AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.5.1 EXOTHERMIC AND ENDOTHERMIC REACTIONS (PACK 4)

SCORE	PERCENTAGE
/163	%

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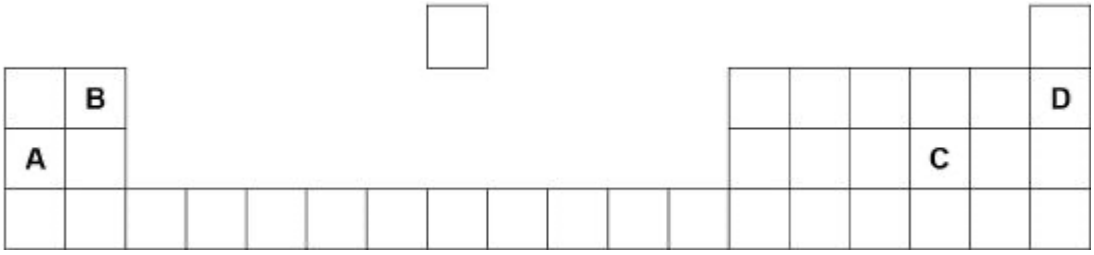
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Q1.

This question is about the elements in Group 2 of the periodic table.

(a) **Figure 1** shows the positions of four elements, **A**, **B**, **C**, and **D**, in the periodic table.

Figure 1



Which element is in Group 2?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

Group 2 metal carbonates break down when heated to produce a metal oxide and a gas.

metal carbonate ⟶ metal oxide + gas

(b) Name the two products when calcium carbonate ($CaCO_3$) is heated.

_____ and _____

(2)

(c) What type of reaction happens when a compound breaks down?

Tick **one** box.

burning ☐

decomposition ☐

neutralisation ☐

reduction ☐

(1)

(d) The metal carbonate takes in energy from the surroundings to break down.

What type of reaction takes in energy from the surroundings?

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Tick **one** box.

combustion ☐

electrolysis ☐

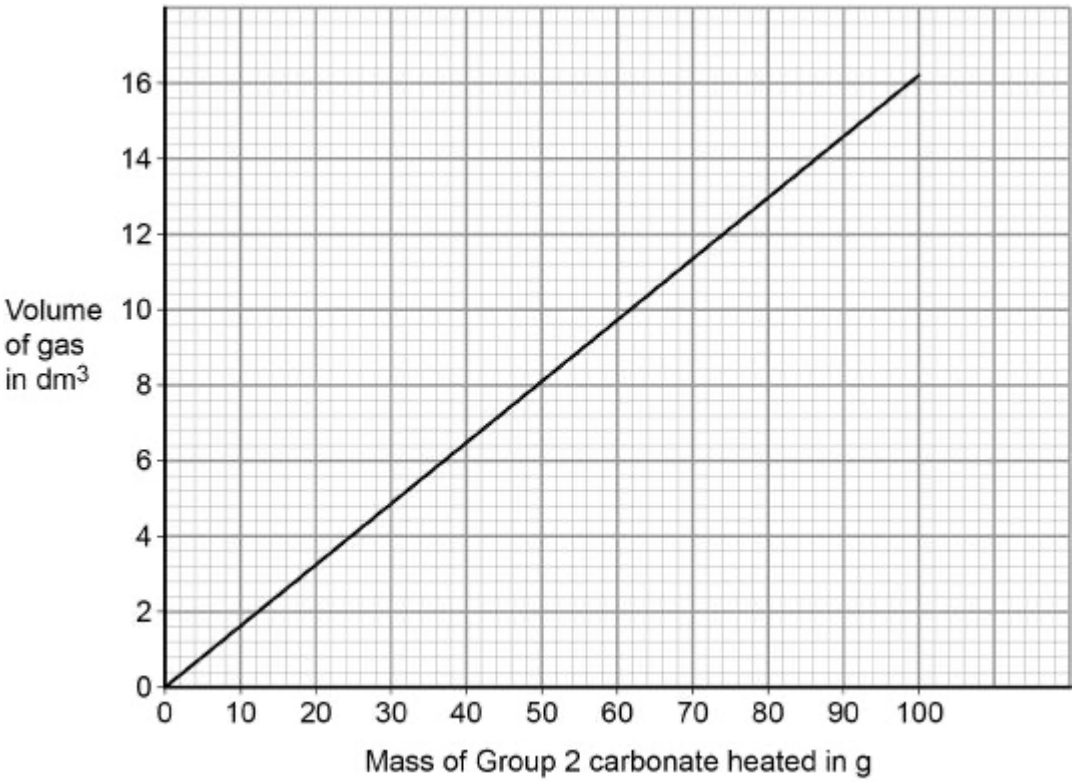
endothermic ☐

exothermic ☐

(1)

(e) **Figure 2** shows the volume of gas produced when a Group 2 metal carbonate is heated.

Figure 2



The student collected 5.2 dm^3 of gas.

What mass of the Group 2 metal carbonate is heated?

Mass = _____ g

(1)

(f) Calculate the mass of the Group 2 carbonate needed to produce 24 dm^3 of gas.

Use your answer from part **(e)** to help you.

