

(ii) a Group 5 element

(1)

(iii) an alkali metal

(1)

(iv) the element with atomic (proton) number of 47

(1)

(v) an element with seven electrons in its outer shell?

(1)

(b) The table shows the boiling points of the Group 7 elements. The elements are arranged **in alphabetical order**.

Group 7 element		
Name	Symbol	Boiling point in °C
Astatine	At	337
Bromine		58
Chlorine	Cl	-34
Fluorine	F	-188
Iodine	I	184

(i) The symbol for bromine is missing from the table.

What is the symbol for bromine? Symbol = _____

(1)

(ii) Arrange these elements in order of **decreasing** boiling point. The first one and the last one have been done for you.

At _____ _____ _____ F

Highest boiling point \longrightarrow Lowest boiling point

(1)

(c) The table shows some statements about Group 7 elements.

Tick (✓) the **two** correct statements.

	Tick (✓)
They are halogens.	
They are metals.	
They become less reactive down Group 7.	
They are compounds.	

(2)

(Total 9 marks)

Q2. The elements in Group 1 are known as the alkali metals.

Which **three** of the following are properties of alkali metals?

Place a tick (✓) in the box against each correct property.

Hard, tough and strong

Low density

Form hydroxides that dissolve in water

React quickly with water

Used as catalysts

Used to make electric cables

(Total 3 marks)

Q3. Sodium reacts with water to produce hydrogen gas and a solution of sodium hydroxide.

Complete the **word** equation for this reaction (do **not** use symbols or formulae).

_____ + _____ _____ + _____

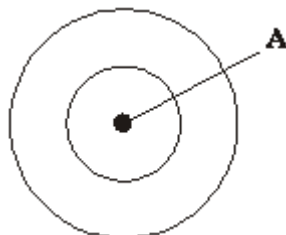
(Total 3 marks)

Q4. This question is about oxygen atoms. The periodic table on the Data Sheet may help you to answer this question.

- (a) (i) Oxygen atoms have 8 electrons.

Complete the diagram to represent the arrangement of electrons in an oxygen atom.

Use crosses (x) to represent the electrons.



(1)

- (ii) Name the part of the oxygen atom that is labelled **A** on the diagram.

(1)

- (b) Two isotopes of oxygen are oxygen-16 and oxygen-18.



Explain, in terms of particles, how the nucleus of an oxygen-18 atom is different from the nucleus of an oxygen-16 atom.

(2)

(Total 4 marks)

Q5. In 1866 John Newlands produced an early version of the periodic table.

Part of Newlands' periodic table is shown below.

Column	1	2	3	4	5	6	7
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca	Cr	Ti	Mn	Fe

Newlands' periodic table arranged all the known elements into columns in order of their atomic weight.

Newlands was trying to show a pattern by putting the elements into columns.

- (a) Iron (Fe) does **not** fit the pattern in column 7.

Give a reason why.

(1)

- (b) In 1869 Dmitri Mendeleev produced his version of the periodic table.

Why did Mendeleev leave gaps for undiscovered elements in his periodic table?

(1)

- (c) Newlands and Mendeleev placed the elements in order of atomic weight.

Complete the sentence.

The modern periodic table places the elements in order of

(1)

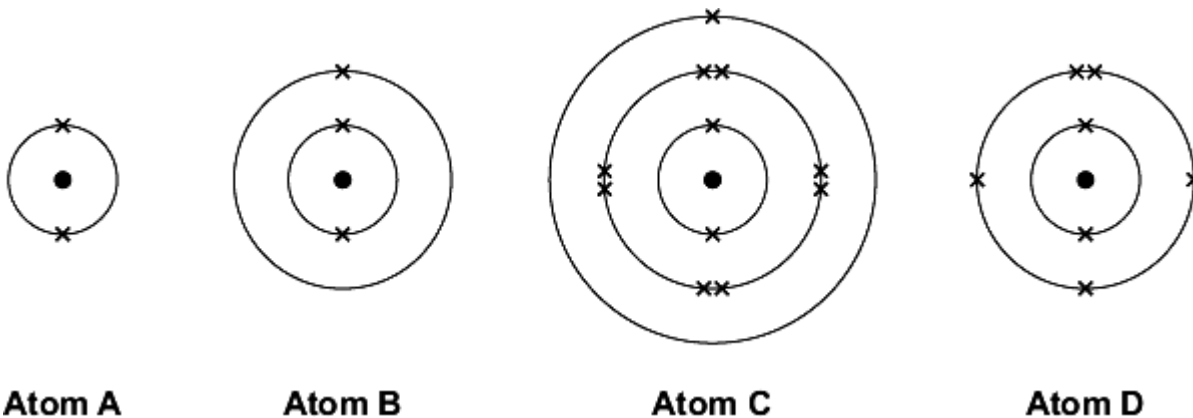
- (d) Lithium, sodium and potassium are all in Group 1 of the modern periodic table.

Explain why.

(2)

(Total 5 marks)

Q6. The diagrams show the electronic structure of four different atoms.



Use the Chemistry Data Sheet to help you to answer these questions.

- (a) Name the two sub-atomic particles in the nucleus of an atom.

_____ (1)

- (b) Why is there no overall electrical charge on each atom?

 _____ (1)

- (c) Why is **Atom A** unreactive?

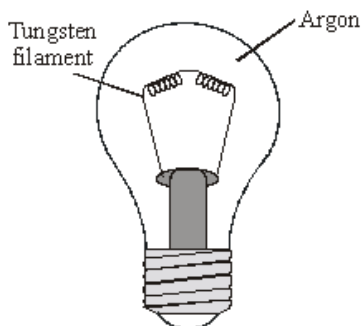
_____ (1)

- (d) Which **two** of these atoms have similar chemical properties?
 Give a reason for your answer.

 _____ (2)

(2)
(Total 5 marks)

Q7. The diagram shows an electric light bulb.



When electricity is passed through the tungsten filament it gets very hot and gives out light.

(a) What reaction would take place if the hot tungsten was surrounded by air?

(1)

(b) State why argon is used in the light bulb. Explain your answer in terms of the electronic structure of an argon atom.

(3)

(Total 4 marks)

Q8. Use the Periodic Table to help you to answer this question.

(a) State **one** similarity and **one** difference in the electronic structure of the elements:

(i) across the Period from sodium to argon;

(2)

(ii) down Group 7 from fluorine to astatine.

(2)

(b) (i) State the trend in reactivity of the Group 1 elements.

(1)

(ii) Explain this trend in terms of atomic structure.

(3)

(c) Hydrogen is an element which is difficult to fit into a suitable position in the Periodic Table. Give reasons why hydrogen could be placed in either Group 1 or Group 7.

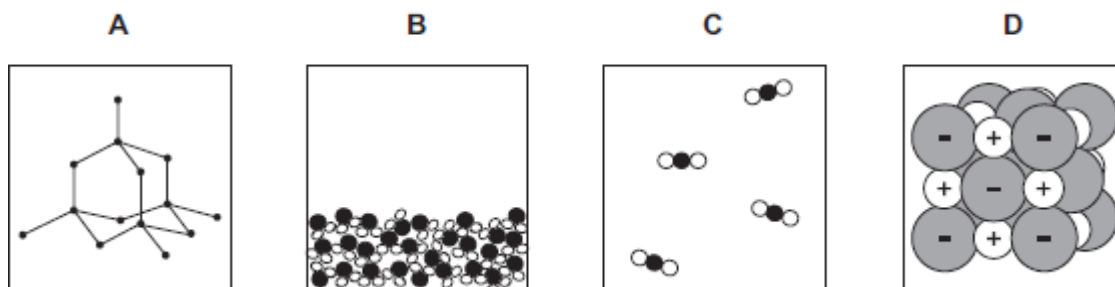
(3)

(Total 11 marks)

Topic 2 – Bonding, Structure and Properties of Matter

Q9. The structures of four substances, **A**, **B**, **C** and **D**, are represented in **Figure 1**.

Figure 1



(a) Use the correct letter, **A**, **B**, **C** or **D**, to answer each question.

(i) Which substance is a gas?

(1)

(ii) Which substance is a liquid?

(1)

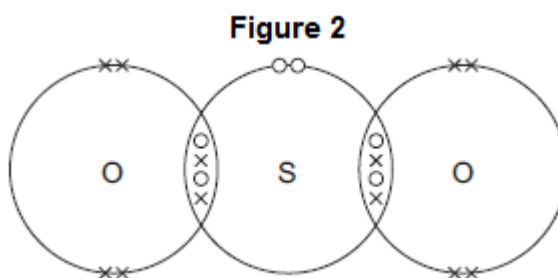
(iii) Which substance is an element?

(1)

(iv) Which substance is made of ions?

(1)

(b) **Figure 2** shows the bonding in substance **C**.



(i) What is the formula of substance **C**?

Draw a ring around the correct answer.



(1)

(ii) Use the correct answer from the box to complete the sentence.

delocalised

shared

transferred

When a sulfur atom and an oxygen atom bond to produce substance **C**,
electrons are _____

(1)

(iii) What is the type of bonding in substance **C**?

