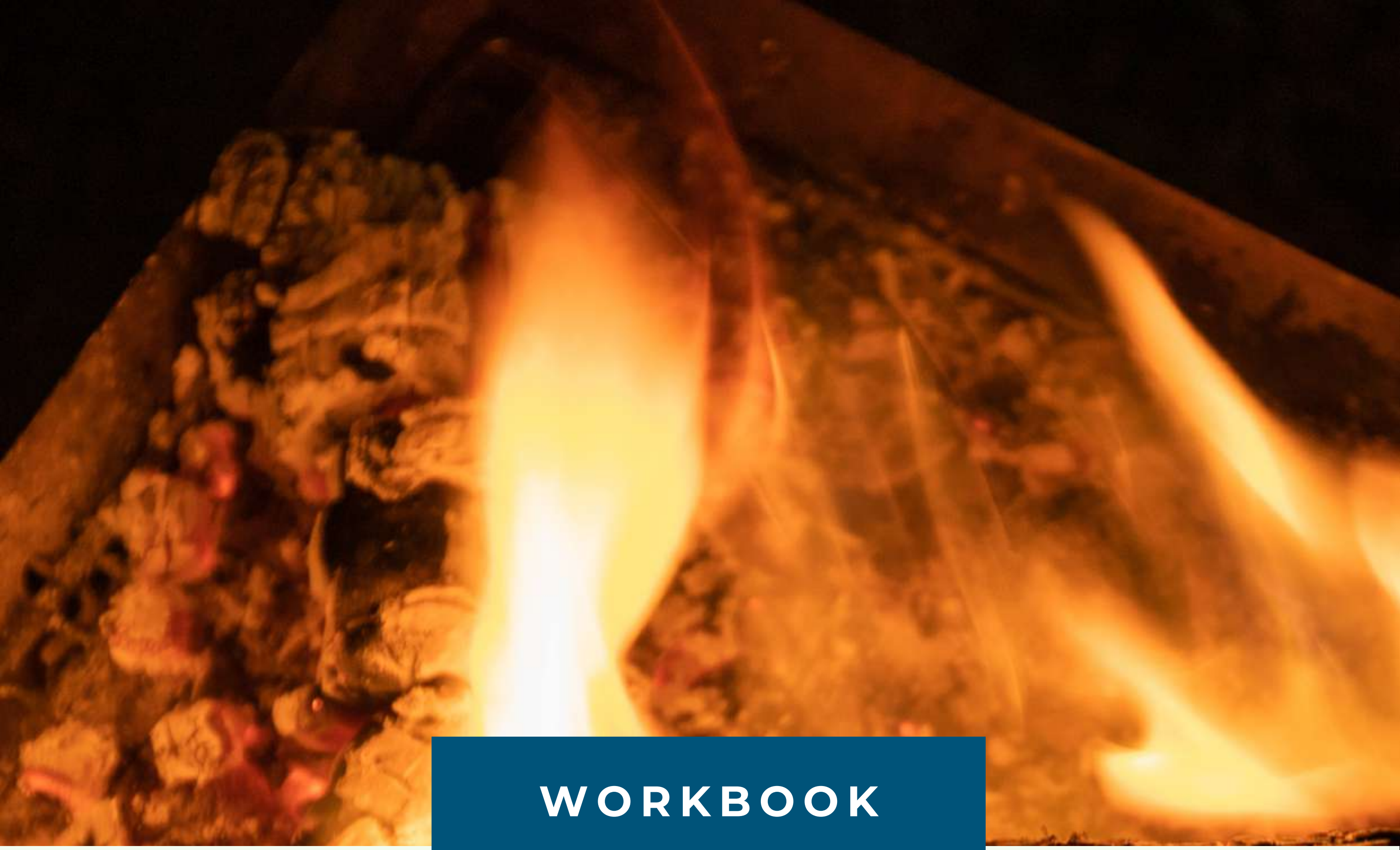


WORKBOOK

Online Chem Tuition

Energy Changes

TOPIC FIVE

6TH APRIL

HELLO!

Welcome to your AQA GCSE Chemistry revision session. This workbook is designed to be straightforward and directly aligned with what I'll cover in the live lesson, it offers a practical way to apply your knowledge as you learn.