_____

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Mass = _____ g

(2)

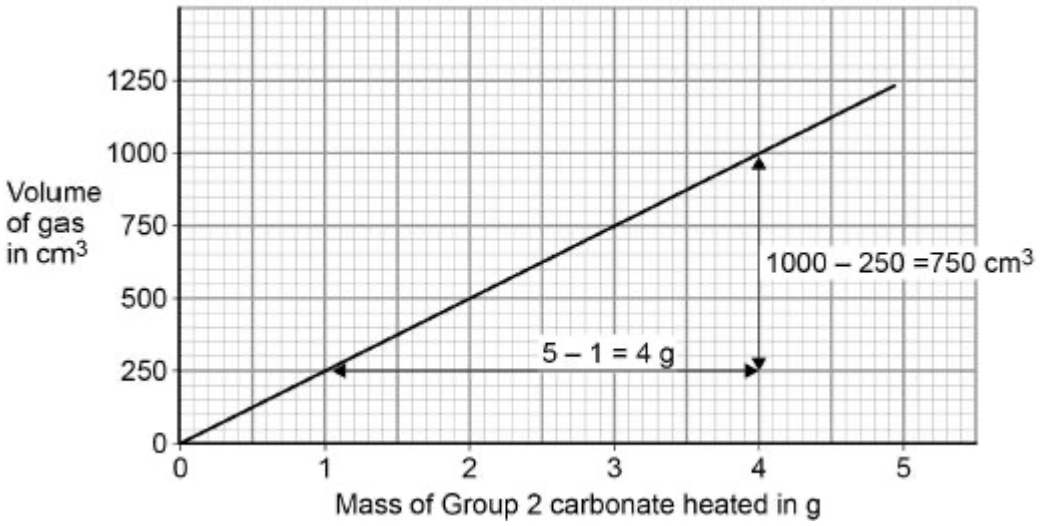
(g) A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

Figure 3 shows a graph of the student's results.

The student calculates the gradient of the line in **Figure 3**

The student makes **two** mistakes.

Figure 3



$$\text{Correct formula for gradient} = \frac{\text{Increase in volume of gas}}{\text{Increase in mass of Group 2 metal carbonate heated}}$$

$$\text{Student's calculation} = \frac{4}{750} = 0.00533 \text{ cm}^3 \text{ per g}$$

Identify the **two** mistakes the student makes.

Calculate the correct gradient of the line.

Mistake 1 _____

_____

Mistake 2 _____

_____

Calculation _____

_____

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Gradient = _____ cm^3 per g

(4)

(h) A student repeated the experiment with a different Group 2 metal carbonate (**X**CO_3).

The relative formula mass (M_r) of **X**CO_3 is 84

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of **X**.

Name metal **X**.

Use the periodic table.

_____

_____

_____

_____

Relative atomic mass (A_r) = _____

Metal **X** is _____

(4)

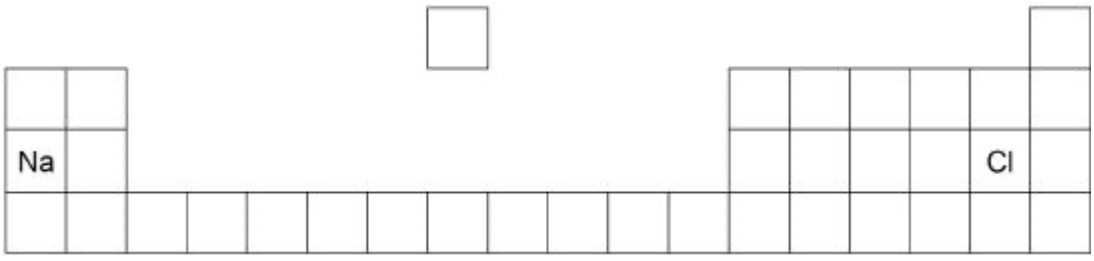
(Total 16 marks)

Q2.

This question is about sodium and chlorine.

Figure 1 shows the positions of sodium and chlorine in the periodic table.

Figure 1



(a) State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

Difference _____

_____

Similarity _____

_____

(2)

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(b) Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

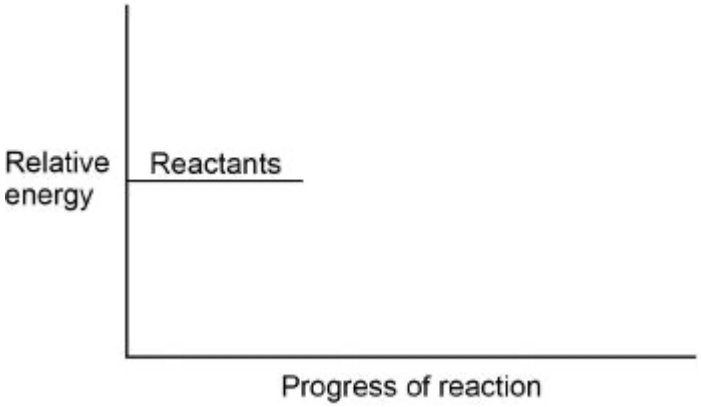
Write about electron transfer in your answer.

(4)

(c) The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

Figure 2



(2)
(Total 8 marks)

Q3.

A teacher extracted copper from copper oxide.

This is the method used.

1. Mix 1.30 g of zinc and 1.59 g of copper oxide.
2. Heat the mixture strongly.
3. When the mixture starts to glow, stop heating.
4. Let the glow spread through the mixture.

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5. Leave the mixture to cool.

(a) This reaction is exothermic.

Which part of the method shows the reaction is exothermic?

Tick **one** box.

- Mix zinc and copper oxide ☐
- Heat the mixture ☐
- Let the glow spread ☐
- Leave to cool ☐

(1)

The equation for the reaction between zinc and copper oxide is:

$$\underset{1.30\ g}{Zn(s)} + \underset{1.59\ g}{CuO(s)} \rightarrow \underset{1.62\ g}{ZnO(s)} + Cu(s)$$

(b) 1.30 g of zinc fully reacted with 1.59 g of copper oxide to produce 1.62 g of zinc oxide.

What mass of copper was produced?

