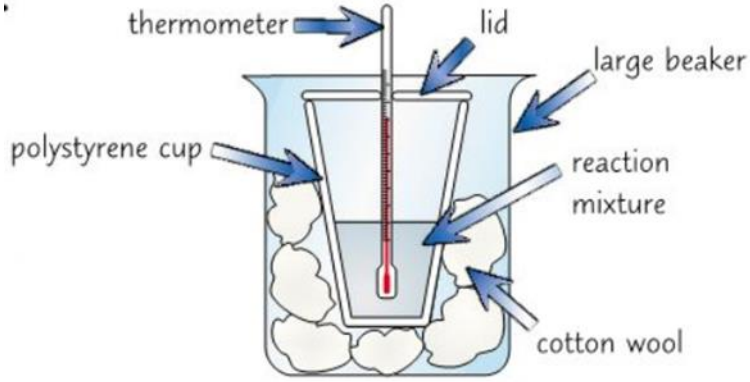
Energy Changes – Exothermic and Endothermic Reactions

EXOTHERMIC – Temperature goes up, gets hot, energy Exits.

ENDOTHERMIC – Temperature goes down, feels cold, energy Enters.

How can exothermic or endothermic reactions be investigated?



Part of Equipment	Function in the Experiment
Thermometer	The thermometer is used to measure the temperature at the start of the reaction and the temperature at the end of the reaction. The temperature change can then be calculated.
Polystyrene Cup	Polystyrene is a thermal insulator. It will stop heat energy getting in and out of the cup. This makes the experiment more accurate, stopping heat escaping
Cotton Wool	Cotton wool is also a thermal insulator. It stops heat energy warming the air surrounding the polystyrene cup and prevents heat loss.
Large Beaker	To stand the polystyrene cup in and hold the cotton wool.
Lid	Stops heat escaping through the top of the plastic cup.

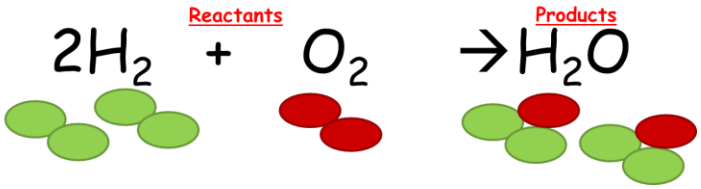
Examples of Exothermic and Endothermic Reactions

Exothermic	Endothermic
Burning Fuels	Decomposition Reactions (Chemicals splitting up because they have been heated)
Displacement Reactions (a more reactive metal reacting with a less reactive metal compound)	Acid + Hydrogen Carbonate
Metal + Acid	Dissolving
Neutralisation (acid and a alkali/base reacting)	

Investigation: How does the mass of magnesium effect the temperature rise when reacted with hydrochloric acid?

Independent Variable (I change)	You are changing the mass of magnesium. Measure out different masses of magnesium using a balanced. E.g. 1g, 2g, 3g 4g 5g
Dependant Variable (I measure)	You are choosing to measuring temperature change. You will measure the temperature before and after and calculate the temperature change.
Control Variables (I keep the same)	To make the investigation a fair test you will need to control all other factors. Volume of hydrochloric acid using a measuring cylinder, concentration of hydrochloric acid .
Collect better results by:	Each mass of magnesium will be repeated three times. Any anomalies (results that are far away from the others) ignored and then the mean (average) calculated. The mean is calculated by adding the results together and dividing by the number of results.
Find the pattern in the results by:	Plot a scatter graph and a line of best fit drawn. The line of best fit should be either a smooth curve or a straight line. Any points that do not lie close to the line are anomalous.

When chemical reactions happen energy is needed (endothermic) to **break** bonds between atoms in the reactants and energy is released (exothermic) to **form** bonds between atoms to make the products.



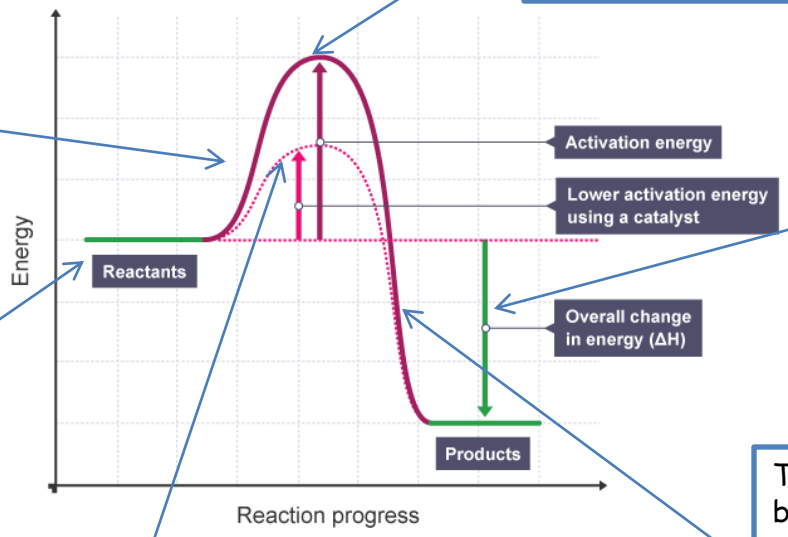
- The bonds between the atoms of hydrogen are broken. Energy needs to be put in – this is endothermic. The bonds between the oxygen atoms also need to be broken.
- The atoms of hydrogen and oxygen join together to form water. Energy is released when bonds form – this is exothermic.
- If more energy is released when the bonds are formed then the reaction is exothermic.
- If more energy is absorbed to break the bonds then the reaction is endothermic.

Reaction Profiles

- A reaction profile is a type of graph. It shows the amount of energy in the reactants (the starting chemicals in a reaction) and the products (the end chemicals).

