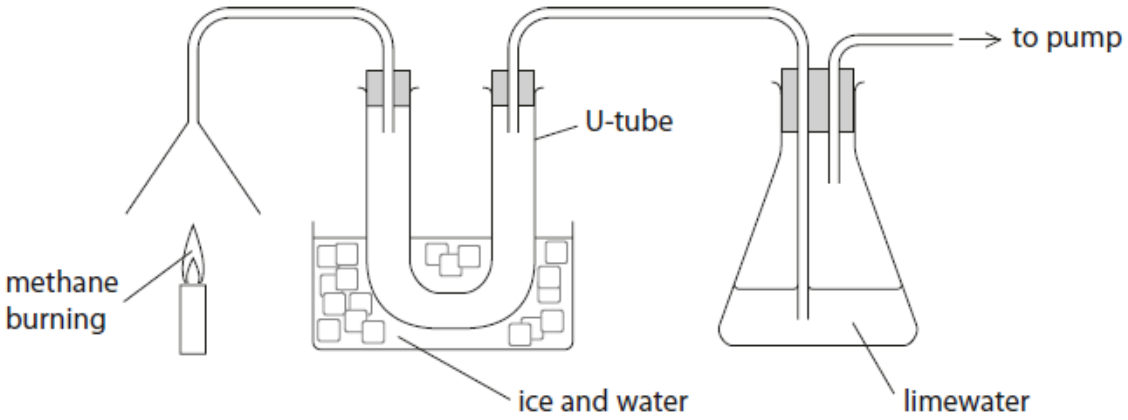
(a) Calculate the mass of oxygen required to react with 32 g of methane.

[M_r of methane = 16]

(2)

mass of oxygen = ... g

(b) The diagram shows methane burning in air. It also shows how the two gases formed are collected and tested.



(i) Explain why water collects in the U-tube.

(2)

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(ii) Describe how anhydrous copper(II) sulfate is used to test for water.

(2)

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(iii) Explain the change in appearance of the limewater.

(3)

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(Total for question = 9 marks)

Q4.

(a) A scientist finds an unlabelled bottle on a shelf.

She thinks the bottle contains a solution of ammonium sulfate, $(NH_4)_2SO_4$

Describe tests the scientist could do to show that the solution is ammonium sulfate.

(6)

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(b) Ammonium sulfate is often used as a fertiliser.

It is prepared by reacting ammonia (NH_3) with sulfuric acid (H_2SO_4).

(i) Name the type of reaction that occurs between ammonia and sulfuric acid.

(1)

.....

(ii) Write a chemical equation for the reaction of ammonia with sulfuric acid.

(1)

.....

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

Show outer electrons only.

(2)

(Total for question = 10 marks)

Q5.

Hydrated ammonium iron(III) sulfate is a violet solid that has the formula $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$

The table shows some tests done on three separate samples of the solid.

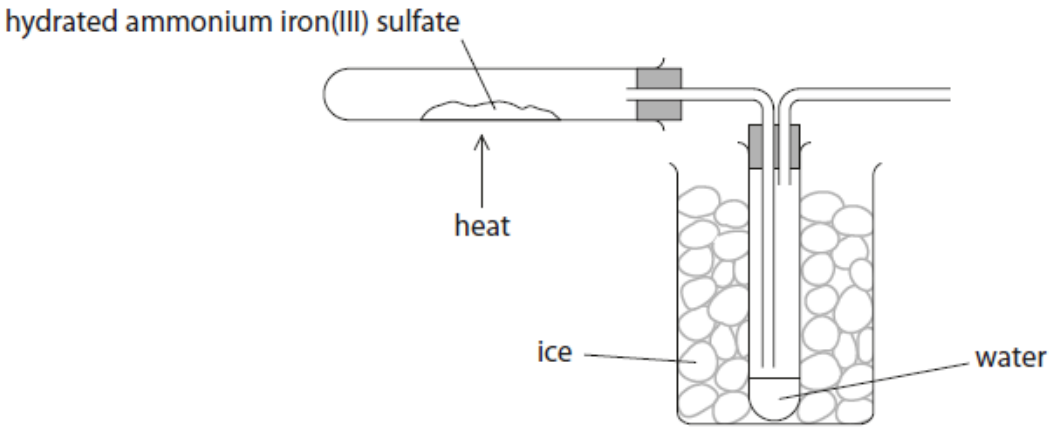
Test	Observation
Dissolve the solid in water and add acidified barium chloride solution.	
Dissolve the solid in water and add sodium hydroxide solution.	
Add sodium hydroxide solution to the solid and warm the mixture. Test the gas given off with moist universal indicator paper.	