_____

_____

Mass of copper produced = _____ g

(1)

(c) What is the physical state of zinc oxide in the reaction?

Tick **one** box.

- Aqueous ☐
- Gas ☐
- Liquid ☐
- Solid ☐

(1)

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(d) Which substance has been oxidised in the reaction?

Tick **one** box.

Copper ☐

Copper oxide ☐

Zinc ☐

Zinc oxide ☐

(1)

(e) What type of reaction takes place when zinc reacts with copper oxide?

Tick **one** box.

Combustion ☐

Crystallisation ☐

Displacement ☐

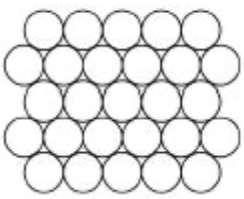
Neutralisation oxide ☐

(1)

Copper is a metal.

(f) Which structure represents the arrangement of atoms in pure copper?

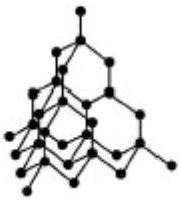
A



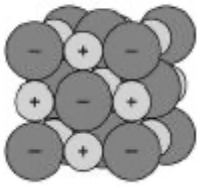
B



C



D



Tick **one** box.

A ☐

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B ☐

C ☐

D ☐

(1)

(g) Copper is used in electrical wiring.

Give **one** reason why.

_____

_____

(1)

(h) In the UK, 40% of the copper we use is recycled copper.

The other 60% is copper obtained by mining.

What is the simplest ratio of recycled copper to copper obtained by mining?

Tick **one** box.

2 : 3 ☐

2 : 5 ☐

4 : 10 ☐

6 : 4 ☐

(1)

(i) What are **two** advantages of recycling copper?

Tick **two** boxes.

Conserves copper ores ☐

Increase in greenhouse gases ☐

Less energy used ☐

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More jobs for miners ☐

More space used at landfill ☐

(2)
(Total 10 marks)

Q4.

A teacher demonstrated the temperature change when hydrochloric acid is added to sodium hydroxide.

This is the method used.

1. Add 25.0 cm^3 of sodium hydroxide solution to a polystyrene cup.
2. Measure the temperature of the sodium hydroxide solution.
3. Add 25.0 cm^3 of hydrochloric acid to the sodium hydroxide solution.
4. Stir the solution.
5. Measure the maximum temperature of the solution.

(a) Draw **one** line from each measurement to the most suitable piece of equipment to use to make the measurement.

Measurement	Equipment
	balance
Temperature of solution	beaker
	measuring cylinder
Volume of hydrochloric acid	metre rule
	thermometer

(2)

(b) The teacher did the experiment four times.

The table below shows the teacher's results.

Experiment	Maximum temperature rise in °C
1	6.1
2	7.8

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3	6.1
4	6.4

Calculate the mean maximum temperature rise.

Do **not** use the anomalous result in your calculation.

_____

_____

_____

_____

Mean maximum temperature rise = _____ °C

(2)

(c) How could the accuracy of the experiment be improved?

Tick **one** box.

Add 20.0 cm^3 of hydrochloric acid ☐

Use a lid on the polystyrene cup ☐

Use a metal beaker ☐

Use a thermometer with a resolution of 1 °C ☐

(1)

The reaction between hydrochloric acid and sodium hydroxide is a neutralisation reaction.

The reaction produces a salt and one other product.

(d) Complete the word equation for the reaction.

hydrochloric acid + sodium hydroxide ⟶ _____ + _____

(2)

(e) Universal indicator is used to measure the pH of solutions.

Hydrochloric acid is pH 1

Sodium hydroxide is pH 13

Draw **one** line from the pH to the colour of universal indicator in a solution with that pH.

pH **Colour of**

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	universal indicator
	green
1	orange
	purple
13	red
	yellow

(2)
(Total 9 marks)

Q5.

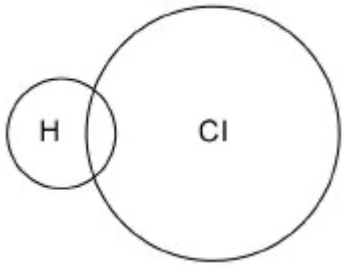
This question is about hydrogen chloride.

(a) A hydrogen atom contains 1 electron and a chlorine atom contains 17 electrons.

Complete **Figure 1** to show a dot and cross diagram for a hydrogen chloride molecule.

Show the outer electrons only.

Figure 1



(2)

Hydrogen gas (H_2) reacts with chlorine gas to produce hydrogen chloride.

(b) Complete the balanced chemical equation for the reaction between hydrogen and chlorine.

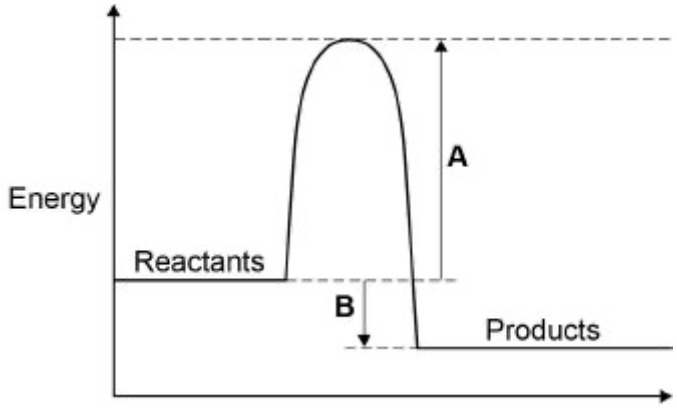
$$H_2 + _____ \rightarrow _____$$

(2)

Figure 2 shows the reaction profile diagram for the reaction between hydrogen and chlorine.