Draw a ring around the correct answer.

covalent

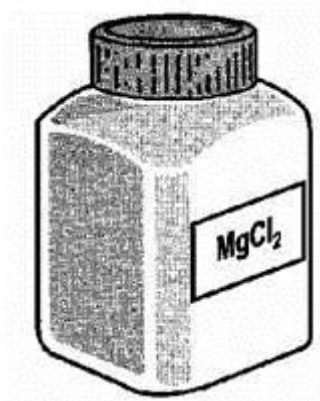
ionic

metallic

(1)

(Total 7 marks)

Q10. The drawing shows a container of a compound called magnesium chloride.



(i) How many elements are joined together to form magnesium chloride?

(1)

(ii) Magnesium chloride is an ionic compound. What are the names of its ions?

_____ ions and _____ ions

(1)

(iii) How many **negative** ions are there in the formula for magnesium chloride?

(1)

(iv) Complete the sentence.

Ions are atoms, or groups of atoms, which have lost or gained

_____ .

(1)

- (v) Suggest **three** properties which magnesium chloride has because it is an ionic compound.

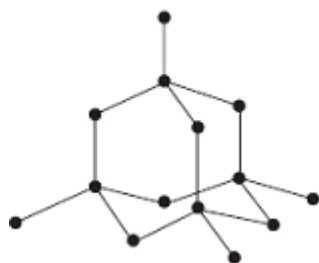
Property 1 _____

Property 2 _____

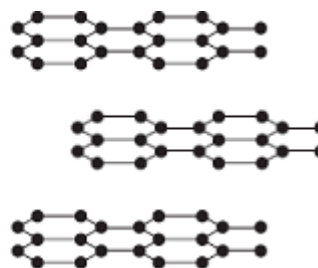
Property 3 _____

(3)
(Total 7 marks)

Q11. The diagrams show the structures of diamond and graphite.



Diamond



Graphite

- (a) Diamond and graphite both contain the same element.

What is the name of this element? _____

(1)

- (b) Use the diagrams above and your knowledge of structure and bonding to explain why:

- (i) graphite is very soft

(2)

- (ii) diamond is very hard

_____ (2)

(iii) graphite conducts electricity.

(2)
(Total 7 marks)

Q12. Here is a symbol equation, with state symbols, for a chemical reaction between solutions of lead nitrate and potassium chloride.



The equation tells you the formulae of the two products of the reaction.

(a) What are the names of the **two** products?

1. _____
2. _____

(2)

(b) What else does the equation tell you about these products?

(2)
(Total 4 marks)

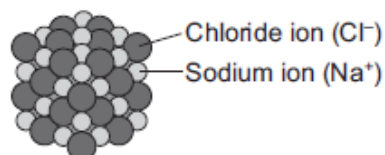
Q13. In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Explain why chlorine (Cl_2) is a gas at room temperature, but sodium chloride (NaCl) is a solid at room temperature.

Chlorine



Sodium chloride



Include a description of the bonding and structure of chlorine and sodium chloride in your answer.

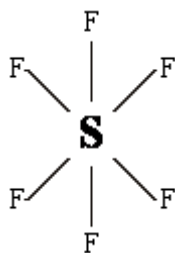
- (c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

(3)
(Total 7 marks)

Q15. Sulphur hexafluoride is a colourless, odourless, non-flammable gas, which is insoluble in water and extremely unreactive. It is used as an insulator in high voltage transformers and switchgear.

The diagram below represents a molecule of sulphur hexafluoride.



- (a) What type of chemical bond holds the sulphur and fluorine atoms together in sulphur hexafluoride molecules?

(1)

- (b) Explain why sulphur hexafluoride has a low boiling point.

(2)

- (c) Explain how **three** of the properties of sulphur hexafluoride make it suitable for use as an insulator inside electrical transformers.

Property 1: _____

Explanation: _____

Property 2: _____

Explanation: _____

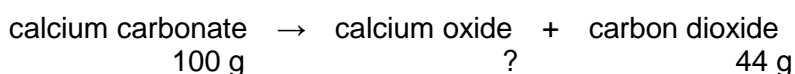
Property 3: _____

Explanation: _____

(3)
(Total 6 marks)

Topic 3 – Quantitative Chemistry

Q16. Calcium oxide (quicklime) is made by heating calcium carbonate (limestone).



- (a) 44 grams of carbon dioxide is produced when 100 grams of calcium carbonate is heated.

Calculate the mass of calcium oxide produced when 100 grams of calcium carbonate is heated.

mass _____ g

(1)

- (b) What mass of carbon dioxide could be made from 100 tonnes of calcium carbonate?

mass _____ tonnes

(1)

(Total 2 marks)

Q17. (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO

NO₂

N₂O₄

N₂O

(1)

- (b) Potassium nitrate is another nitrogen compound. It is used in fertilisers. It has the formula **KNO₃**.
The **M_r** of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

Percentage of nitrogen = _____ %

(2)

(Total 3 marks)

- Q18.** (a) The formula for ammonia is NH₃. What does the formula tell you about each molecule of ammonia?

(3)

- (b) Ammonia is used to make nitric acid (HNO₃). Calculate the formula mass (M_r) for nitric acid. (Show your working).

(3)

(Total 6 marks)

- Q19.** Follow the steps to find the percentage of iron in iron oxide.

Relative atomic masses: O 16; Fe 56.

- (i) Step 1

Calculate the relative formula mass of iron oxide, Fe₂O₃.

(1)

(ii) Step 2

Calculate the total relative mass of just the iron atoms in the formula, Fe_2O_3 .

(1)

(iii) Step 3

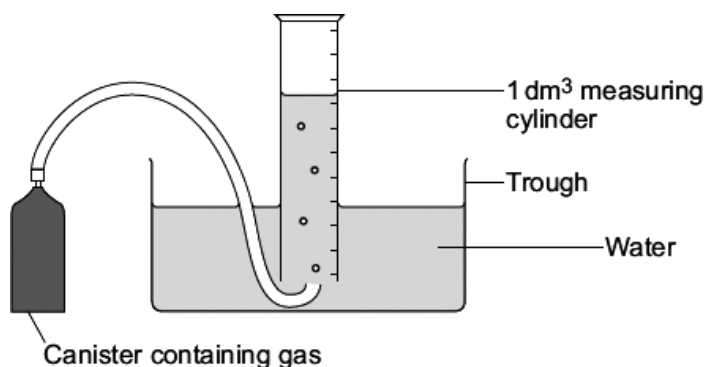
Calculate the percentage (%) of iron in the iron oxide, Fe_2O_3 .

Percentage of iron _____ %

(1)

(Total 3 marks)

Q20. Some students did an experiment to find the relative formula mass (M_r) of a gas.



This is the method they used.

- The mass of the canister of gas was measured using a balance, which weighed to two decimal places.
- The measuring cylinder was filled with 1 dm^3 of the gas from the canister.
- The mass of the canister of gas was measured again.
- The temperature of the laboratory was measured.
- The air pressure in the laboratory was measured.

The students repeated the experiment three times.

(a) The results for one of the experiments are shown in the table below.

Mass of the canister of gas before filling the measuring cylinder	53.07 g
Mass of the canister of gas after filling the measuring cylinder	51.21 g

Calculate the mass of the 1 dm³ of gas in the measuring cylinder.

Mass = _____ g

(1)

(b) How could the results be made more precise?

(1)

(c) The students used their results to calculate values for the relative formula mass (M_r) of this gas.

The results are shown in the table below.

Experiment	1	2	3	4
Relative formula mass (M_r)	45.4	51.5	46.3	45.8

(i) Calculate the mean value for these results.

Mean = _____

(2)

(ii) The four results are different.
The students thought this was because of experimental error.

Suggest **two** causes of experimental error in this experiment.

(2)

(iii) It was important for the students to repeat the experiment.
Suggest why.

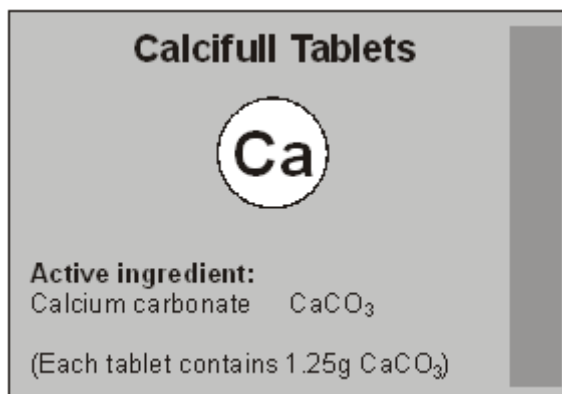
(1)

(d) The teacher told the students that the formula of the gas is C₃H₈
Calculate the relative formula mass (M_r) of this gas. You should show your working.
Relative atomic masses: H = 1; C = 12.

Relative formula mass = _____

(2)

Q21. Calcium carbonate tablets are used to treat people with calcium deficiency.



- (a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

Relative formula mass = _____

(2)

- (b) Calculate the percentage of calcium in calcium carbonate, CaCO_3 .

Percentage of calcium = _____ %

(2)

- (c) Calculate the mass of calcium in each tablet.

Mass of calcium = _____ g

(2)

- (d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).



Suggest why the patient may suffer from 'wind'.

(1)
(Total 7 marks)

Q22. Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.



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

Calculate the relative formula mass (M_r) of FeSO_4

Relative atomic masses: O = 16; S = 32; Fe = 56.

