



Chemistry:

Transition from GCSE to AS level

Part 3 - Amount of Substance

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AMOUNT OF SUBSTANCE

CHEMICAL CALCULATIONS

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Definitions

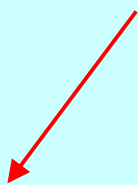
Relative atomic mass

$$A_r = \frac{\text{average mass of one atom}}{\frac{1}{12} \text{ mass of one } ^{12}\text{C atom}}$$

Relative molecular (formula) mass

$$M_r = \frac{\text{average mass of one 'molecule'}}{\frac{1}{12} \text{ mass of one } ^{12}\text{C atom}}$$

entity



Note “relative” - no units

Definitions

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Relative atomic masses

given to 1 decimal place on periodic tables

e.g. $\text{Mg} = 24.3$

$\text{Fe} = 55.8$

$\text{Na} = 23.0$

Don't approximate

Relative molecular mass (M_r) is found by adding relative atomic mass (A_r) values

$$\text{CH}_4 = 12.0 + 4(1.0) = 12.0 + 4.0 = \mathbf{16.0}$$

$$\begin{aligned}\text{NH}_4\text{NO}_3 &= 14.0 + 4(1.0) + 14.0 + 3(16.0) \\ &= 14.0 + 4.0 + 14.0 + 48.0 \\ &= \mathbf{80.0}\end{aligned}$$

$$\begin{aligned}\text{Al}_2(\text{SO}_4)_3 &= 2(27.0) + 3[32.1 + 4(16.0)] \\ &= 54.0 + 3[32.1 + 64.0] \\ &= 54.0 + 3[96.1] \\ &= 54.0 + 288.3 \\ &= \mathbf{342.3}\end{aligned}$$

Relative molar mass of any substance in grams
contains a fixed number of particles

