Energy Changes

Endothermic vs Exothermic Reactions

➢ Transferring Energy

- **Stored Energy : Energy** is stored in chemicals, with the amount of energy stored depending on the energy contained within the chemical bonds.
- **Conserved Energy:** During a chemical reaction, energy is **conserved**. This means that energy cannot be destroyed or created: it can only be exchanged with the surroundings when reactions occur.
- **Exchanged of energy with the surroundings:** When chemical reactions occur, through collisions, energy can be **exchanged** with the surroundings. If energy is released to the surroundings through a reaction, the product molecules must have less energy than the reactant. The difference in energy must equal the energy transferred.

➢ Types of Energy :

1. Exothermic Reactions
2. Endothermic Reaction

1. Exothermic Reactions:

- **Energy is exchanged with the surroundings.** During an **exothermic** reaction, energy is **released** to the surroundings.
- **Increase in Temperature:** During an exothermic reaction, the temperature of the surroundings will **rise**. This is due to the energy being transferred to the surroundings.

➢ Example Reactions

There are several reactions that release energy to the surroundings, therefore being classified as exothermic. These reactions include:

- **Redox reactions including displacement reactions**. All **displacement** reactions are types of redox reactions. Redox reactions involve both oxidation and reduction. For example, when iron oxide is reduced by carbon, energy is given out in the reaction.

Iron oxide + carbon → Iron + carbon dioxide

$$2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(s) + 3CO_2(g)$$

- **Combustion or burning**. For example, when magnesium is **burnt** in oxygen, a very bright light is observed and a great deal of energy is given out.

Magnesium + oxygen → magnesium oxide

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

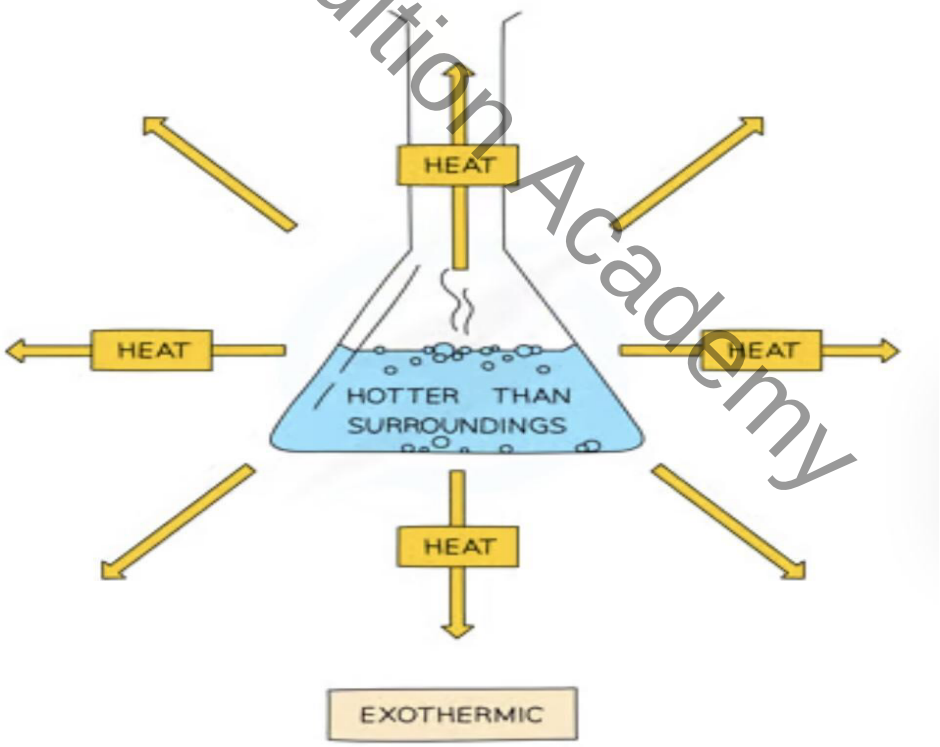
Burning fuels, like methane and petrol, release a great deal of useful energy.

- **Neutralisation** – acid + base reactions. When an acid is **neutralised** by a base or an alkali, energy is released.