The relative formula mass (M_r) = _____

(2)

(b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

(1)

(c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron?

Remember to give the unit.

(1)

(Total 4 marks)

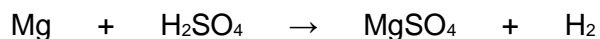
Q23. (a) The formula for the chemical compound magnesium sulphate is MgSO_4 .

Calculate the relative formula mass (M_r) of this compound. (Show your working.)

(2)

(b) Magnesium sulphate can be made from magnesium and dilute sulphuric acid.

This is the equation for the reaction.



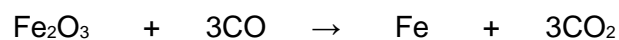
Calculate the mass of magnesium sulphate that would be obtained from 4g of magnesium.
(Show your working.)

Answer _____ g

(2)

(Total 4 marks)

Q24. Iron is the most commonly used metal. Iron is extracted in a blast furnace from iron oxide using carbon monoxide.



(a) A sample of the ore haematite contains 70% iron oxide.

Calculate the amount of iron oxide in 2000 tonnes of haematite.

Amount of iron oxide = _____ tonnes

(1)

- (b) Calculate the amount of iron that can be extracted from 2000 tonnes of haematite.
(Relative atomic masses: O = 16; Fe = 56)

Amount of iron = _____ tonnes

(4)

(Total 5 marks)

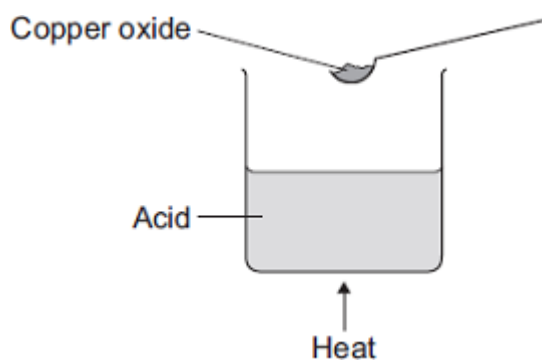
Topic 4 – Chemical Changes

Q25. A student added copper oxide to an acid to make copper sulfate.

The student heated the acid.

The student added copper oxide until no more reacted.

- (a) The diagram shows the first stage in the experiment.



- (i) Complete the word equation.

Copper oxide + _____ acid → copper sulfate + water

(1)

- (ii) Which **one** of these values could be the pH of the acid?

Draw a ring around the correct answer.

1

7

11

(1)

- (iii) Why is the acid heated?

(1)

- (b) After the reaction is complete, some solid copper oxide remains.
Why?

(1)

- (c) The student removed the solid copper oxide from the solution.
Suggest what the student should do to the solution to form copper sulfate crystals.

(1)

- (d) The mass of copper sulfate crystals was less than the student expected.
Tick (✓) the **one** statement that explains why the mass of copper sulfate crystals was less than expected.

Statement	Tick (✓)
Some copper sulfate may have been lost during the experiment.	
The student added too much copper oxide.	
The copper sulfate crystals were wet when they were weighed.	

(1)

(Total 6 marks)

Q26. Humphrey Davy was a professor of chemistry.

In 1807 Humphrey Davy did an electrolysis experiment to produce potassium.

- (a) (i) Humphrey Davy was the first person to produce potassium.

Draw a ring around the correct answer to complete each sentence.

Humphrey Davy's experiment to produce this new element was quickly

accepted by other scientists because he

had a lot of money.
had a lot of staff to help.
was well qualified.

(1)

- (ii) Other scientists were able to repeat Davy's experiment.

Draw a ring around the correct answer to complete each sentence.

Being able to repeat Davy's experiment is important because

other scientists can

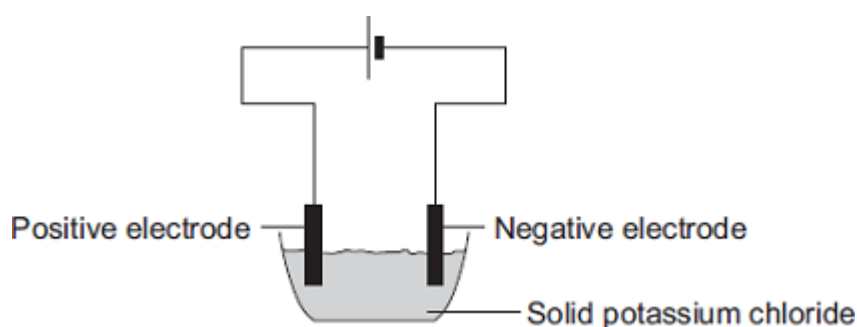
check the results of the experiment.

see if the experiment is safe.

take the credit for the discovery.

(1)

- (b) A student tried to electrolyse potassium chloride.



Potassium chloride contains potassium ions (K^+) and chloride ions (Cl^-).

- (i) The student found that solid potassium chloride does not conduct electricity.

Use the correct answer from the box to complete the sentence.

are too big

cannot move

have no charge

Solid potassium chloride does not conduct electricity because

the ions _____.

(1)

- (ii) What could the student do to the potassium chloride to make it conduct electricity?

(1)

- (iii) During electrolysis why do potassium ions move to the negative electrode?

(1)

- (iv) Draw a ring around the correct answer to complete the sentence.

When the potassium ions reach the negative electrode

they turn into potassium

atoms.
electrodes.
molecules.

(1)
(Total 6 marks)

Q27. The salt sodium hydrogen phosphate (Na_2HPO_4) is used as a softening agent in processed cheese. It can be made by reacting phosphoric acid (H_3PO_4) with an alkali.

- (a) Complete the name of an alkali that could react with phosphoric acid to make sodium hydrogen phosphate.

_____ hydroxide

(1)

- (b) What is the name given to a reaction in which an acid reacts with an alkali to make a salt?

(1)

- (c) How would the pH change when alkali is added to the phosphoric acid solution?

(1)

- (d) What ions are present when any acid is dissolved in water?

(1)

- (e) What ions are present when any alkali is dissolved in water?

(1)

- (f) Write a chemical equation for the reaction which takes place between the ions you have named in (e) and (f).

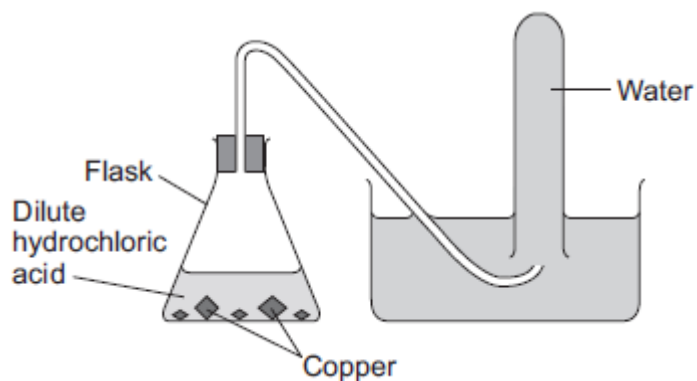
(1)

(Total 6 marks)

Q28. A student was trying to produce hydrogen gas.

Figure 1 shows the apparatus she used.

Figure 1



(a) No gas was produced.

The student's teacher said that this was because the substances in the flask did **not** react.

(i) Suggest why the substances in the flask did **not** react.

(1)

(ii) Which two substances could the student have put in the flask to produce hydrogen safely?

Tick (✓) **one** box.

Gold and dilute hydrochloric acid

Potassium and dilute hydrochloric acid

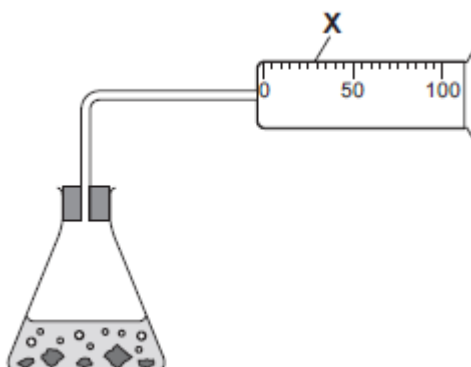
Zinc and dilute hydrochloric acid

(1)

(b) Another student did produce hydrogen from two substances.

Figure 2 shows the apparatus the student used to collect and measure the volume of the hydrogen gas.

Figure 2



Give the name of the apparatus labelled X.

(1)

(c) The student did the experiment four times. Her results are shown in the table below.

Experiment	Volume of hydrogen collected in one minute in cm ³
1	49
2	50
3	35
4	48

(i) One of the results is anomalous.

Which result is anomalous? Write your answer in the box.

Give a reason for your choice.

(2)

(ii) Calculate the mean volume of hydrogen collected in one minute.

Mean volume = _____ cm³

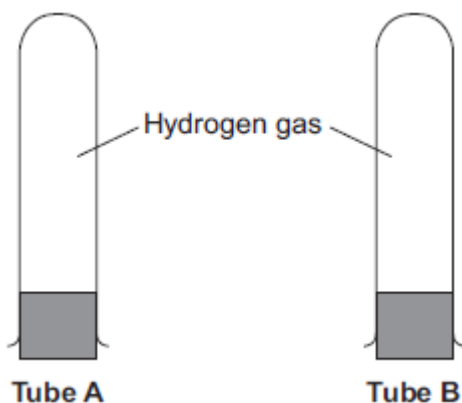
(2)

(iii) Give a reason why the experiment should be repeated several times.