(a) Complete the table to show the observation made in each test.

(3)

(b) A student needs to find the value of x in the formula $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$

He uses this apparatus.



The hydrated solid decomposes when heated gently.

The equation for the reaction is

$$(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O \rightarrow (NH_4)_2SO_4.Fe_2(SO_4)_3 + xH_2O$$

The table shows the student's results.

mass of empty test tube in g	22.04
mass of test tube and $(NH_4)_2SO_4.Fe_2(SO_4)_3.xH_2O$ in g	34.09
mass of test tube and $(NH_4)_2SO_4.Fe_2(SO_4)_3$ in g	28.69

(i) Calculate the mass of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ produced by heating.

(1)

mass of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ = ... g

(ii) Calculate the mass of water produced.

(1)

mass of water = ... g

(iii) Calculate the value of x.

[M_r of $(NH_4)_2SO_4.Fe_2(SO_4)_3$ = 532 and M_r of H_2O = 18]

Give your answer to the nearest whole number.

(4)

value of x = ...

(Total for question = 9 marks)

Q6.

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 ☒.

Iron reacts with dilute sulfuric acid to form a salt called iron(II) sulfate.

The formula of iron(II) sulfate is $FeSO_4$

(a) (i) How many different elements are there in iron(II) sulfate?

(1)

☐ **A** 2

☐ **B** 3

☐

C 4

☒ **D** 6

(ii) Use information from the Periodic Table to calculate the relative formula mass of iron(II) sulfate.

(2)

relative formula mass = ...

(b) Some iron filings are added to dilute sulfuric acid. The mixture is warmed and hydrogen gas is given off.

(i) State why the mixture is warmed.

(1)

.....

.....

(ii) State the observation that shows a gas is being given off.

(1)

.....

(iii) Give the test for hydrogen gas.

(1)

.....

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(c) When the reaction stops, some iron filings remain.

(i) State why the reaction stops.

(1)

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(ii) Give a chemical equation for the reaction between iron and sulfuric acid.

(1)

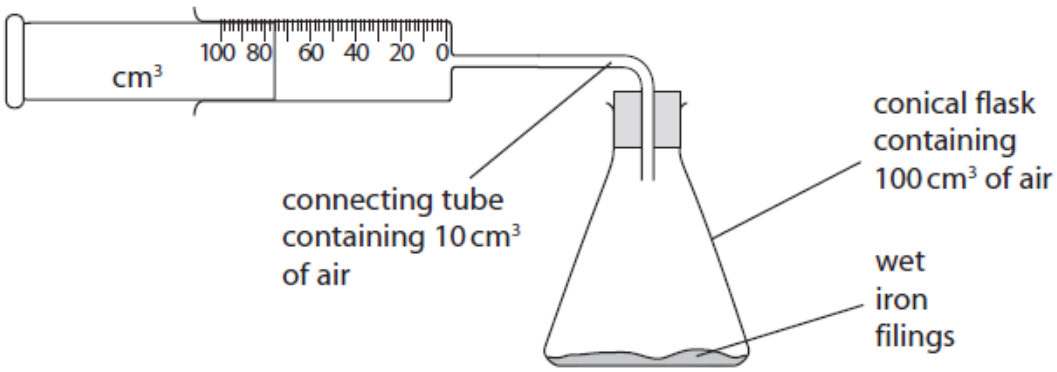
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(Total for question = 8 marks)

Q7.