What's in the Workbook:

- **Questions**: These are selected to match the lesson topic, providing you with a chance to practice and solidify your understanding.
- **Symbols Guide**:
  - HT - Indicates advanced content aimed at **Higher Tier** students.
  - - Signifies material for **GCSE Chemistry** students only.

Using the Workbook During Lesson:

- **Stay Engaged**: Be ready to participate and use the workbook alongside the lesson. You can use the chat to ask questions or get help.
- **Peer Learning**: Take advantage of the group setting. Your classmates' questions can provide additional insights.

Zoom Lesson:

Make sure you have your workbook and a pen ready and join us here.

See you on Zoom!

ALISON GREEN

Online Chem Tuition

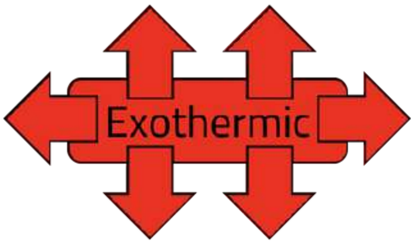
EXOTHERMIC AND ENDOTHERMIC

ENERGY TRANSFERS DURING REACTIONS

Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place. If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred.

EXOTHERMIC

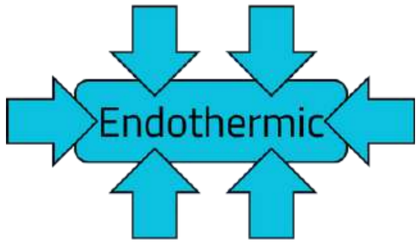
Transfers energy to the surroundings so the temperature of the surroundings increases.



Exothermic reactions include combustion, many oxidation reactions and neutralisation. Everyday uses of exothermic reactions include self-heating cans and hand warmers.

ENDOTHERMIC

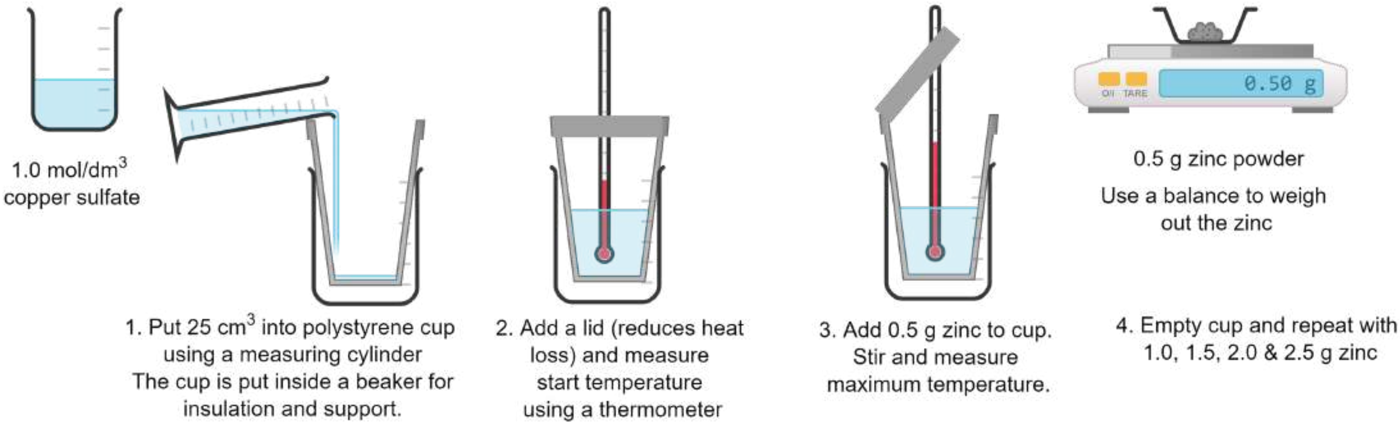
Takes in energy from the surroundings so the temperature of the surroundings decreases.