(1)

- (d) A teacher collected two tubes full of hydrogen gas, as shown in **Figure 3**.

Figure 3



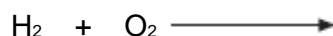
She tested tube **A** with a lighted splint as soon as she took the bung out.

She tested tube **B** with a lighted splint a few seconds after taking the bung out.

- (i) Suggest why tube **B** gave a much louder pop than tube **A**.

(1)

- (ii) Complete and balance the chemical equation for the reaction that takes place when the hydrogen reacts in this test.



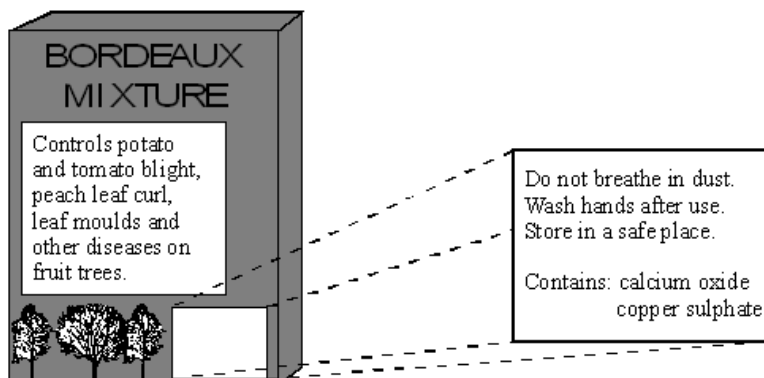
(2)

(Total 11 marks)

Q29.

Bordeaux Mixture controls some fungal infections on plants.

A student wanted to make some Bordeaux Mixture.



(a) The student knew that calcium oxide could be made by heating limestone. Limestone contains calcium carbonate, CaCO_3 .

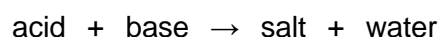
(i) Write the word equation for this reaction.

_____ (1)

(ii) What type of reaction is this?

_____ (1)

(b) The student knew that copper sulphate, CuSO_4 , could be made by the following general reaction.



(i) What type of reaction is this?

_____ (1)

(ii) The base used is copper oxide. Name and give the chemical formula of the acid used.

Name _____

Chemical formula _____

(2)

(c) The student wrote about how the copper sulphate was made.

“Some of the acid was warmed. Copper oxide was added. The mixture was stirred. More copper oxide was added until no more would react. The mixture was then filtered.”

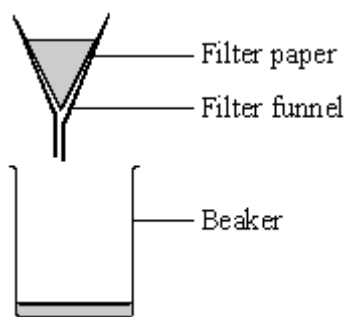
(i) Why was the acid warmed?

_____ (1)

(ii) Copper oxide was added until no more would react. Explain why.

_____ (2)

(iii) The filtration apparatus is shown.



Describe and explain what happens as the mixture is filtered.

(2)

(Total 10 marks)

Q30. This question is about potassium.

(a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

(i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

(2)

(ii) Humphrey Davy was the first person to produce potassium.

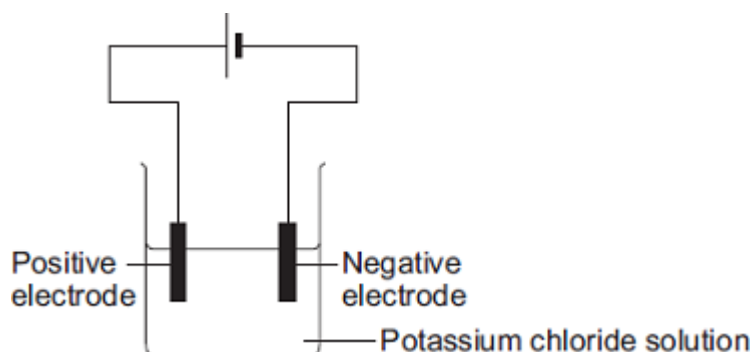
Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

(1)

- (b) A student dissolved some potassium chloride in water. The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

(3)

- (c) The student tried to electrolyse molten potassium chloride to produce potassium.

- (i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

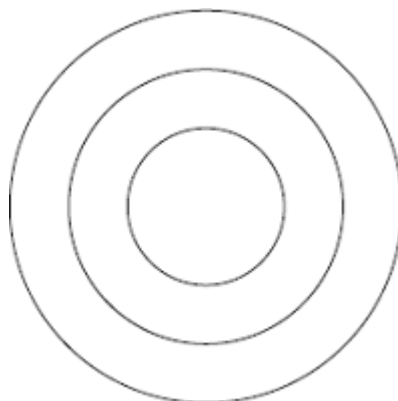
(2)

(ii) Complete and balance the equation for the reaction at the positive electrode.



(1)

(iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).

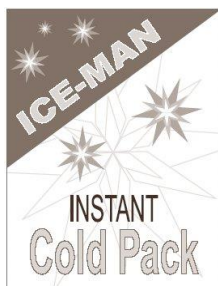


(1)

(Total 10 marks)

Topic 5 – Energy Changes

Q31. Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water. Inside this bag is a smaller bag containing ammonium nitrate.

The outer bag is squeezed so that the inner bag bursts. The pack is shaken and quickly gets very cold as the ammonium nitrate dissolves in the water.

(a) **One** of the statements in the table is correct.
Put a tick (✓) next to the correct statement.

Statement	(✓)
The bag gets cold because heat energy is given out to the surroundings.	
The bag gets cold because heat energy is taken in from the surroundings.	
The bag gets cold because plastic is a good insulator.	

(1)

- (b) Draw a ring around the word that best describes the change when ammonium nitrate dissolves in water.

electrolysis endothermic exothermic

(1)

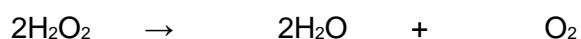
- (c) Suggest and explain why the pack is shaken after the inner bag has burst.

(2)

(Total 4 marks)

Q32. Hydrogen peroxide decomposes slowly to give water and oxygen.

The reaction is *exothermic*.



- (a) In an *exothermic* reaction, energy is given out.

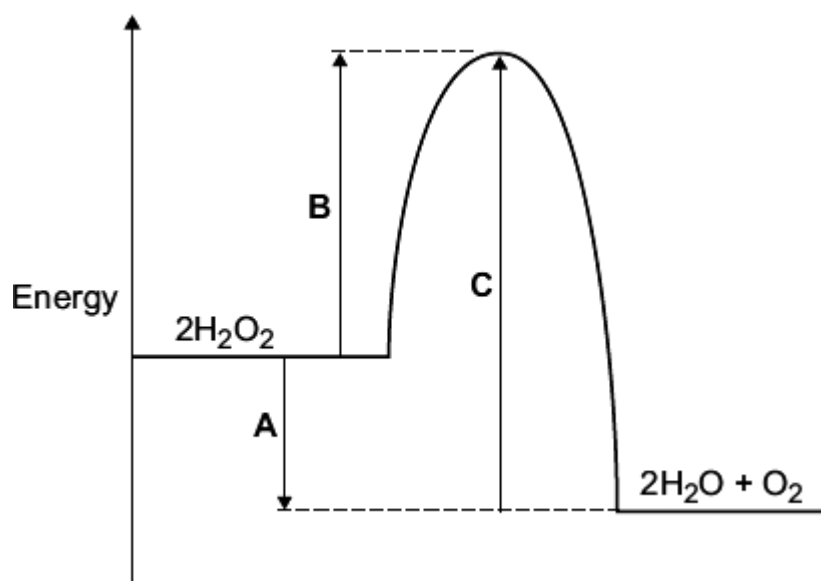
Draw a ring around the correct answer to complete the sentence.

In an *exothermic* reaction, the temperature

goes down.
goes up.
stays the same.

(1)

- (b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.
Use the diagram to help you answer these questions.

(i) Which energy change, **A**, **B** or **C**, is the activation energy?

(1)

(ii) Which energy change, **A**, **B** or **C**, shows that this reaction is exothermic?

(1)

(iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Draw a ring around the correct answer to complete each sentence.

Hydrogen peroxide decomposes quickly because

manganese(IV) oxide is

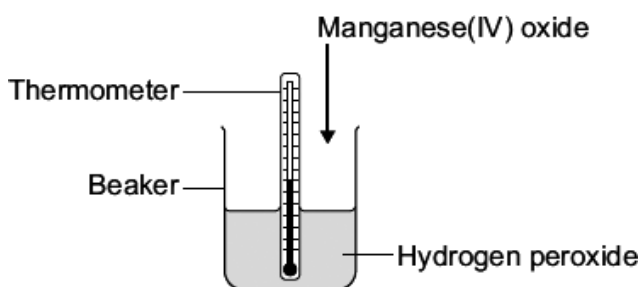
a catalyst.
an element.
a solid.

The manganese(IV) oxide has lowered the

activation energy.
boiling point.
temperature.

(2)

(c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide. The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide, stirred the mixture and recorded the highest temperature.

(i) Suggest why the student stirred the mixture before recording the highest temperature.

