Jim's Basic Chemistry Notes

Element – a substance which cannot be broken down into anything simpler.
Atom – the smallest part of an element that can take part in a chemical reaction.
Compound – two or more elements chemically combined.
Mixture - a substance consisting of two or more substances mixed together (not in fixed proportions and not chemically bonded)

Mixture	Compound
Consists of two or more substances	Consists of a single substance
Behaves like the separate substances making it up	Behaves as something new
Has variable composition	Has fixed composition
Can be easily separated by physical means	Can be separated only by a chemical reaction

Acids, Bases and Salts

An **acid** is a substance that contains hydrogen which may be replaced, completely or in part, by a metal to form a salt.
A **base** is the oxide or hydroxide of a metal or ammonium which reacts with an acid to form a salt and water only.
A **salt** is the substance formed when all, or part of, the hydrogen of an acid is replaced a metal.
A normal salt is formed when all of the hydrogen of an acid has been replaced by a metal (sodium sulfate – Na_2SO_4 – is a normal salt as both hydrogens in sulfuric acid have been replaced by sodium).
An acid salt is formed when only part of the hydrogen of an acid has been replaced by a metal (sodium hydrogen sulfate – $NaHSO_4$ – here only one of the two hydrogens in sulfuric acid has been replaced by a metal).

Three Methods of Salt Formation

1) Acid + Metal → Salt + Hydrogen
eg. H_2SO_4 + Mg → $MgSO_4$ + H_2
sulfuric acid + magnesium → magnesium sulfate + hydrogen

2) Acid + Base → Salt + Water only
eg. H_2SO_4 + CuO → $CuSO_4$ + H_2O
sulfuric acid + copper oxide → copper sulfate + water

3) Acid + Carbonate → Salt + Water + Carbon Dioxide
eg. H_2SO_4 + $CuCO_3$ → $CuSO_4$ + H_2O + CO_2
sulfuric acid + copper carbonate → copper sulfate + water + carbon dioxide

A base that is soluble in water is called an **alkali.** Common alkalis are sodium hydroxide (NaOH), potassium hydroxide (KOH) and ammonium hydroxide (NH_4OH).

Acids and pH

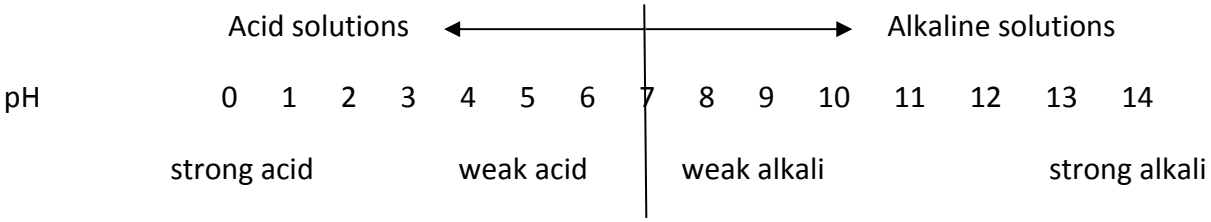
The three common mineral acids are:
hydrochloric acid HCl – monobasic (monoprotic) acid as has one replaceable H
nitric acid HNO_3 – monobasic (monoprotic) acid as has one replaceable H
sulfuric acid H_2SO_4 – dibasic (diprotic) acid has two replaceable Hs.

The acid radical is the part of the acid left once the replaceable H/Hs has/have been removed. The valency of the acid radical is the same as the replaceable Hs in the acid. This information, together with salts formed from these acids, is given in the table below.

Acid	Acid Radical	Valency of acid radical	Salt formed
Hydrochloric acid – HCl	Cl^-	1-	chloride
Nitric acid – HNO_3	NO_3^-	1-	nitrate
Sulfuric acid – H_2SO_4	SO_4^{2-}	2-	sulfate

Metal oxides and hydroxides are basic – eg. CuO, NaOH
Non-metal oxides are acidic – eg. sulfur dioxide SO_2

The pH scale gives a measure of the strength of an acid as measured by its hydrogen ion concentration. The pH scale given in GCSE books usually goes from 0 to 14 but pH values can be negative and above 14. The pH scale usually given, together with acid/alkali strengths is given below.



An easy way to remember which has pH numbers below and above 7 is: **ac**id comes before **al**kali in the dictionary so acids have pH number 0-7, ie. come first on the pH scale above.

Strength and Concentration of Acids

The strength of an acid must not be confused with its concentration. The strength of an acid, as stated above, gives a measure of its hydrogen **ion** concentration.

The concentration of an acid, as measured by its molarity, gives a measure of how much water has been added.
A good way to **demonstrate** this distinction between strength and concentration is as follows.
Add a piece of magnesium ribbon to dilute sulfuric acid (2M) in a **boiling** tube – there is a vigorous reaction.
Then add a piece of magnesium ribbon to concentrated sulfuric acid in a **boiling** tube (18M) – there is hardly any reaction.