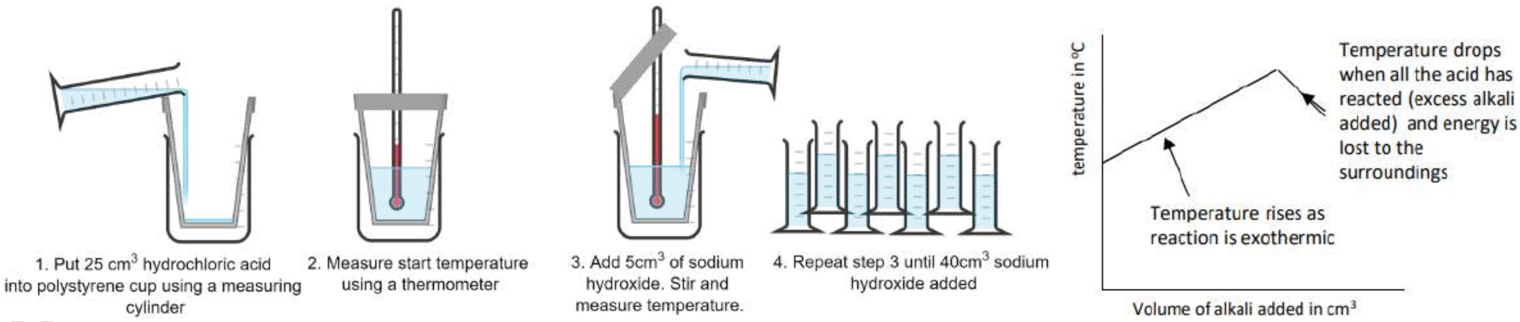
Endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate. Some sports injury packs are based on endothermic reactions.

INVESTIGATING TEMPERATURE CHANGES - REQUIRED PRACTICAL 4

Investigate the variables that affect temperature changes in reacting solutions.
For investigating the **displacement reaction** between zinc and copper sulfate solution this method can be used:



For investigating the temperature change during a **neutralisation reaction** this method can be used:

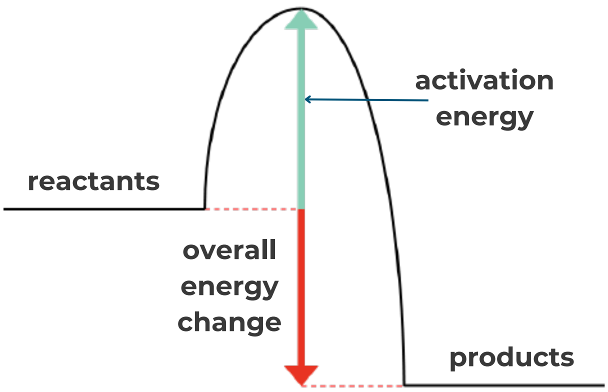


EXOTHERMIC AND ENDOTHERMIC

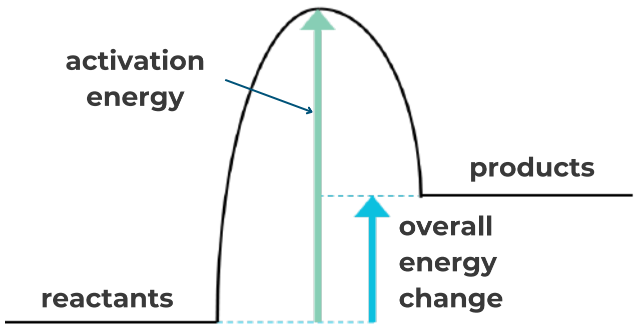
REACTION PROFILES

Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

EXOTHERMIC



ENDOTHERMIC



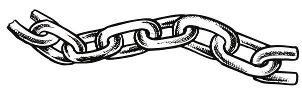
Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The **minimum amount of energy** that **particles** must have to **react** is called the **activation energy.**

HT ENERGY CHANGE OF REACTIONS

BOND BREAKING

Requires energy so **endothermic**

BOND MAKING



Releases energy so **exothermic**

The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction.

In an **exothermic** reaction, the **energy released** from **forming new bonds** is **greater** than the **energy needed** to **break existing bonds**.

In an **endothermic** reaction, the **energy needed** to **break existing bonds** is greater than the **energy released** from **forming new bonds**.

HT BOND ENERGY CALCULATIONS

The energy needed to break bonds and the energy released when bonds are formed can be calculated from bond energies.

Energy change of reaction = sum of bonds energies broken – sum of bonds energies made

Example: Using the following mean bond energy data to calculate the energy change for this reaction

2 H – H + O = O → 2 H - O - H

Energy change = Sum of bond energies broken – Sum of bond energies made

= (2 x H-H + 1x O=O) – (4 x O-H)

= (2x436 + 498) – (4 x 464) = - 486 kJ /mol

Bond	Bond energy (kJ /mol)
H-H	436
O-H	464
O=O	498

A student investigated the temperature change in displacement reactions between box metals and copper sulfate solution. The table shows the student's results.