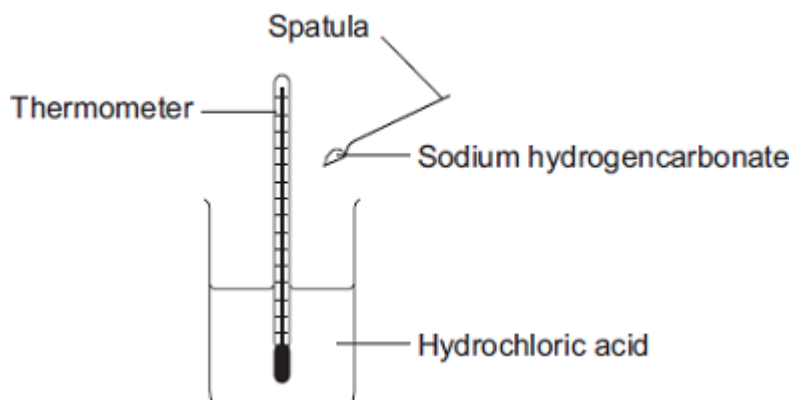
(1)

(ii) The biggest error in this experiment is heat loss.

Suggest how the student could change the apparatus so that less heat is lost.

(1)
(Total 7 marks)

Q33. (a) Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula measures of sodium hydrogencarbonate	Start temperature in °C	Final temperature in °C	Change in temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

(i) Describe, as fully as you can, the trends shown in the students' results.

(3)

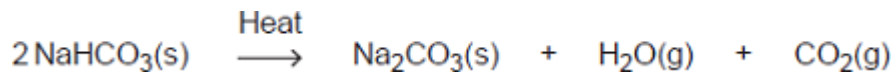
(ii) State the type of energy transfer for this reaction.

(1)

(b) Sodium hydrogencarbonate is used as baking powder for making cakes.

When the cake mixture is baked the sodium hydrogencarbonate decomposes.

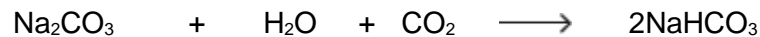
The equation for the reaction is:



(i) The cake mixture rises when baked. Use the equation to suggest why.

(1)

(ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.



Do the reactants need to be heated?

Give a reason for your answer.

(1)

(c) (i) Calculate the relative formula mass of sodium hydrogencarbonate (NaHCO_3).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

Relative formula mass (M_r) = _____

(2)

(ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

Percentage of carbon = _____ %

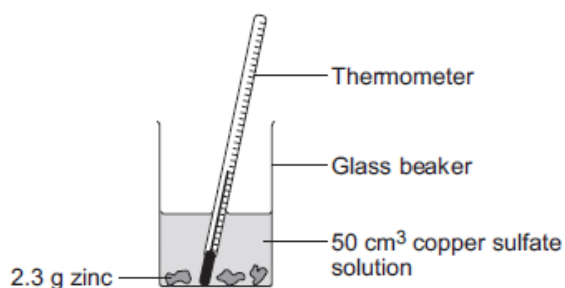
(1)

(Total 9 marks)

Q34. A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

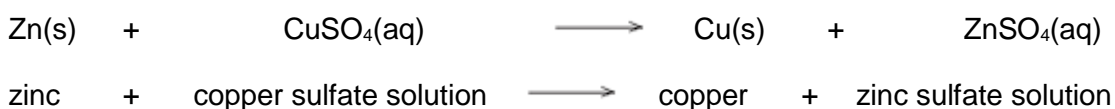
The student used the apparatus shown below.



The student:

- measured 50 cm³ copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:



- (a) The thermometer reading changes during the reaction.
Give **one** other change the student could **see** during the reaction.

(1)

- (b) Suggest **one** improvement the student could make to the apparatus.
Give a reason why this improves the investigation.

Improvement _____

Reason _____

(2)

- (c) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The student's results are shown in the table below.

Experiment number	Concentration of copper sulfate in moles per dm ³	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

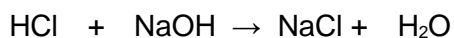
Describe **and** explain the trends shown in the student's results.

(6)
(Total 9 marks)

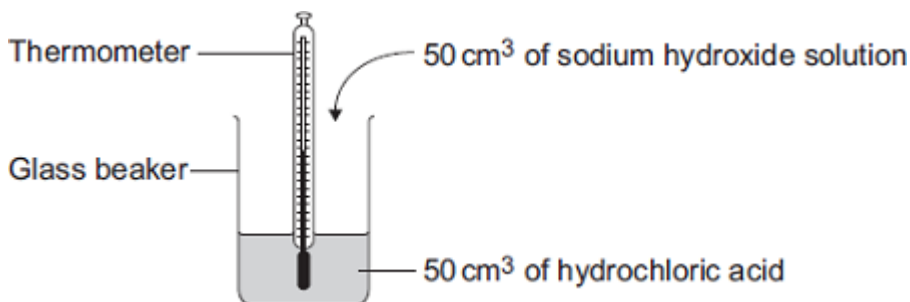
Q35. Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:



The student used the apparatus shown in the diagram.



The student placed 50 cm³ of hydrochloric acid in a glass beaker and measured the initial temperature.

The student then quickly added 50 cm³ of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

(a) The biggest error in this experiment is heat loss.

Suggest how the apparatus could be modified to reduce heat loss.

(1)

(b) Suggest why it is important to mix the chemicals thoroughly.

(1)

- (c) Which **one** of these experiments was probably done on a different day to the others?

Give a reason for your answer.

_____ (1)

- (d) Suggest why experiment **4** should **not** be used to calculate the average temperature change.

_____ (1)

- (e) Calculate the average temperature change from the first three experiments.

Answer = _____ °C (1)

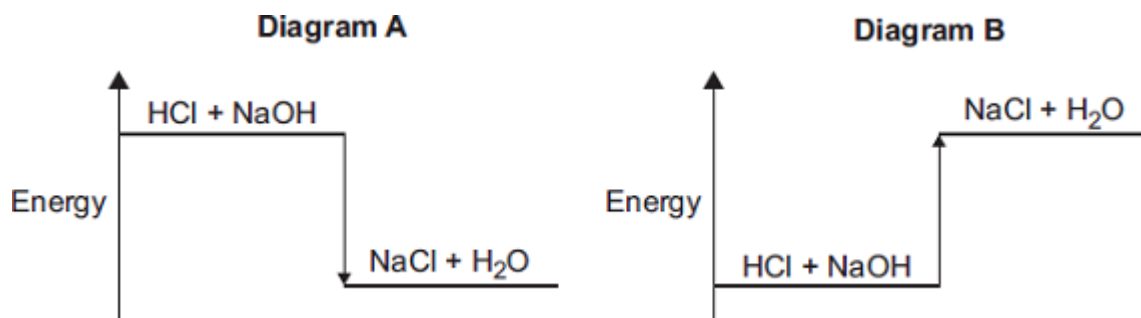
- (f) Use the following equation to calculate the energy change for this reaction.

$$\text{Energy change in joules} = 100 \times 4.2 \times \text{average temperature change}$$

Answer = _____ J (1)

- (g) Which **one** of these energy level diagrams represents the energy change for this reaction?

Give a reason for your answer.

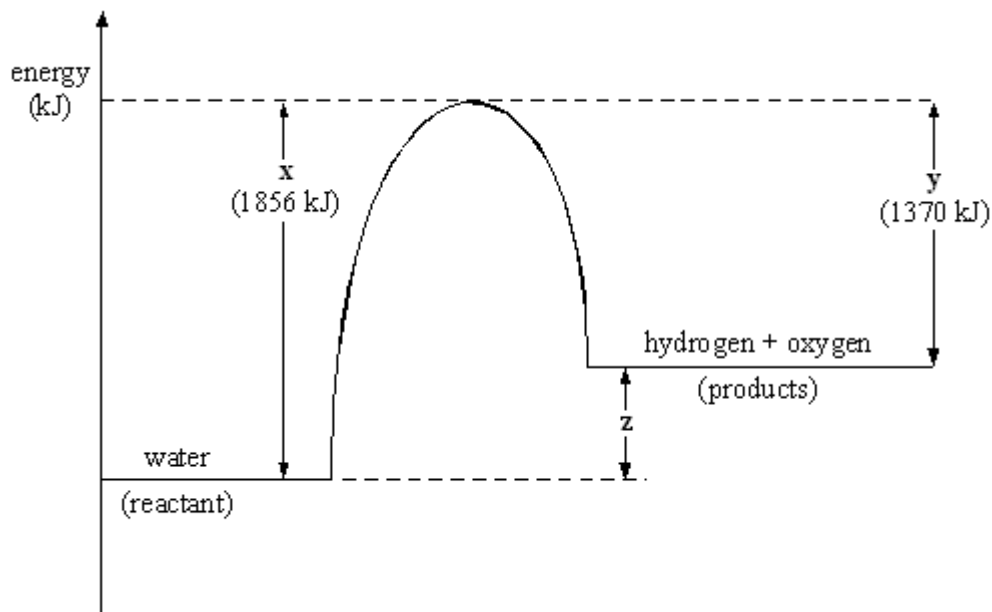


_____ (1)
(Total 7 marks)

Q36. The symbol equation shows the decomposition of water.