When diluting an acid I know it should be done in alphabetical order, ie. acid to water, but if water is then added **slowly and very carefully, wearing goggles and using a safety screen**, to the concentrated sulfuric acid tube, the magnesium ribbon can been seen to react more vigorously as the acid is diluted.

Explanation – the concentrated sulfuric acid is covalent, hence no/not many hydrogen ions. Upon dilution the concentrated acid dissociates to release hydrogen ions and so making it stronger.

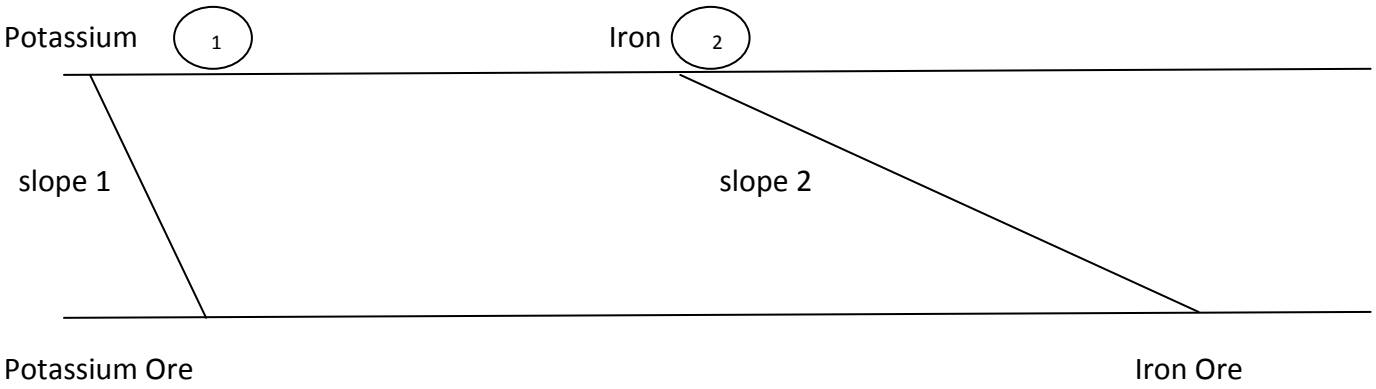
The Activity Series and Metal Extraction

The activity series is:

Potassium K
Sodium Na
Calcium Ca
Magnesium Mg
Aluminium Al
} extracted by electrolysis

Zinc Zn
Iron Fe
Tin Sn
Lead Pb
Hydrogen H
Copper Cu
Silver Ag
Gold Au
} extracted by carbon reduction in Blast Furnace

The more reactive a metal, the greater its tendency to react and form compounds. The compounds formed from reactive metals are more stable than those formed from less reactive metals. The compounds from more reactive metals thus require more energy to break them down to release the metal.
Consider the diagram below.



Liken potassium to boulder 1 and iron to boulder 2. Boulder 1 will roll down the slope 1 faster than boulder 2 will roll down slope 2 just as potassium will react to form its compound or ore faster or more vigorously than iron will react to form its compound or ore.
Once boulder 1 is at the bottom of slope 1 it will take more energy to push it back up to the top of slope 1 than it will to push boulder 2 back up slope 2. Similarly, it will take more energy to extract potassium from its ore than it will to extract iron from its ore.

The reason for putting hydrogen in there is: metals above hydrogen will release it from an acid but metals below hydrogen will not release it from an acid.

Valency and Formulae

The valency of an atom is the number of electrons that atom has to lose or gain to achieve a full outer shell.
Consider period 3 below.

Black indicates electrons lost by metals; red indicates electrons gained by non-metals.

Group	1	2	3	4	5	6	7	0
Element	Na	Mg	Al	Si	P	S	Cl	Ar
Electrons gained or lost	1	2	3		3	2	1	0
Valency	1	2	3		3	2	1	0

To find the formula of a compound, eg. aluminium sulfide, formed by the combination of aluminium and sulfur, carry out the following steps.

1) Write down the symbol of each element Al S

2) Put the valency of each element above its symbol 3 2 Al S

3) Swap the valencies over as shown by the arrows to give Al_2S_3

The formula of sodium sulfate is worked out as (following the 3 steps above):

1) Na SO_4

2) 1 2 Na SO_4

3) Na_2SO_4

The formula of magnesium nitrate is:

1) Mg NO_3

2) 2 1 Mg NO_3

3) $Mg(NO_3)_2$

I hope you have found these notes useful. Should you require notes on other topics just email me at mail@jimbakersonlinelearning.co.uk.

I should like to wish you all the very best in your Chemistry teaching, and remember, a prerequisite to quality learning is a command of the subject matter by the teacher.

Jim Baker 17-12-2011

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