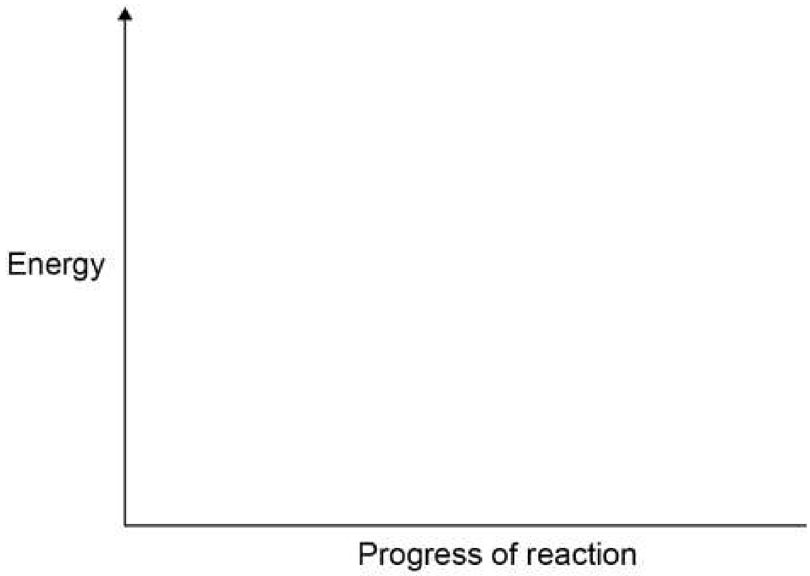
Q1.a) The student concluded that the reactions between the metals and copper sulfate box solution are endothermic. Give **one** reason why this conclusion is **not** correct.

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

[1 mark]

AQA June 18 H Q5.2

Q1.b) Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution below.



[3 marks]

AQA June 18 H Q5.4

Q2. The displacement reaction between aluminium and iron oxide has a high activation energy. What is meant by 'activation energy'?

[1 mark]

AQA June 20 H Q6.1

A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution. This is the method used.

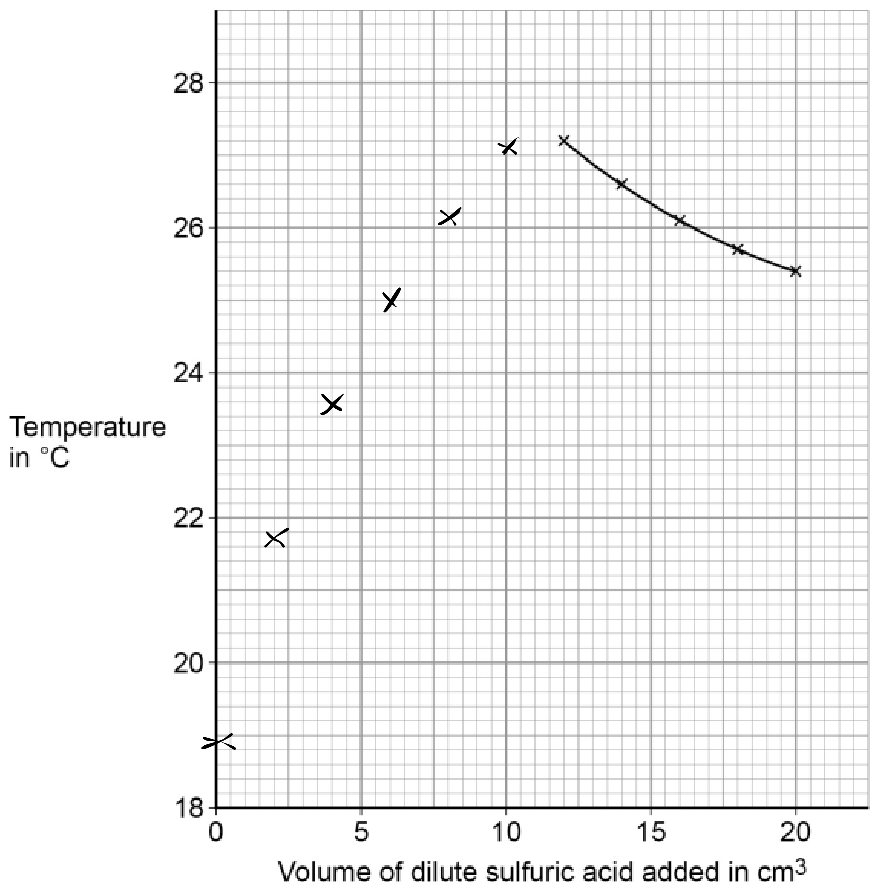
1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.
2. Record the temperature of the solution.
3. Add 2.0 cm^3 dilute sulfuric acid.
4. Stir the solution.
5. Record the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