For example:

Hydrochloric acid + sodium hydroxide → sodium chloride + water

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

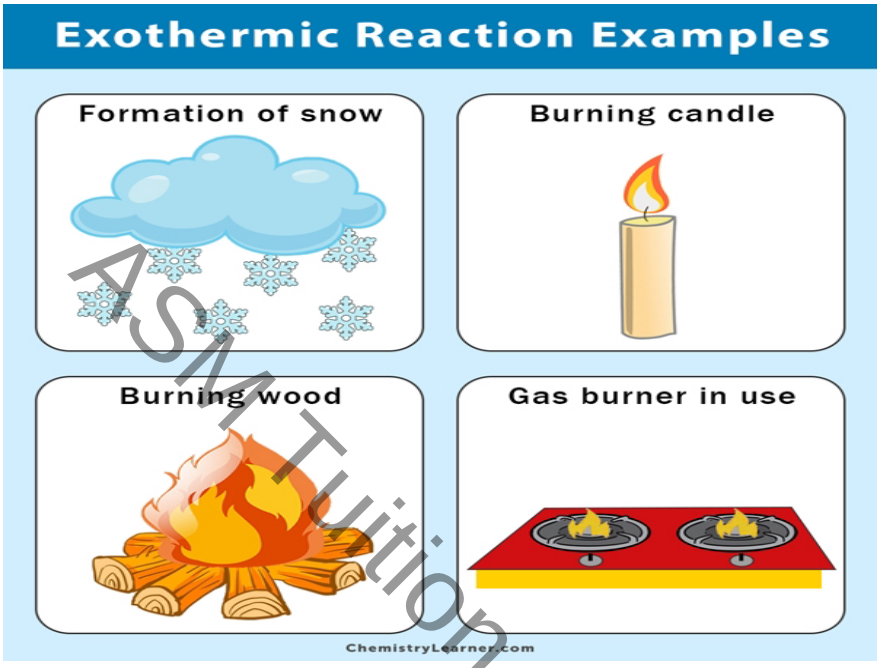


Specific Examples

- **Self heating cans use exothermic reactions.** Another example of everyday exothermic reactions comes in the form of **self-heating** drinks cans. Within the base of

the can, exothermic reactions take place, releasing energy into the surroundings. The energy released is used to heat up the drink.

- **Hand warmers oxidize iron.** In order to heat up, **hand warmers** oxidise iron in air. This reaction releases energy to the surroundings and therefore can be classed as an exothermic reaction too.



2. Endothermic Reactions

- **Energy is exchanged with the surroundings.** During an **endothermic** reaction, energy is absorbed (or taken in) from the surroundings.
- **The temperature will fall.** During an endothermic reaction, the temperature of the surroundings will **fall**. This is due to the energy being taken in from the surroundings.

➢ Example Reactions

There are a couple of reactions that absorb energy from the surroundings, therefore being classified as endothermic. These reactions include:

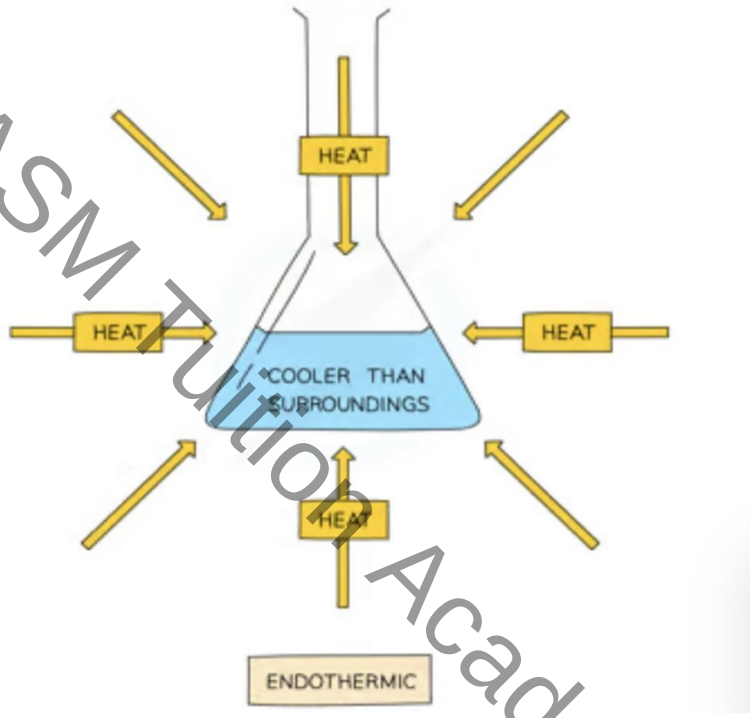
- **Citric acid reacting with sodium hydrogencarbonate**. Bubbles of **carbon dioxide** gas are formed and the temperature decreases during the reaction.

