## Physical changes and chemical reactions

| Physical changes | Chemical reactions |
|---|---|
| Do not make new substances. | Always make one or more new substances. |
| Are often easy to reverse. | Are usually difficult to reverse. |
| The substances may change state or just be mixed together. | The new substances have different properties from the original substances. |
| Examples include: melting, boiling, condensing, freezing. | Examples include: combustion, neutralisation, thermal decomposition. |

## Gas pressure

**Gas pressure** is caused by the force of the particles hitting the walls of the container.

| Change that increases pressure | Reason |
|---|---|
| increase the temperature | the particles move faster and so hit the walls of the container with more force and more often |
| increase the number of particles in the container | the particles are closer together and hit the walls of the container more often |
| decrease the volume of the container | the particles are closer together and hit the walls of the container more often |

## The reactivity series

This is a list of metals in order of reactivity, with the most reactive at the top.

The metals that react with water produce a metal hydroxide and hydrogen.

The metals that react with dilute acids produce a salt and hydrogen.

Most metals react with oxygen from the air to form metal oxides. This is an **oxidation** reaction.

| Metal | Reaction with oxygen in air | Reaction with cold water | Reaction with dilute acid |
|---|---|---|---|
| potassium | 🔥 | 🔥 | 💥 |
| sodium | 🔥 | ✓✓✓ | 💥 |
| lithium | 🔥 | ✓✓ | ✓✓✓ |
| calcium | 🔥 | ✓✓ | ✓✓✓ |
| magnesium | 🔥 | ✓ | ✓✓ |
| aluminium | ✓✓✓ | ●●● | ✓✓ |
| zinc | ✓✓ | ●●● | ✓✓ |
| iron | ✓✓ | ●●● | ✓ |
| tin | ✓ | ●●● | ✓ |
| lead | ✓ | ●●● | ✓ |
| copper | ✓ | ✗ | ✗ |
| mercury | ●●● | ✗ | ✗ |
| silver | ●●● | ✗ | ✗ |
| gold | ✗ | ✗ | ✗ |
| platinum | ✗ | ✗ | ✗ |

Increasing reactivity

Key

| | | |
|---|---|---|
| 💥 explosive | 🔥 can catch fire | ✓✓✓ reacts very quickly |
| ✓✓ reacts quickly | ✓ reacts | ●●● slow or partial reaction |
| ✗ no reaction | | |

### Rusting of iron

Steel is an alloy containing iron mixed with small amounts of carbon and sometimes other metals. Iron and steel need air and water to rust. Salt makes them rust more quickly than usual.

Rusting can be prevented by:

- a physical barrier to stop the air and water being in contact with the iron
- sacrificial protection, in which blocks of a more reactive metal, such as zinc or magnesium, are attached to the iron. They then corrode instead of the iron.

Stainless steel is an alloy of iron containing chromium and it does not rust.

## Hydrocarbons

These substances contain hydrogen and carbon only. They burn in a plentiful supply of air to form carbon dioxide and water:

hydrocarbon + oxygen → carbon dioxide + water

The test for oxygen is that it relights a glowing splint.

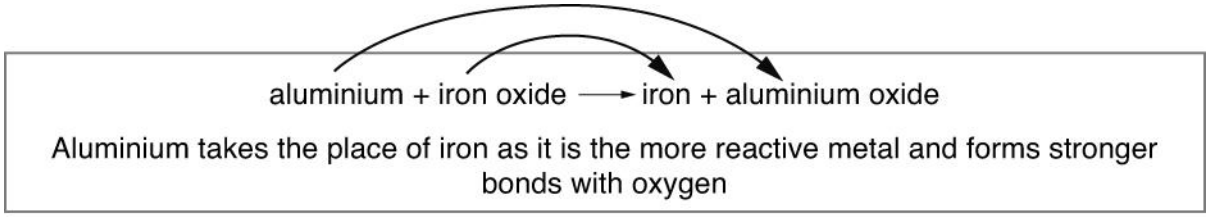
An input of energy from a flame or spark is needed to start the combustion reaction by breaking some bonds in the reactants. Explosive mixtures contain an **oxidising agent** to provide extra oxygen for the reaction.

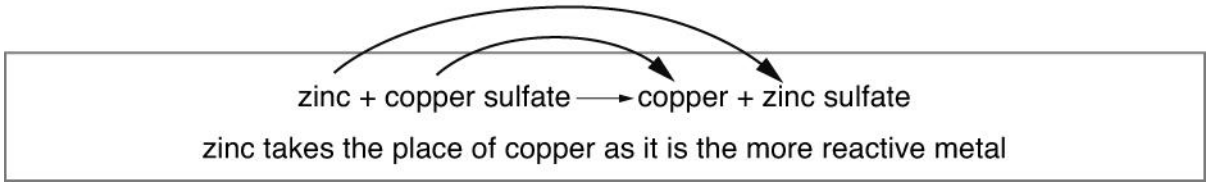
## Energy changes

- Exothermic reactions transfer energy from the reactants to the surroundings. The temperature of the surroundings increases.
- Endothermic reactions use energy transferred from the surroundings to the reactants. The temperature of the surroundings decreases.

## Displacement reactions

In a **displacement reaction** a more reactive metal takes the place of a less reactive metal in a compound.




## Extracting metals

- Most metals occur as compounds in ores in the Earth's crust. Only a few, such as silver and gold, occur as the metallic element.
- The metals high in the reactivity series are difficult to chemically extract from their ores and their isolation has happened relatively recently.
- The metals lower in the reactivity series are easier to extract from their ores and they have been available to use as the pure elements for much longer.
- Metals from zinc downwards in the reactivity series can be extracted from their ores by heating with carbon.
- Metals above zinc in the reactivity series need electrolysis to extract them from their ores.
- Oxidation is the gain of oxygen. **Reduction** is the loss of oxygen.

## Percentage loss or gain

This is the $\frac{\text{actual change}}{\text{original amount}} \times 100$