An energy level diagram for this reaction is shown below.



Explain the significance of **x**, **y** and **z** on the energy level diagram in terms of energy transfers that occur in the reaction. You should make specific reference to the bonds broken and formed and to the nett energy transfer (energy transferred to or from the surroundings).

(Total 6 marks)

Q37. The equation for the reaction of ethene and bromine is:

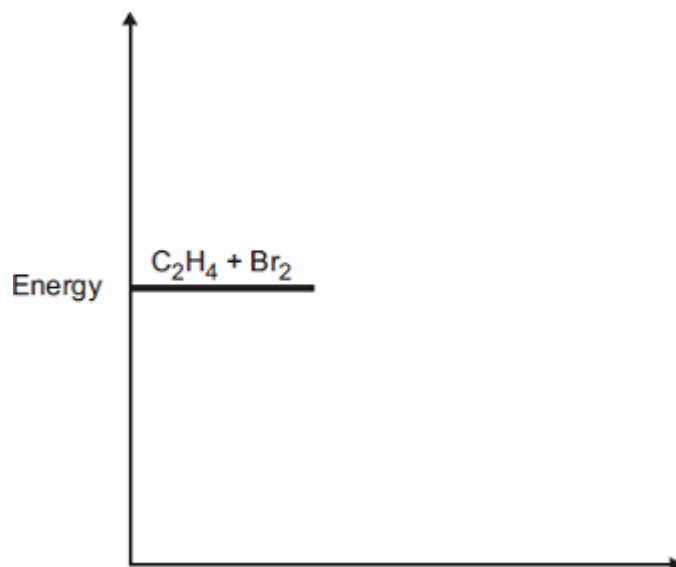


The reaction is exothermic.

(a) Complete the energy level diagram.

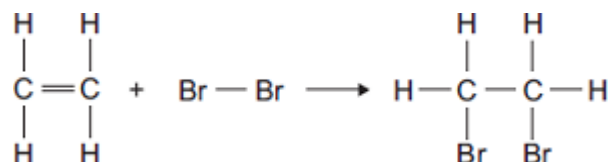
You should label:

- the activation energy
- the enthalpy change (ΔH).



(3)

(b) (i) The equation for the reaction can be represented as:



Bond	Bond dissociation energy in kJ per mole
C—H	413
C = C	614
Br—Br	193
C—C	348
C—Br	276

Use the bond dissociation energies in the table to calculate the enthalpy change (ΔH) for this reaction.

Enthalpy change (ΔH) = _____ kJ per mole

(3)

(ii) The reaction is exothermic.

Explain why, in terms of bonds broken and bonds formed.

(2)

(Total 8 marks)

Topic 1 – Atomic Structure and the Periodic Table Mark Scheme

Q1.

- (a) (i) B 1
- (ii) E 1
- (iii) F 1
- (iv) D 1
- (v) C 1
- (b) (i) Br
do not accept BR or br or bR
ignore numbers
allow written in table if answer blank 1
- (ii) I Br Cl
allow iodine, bromine, chlorine
allow I,B,C
allow capitals or lower case
allow 184, 58, -34
ignore numbers 1
- (c) they are halogens 1
- they become less reactive down Group 7 1

[9]

Q2.

- low density 1
- form hydroxides that dissolve in water 1
- react quickly with water
four ticks – max 2 marks
five ticks – max 1 mark
all boxes ticked – 0 marks 1

[3]

Q3.

- correct reactants (i.e. sodium + water either way round)
- correct products (i.e. sodium hydroxide + hydrogen, either way round)
- arrow \rightarrow / $=$ [do not allow produce/makes or similar]

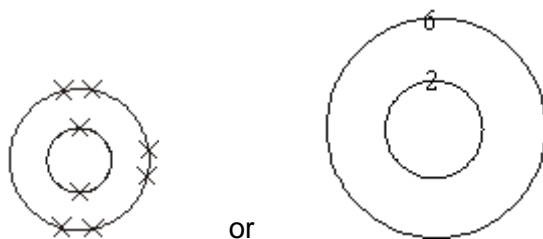
[do not allow symbols or formulae]

each for 1 mark

[3]

Q4.

(a) (i)



or

1

*allow any arrangement of electrons on the shells
accept o, x, - **or** e as representing electrons*

(ii) nucleus

accept nucleus (protons plus neutrons)

*do **not** accept protons plus neutrons on its own*

allow nuclei / nucles / neucleus / phonetic spelling

*do **not** accept neutron*

1

(b) it has **2** more neutrons **or** converse

*accept 'it has more neutrons' **or** 'different number of neutrons' for **1 mark***

*'2 more protons / electrons + correct number of neutrons' =
max **1 mark***

or

O-16 has 8 neutrons (**1 mark**)(*)

O-18 has 10 neutrons (**1 mark**)(*)

()if incorrectly calculated but shows more neutrons in O-18
allow for **1 mark***

accept it has more particles

or

*it has 2 more particles for **1 mark***

ignore any reference to charges

*just 2 more without reference to particles = **0 marks***

2

[4]

Q5.

- (a) (iron) is a metal
accept transition element
allow (iron) had different properties (to oxygen and sulfur)
ignore electrons 1
- (b) so that elements with similar properties could be placed together
allow to make the pattern fit
ignore undiscovered elements 1
- (c) atomic number(s)
allow proton number(s) 1
- (d) all have one electron in the outer shell (highest energy level)
allow same number of electrons in the outer shell (highest energy level) 1
- (so they) have similar properties
or
react in the same way
allow specific reactions e.g. with water 1

[5]

Q6.

- (a) protons (**and**) neutrons
both needed for 1 mark
ignore p / + and n / 0
*do **not** accept electrons* 1
- (b) because the number of protons is equal to the number of electrons
allow protons and electrons balance / cancel out
allow positive / + and negative / - balance / cancel out 1
- (c) *it = atom A*
because atom A has a full highest energy level **or** full outer shell
*allow all the shells are full **or** no incomplete shell*
or because atom A has a stable arrangement of electrons
allow because atom A is in Group 0 / a noble gas 1
- (d) (atom) B / lithium / Li (**and**)

(atom) C / sodium / Na

both needed for 1 mark

1

because they have the same number/one outer electron(s)

linked to answer for first mark

accept because both need to lose one / an electron

allow because (atoms) B and C are in Group 1 / the same group / are alkali metals

1

[5]

Q7.

- (a) react with oxygen / oxidise / burn in oxygen / burning / combustion **or** tungsten to tungsten oxide **or** makes an oxide

key idea is oxidation

ignore breaking ignore fire / flames / exothermic

ignore react with air

1

- (b) it is (very) unreactive / not reactive / inert / does not react with tungsten **or** it is a noble gas **or** it is in group 0 or 8 or 18

*do **not** accept unreactive / inert metal **or** argon is not very reactive*

1

full outer shell (of electrons) / 8 electrons in outer shell

1

does not need to gain / lose / swap / transfer / share electrons **or** does not need to form bonds

does not bond ionically / covalently

1

[4]

Q8.

- (a) (i) same number of shells/2 full shells/3 shells/same number of energy levels

any 1 for 1 mark

increasing number of electrons/different number of electrons/
number of electrons same as group
number

(if electrons not specifically mentioned assume they are referring to electrons)

any 1 for 1 mark

2

- (ii) all have 7 electrons in outer shell/same number in outer shell/
each has one electron missing from outer shell
each can accept one electron

any 1 for 1 mark

number of shells/energy levels increases

	increasing number of electrons <i>any 1 for 1 mark</i>	2
(b)	(i) increases down group/decreases up <i>for 1 mark</i>	1
	(ii) down group atoms get bigger/larger/have more shells/ more energy levels <i>for 1 mark</i>	
	electrons further away from nucleus/more shielding down group <i>for 1 mark</i>	
	outer electron more easily lost/less firmly held <i>for 1 mark</i>	3
(c)	H ⁺ or has positive ions/one electron in outer shell/can lose one electron/H ⁺ ions discharged at negative electrode (max 2) covalent bonds or compounds/forms diatomic mols. or example/ ability to form H ⁻ ions/non-conductor/ low Mt.Pt or low B.P. (max 2) <i>(overall max 3)</i>	3

[11]

Topic 2 – Bonding Structure and Properties of Matter Mark Scheme

Q9.

(a)	(i)	C	1
	(ii)	B	1
	(iii)	A	1
	(iv)	D	1
(b)	(i)	SO ₂	1
	(ii)	shared	1
	(iii)	covalent	1

[7]

Q10.

- (i) two
or 2
1
- (ii) magnesium **and** chloride
either order
not positive / negative
do not credit 'chlorine'
accept Mg^{++} **and** Cl^-
do not credit just Mg and Cl^-
accept cation(s) **and** anion(s)
1
- (iii) 2
1
- (iv) electrons
accept charges
1
- (v) any **three** from
- (is a) giant structure/lattice structure
 - crystalline / hard
accept just 'crystals(s)'
 - high melting point / solid
 - high boiling point
 - conductor (of electricity) when dissolved **in** water
or conductor (of electricity) when ions are free to move
 - conductor (of electricity) when molten
 - soluble in water
- 3

[7]

Q11.