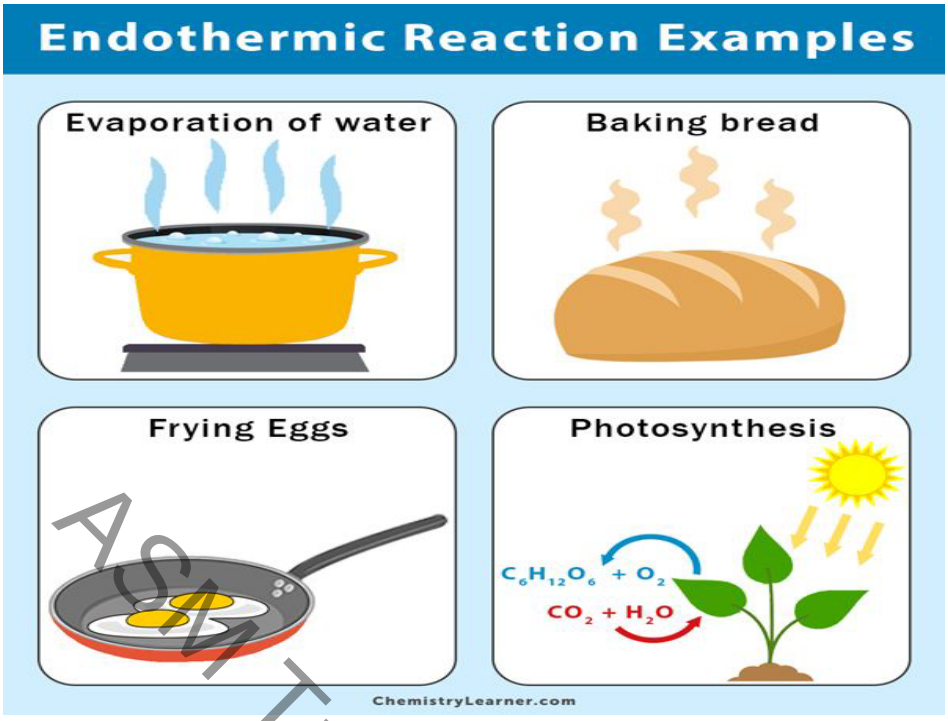
- **Calcium carbonate can be thermally decomposed**. If we heat up calcium carbonate, this causes it to **thermally decompose** into carbon dioxide and calcium oxide.