Q3.a) Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

[2 marks]

AQA June 19 H Q9.1

Graph below shows the students results



Q3.b) Draw a line of best fit through these points on the graph then extend the lines of best fit until they cross.

[2 marks]

AQA June 19 H Q9.2

Q3.c) Use the graph to determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm³ of the potassium hydroxide solution.

[1 mark]

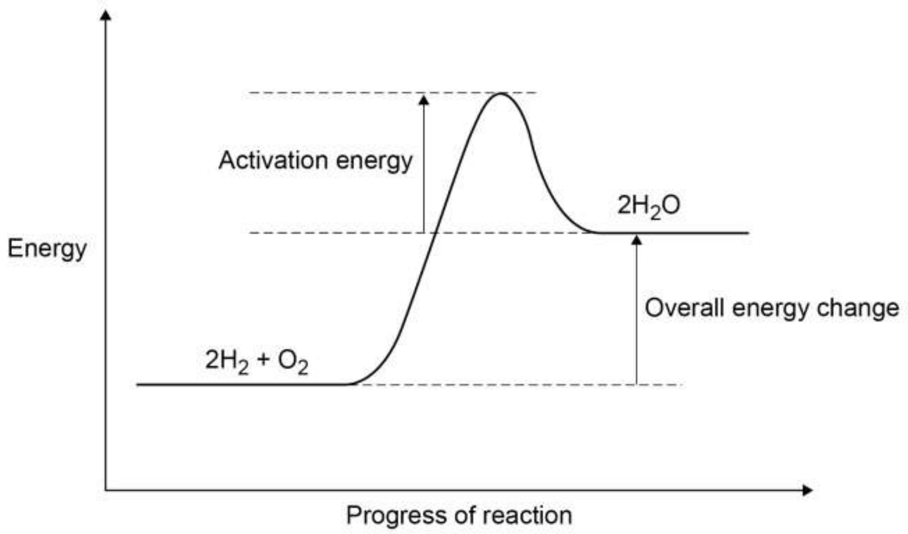
AQA June 19 H Q9.3

Q3.c) Use the graph to determine the overall temperature change when the reaction is complete.

[1 mark]

AQA June 19 H Q9.4

Q4. A student drew a reaction profile for the reaction between hydrogen and oxygen. Below is the student's reaction profile.



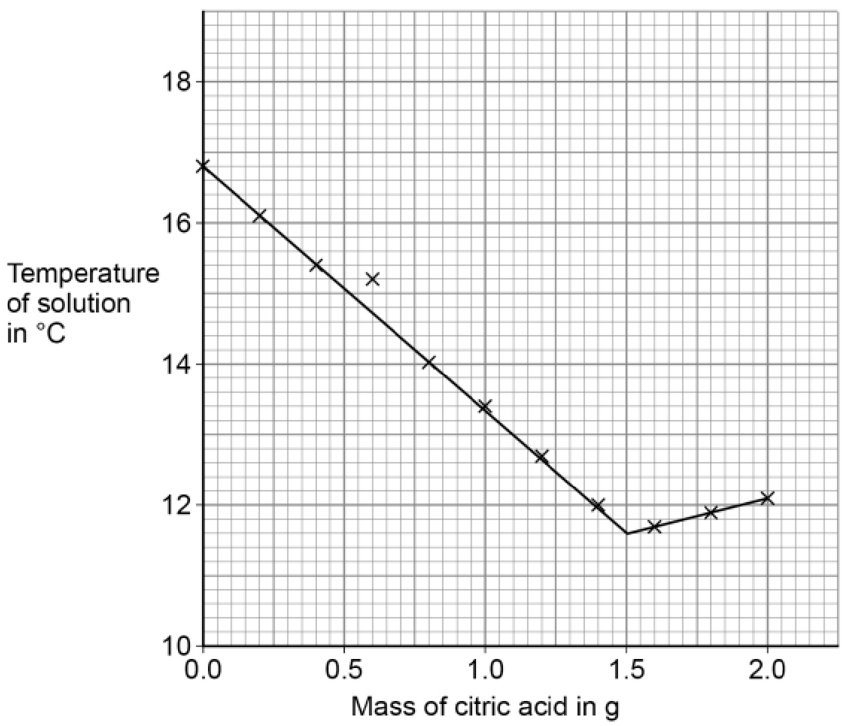
The student made two errors when drawing the reaction profile. Describe the two errors.