- (a) carbon
allow C
1
- (b) (i) (atoms are in) layers (that) can slide over each other
1
- because between the layers there are only weak forces
accept because there are no (covalent) bonds between the layers
accept Van der Waals forces between the layers
do **not** allow intermolecular bonds between the layers

if no other marks are awarded allow weak intermolecular forces for 1 mark

1

- (ii) because each atom forms four (covalent) bonds **or** (diamond is a) giant (covalent) structure **or** lattice **or** macromolecular

any reference to ionic / metallic bonding or intermolecular forces scores a maximum of 1 mark

accept carbon forms a tetrahedral shape

1

(and) covalent bonds are strong

accept covalent bonds need a lot of energy / difficult to break

1

- (iii) because graphite has delocalised electrons

allow sea of electrons

allow each carbon atom has one free electron

1

which can move through the whole structure (and carry the current / charge / electricity)

1

[7]

Q12.

- (a) lead chloride } *in any order*
potassium nitrate }

for 1 mark each

2

- (b) lead chloride is solid / a precipitate
potassium nitrate is aqueous / in solution / dissolves in water
NOT liquid

for 1 mark each

2

(Accept ratio of molecular KNO_3 : PbCl_2 is 2:1 for 2 marks)
(do not accept relative number of atoms in each compound)

One is a solid, one is a solution – worth 1 mark

[4]

Q13.

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

0 marks

No relevant content

Level 1 (1–2 marks)

*There is a statement about the bonding and / or structure **or** melting / boiling point of chlorine **or** sodium chloride.*

Level 2 (3–4 marks)

*There are statements about the bonding and / or structure of chlorine **or** sodium chloride.*

Level 3 (5–6 marks)

*There are statements about the bonding and / or structure of chlorine **and** sodium chloride.*

*There is an explanation of why chlorine is a gas **or** sodium chloride is a solid.*

Examples of chemistry points made in response:

Chlorine:

covalent bonds between atoms

forming (simple) molecules

no / weak attraction / bonds between molecules

low boiling point

Sodium chloride:

*ionic bonds **or** electrostatic attraction*

strong bonds

in all directions

between oppositely charged ions

forming giant lattice

large amounts of energy needed to break bonds

high melting point

[6]

Q14.

(a) *weaker bonds*

allow (other substances) react with the silicon dioxide

or

fewer bonds

ignore weaker / fewer forces

or

disruption to lattice

*do **not** accept reference to intermolecular forces / bonds*

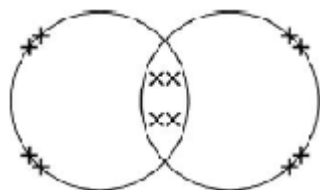
1

(b) (i) Na_2O

*do **not** accept brackets or charges in the formula*

1

(ii)



electrons can be shown as dots, crosses, e or any combination

2 bonding pairs

accept 4 electrons within the overlap

1

2 lone pairs on each oxygen

accept 4 non-bonding electrons on each oxygen

1

(c) *lattice / regular pattern / layers / giant structure / close-packed arrangement*

1

(of) positive ions **or** (of) atoms

1

(with) delocalised / free electrons

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max 2*

1

[7]

Q15.

(a) covalent/description of covalent

for 1 mark

1

(b) forces/bonds between the molecules/particles (not atoms) are weak

for 1 mark each

2

(c) non-flammable so it will not burn etc.
extremely unreactive so it will not react with materials in the transformer,
does not conduct electricity so it can insulate the transformer
gas so it has freedom to move and insulate whole area

for 1 mark each

3

[6]

Topic 3 – Quantitative Chemistry Mark Scheme

Q16.

(a) 56g

for 1 mark

1

- (b) 44 tonnes
for 1 mark

1

[2]

Q17.

- (a) N₂O

1

- (b) 13.8 to 14

gains full marks without working

if answer incorrect

13 gains 1 mark

or

14/101 × 100 gains 1 mark

2

[3]

Q18.

- (a) *reference to*
hydrogen (atoms))
nitrogen (atoms)) **but not** molecules

each for 1 mark

ratio of 1N to 3H **atoms**

for 1 further mark

or 1 nitrogen atom and 3 hydrogen atoms
(ignore any incorrect statements about nature of bonding)

3

- (b) *evidence of*

H = 1

N = 14

O = 16

gains 1 mark

but

H = 1

N = 14

O = 16 × 3 or 48

gains 2 marks

but 63

gains 3 marks

3

[6]

Q19.

- (i) 160

ignore units

1

- (ii) 112
ignore units 1
- (iii) 70
*do **not** carry forward errors* 1

[3]

Q20.

- (a) 1.86
ignore units / 1.9 1
- (b) use a balance which weighs to more decimal places
accept (use a measuring cylinder with) smaller (scale) divisions / intervals
- or** use more sensitive balance
allow reference to more decimal places allow smaller units / scale 1

- (c) (i) 45.8(3333333)
correct answer gains 2 marks with or without working
ignore units / 46
if the answer is not correct then evidence of:
(45.4 + 46.3 + 45.8) ÷ 3
***or** 137.5 ÷ 3*
***or** 47.25 / 47.3 / 47.2 gains 1 mark* 2

- (ii) any **two** from:
ignore zero error / faulty equipmen
- loss of gas **or** leak
 - error in measurement of volume of gas / gas in cylinder / 1 dm³
 - error in weighing the canister / gas at start
 - error in weighing the canister / gas at end
error in weighing the canister / gas = 1 mark
 - change in temperature
allow incorrect measurement of temperature
 - change in pressure
allow incorrect measurement of pressure
if no other mark awarded allow error in weighing for 1 mark

- (iii) any **one** from:

*ignore fair test / precise / valid **or** to check for errors / mistakes*

- check for anomalous results
- to find the mean / average
allow improve (accuracy of) mean / average
- (improve) reliability / make reliable

1

(d) 44

*correct answer gains **2** marks with or without working
ignore units*

*if the answer is incorrect evidence of $(3 \times 12) / 36$ **and** $(8 \times 1) / 8$ gains **1** mark*

2

[9]

Q21.

(a) 100

ignore units

*$40 + 12 + (3 \times 16)$ for **1** mark*

1

(b) 40

*(**ecf** from part (a) can get **2** marks)*

*$\frac{40}{\text{their (a)}} \times 100$
for **1** mark*

1

(c) 0.5

*(**ecf** from part (b) can get **2** marks)*

*$1.25 \times \left(\frac{\text{their (b)}}{100} \right)$ **or** other correct working for **1** mark*

2

(d) gas produced **or** carbon dioxide / CO₂ produced

1

[7]

Q22.

(a) 152 correct answer with **or** without working = **2** marks
 $56 + 32 + (4 \times 16)$ gains **1** mark

ignore any units

2

(b) 152g(rams)

*ecf from the answer to (a) and g
must have unit g / gram / gramme / grams etc
accept g / mol **or** g per mole **or** $g \text{ mole}^{-1}$ **or** g/mol **or** g per
mol **or** $g \text{ mol}^{-1}$
do **not** accept g m
do **not** accept G*

1

(c) 76(g)

*ecf from their answer to (a) or (b) divided by 2
ignore units*

1

[4]

Q23.

(a) Mg S O₄
24 + 32 + 16 (x4) or 64 / evidence of all A_r's
gains 1 mark

but (M_r) = 120
gains 2 marks

2

(b) evidence that 24(g) magnesium would produce 120(g) magnesium sulphate
gains 1 mark

or correct scaling by 1/6

but 20(g) magnesium sulphate
*gains 2 marks
[credit error carried forward from (a) with full marks in (b)]*

2

[4]

Q24.

(a) 1400

1

(b) 980

correct answer gains full credit

160 tonnes Fe₂O₃ produces 112 tonnes Fe
*if incorrect allow one mark for relative formula mass iron
oxide = 160
allow e.c.f.*

1400 tonnes Fe₂O₃ will produce $1400 / 160 \times 112$ tonnes Fe
*use of 2000 tonnes Fe₂O₃ – deduct one mark only if
working out is correct*

4

[5]

Topic 4 – Chemical Changes Mark Scheme

Q25.

- (a) (i) sulfuric 1
- (ii) 1 1
- (iii) to speed up the reaction 1
- (b) because copper oxide in excess
allow copper oxide unreacted
- or**
- because acid all used up / neutralised 1
- (c) evaporation
allow heating
allow cooling
allow leave (to evaporate)
do not accept freezing
- or**
- crystallisation 1
- (d) Some copper sulfate may have been lost during the experiment 1
- [6]**

Q26.

- (a) (i) was well qualified 1
- (ii) check the results of the experiment 1
- (b) (i) cannot move 1
- (ii) melt it / make it a liquid
allow heat it
allow dissolve (in water) / make a solution 1
- (iii) they are positive
allow opposites attract or opposite charges 1
- (iv) atoms

Q27.

- (a) sodium 1
- (b) neutralisation 1
- (c) increase/inc. number 1
- (d) H⁺ 1
- (e) OH⁻ 1
- (f) H⁺ + OH⁻ → H₂O 1

[6]

Q28.

