NEUTRALISATION

The reactions between acids and bases (including hydrogen carbonates and carbonates) are called neutralisation reactions because the acid is neutralised. In other words, the acid and the base (or hydrogen carbonate / carbonate) are neutralized, or the pH *gets close to 7*.

ACID + BASE → SALT + WATER

When acids react with bases, such as calcium oxide or magnesium hydroxide, a salt and water are made. Because no gas is made, there is no obvious sign that a reaction is occurring apart from a solid dissolving and/or a colour change in some reactions.

hydrochloric acid + calcium oxide → calcium chloride + water

$$2HCl + CaO \rightarrow CaCl_2 + H_2O$$

Everyday example: Calcium oxide is a base that is put on soils that are too acidic.

hydrochloric acid + aluminium hydroxide → aluminium chloride + water

$$3HCl + Al(OH)_3 \rightarrow AlCl_3 + 3H_2O$$

Everyday example: Aluminium hydroxide is the active ingredient in some indigestion tablets, taken as an antacid when someone has discomfort due to too much stomach acid.

ACID + CARBONATE → SALT + WATER + CARBON DIOXIDE

When acids react with carbonates a salt, water and carbon dioxide are made.

The carbon dioxide gas produced causes bubbling during the reaction, which is observed as fizzing. It can be detected by passing the gas through a colourless solution of limewater, which will go cloudy.

sulfuric acid + copper carbonate → copper sulfate + water + carbon dioxide

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

Common Lab Experiment: Green copper carbonate powder bubbles when mixed with sulfuric acid and produces blue copper sulfate solution.

ethanoic acid + sodium hydrogen carbonate → sodium ethanoate + water + carbon dioxide

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

Popular Science Model: Ethanoic acid and baking soda (and red food colouring) are often used to make the 'lava eruption' in a model volcano.

EXTRA FOR EXPERTS

All carbonates and hydrogen carbonates react in a similar way with acid. This is because, essentially, the same chemistry is happening.

Hydrogen ions from the acid, $H^+(aq)$ are reacting with carbonate ions, $CO_3^{2-}(s)$ or $CO_3^{2-}(aq)$

The state symbol (s) means solid, while (aq) means dissolved in water.

$$2H^+(aq) + CO_3^{2-}(s) \rightarrow H_2O(l) + CO_2(g)$$

If you add dilute nitric acid solution to potassium carbonate powder, it reacts and the products are colourless potassium nitrate solution, water and carbon dioxide gas.

The potassium ions and nitrate ions are known as spectator ions.

$$2HNO_3(aq) + K_2CO_3(s) \rightarrow 2KNO_3(aq) + H_2O(l) + CO_2(g)$$

Hydrogen ions from the acid react with hydrogen carbonates in the same way as carbonates.

$$H^+(aq) + HCO_3^-(s) \rightarrow H_2O(l) + CO_2(g)$$

If you add dilute hydrochloric acid to solid sodium hydrogen carbonate, it will react to make water as well as giving off colourless carbon dioxide gas.

This time it produces colourless sodium chloride solution; sodium and chloride ions are spectator ions.

$$HCl(aq) + NaHCO_3(s) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

EVERYDAY EXAMPLE

Limescale deposits can collect on the element of your electric jug. Limescale is calcium carbonate, $CaCO_3(s)$. Both vinegar (ethanoic acid, CH_3COOH) and lemon juice, (citric acid, $H_3C_6H_5O_7$) will do a great job of removing these limescale deposits.

calcium carbonate + ethanoic acid → calcium ethanoate + water + carbon dioxide

$$CaCO_3(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Ca(aq) + H_2O(l) + CO_2(g)$$

$$CO_3^{2-}(s) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$$

calcium carbonate + citric acid → calcium citrate + water + carbon dioxide

$$3CaCO_3(s) + 2H_3C_6H_5O_7(aq) \rightarrow (C_6H_5O_7)_2Ca_3(aq) + 3H_2O(l) + 3CO_2(g)$$

$$3CO_3^{2-}(s) + 6H^+(aq) \rightarrow 3H_2O(l) + 3CO_2(g)$$