Figure 2

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(c) What do **A** and **B** represent on **Figure 2**?

A _____

B _____

(2)

(d) How does the reaction profile diagram show that the reaction is exothermic?

_____

_____

(1)

(e) Hydrogen chloride gas dissolves in water to form hydrochloric acid.

Hydrochloric acid contains hydrogen ions and chloride ions.

Explain why hydrogen chloride gas does not conduct electricity but hydrochloric acid is able to conduct electricity.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q6.

A teacher demonstrated the extraction of copper from copper oxide.

This is the method used.

1. Mix 1.30 g of zinc and 1.59 g of copper oxide.
2. Heat the mixture strongly.

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3. When the mixture starts to glow, stop heating.
4. Let the glow spread through the mixture.
5. Leave the mixture to cool.
6. Add hydrochloric acid to the cooled mixture.
7. Filter the mixture obtained in step 6.

(a) A student concluded that an exothermic reaction had taken place.

Explain how an observation made during the demonstration shows this.

(2)

(b) The equation for the reaction between zinc and copper oxide is:

$$Zn + CuO \longrightarrow ZnO + Cu$$

1.59 g of copper oxide reacted.

Calculate the mass of copper produced.

Relative atomic masses (A_r): Cu = 63.5 O = 16 Zn = 65

Mass of copper produced = _____ g

(3)

(c) Explain why steps 6 and 7 result in only copper being obtained as the residue.

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(4)

(d) The ionic equation for the reaction is:

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$

Which statement about the reaction between zinc and copper ions is correct?

Tick **one** box.

Copper ions have been oxidised because the copper ions have gained electrons.	☐
Copper ions have been oxidised because the copper ions have lost electrons.	☐
Zinc has been oxidised because the zinc atoms have gained electrons.	☐
Zinc has been oxidised because the zinc atoms have lost electrons.	☐

(1)

(Total 10 marks)

Q7.

Crude oil is a mixture of hydrocarbons.

Hydrocarbons can be used as fuels.

(a) One alkane hydrocarbon contains 34 hydrogen atoms.

What is the formula of the hydrocarbon?

Tick **one** box.

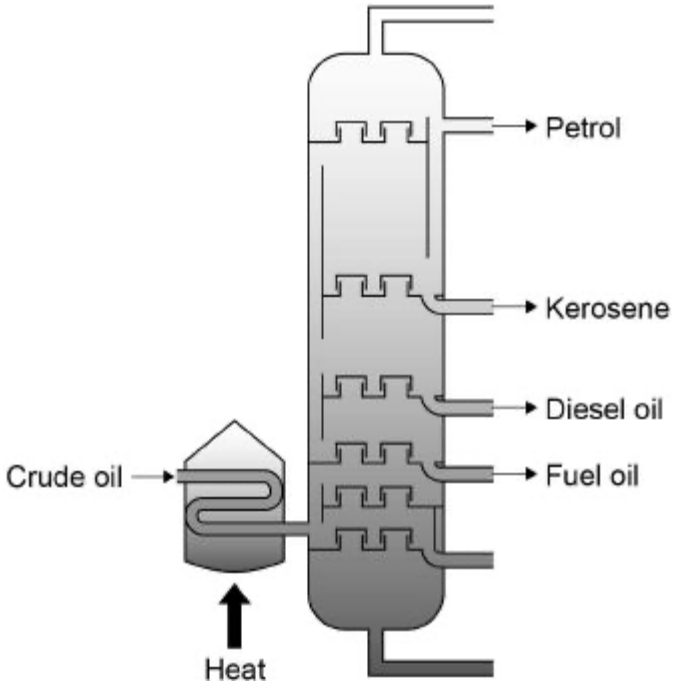
$C_{15}H_{34}$	☐
$C_{16}H_{34}$	☐
$C_{17}H_{34}$	☐
$C_{18}H_{34}$	☐

(1)

(b) **Figure 1** represents a fractionating column used to separate crude oil.

Figure 1

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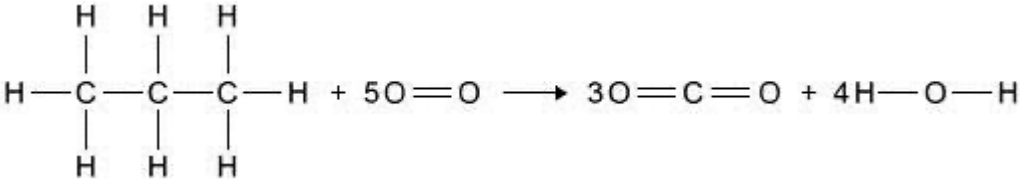
Describe how crude oil is separated using fractional distillation.

(4)

(c) Propane is a hydrocarbon fuel obtained from crude oil.

Figure 2 shows the displayed equation for the complete combustion of propane.

Figure 2



The table below shows bond energies.

Bond	**Bond energy in kJ/mol**

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C−C	347
C−H	413
O=O	495
C=O	799
O−H	467

Calculate the overall energy change in kJ/mol for the reaction.

Use the diagram and the table above.

Overall energy change = _____ kJ/mol

(3)

(d) Some fuels are obtained from plants.

Evaluate the environmental impact of fuels obtained from plants and from crude oil.

(4)

(e) Butane is another hydrocarbon fuel obtained from crude oil.

The equation for the complete combustion of butane is:

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$2\ C_4H_{10} + 13\ O_2 \longrightarrow 8\ CO_2 + 10\ H_2O$

14.5 g of butane was burned in 72.0 g of oxygen. Determine the limiting reactant.

You must include calculations in your answer.

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

(4)

(Total 16 marks)

Q8.

This question is about compounds of oxygen.