= the Avogadro Number

= one **mole**

The mole is a number of particles = 6.02×10^{23}

We use the mole to count amounts of substances

(i) by mass for any pure substance

(ii) by volume for gases

(iii) by volume and concentration for solutes in
solution

(i) moles and masses

$$\text{Moles} = \frac{\text{mass given}}{\text{mass of one mole}(M_r)}$$

For solids or any pure substance

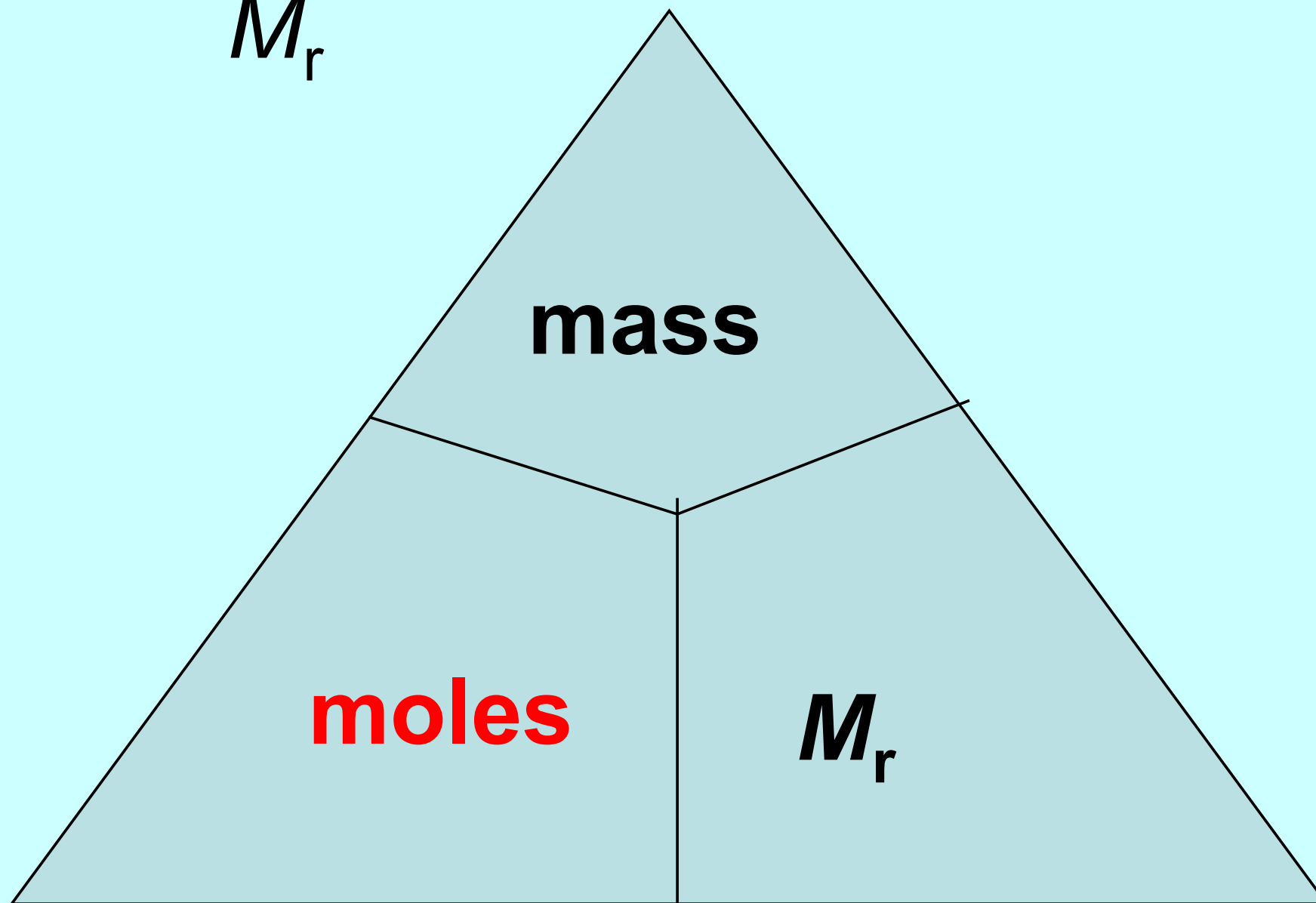
LEARN

Some maths.....

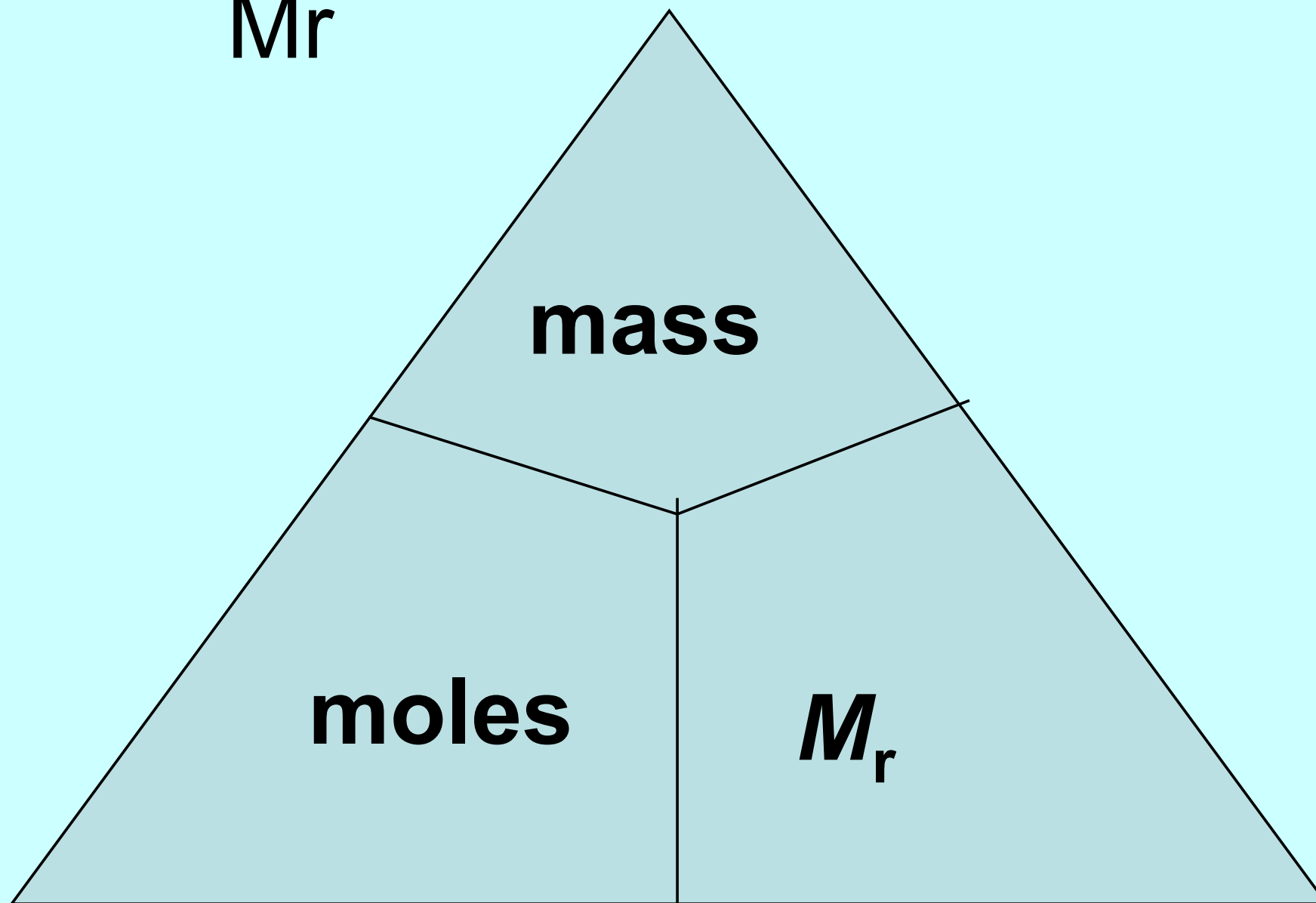
- Make sure you can rearrange this expression
- Use a “triangle” if necessary