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.

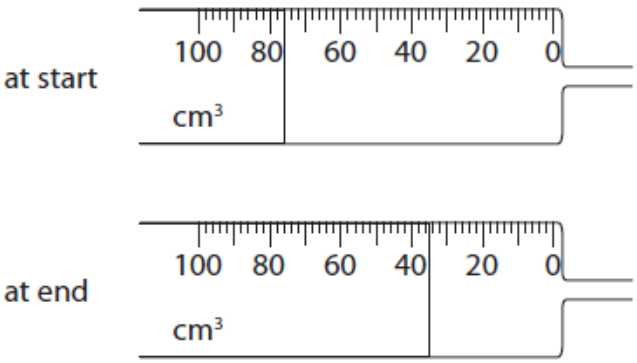


An excess of wet iron filings is used.

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)

Q8.

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

(a) 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

(b) 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)

.....

.....

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

State symbols are not required.

(1)

..... Rb + ... H_2O → ..... RbOH + ... H_2

(Total for question = 7 marks)

Q9.

This question is about the oxides of lead.

(a) Yellow lead oxide (PbO) can be reacted with hydrogen to produce lead.

(i) Complete the equation for the reaction by adding the missing state symbols.

(1)

$PbO(s) + H_2(.....) \rightarrow Pb(.....) + H_2O(.....)$

(ii) What is the charge on the lead ion in PbO?

(1)

☒ **A** 1−

☒ **B** 1+

☒ **C** 2−

☒ **D** 2+

(iii) Explain why the reaction of yellow lead oxide with hydrogen is a redox reaction.

(2)

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(iv) Describe a physical test to show that the water produced in this reaction is pure.

(2)

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(b) When red lead oxide (Pb_3O_4) is heated, yellow lead oxide forms.

The equation for the reaction is

$$2Pb_3O_4 \rightarrow 6PbO + O_2$$

A scientist heats a known mass of red lead oxide in a crucible in a fume cupboard.

The scientist leaves the crucible to cool, then records the total mass of the crucible and its contents.

(i) Describe what the scientist should do next to make sure that all the red lead oxide has reacted.

(2)

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(ii) The red lead oxide used in the reaction has a mass of 5.48 g.

Calculate the maximum mass of yellow lead oxide that could form.

[M_r of Pb_3O_4 = 685 M_r of PbO = 223]

(3)

maximum mass of PbO = ... g

(Total for question = 11 marks)

Q10.

Use the Periodic Table to help you answer this question.

(a) (i) Name the element with atomic number 16.

(1)

.....

(ii) Name the element in Group 3 and Period 2.

(1)

.....

(iii) Name an element that is a liquid at room temperature.

(1)

.....

(b) (i) Determine the number of neutrons in a chlorine atom with mass number 37.

(1)

.....

(ii) Give the formula of a sulfide ion.

(1)

.....

(iii) Give the formula of magnesium fluoride.

(1)

.....

(Total for question = 6 marks)

Q11.

Many different salts can be prepared from acids.

(a) The table shows the reactants used in two salt preparations.

Complete the table to show the name of the salt formed and the other product(s) in each case.

(4)