The reaction between carbon and oxygen is exothermic.

(a) What does exothermic reaction mean?

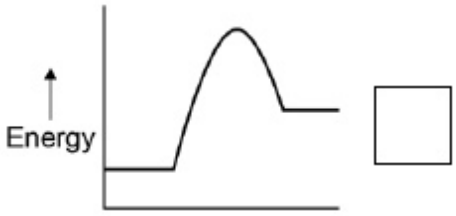
(1)

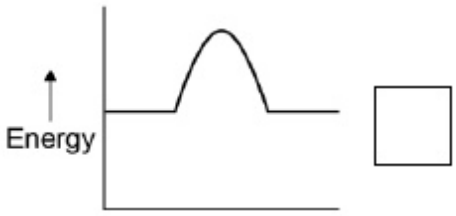
(b) Which is the correct reaction profile (energy level diagram) for an exothermic reaction?

Tick **one** box.



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(1)

(c) The percentage by mass of oxygen in carbon dioxide (CO_2) is calculated by the equation:

$$\text{percentage by mass} = \frac{\text{number of atoms of O} \times \text{Relative atomic mass of oxygen (O)}}{\text{relative molecular mass of carbon dioxide } (CO_2)} \times 100$$

Relative atomic masses (A_r): C = 12 O = 16

Calculate the percentage by mass of oxygen in carbon dioxide (CO_2).

Percentage by mass of oxygen = _____ %

(3)

Hydrogen peroxide decomposes to produce water and oxygen.

(d) Balance the chemical equation.

$$____\ H_2O_2 \rightarrow ____\ H_2O + O_2$$

(1)

(e) 6.8 g of hydrogen peroxide decomposes to produce 3.6 g of water.

Calculate the mass of oxygen produced when 68 g of hydrogen peroxide decomposes.

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_____

_____

_____

_____

Mass of oxygen = _____ g

(2)

(Total 8 marks)

Q9.

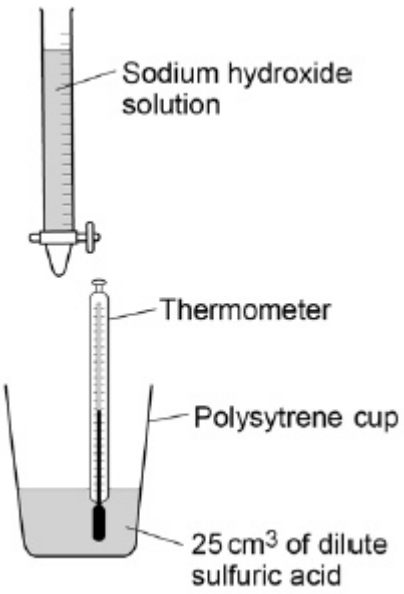
Some students investigated the change in temperature as sodium hydroxide solution is added to dilute sulfuric acid.

This is the method used.

1. Put 25 cm^3 of dilute sulfuric acid into a polystyrene cup.
2. Measure the initial temperature of the dilute sulfuric acid.
3. Add 4 cm^3 of sodium hydroxide solution to the dilute sulfuric acid.
4. Stir the mixture.
5. Measure the highest temperature of the mixture.
6. Repeat steps 3–5 until 40 cm^3 of sodium hydroxide solution have been added.

Figure 1 shows the apparatus the student used.

Figure 1



(a) The volume of sodium hydroxide solution is a variable.

Which **two** words can be used to describe this type of variable?

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Tick **two** boxes.

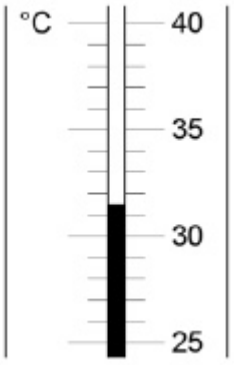
Categoric	☐
Continuous	☐
Control	☐
Dependent	☐
Independent	☐

(2)

(b) The dilute sulfuric acid has an initial temperature of 24.0 °C

Figure 2 shows the highest temperature.

Figure 2



Calculate the change in temperature.

_____

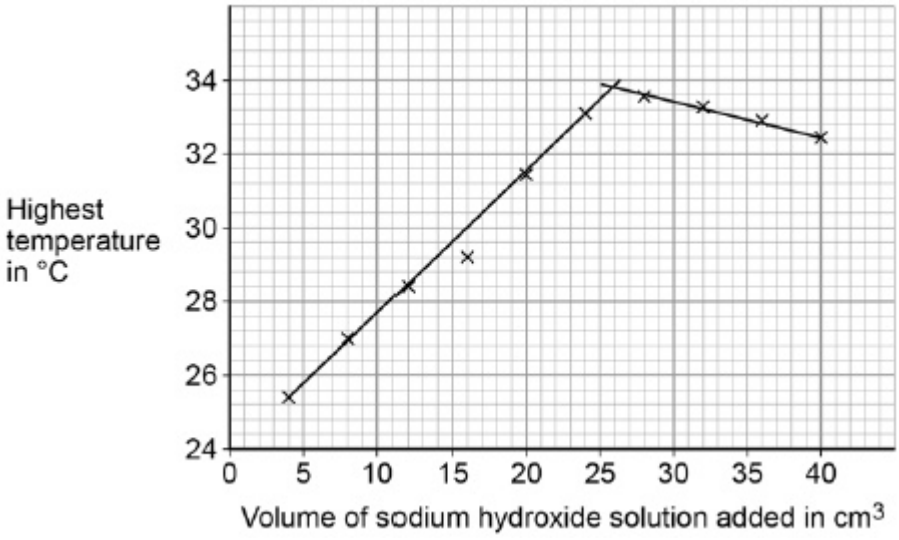
Temperature = _____ °C

(2)

Figure 3 shows the students' results.

