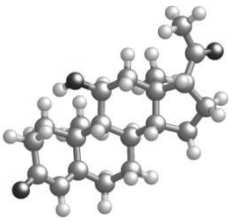

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Revision Notes for Secondary Two – Acids, Bases and Salts

1. Acids are chemicals that dissolve in water to produce hydrogen ions as the only positive ion.

2. Examples of acids include:

Name	Formula	Strong or Weak	Basicity
hydrochloric acid	$\underline{H}Cl$	strong acid	monobasic
nitric acid	$\underline{H}NO_3$	strong acid	monobasic
sulfuric acid	$\underline{H_2}SO_4$	strong acid	dibasic
phosphoric acid	$\underline{H_3}PO_4$	weak acid	tribasic
ethanoic acid	$CH_3COO\underline{H}$	weak acid	monobasic

*The hydrogen atom(s) that have been underlined represent the hydrogen of the acid that can be replaced by a metal when the acid reacts to form a salt.

3. **a)** *Strong acids* completely / fully ionise when dissolved in water to produce hydrogen ions as the only positive ion.

b) *Weak acids* only partially ionise when dissolved in water to produce hydrogen ions as the only positive ion.

4. **a)** *Monobasic* acids produce a maximum number of *one* hydrogen ion per molecule of acid when dissolved in water (1 H can be replaced by a metal), *e.g.* $HNO_3(l) \rightarrow H^+(aq) + NO_3^-(aq)$

b) *Dibasic* acids produce a maximum number of *two* hydrogen ions per molecule of acid when dissolved in water (2 H can be replaced by a metal), *e.g.* $H_2SO_4(l) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

c) *Tribasic* acids produce a maximum number of *three* hydrogen ions per molecule of acid when dissolved in water (3 H can be replaced by a metal), *e.g.* $H_3PO_4(l) \rightarrow 3H^+(aq) + PO_4^{3-}(aq)$

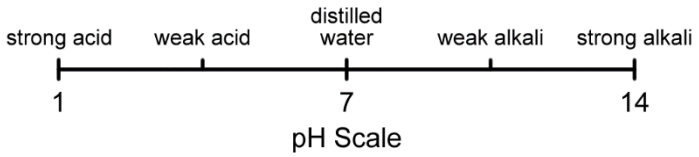
5. *Bases* are usually *metal oxides* or *metal hydroxides*, *e.g.* magnesium oxide (formula – MgO), copper(II) oxide (formula – CuO), iron (III) oxide (formula – Fe_2O_3), sodium hydroxide (formula – NaOH) and calcium hydroxide (formula – $Ca(OH)_2$).

If a base can be dissolved in water to form an aqueous solution, then the base can be further referred to as an *alkali*, and the solution that has been formed can be further referred to as an *alkaline solution*. The alkaline solution will contain hydroxide ions, *e.g.*

$NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$ and $Ca(OH)_2(s) \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$

Ammonia is considered to be a *weak alkali*, e.g. $NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

6. The pH scale indicates the degree / extent of acidity or alkalinity of a solution.



Acids have pH values less than 7. A relatively strong acid may have a pH value of 1 – 3, while a relatively weak acid may have a pH value of 4 – 6. Distilled (pure) water will have a pH value of exactly 7. Alkalis have pH values greater than 7. A relatively weak alkali may have a pH value of 8 – 11, while a relatively strong alkali may have a pH value of 12 – 14.

7. The various reactions of acids and bases typically produce salts as one of the reaction products. A salt is an ionic compound, composed of a positive cation and negative anion. A salt is produced when a metal replaces the hydrogen of an acid.

a) acid + metal $\rightarrow$ salt + hydrogen

hydrochloric acid + magnesium $\rightarrow$ magnesium chloride + hydrogen

$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$

Note: Metals such as copper, gold, platinum and silver do *not* react directly with acids.

Note: Test for hydrogen gas – extinguishes a burning splint with a squeaky "pop" sound.

b) acid + base $\rightarrow$ salt + water

nitric acid + copper(II) oxide $\rightarrow$ copper(II) nitrate + water

$2HNO_3(aq) + CuO(s) \rightarrow Cu(NO_3)_2(aq) + H_2O(l)$

c) acid + metal carbonate $\rightarrow$ salt + water + carbon dioxide

sulfuric acid + zinc carbonate $\rightarrow$ zinc sulfate + water + carbon dioxide

$H_2SO_4(aq) + ZnCO_3(s) \rightarrow ZnSO_4(aq) + H_2O(l) + CO_2(g)$

Note: Test for carbon dioxide gas – white precipitate when bubbled through limewater.

d) ammonium salt + base $\rightarrow$ salt + water + ammonia

ammonium chloride + magnesium oxide $\rightarrow$ magnesium chloride + water + ammonia

$2NH_4Cl(aq) + MgO(s) \rightarrow MgCl_2(aq) + H_2O(l) + 2NH_3(g)$

Note: Test for ammonia gas – turns damp red litmus paper blue.

8. It is important to use the correct valencies in order to obtain the correct formulae when writing balanced chemical equations.

- Valency = **1**: hydrogen, silver, Group 1 elements, Group 17 elements, NH_4^+, OH^-, NO_3^-.
- Valency = **2**: zinc, copper(II), iron(II), Group 2 elements, Group 16 elements, CO_3^{2-}, SO_4^{2-}.
- Valency = **3**: iron(III), Group 13 elements, Group 15 elements, PO_4^{3-}.
- Valency = **4**: Group 14 elements, specifically carbon and silicon.

9. It is important to know the solubility rules in order to write the correct state symbols when writing balanced chemical equations.

- All sodium salts, potassium salts and ammonium salts are *soluble* in water.
- All nitrates are *soluble* in water.
- All chlorides are *soluble* in water, except Ag*Cl* & PbCl_2 which are insoluble.
- All sulfates are *soluble* in water, except $BaSO_4$, $CaSO_4$ & $PbSO_4$ which are insoluble.
- All carbonates are *insoluble* in water, except Na_2CO_3, K_2CO_3 & $(NH_4)_2CO_3$ which are soluble.
- All hydroxides are *insoluble* in water, except NaOH, KOH & NH_4OH which are soluble.

10. Oxides of the chemical elements (compounds formed when a chemical element has reacted with oxygen) can be classified as being either *acidic*, *basic*, *neutral* or *amphoteric*.

a) Acidic oxides (react with bases) – oxides of non-metallic elements, *e.g.* CO_2 and SO_2.

b) Basic oxides (react with acids) – oxides of metallic elements, *e.g.* CuO and MgO.

c) Neutral oxides (do not react with either acids or bases) – *e.g.* carbon monoxide (CO), nitrogen monoxide (NO), dinitrogen monoxide (N_2O) and water (H_2O).

d) Amphoteric oxides (react with both acids and bases) – *e.g.* aluminium oxide (Al_2O_3), lead(II) oxide (PbO) and zinc oxide (ZnO).