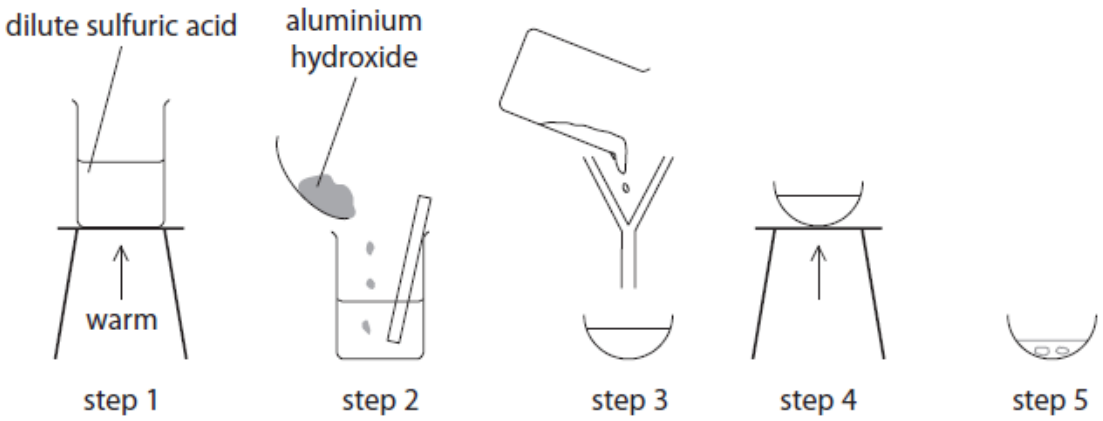
Reactants	Name of salt formed	Other product(s)
zinc + hydrochloric acid		
calcium carbonate + nitric acid		

(b) A student uses the reaction between aluminium hydroxide and dilute sulfuric acid to prepare a pure, dry sample of aluminium sulfate crystals.

The equation for the reaction used to prepare this salt is

$$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$$

The diagram shows the steps in the student's method.



(i) State **two** ways to make sure that all the acid is reacted in step 2.

(2)

1 .....

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2 .....

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(ii) State the purpose of filtration in step 3.

(1)

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(iii) In step 5, the basin is left to cool to room temperature to allow crystals of aluminium sulfate to form.

State **one** method of drying these crystals.

(1)

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(c) The student records this information about the reagents she uses in her preparation.

mass of aluminium hydroxide = 3.9 g

amount of sulfuric acid = 0.090 mol

Determine which reagent is in excess, making use of this information and the equation in part

(b).

(3)

reagent used in excess = ...

(d) Another student prepares 0.25 mol of aluminium sulfate. The formula of aluminium sulfate is $Al_2(SO_4)_3$

Calculate the mass of aluminium sulfate prepared.

(3)

mass = ... g

(e) The equation for another reaction used to prepare a sample of a salt is

$$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$$

In one experiment, the amount of lead(II) oxide used was 0.75 mol and the amount of nitric acid used was 1.5 mol. At the end of the experiment, the mass of lead(II) nitrate obtained was 209 g.

Calculate the percentage yield of lead(II) nitrate in this experiment.

[M_r of lead(II) nitrate = 331]

(3)

percentage yield = ... %

(Total for question = 17 marks)

Q12.

In 1937 an airship full of hydrogen gas flew from Germany to America.



(Source: © Michael Rosskothen/Shutterstock)

(a) Which property of hydrogen makes it a suitable gas to use in an airship?

(1)

☒ **A** colourless

☒ **B** insoluble in water

☒ **C** low density

☒ **D** no smell

(b) Explain why helium is now used in airships instead of hydrogen.

(2)

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(c) Hydrogen is used to manufacture ammonia, NH_3

Hydrogen is reacted with nitrogen using an iron catalyst.

(i) Give a chemical equation for this reaction.

(1)

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(ii) State why a catalyst is used in this reaction.

(1)

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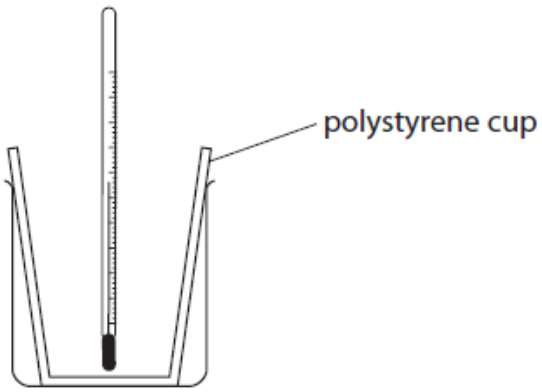
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(Total for question = 5 marks)

Q13.