Figure 3

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(c) Determine the volume of sodium hydroxide solution that gives the highest temperature change.

Use **Figure 3** to help you answer this question.

Volume = _____ cm^3

(1)

(d) In **Figure 3** the temperature when 16 cm^3 of sodium hydroxide solution is added is anomalous.

Suggest **one** error that could have been made in the method which would cause this anomalous result.

_____

_____

(1)

(e) The sodium hydroxide solution in this investigation contains 80 grams per dm^3

The students use 40 cm^3 of sodium hydroxide solution.

Calculate the mass of sodium hydroxide in 40 cm^3

_____

_____

_____

_____

_____

Mass = _____ g

(3)

(Total 9 marks)

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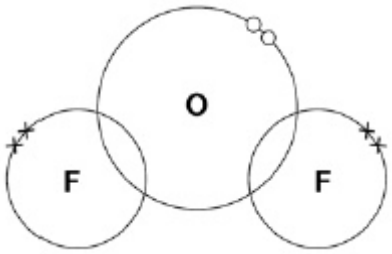
Q10.

This question is about oxygen.

(a) One oxygen atom shares one pair of electrons with each fluorine atom in oxygen difluoride (OF_2).

Complete the dot and cross diagram of oxygen difluoride below.

You should show only the electrons in the outer shells.



(2)

(b) Oxygen difluoride (OF_2) has a melting point of – 224 °C and a boiling point of –145 °C

What is the state of oxygen difluoride at room temperature?

Explain your answer in terms of structure and bonding.

_____

_____

_____

_____

_____

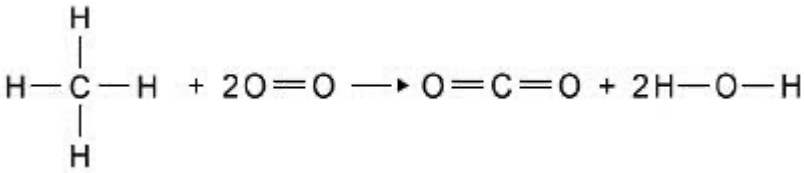
_____

_____

_____

(4)

(c) The equation shows the reaction of methane with oxygen.



The table shows the bond energies.

Bond	**C–H**	**O=O**	**C=O**	**O–H**
Bond	412	496	803	463

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dissociation energy in kJ per mole				

Calculate the overall energy change for the combustion of one mole of methane.

Energy change = _____ kJ mol^{-1}

(3)

(Total 9 marks)

Q11.

Some students investigated the reactivity of four unknown metals, **W**, **X**, **Y** and **Z**.

The letters are not the symbols of these elements.

The students used metal salt solutions of copper nitrate, magnesium sulfate and zinc chloride.

This is the method used.

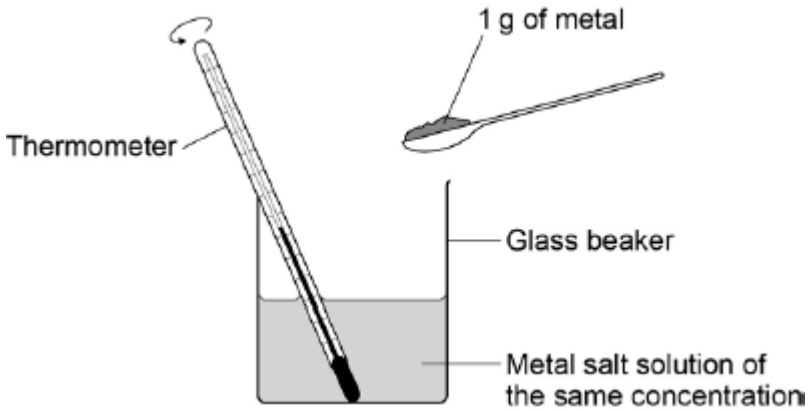
1. Pour a solution of a metal salt into a glass beaker.
2. Measure the temperature of the solution.
3. Add 1 g of metal to the solution.
4. Measure the temperature of the solution.
5. Calculate the temperature increase.

The students did the experiment using each salt solution with each metal.

Figure 1 shows the apparatus the students used.

Figure 1

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The table below shows the students' results.

	Temperature increase in °C			
Solution	**Metal W**	**Metal X**	**Metal Y**	**Metal Z**
Copper nitrate	46	10	29	No change
Magnesium sulfate	No change	No change	No change	No change
Zinc chloride	15	No change	No change	No change

(a) Which metal is **least** reactive?

Tick **one** box.

Metal W ☐

Metal X ☐

Metal Y ☐

Metal Z ☐

(1)

(b) How do the results show that magnesium is **more** reactive than the metals **W**, **X**, **Y** and **Z**?

_____

_____

(1)

(c) How do the results show that the reaction between metal **Y** and copper nitrate solution is exothermic?

_____

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_____

(1)

(d) One student said that the investigation was not valid (a fair test).

Write a plan for the investigation that includes improvements to the method and apparatus.

_____

_____

_____

_____

_____

_____

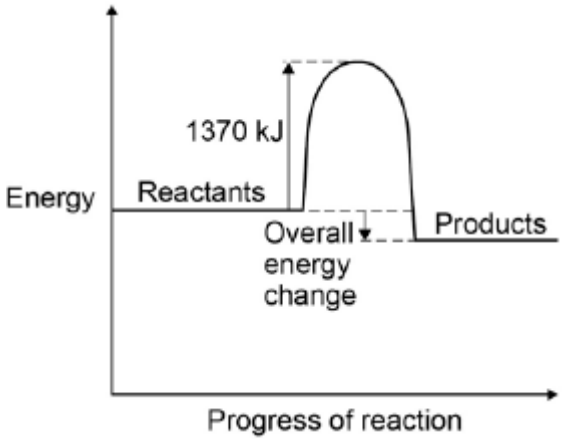
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_____

(4)

(e) **Figure 2** shows the reaction profile of an exothermic reaction.