[2 marks]

AQA June 20 H Q7.1

This question is about citric acid ($C_6H_8O_7$). Citric acid is a solid. A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution. This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.20 g of citric acid to the polystyrene cup.
4. Stir the solution.
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added. The student plotted the results on a graph.



Q5.a) The graph shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.
The student correctly:
• measured the mass of the citric acid
• read the thermometer • plotted the point.
Suggest one reason for the anomalous point.

[1 mark]

AQA June 20 H Q9.1

Q5.b) Explain the shape of the graph in terms of the energy transfers taking place. You should use data from graph in your answer

[3 marks]

AQA June 20 H Q9.2

Q5.c) A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape. Sketch a line on graph to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same. Explain your answer

[3 marks]

AQA June 20 H Q9.3

Sodium carbonate reacts with hydrochloric acid in an exothermic reaction. The equation for the reaction is:

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

A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

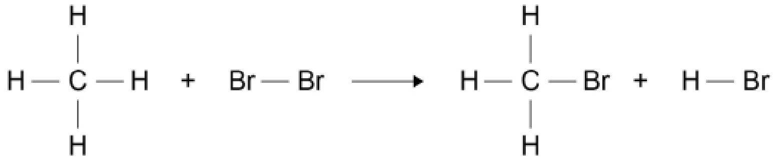
Q6. Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

[6 marks]

AQA June 22 H Q2.1

Q6. Bromine reacts with methane in sunlight. Below is the displayed formulae for the reaction of bromine with methane.

HT



The table shows the bond energies and the overall energy change in the reaction.

	C—H	Br—Br	C—Br	H—Br	Overall energy change
Energy in kJ/mol	412	193	**X**	366	– 51

Calculate the bond energy X for the C-Br bond.

[4 marks]

AQA June 18 H Q7.4

Q7. Below is the displayed formula equation for the reaction of hydrogen sulfide with oxygen.

HT

$$2\,H{-}S{-}H \;+\; 3\,O{=}O \longrightarrow 2\,H{-}O{-}H \;+\; 2\,O{=}S{=}O$$

The table shows some of the bond energies.

Bond	H—S	O═O	H—O	S═O
Energy in kJ/mol	364	498	464	**X**

In the reaction the energy released forming new bonds is 1034 kJ/mol greater than the energy needed to break existing bonds. Calculate the bond energy X for the S=O bond.

[5 marks]

AQA June 21 H Q8.4

CHEMICAL AND FUEL CELLS

CELLS AND BATTERIES

Cells contain chemicals which react to produce electricity. The voltage produced by a cell is dependent upon a number of factors including the type of electrode and electrolyte.

A **simple cell** can be made by connecting **two different metals in contact with an electrolyte**. The bigger the difference in reactivity between the two metals the larger the voltage.

Batteries consist of **two or more cells** connected together in series to provide a greater voltage.

NON-RECHARGABLE CELLS

The chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non-rechargeable.

RECHARGABLE CELLS

Can be recharged because the chemical reactions are reversed when an external electrical current is supplied.

FUEL CELLS

Fuel cells are supplied by an external source of fuel (eg hydrogen) and oxygen or air. The fuel is oxidised electrochemically within the fuel cell to produce a potential difference.

The overall reaction in a hydrogen fuel cell involves the oxidation of hydrogen to produce water.

Hydrogen + oxygen → water or $2H_2 + O_2 \rightarrow 2H_2O$

Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.