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 ☒.

A student uses this apparatus to investigate the reaction between zinc and copper(II) sulfate solution.



This is the student's method.

- add 50.0 cm^3 of copper(II) sulfate solution to the polystyrene cup
- record the initial temperature
- add excess zinc and stir
- record the highest temperature of the mixture

An exothermic reaction occurs.

(a) State what is meant by the term **exothermic**.

(1)

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.....

(b) This is the equation for the reaction.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

(i) What is the name of this type of reaction?

(1)

☒ **A** combustion

☒ **B** decomposition

☒ **C** displacement

☒ **D** neutralisation

(ii) Apart from the temperature increasing, give two other observations that the student could make during the reaction.

(2)

1 .....

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2 .....

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(iii) State why silver does not react with copper(II) sulfate solution.

(1)

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

volume of copper(II) sulfate solution	50.0 cm^3
initial temperature of copper(II) sulfate solution	20.5 °C
highest temperature of mixture	37.0 °C

Calculate the heat energy change (Q) in kJ.

[for the solution, c = 4.2 J/g/°C mass of 1.00 cm^3 of solution = 1.00 g]

(4)

Q= ..... kJ

(Total for question = 9 marks)

Q14.

This question is about the reactivity of metals.

(a) Table 1 shows whether a reaction occurs between a metal and an aqueous solution of a metal sulfate.

Metal	Metal sulfate	Does a reaction occur?
manganese	chromium sulfate	yes
tin	cadmium sulfate	no
chromium	cadmium sulfate	yes

Table 1

(i) Name the type of reaction that occurs between manganese and chromium sulfate.

(1)

.....

(ii) Use the information in Table 1 to complete the order of reactivity.

(1)

most reactive

least reactive

manganese

.....

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(b) Table 2 shows the colours of four metals and the colours of their metal sulfate solutions.

Metal	Colour of metal	Colour of metal sulfate solution
copper	brown	blue
iron	dark grey	green
magnesium	silvery	colourless
zinc	light grey	colourless

Table 2

When a metal is added to a metal sulfate solution there may be a colour change on the surface of the metal and in the solution.

Use the information in Table 2 and your knowledge of the reactivity series to explain any colour changes in these two experiments.

(5)

copper added to magnesium sulfate solution .....

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zinc added to iron sulfate solution .....

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(c) A different experiment can be used to place metals in order of reactivity.

This is the method.

Step 1 add 1 g of a metal to 25 cm^3 of dilute sulfuric acid

Step 2 measure the volume of gas produced in one minute

(i) Give two variables that should be controlled in this experiment.

(2)

1 .....

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2 .....

.....

(ii) A small piece of calcium is added to some dilute sulfuric acid in a beaker.

One of the products of the reaction, calcium sulfate, is insoluble in water.

Suggest why the reaction stops after a short time, even though the beaker still contains calcium and dilute sulfuric acid.

(1)

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.....

(d) 1.00 g of aluminium is added to 0.0600 mol of dilute sulfuric acid.

The equation for the reaction is

$$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

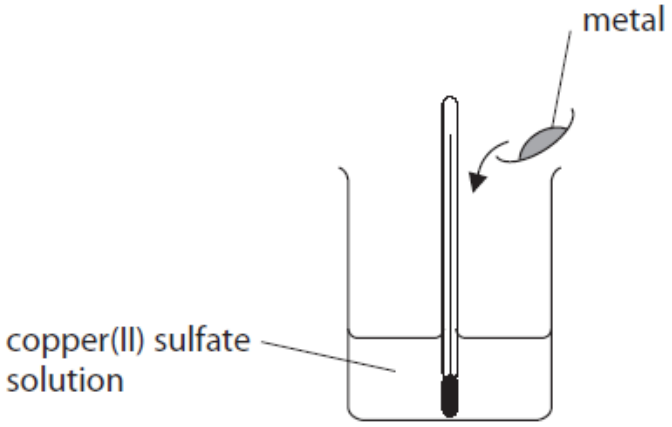
Show by calculation that the sulfuric acid is in excess.