Figure 2



What does the energy value of 1370 kJ represent?

Tick **one** box.

Activation energy ☐

Products energy ☐

Reactants energy ☐

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Released energy ☐

(1)

(f) The overall energy change is 386 kJ.

What percentage of 1370 kJ is this?

Give your answer to two significant figures.

_____

Percentage = _____ %

(2)

(Total 10 marks)

Q12.

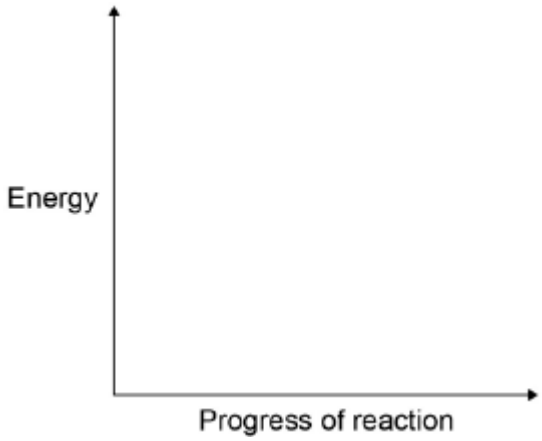
Exothermic reactions transfer energy to the surroundings.

(a) Draw a reaction profile for an exothermic reaction using the axes in **Figure 1**.

Show the:

- relative energies of the reactants and products
- activation energy and overall energy change.

Figure 1

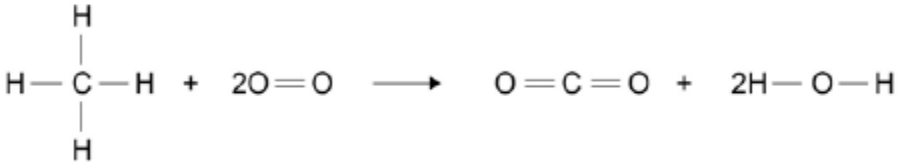


(2)

(b) Combustion is an exothermic reaction.

Calculate the overall energy change for the complete combustion of one mole of methane in oxygen.

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



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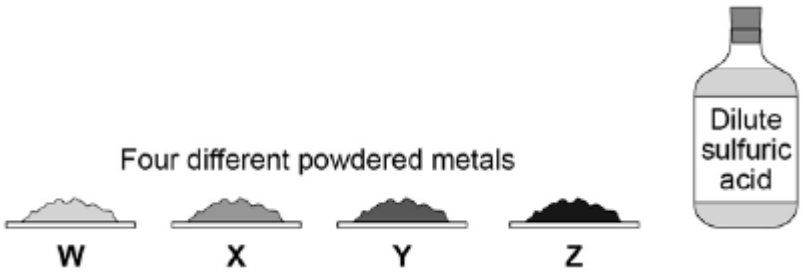
Bond	Bond energy in kJ / mol
C — H	413
O = O	498
C = O	805
O — H	464

Overall energy change = _____ kJ / mol

(3)

(c) **Figure 2** shows the chemicals given to a student.

Figure 2



The student wants to investigate the reactivity of the four metals.

Outline a plan the student could use to investigate the relative reactivity of the four metals, **W**, **X**, **Y** and **Z**.

The plan should use the fact that all four metals react exothermically with dilute sulfuric acid.

You should name the apparatus used and comment on the safe use of the chemicals.

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(6)

(d) Another student used displacement reactions to investigate the relative reactivity of the four metals, **W**, **X**, **Y** and **Z**.

The table below shows the student's results.

	Observations			
Solution	**Metal W**	**Metal X**	**Metal Y**	**Metal Z**
Copper nitrate	Brown layer formed on metal	Brown layer formed on metal	Brown layer formed on metal	No change
Magnesium sulfate	No change	No change	No change	No change
Sulfuric acid	Gas bubbles produced	Few gas bubbles produced	Gas bubbles produced	No change
Zinc chloride	Grey layer formed on metal	No change	No change	No change

Give the order of reactivity of metals, **W**, **X**, **Y** and **Z**.

Use the results in the table above to justify your answer.

_____ > _____ > _____ > _____

(3)

(e) The student concluded that these results could also be used to justify the order of reactivity of copper, magnesium, hydrogen and zinc.

The student is **not completely** correct. Use the results in the table above to explain

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why.

Suggest one further experiment that would provide evidence for the student's conclusion.

(4)

(Total 18 marks)

Q13.

This question is about the reactions of acids.

(a) When dilute hydrochloric acid is reacted with sodium hydroxide solution there is a temperature change.

Explain how the temperature changes.

(2)

(b) Acids produce hydrogen ions in aqueous solutions.

What is the ionic equation for neutralisation reactions?

Tick **one** box.

$H^+(aq) + H_2O(l) \rightarrow H_3O^+(aq)$ ☐

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ ☐

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$2\ H_2O(l) \rightarrow H_3O^+(aq) + OH^-(aq)$ ☐

$H_2O(l) \rightarrow 2\ H^+(aq) + O^{2-}(aq)$ ☐

(1)

(c) Sulfuric acid reacts with copper carbonate to produce a salt, water and carbon dioxide.

$H_2SO_4 + CuCO_3 \longrightarrow CuSO_4 + H_2O + CO_2$

What is the name of the salt produced?