ADVANTAGES

- No pollutants produced -only water
- Do not need recharging- quicker to refuel than to recharge a rechargeable cell
- Can travel further before refuelling in comparison to rechargeable cells
- No toxic chemicals to dispose of at end of the cell's life
- Hydrogen can be renewable if made by electrolysis using renewable energy

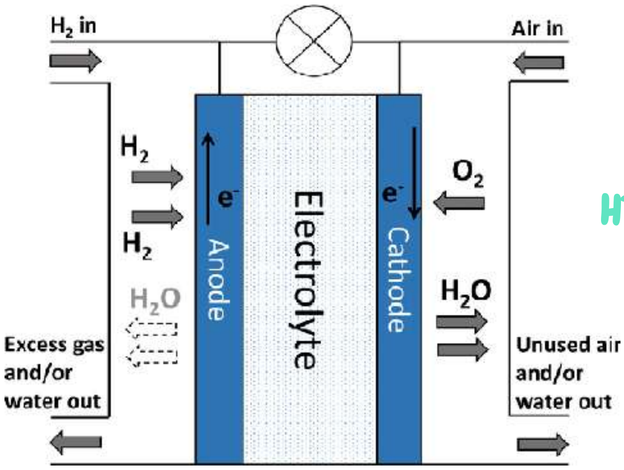
DISADVANTAGES

- Hydrogen is highly flammable/explosive Hydrogen is difficult to store/takes up a lot of space
- Hydrogen not renewable if produced using fossil fuels
- Not many hydrogen filling stations

update

Half-equation at anode

HT $H_2 \rightarrow 2H^+ + 2e^-$



Half-equation at cathode

HT $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Alkaline batteries are non-rechargeable.

Q8.a) Why do alkaline batteries eventually stop working?

[1 mark]

AQA June 22 H Q1.2

Q8.b) Why can alkaline batteries not be recharged?

[1 mark]

AQA June 22 H Q1.2

Q8.c) Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars. Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

$$\_\_\_\_\_\_ H_2 + \_\_\_\_\_\_ \rightarrow \_\_\_\_\_\_ H_2O$$

[2 marks]

AQA June 22 H Q3.4

Q8.d) Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell. Write a half equation for one of these reactions.

HT

[2 marks]

AQA June 22 H Q3.4

Q9. The table shows data about different ways to power electric cars.

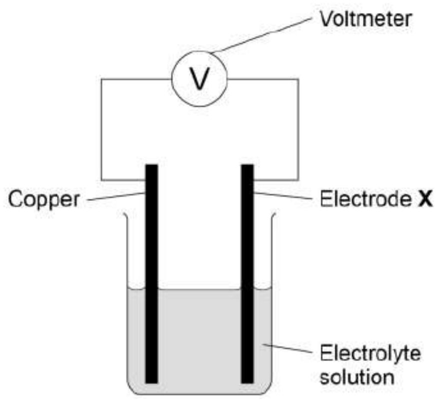
	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars. Use the table and your own knowledge.

[6 marks]

AQA June 18 H Q3.5

This question is about chemical cells. A student investigated the voltage produced by different chemical cells. Below is the apparatus.



This is the method used.
1. Use cobalt as electrode X.
2. Record the cell voltage.
3. Repeat steps 1 and 2 using different metals as electrode X

Q10.a) Suggest **two** control variables used in this investigation.

[2 marks]
AQA June 19 H Q6.1

The table shows the students results.

Q10.b) Write the six metals used for electrode X in order of reactivity. Use the table. Justify your order of reactivity.

Electrode X	Voltage of cell in volts
cobalt	+0.62
copper	0.00
magnesium	+2.71
nickel	+0.59
silver	–0.46
tin	+0.48

[4 marks]
AQA June 19 H Q6.2

10.c) Which pairs of metals would produce the greatest voltage when used as the electrodes in the cell?

[1 mark]
AQA June 19 H Q6.3

ADDITIONAL RESOURCES

Congratulations on completing the workbook!

To further enhance your understanding and support your revision, I've curated a list of additional FREE resources.

VIDEO

BOND ENERGY CALCULATIONS

This Facebook Live recording goes bond energy calculations.

ACCESS NOW

VIDEO

TEMPERATURE CHANGE

This Facebook Live recording goes through investigating temperature change required practical

ACCESS NOW

WORKSHEET

Here are three videos from my recorded masterclasses.

VIDEO

EXOTHERMIC & ENDOTHERMIC

ACCESS NOW

VIDEO

REACTION PROFILES

ACCESS NOW

VIDEO

BOND ENERGY CALCULATIONS

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