- (a) (i) copper is less reactive than hydrogen **or** copper is unreactive 1
- (ii) Zinc and dilute hydrochloric acid 1
- (b) (gas) syringe 1
- (c) (i) 35 1
allow 3
- because not close to others
accept it is much lower than the others
ignore references to trends or patterns
dependent on the first mark 1
- (ii) (49 + 50 + 48) / 3
= 49
correct answer with or without working gains 2 marks 1
allow ecf from anomaly identified in (i) for 2 marks:
 - *Exp 1 anomalous gives 43.3*
 - *Exp. 2 anomalous gives 44*
 - *Exp. 4 anomalous gives 44.7**answer of 45.5 or 46 (anomaly not excluded) gains 1 mark*
*correct working **excluding anomaly** but with wrong answer gains 1 mark*

1

- (iii) so that a mean can be calculated
accept improves accuracy of the mean or so anomalies can be identified / discarded or to reduce effect of random errors ignore makes it a fair test ignore reliability, validity, repeatability, reproducibility

1

- (d) (i) idea of mixing with oxygen / air, letting air / oxygen in
accept converse

1

- (ii) H₂O
do not accept incorrect additional products

1

balancing 2 ... (1) ... 2
allow fractions or multiples dependent on first mark

1

[11]

Q29.

- (a) (i)

calcium carbonate	→	calcium oxide	+	carbon dioxide
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accept CaO₃ → CaO + CO₂

1

- (ii) (thermal) decomposition
accept endothermic accept reversible

1

- (b) (i) neutralisation
accept exothermic

1

- (ii) sulphuric (acid) H₂SO₄

2

- (c) (i) to speed up the reaction
accept to increase the rate of reaction or to increase the number or rate of collisions do not accept "dissolves" copper oxide faster

1

- (ii) all acid reacts
accept there will be no acid left or acid used up

1

acid is neutralised (for 2 marks)
do not accept to form a concentrated or saturated solution

1

(excess) copper oxide collects in filter paper
accept larger particles (of copper oxide) cannot pass through filter paper

1

copper sulphate solution passes through the filter paper
*accept dissolved copper sulphate passes through filter paper
or smaller particles (of copper sulphate) in solution (liquid) pass through filter paper
accept (black) solid collects in filter paper and filtrate or soluble solid or (blue) solution (liquid) passes through filter paper for 1 mark only*

1

[10]

Q30.

(a) (i) current / charge couldn't flow
allow could not conduct (electricity)

1

because the ions / particles couldn't move
do not accept electrons/ molecules / atoms

or

(salt) needs to be molten / (1) dissolved (to conduct electricity)

so that the ions / particles can move (1)
do not accept electrons / molecules / atoms

1

(ii) he had status
accept he had authority or experience

or

he had evidence / proof
accept the experiment could be repeated

1

(b) hydrogen / H₂
do not allow hydrogen ions

1

the ions are positive
accept because opposite (charges) attract

1

potassium is more reactive (than hydrogen)
*accept potassium ions are less easily discharged (than hydrogen)
or potassium ions are less easily reduced (than hydrogen)*

1

(c) (i)	gain electron(s) <i>accept fully balanced correct equation for 2 marks</i>	1
	one electron <i>if no other marks awarded allow (potassium ions) reduced for 1 mark</i>	1
(ii)	$2 \text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ <i>must be completely correct, including charge on electron accept correct multiples</i>	1
(iii)	2, 8, 8 <i>accept any combination of dots, crosses, "e" or any other relevant symbol ignore any charges if given</i>	1
		[10]

Topic 5 – Energy Changes Mark Scheme

Q31.

(a)	the bag gets cold because heat energy is taken in from the surroundings	1
(b)	endothermic	1
(c)	any two from: <ul style="list-style-type: none"> • mix / spread (the ammonium nitrate and water) • dissolve <u>faster</u>(*) • get cold <u>faster</u> or so the <u>whole</u> bag gets cold(*) <i>(*)allow increase rate or quicker reaction</i> • particles collide <u>more</u> or <u>more</u> collisions 	2
		[4]

Q32.

(a)	goes up	1
(b) (i)	B	1
(ii)	A	1
(iii)	a catalyst	

- 1
- activation energy
- 1
- (c) (i) eg (ensures) complete reaction
allow spread heat / energy
- or** even heating
allow mixes properly or mix them together or to get correct temperature
ignore dissolves
- 1
- (ii) lid (on beaker)
accept cover beaker
- or**
- insulate (beaker) / use a plastic cup
- 1

[7]

Q33.

- (a) (i) the more sodium hydrogencarbonate the greater the temperature change
accept examples from the table
- 1
- up to 8 spatula measures
accept any correct indication of when change occurs
- 1
- then the temperature change is constant
*if no marks awarded allow 1 mark for:
the more sodium hydrogencarbonate the lower the final temperature*
- 1
- (ii) energy is taken in from the surroundings **or** endothermic
- 1
- (b) (i) gas / carbon dioxide / steam / water is produced
accept carbon dioxide is a gas or steam / water is a gas
allow gas / air expands when heated
- 1
- (ii) no, because (reaction) is exothermic
or
yes, to start the reaction
allow no, because (reactants) were formed by heating
ignore references to cooling
- 1
- (c) (i) 84
correct answer with or without working gains 2 marks

*if no answer or incorrect answer then evidence of
23 +1 + 12 + (3 × 16) gains 1 mark*

2

- (ii) 14.29
*accept rounding to 14.3 or 14
allow ecf from (c)(i)*

1

[9]

Q34.

- (a) any **one** from:

- solution becomes colourless or colour fades
- zinc becomes bronze / copper coloured
allow copper (forms) or a solid (forms)
- zinc gets smaller
allow zinc dissolves
- bubbles or fizzing.
ignore precipitate

1

- (b) improvement:
use a plastic / polystyrene cup or add a lid
accept use lagging / insulation

1

reason - must be linked
reduce / stop heat loss

OR

improvement:

use a digital thermometer
allow use a data logger

reason - must be linked

more accurate or easy to read or stores data
*allow more precise or more sensitive
ignore more reliable
ignore improvements to method, eg take more readings*

1

- (c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1–2 marks)

There is a statement about the results.

Level 2 (3–4 marks)

There are statements about the results. These statements may be linked or may include data.

Level 3 (5–6 marks)

There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:

Description:

Statements

Concentration of copper sulfate increases

Temperature change increases

There is an anomalous result

The temperature change levels off

Reaction is exothermic

Linked Statements

Temperature change increases as concentration of copper sulfate increases

The temperature change increases, and then remains constant

After experiment 7 the temperature change remains constant

Statements including data

The trend changes at experiment 7

Experiment 3 is anomalous

Attempted Explanation

Temperature change increases because rate increases

Temperature change levels off because the reaction is complete

Explanation

As more copper sulfate reacts, more heat energy is given off

Once copper sulfate is in excess, no further heat energy produced

6

[9]

Q35.

- (a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed
any sensible modification to reduce heat loss

ignore prevent draughts
ignore references to gas loss
ignore bomb calorimeter

1

- (b) all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat

'so they react' is insufficient for the mark

accept increase chances of (successful) collisions / collision rate increase

*do **not** accept rate of reaction increase / make reaction faster*

1

- (c) experiment 2 **and**
different / higher / initial / starting temperature

*accept experiment 2 **and** the room is hotter / at higher temperature*

*do **not** accept temperature change / results higher*

1

- (d) temperature change does not fit pattern

*accept anomalous / odd **or** it is the lowest **or** it is lower than the others **or** it is different to the others*

'results are different' is insufficient

1

- (e) 7 / 7.0

1

- (f) $(100 \times 4.2 \times 7) = 2940$

ecf from (e)

1

- (g) diagram A **and**
reaction exothermic / heat evolved / ΔH is negative / temperature rises

accept energy is lost (to the surroundings)

accept energy of products lower than reactants

allow arrow goes downwards

1

[7]

Q36.

ideas that

- x = the energy required / taken in / used* to break the bonds of water / reactant [**not used up / formed*]

gains 1 mark

- **but** = the energy required taken in / used to break the bonds in water **or** activation energy

gains 2 marks

- y = the energy released given out when bonds form

gains 1 mark

- **but** = the energy released / given out when hydrogen / oxygen form
gains 2 marks
- $z = 1856 - 1370$ or $(+)486$ kJ
for 1 mark

or difference between x and y **or** net energy transferred

- overall, energy is taken in / absorbed in the reaction
or the reaction is endothermic **or** energy required to break existing bonds is > energy released when new bonds form
for 1 mark

[6]

Q37.

- (a) products are at a lower energy level than reactants

*if candidate has drawn a profile for an endothermic reaction
penalise first marking point only*

1

activation energy correctly drawn and labelled

1

ΔH correctly labelled

1

- (b) (i) -93 (kJ per mole)

correct answer with or without working gains 3 marks

allow 2 marks for $+93$ kJ per mole

*if any other answer is seen award up to 2 marks for any two
of the steps below:*

*bonds broken $(614 + 193) = 807$ (kJ) **or** $(614 + 193 + (4 \times 413)) = 2459$ (kJ)*

*bonds formed $(348 + 276 + 276) = 900$ (kJ) **or** $348 + (2 \times 276) + (4 \times 413) = 2552$ (kJ)*

bonds broken – bonds formed

allow ecf for arithmetical errors

3

- (ii) more energy is released when the bonds (in the products) are formed

1

than is needed to break the bonds (in the reactants)

*if no other marks gained, allow 1 mark for energy released
for bond making **and** energy used for bond breaking*

1

[8]