(2)

(Total for question = 12 marks)

Q15.

A student uses this apparatus to investigate the temperature changes that occur when metals are added to copper(II) sulfate solution.

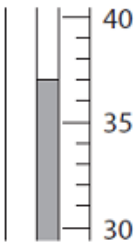
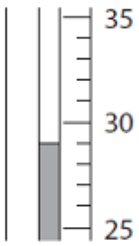
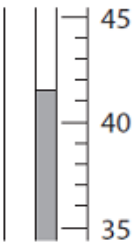
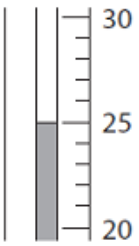
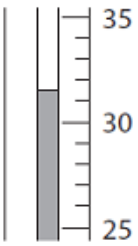


This is the student's method.

- add a sample of aluminium to a beaker containing 25 cm^3 of copper(II) sulfate solution
- stir the mixture and record the highest temperature reached

The student repeats the experiment four times, using the same amount of a different metal each time.

(a) The table shows the thermometer readings for each metal.

	Aluminium	Iron	Magnesium	Silver	Zinc
Thermometer reading					
Highest temperature reached in °C				25.0	

Complete the table by recording the highest temperature reached for each metal, giving all temperatures to the nearest 0.5 °C.

(2)

(b) The initial temperature of the copper(II) sulfate solution in each experiment is 25.0 °C.

(i) Suggest why magnesium produces the largest temperature rise.

(1)

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(ii) Explain why there is no temperature change with silver.

(2)

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(c) In the experiment with magnesium, using 25 cm^3 of solution means that the copper(II) sulfate is in excess.

In another experiment, the student uses the same amount of magnesium but adds it to 50 cm^3 of copper(II) sulfate solution.

Explain how the change in volume affects the temperature rise.

(2)

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(d) In another experiment, the student adds a metal to 45 cm^3 of copper(II) sulfate solution

and obtains a temperature rise of 15.0 °C.

The mass of 1.0 cm^3 of the solution is 1.0 g.

The specific heat capacity, c, of the solution is 4.2 J/g/°C.

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

(4)

Q ..... kJ

(Total for question = 11 marks)

Q16.

This question is about the rusting of iron.

(a) Water is needed for iron to rust.

(i) Name one other substance needed for iron to rust.

(1)

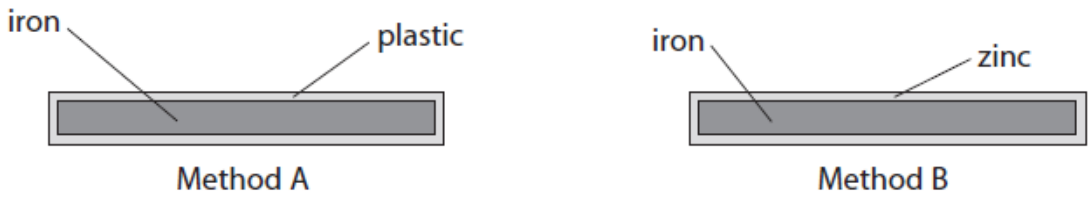
.....

(ii) Give the chemical name for rust.

(1)

.....

(b) The diagram shows two methods used to prevent iron from rusting.



Method A will only work if the plastic coating is not damaged.

Method B will work even when the zinc coating is damaged.

(i) Explain how method A prevents iron from rusting.

(2)

.....

.....

.....

.....

(ii) Give the name of method B.

(1)

.....

(iii) Explain how method B prevents iron from rusting even when the zinc coating is damaged.

(2)

.....

.....

.....

.....