_____

(1)

(d) A student reacted four metals with water and with a dilute acid to work out the order of reactivity of the metals.

The table below shows some of the observations.

Metal	Reaction with water	Reaction with dilute acid
Calcium	Bubbles of gas	**X**
Copper	**Y**	No bubbles of gas
Magnesium	Few bubbles of gas	Bubbles of gas
Zinc	No bubbles of gas	Bubbles of gas

Write the observations for **X** and **Y**.

Observation at **X** _____

Observation at **Y** _____

(2)

(e) Write the four metals, calcium, copper, magnesium and zinc, in order of reactivity.

Start with the **most** reactive metal.

_____ _____ _____ _____

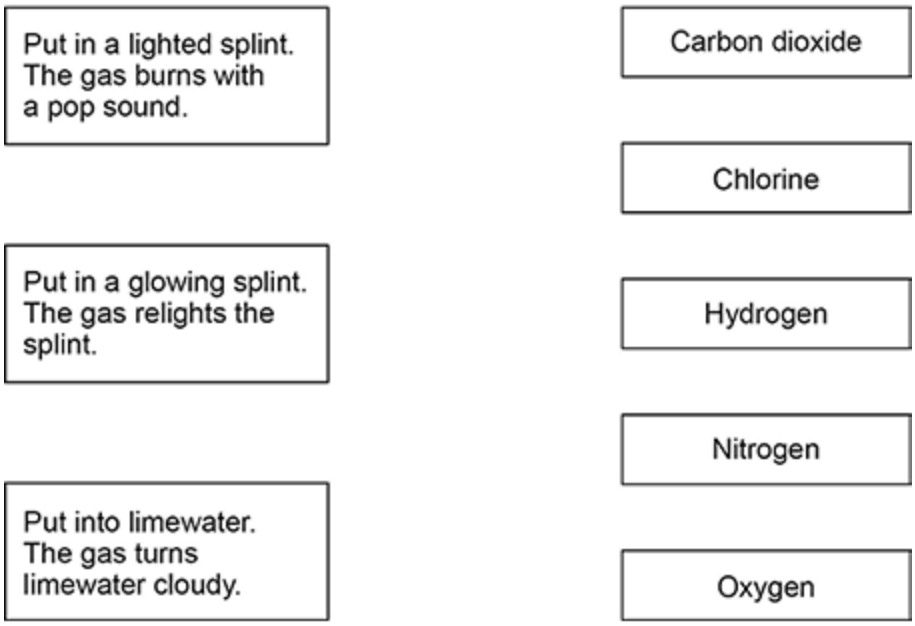
(2)

(f) Some gases given off in reactions can be identified by chemical tests.

Draw **one** line from each chemical test to the name of the gas.

Chemical test	**Gas**

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(3)

(g) Acids react with bases to produce salts and water (H_2O).

The electronic structure of a hydrogen atom is 2,1

The electronic structure of an oxygen atom is 2,6

Draw a diagram to show the arrangement of the outer shell electrons in a molecule of water.

(2)

(Total 13 marks)

Q14.

The rate of chemical reactions can be changed by changing the conditions.

(a) Methane burns in oxygen to produce carbon dioxide and water.

The activation energy for the reaction is 2648 kJ / mol.

The reaction gives out 818 kJ / mol of energy.

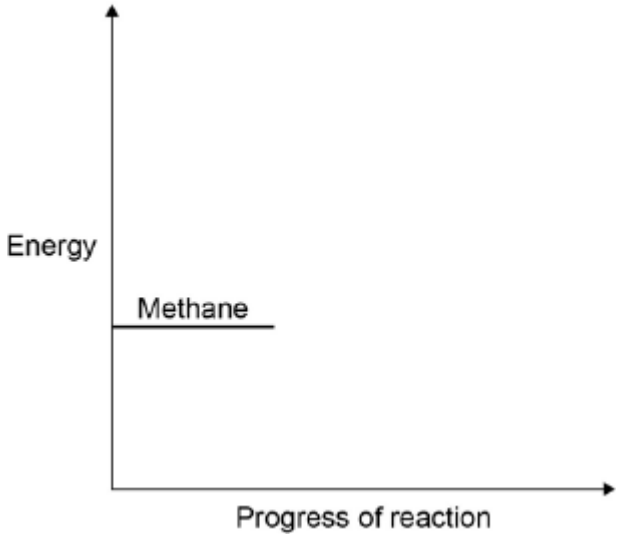
The figure below shows the reaction profile for this reaction.

Complete the reaction profile.

Draw arrows to represent:

- the activation energy
- the energy given out.

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(4)

(b) What percentage of the activation energy is the energy given out?

_____

(1)

(c) Calcium carbonate decomposes when it is heated:

The decomposition of calcium carbonate is an endothermic reaction.

How would the reaction profile for decomposition of calcium carbonate be different from the reaction profile of methane burning in oxygen?

_____

(1)

(d) Catalysts are used in chemical reactions in industry.

Give **two** properties of catalysts.

For each property, explain why it makes the catalyst useful in industry.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e) Enzymes are biological catalysts.

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What type of molecule is an enzyme?

Tick **one** box.

Carbohydrate	☐
Hydrocarbon	☐
Lipid	☐
Protein	☐

(1)

(f) If enzymes are denatured they stop working.

Give **two** ways an enzyme can be denatured.

1. _____

2. _____

(2)

(g) An enzyme called lactase catalyses the reaction that breaks down lactose to smaller molecules.

One model used to explain how enzymes affect reactions is called the lock and key model.

Use the lock and key model to explain why lactase cannot be used to speed up **all** chemical reactions.

_____

_____

_____

_____

_____

_____

(3)

(Total 16 marks)

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