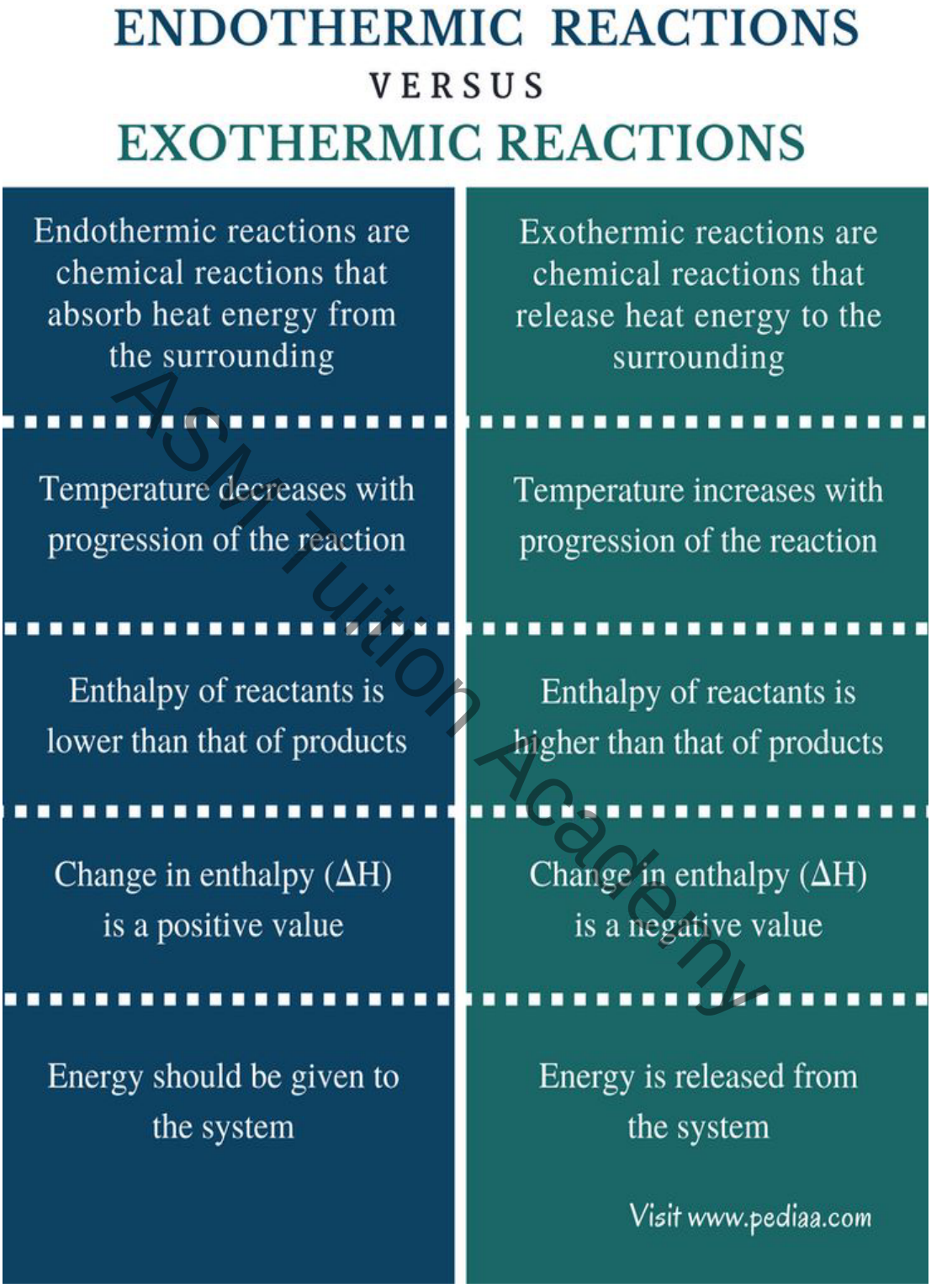
The calcium oxide is sometimes known as quicklime. The reaction is endothermic, since it takes in heat from the surroundings.

$$CaCO3 + HEAT \rightarrow CO2 + CaO$$

- **Sports injury packs are endothermic.** Instead of needing to be frozen, **sports injury packs** can undergo an endothermic chemical reaction. The reaction causes the pack to become cool instantly, by taking in energy from the surroundings.







Investigating Energy Transfer

- The experiment essentially works by observing how the temperature changes during a reaction.
- If the temperature increases, the reaction is exothermic because energy has been given out to the surroundings, which has resulted in the temperature increasing.
- If the temperature decreases, the reaction is endothermic because energy has been taken in from the surroundings, which has resulted in the temperature decreasing.
- There is a lot of insulation in this experiment and this is to reduce the amount of energy that is lost to the environment. Example of insulation in this experiment are the polystyrene cup with a lid, and the polystyrene cup being placed inside a beaker full of cotton wool.

Concentration Effecting the Neutralisation Reaction

To investigate the effect that the concentration of hydrochloric acid has on the temperature change when hydrochloric acid reacts with sodium hydroxide.

1) Put a certain volume **(like 25 cm^3) of 0.25 mol/dm^3 of hydrochloric acid and sodium hydroxide** in different beakers (the volume and concentration of sodium hydroxide will be the same every time).

2) We then place both of the separate beakers in a water bath and heat them up to a certain **temperature (like 30°C).**

3) When both of the beakers are at the desired temperature (30°C), we mix them together in the polystyrene cup and place the lid on.

4) We then monitor the temperature and record the highest temperature.

5) We then repeat all of the previous steps for some different concentrations of hydrochloric acid; we would undertake the same steps for a concentration of **0.5 mol/dm^3, a concentration of 0.75 mol/dm^3,** a concentration of 1 mol/dm^3 etc.

6) We then compare our results for temperature change against concentration.