(Total for question = 7 marks)

Q17.

Sodium hydroxide dissolves in water, forming a strongly alkaline solution.

Ammonia dissolves in water, forming a slightly less alkaline solution.

(a) (i) Identify the ion that makes the sodium hydroxide solution alkaline.

(1)

.....

(ii) What is a possible pH of ammonia solution?

(1)

☒ **A** 3

☒ **B** 6

☒ **C** 11

☒ **D** 14

(b) When ammonia solution reacts with sulfuric acid, a neutralisation reaction occurs and ammonium sulfate forms.

(i) How does the sulfuric acid act in this reaction?

(1)

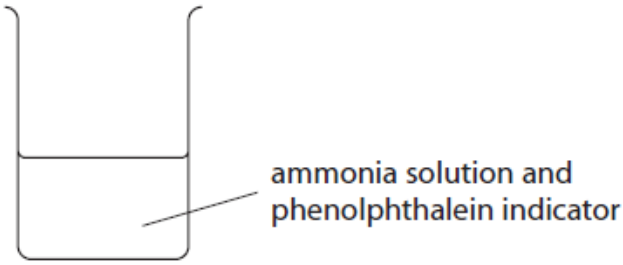
☒ **A** as a neutron donor

☒ **B** as a neutron acceptor

☒ **C** as a proton donor

☒ **D** as a proton acceptor

(ii) The diagram shows a beaker containing some ammonia solution and a few drops of phenolphthalein indicator.



Dilute sulfuric acid is added to the beaker until it is in excess.

What are the colours of the phenolphthalein indicator before and after adding excess sulfuric acid?

(1)

	Before	After
☒ **A**	orange	red
☒ **B**	yellow	red
☒ **C**	pink	colourless
☒ **D**	colourless	pink

(c) Ammonium sulfate is used by gardeners as a fertiliser because it contains nitrogen.

(i) Explain why the chemical formula of ammonium sulfate is $(NH_4)_2SO_4$

Refer to the charges on the ions in your answer.

(2)

.....

.....

.....

(ii) Calculate the relative formula mass of ammonium sulfate, $(NH_4)_2SO_4$

(1)

relative formula mass = ...

(iii) Calculate the mass, in grams, of nitrogen in 1.0 kg of ammonium sulfate.

(3)

mass = ... g

(Total for question = 10 marks)

Q18.

(a) Explain the meaning of the term **thermal decomposition**.

(2)

.....

.....

.....

.....

(b) The equation for the thermal decomposition of potassium hydrogencarbonate is

$$2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$$

Calculate the maximum mass of K_2CO_3 that could be produced from the thermal decomposition of 2.50 g of $KHCO_3$

(4)

maximum mass of K_2CO_3 = ... g

(Total for question = 6 marks)

Q19.

A student does these two tests on a solution made from a white solid.

- flame test
- add acidified silver nitrate solution

The table shows his results.

Test	Result
flame test	red flame
add acidified silver nitrate solution	cream precipitate

(a) Give the formula of the ion that produces the red flame.

(1)

.....

(b) Name the cream precipitate.

(1)

.....

(c) Identify the white solid.

(1)

.....

(d) The student uses a clean metal wire in the flame test.

(i) State why the wire should be clean when used in the flame test.

(1)

.....

.....

(ii) The table lists properties of some metals.

Add ticks (✓) to the table to show the two properties needed in a metal wire used in a flame test.

