What you need to know for…

AS 90944 – ACIDS AND BASES

- external, 4 credits

From NZQA:
Aspects of acids and bases will be selected from:

• **Atomic structure** (**electron arrangement** of atoms and monatomic ions of the first 20 elements, **ionic bonding**, names and formulae of **ionic compounds**).

• Properties (acids release hydrogen ions in water, reactions of **acids** (**HCl**, **H_2SO_4**, **HNO_3**) with **bases** (metal **oxides**, **hydroxides**, **carbonates** and **hydrogen carbonates**) to form **salts**, **pH** and effects on **indicators**.

• Rates of reaction and particle theory.

• Uses (**neutralisation** , carbon dioxide formation, salt formation).

Atoms: unit of matter, made of **protons**, neutrons, **electrons**

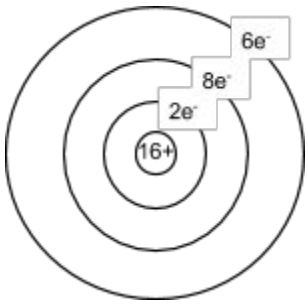
Element: a substance made up of only 1 type of atom

	Charge	Mass	Position	Notes
protons	+	1	Nucleus	no. of protons = **atomic no**.
neutrons	*None*	*1*	*Nucleus*	*#p + #n = mass no.*
electrons	-	0	Shells	no. electrons = no. protons in an atom (**neutral**)

Electron arrangement: in **shells**: **2, 8, 8**, 18…

Fill from the inside out.

Sulfur (atomic number 16) can be drawn as



Periodic table

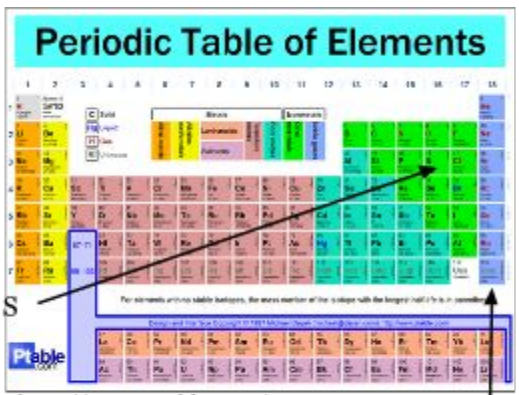
Arranged in:

- horizontal **periods** (increasing number of **valence** (outer shell) electrons), and
- vertical **groups** (increasing number of filled shells)

e.g. Sulfur (S):

*- Period **3** (filling **3**rd shell)*

*- Group 1**6** (has **6** in valence shell)*



Group 18

Group **18** all have **full** valence shells

Ion: atom that has gained or lost electrons to get a full outer shell

e.g. Sulfur (atomic number 16):

- *electron arrangement: 2, 8, 6*
- *would gain 2e- to get a full shell of 8.*
- *Now it has a 2-* ***charge*** *overall (still 16+, but now 18-)*
- *written as:* S^{2-}

You need to know the ***names*** *of all of these from the table (given to you in the exam).*

+1	+2	+3	−3	−2	−1
NH_4^+	Ca^{2+}	Al^{3+}		O^{2-}	OH^-
Na^+	Mg^{2+}	Fe^{3+}		S^{2-}	Cl^-
K^+	Cu^{2+}			CO_3^{2-}	NO_3^-
Ag^+	Pb^{2+}			SO_4^{2-}	HCO_3^-
H^+	Fe^{2+}				F^-
	Ba^{2+}				
	Zn^{2+}				

Ionic compounds:

anions (-ve charge) and **cations** (+ve charge) are now attracted...
forming an *uncharged* (**neutral**) substance...
kept together by an "**ionic bond**".

Note: **charges always balance as no. e⁻s gained = the no. e⁻s lost**.

Example: Na_2S: *Na loses 1e⁻ to be* Na^+*, S gains 2e⁻ to be* S^{2-}*.*
Therefore 2 Na^+ *will bond with 1* S^{2-}*.*
Charges are balanced, electrons are balanced.