The 'hill' is the amount of energy that needs to be put in to start the reaction. This is called activation energy.

The rise represents energy being put in to break bonds – this is an endothermic process.



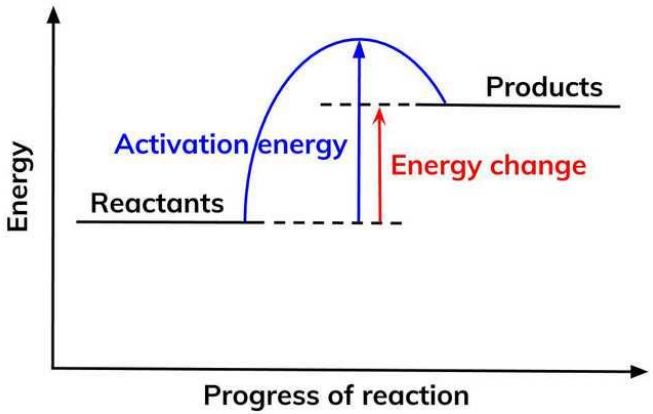
The difference between their energies is the energy change in the reaction.

This reaction profile shows that the reactants had greater energy than the products.

The fall represents energy being released to the surrounds when bonds are made – this is an exothermic process.

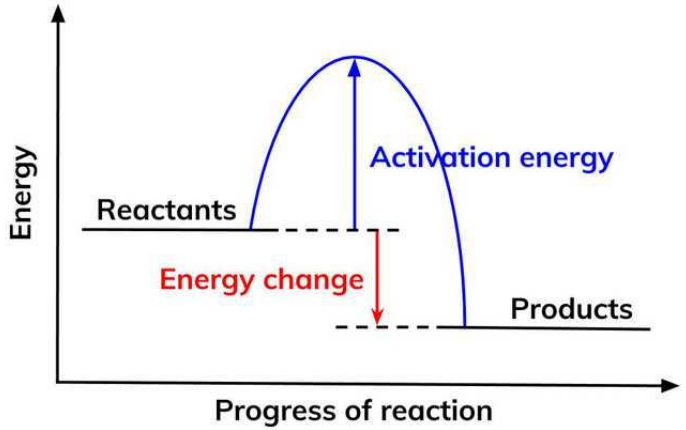
Catalysts are chemicals (often transition metals) that lower the activation energy. They allow the reaction to progress by an alternative route – less energy is needed for the reaction to get started.

Endothermic Reaction



- The products have higher energy than the reactants therefore energy has gone in – endothermic.
- Less energy was released when bonds were formed to make the products than was absorbed to break the bonds in the reactants – **overall** the reaction is endothermic.

Exothermic Reaction



- The products have lower energy than the reactants therefore energy has exited - exothermic.
- More energy was released when bonds were formed to make the products than was absorbed to break the bonds in the reactants – **overall** the reaction is exothermic.

QUESTIONS

Exothermic or Endothermic??

a) Heat is given out
b) Heat energy is taken in
c) Reactants have less energy than products
d) Gets hot
e) Reactants have more energy than products
f) Gets cold

You have been asked to investigate how the mass of ammonium chloride effects the temperature change when the ammonium chloride was dissolved in water. Sequence these steps to describe the experiment:

	Take the temperature again. Calculate the temperature change.
	Place the water into the polystyrene cup. Measure the temperature of the water and record it.
	Repeat the experiment using 2g of ammonium chloride.
	Measure out 1g of ammonium chloride. Measure out 100ml of water.
	Add the ammonium chloride and stir.

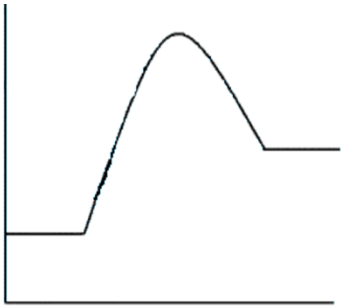
QUESTIONS

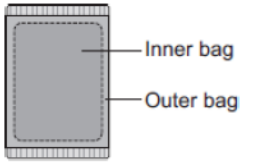
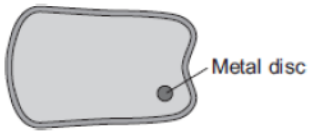
Are these reactions exothermic or endothermic?

Reaction	Starting Temp (°C)	End Temp (°C)	Temp Change (°C)	Exothermic or Endothermic?
A	12	24		
B	16	15		
C	-12	-42		
D	-6	3		
E	-9	-2		
F	106	144		
G	37	39		
H	21	9		
I	43	-1		

This reaction profile is for an endothermic reaction. Label the reaction profiles with the following:

- Energy In
- Energy Out
- Activation Energy
- Energy Changes
- Bonds Broken
- Bonds Made
- Endothermic
- Exothermic



Disposable hand warmer	Reusable hand warmer
	
The hand warmer stays warm for 10 hours.	The hand warmer stays warm for 30 minutes.
The maximum temperature reached is 45°C.	The maximum temperature reached is 54°C.
The contents are: • Iron filings (small pieces of iron) • Water • Salt (catalyst) • Vermiculite (a mineral that holds water)	The contents are: • Sodium ethanoate • Water • Metal disc (to start crystallisation) Reusable hand warmers are regenerated by putting into boiling water, then cooling.

Write an evaluation of these hand warmers. Which would be most suitable for a walker?

What's wrong with these answers?

Question: the reaction was exothermic. Explain in terms of bonds broken and bonds made.

The reaction is exothermic because there is more energy in the reactants than in the products.

The reaction was exothermic because more energy was needed to make the bonds than was needed to break the bonds.

The reaction was exothermic because more bonds were made than broken.

What's the correct answer?