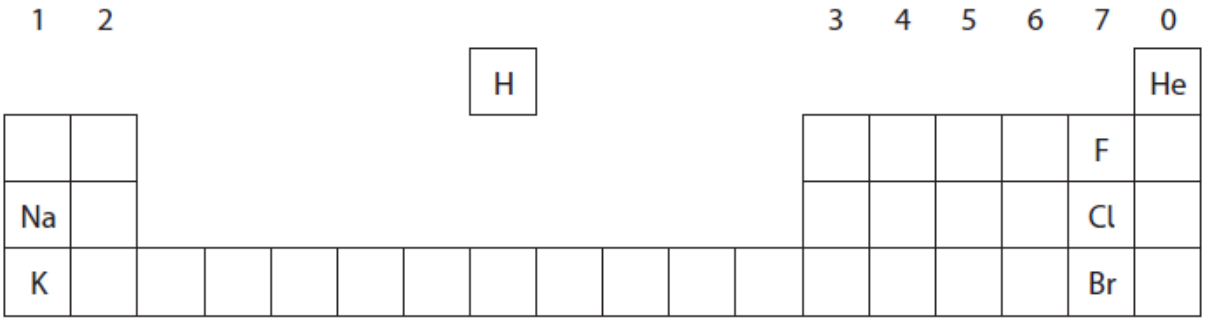
(2)

Property	
good conductor of electricity	
high density	
high melting point	
unreactive	

(Total for question = 6 marks)

Q20.

The diagram shows the positions of some elements in the Periodic Table.



(a) Use symbols from this table to answer these questions.

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

(i) Give the symbol of a metal.

(1)

.....

(ii) Give the symbol of a noble gas.

(1)

.....

(iii) Give the symbol of a liquid at room temperature.

(1)

.....

(iv) Give the symbols of the two elements in Period 3

(1)

..... and .....

(b) Deduce the electronic configuration of Na

(1)

.....

(Total for question = 5 marks)

Q21.

A student uses this method to investigate the reaction of dilute hydrochloric acid with zinc.

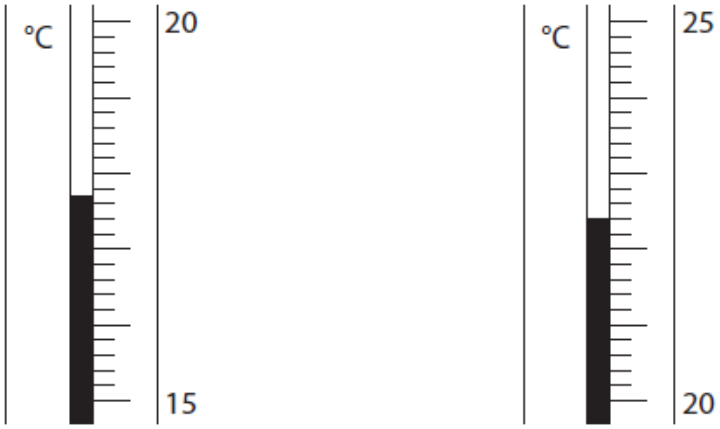
- pour some dilute hydrochloric acid into a glass beaker
- record the initial temperature of the acid
- add a piece of zinc and stir the mixture
- record the temperature of the mixture after one minute

(a) Write a word equation for the reaction of dilute hydrochloric acid with zinc.

(1)

.....

(b) The diagram shows the thermometer readings for this reaction.



before adding zinc

after adding zinc

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

(3)

temperature in °C after adding zinc	
temperature in °C before adding zinc	
temperature change in °C	

(c) Another student repeats the method using five different metals to compare their reactivity.

(i) This student uses a polystyrene cup instead of a glass beaker.

Explain why a polystyrene cup is better than a glass beaker in this investigation.

(2)

.....

.....

.....

.....

(ii) Give three factors that the student should keep constant in this investigation.

(3)

1 .....

2 .....

3 .....

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

Metal added	Observation	Temperature change in °C
copper	no bubbling	0.0
iron	slow bubbling	
magnesium	rapid bubbling	8.7
tin	very slow bubbling	1.4
zinc	moderate bubbling	5.1

(i) State why there is no temperature change for copper.

(1)

.....

.....

(ii) Predict the temperature change for iron.

(1)

temperature change = ... °C

(iii) Deduce the order of reactivity of the five metals.

(1)

most reactive

.....

.....

.....

.....

.....

least reactive

(Total for question = 12 marks)