Naming: positive (cation) first, negative (anion) second
always end in **-ide**, or if **lots of O**s in the ion **-ate**

Example:

Calcium flouride*: One* Ca^{2+} *bonds with two* F^- *to make* CaF_2

Note: ***superscript*** ($^{2+}$) for ionic **charges**

subscript ($_2$) for **more than 1** atom/ion. DO NOT get them muddled.

Lead nitrate *one* Pb^{2+} *bonds with each* NO_3^- *to make* $Pb(NO_3)_2$

Note: the **brackets** are needed around NO_3 to show that there is 2 of the **polyatomic ion** (2 lots of NOOO)

ACIDS AND BASES:

Acids: *you must know*		
Hydrochloric acid	**HCl**	makes **chloride** (Cl) salts
Sulfuric acid	**H_2SO_4**	makes **sulfate** (SO_4) salts
Nitric acid	**HNO_3**	makes **nitrate** (NO_3) salts

Bases and carbonates:	
Metal **oxide**	e.g. Li_2O, ZnO
Metal **hydroxide**	e.g. KOH, $Ba(OH)_2$
Metal **carbonate**	e.g. Na_2CO_3, $FeCO_3$, $Al_2(CO_3)_3$
Metal **hydrogen carbonate**	e.g. $AgHCO_3$, $Mg(HCO_3)_2$

pH: the **proportion of H^+ ions** in a substance.

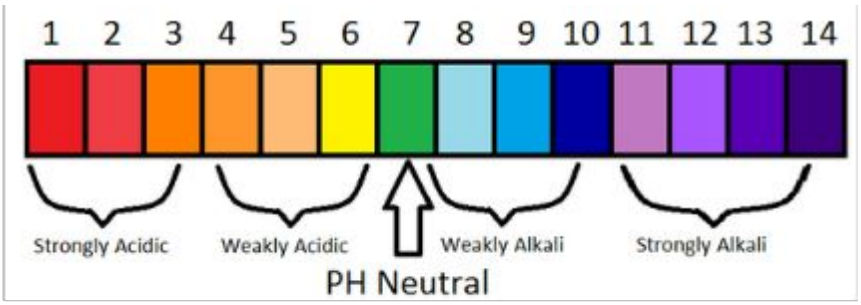
Low number = **acidic** (lots of H^+)

High number = **basic** (little H^+)

Indicators: substances change colour to *indicate* pH

Universal Indicator:

*Pick the **best** pH number or colour for an answer. Don't give a range.*



Red Orange Yellow Green Blue Purple

Red litmus: turns blue in base **Blue litmus**: turns red in acid

Description	Colour of UI	pH	Ions present
Very acidic	Red	1	many H^+
Slightly acidic	Orange/yellow	3	$H^+ > OH^-$
Neutral	Green	7	$H^+ = OH^-$
Slightly basic	Blue	10	$H^+ < OH^-$
Very basic	Purple	14	many OH^-

NEUTRALISATION REACTIONS:

base + acid → water + metal salt

e.g. $HCl + NaOH \rightarrow H_2O + NaCl$

note: the H^+ (acid) and the OH^- (base) join to make water (H_2O), the leftover is the salt

metal carbonate + acid → water + metal salt + carbon dioxide

e.g. $MgCO_3 + HNO_3 \rightarrow H_2O + Mg(NO_3)_2 + CO_2$

note: CO_3^{2-} acts just like O^{2-}, but with CO_2 attached (HCO_3^- is like OH^- with CO_2 attached)

BALANCING EQUATIONS:

Some equations, like...

$$MgCO_3 + HNO_3 \rightarrow H_2O + Mg(NO_3)_2 + CO_2$$

...don't have the right number of atoms on each side. As things can't be magically made or vanish, we have to balance the equation to show how many of each thing react and are produced.

$$MgCO_3 + \mathbf{2}HNO_3 \rightarrow H_2O + Mg(NO_3)_2 + CO_2$$ is now *balanced*

REACTION RATES:

A reaction can be sped up by ensuring there are more successful **collisions per second**.

This can be done by:

- Increasing the **temperature**; **particles move faster** (more collisions/sec), and particles hit harder (more are successful).
- Increasing the **concentration**; **more particles per mL** (more collisions/sec)
- Increasing the **surface area** of a solid; **more particles are exposed** (more collisions/sec)
- Adding a **catalyst**; **particles need less energy to react** (more collisions are successful)