$$\text{Moles} = \frac{\text{mass}}{M_r}$$

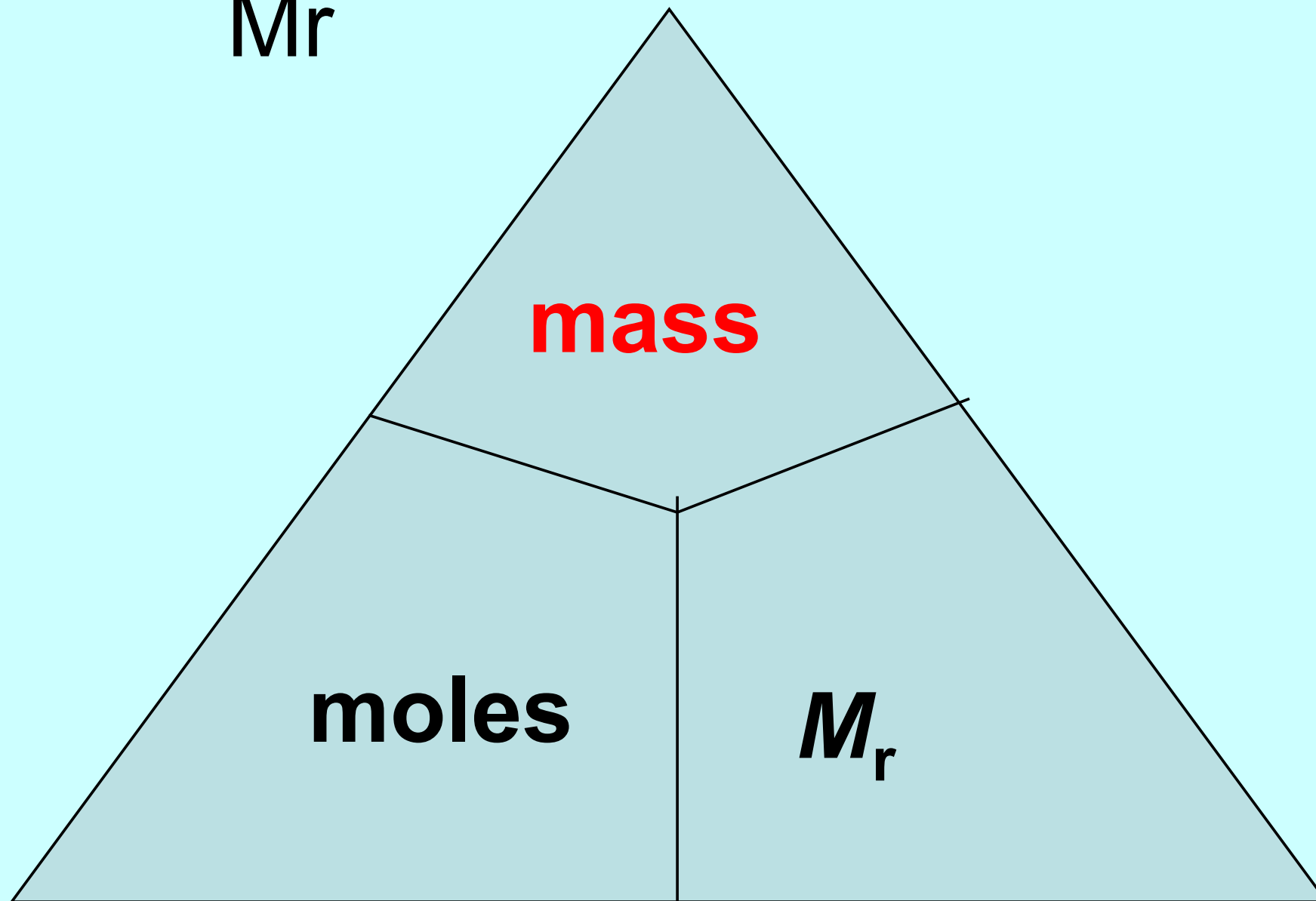
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$$\text{mass} = \text{moles} \times M_r$$

(i) How many moles in 3.2g of methane?

$$M_r \text{ of methane, CH}_4 = 16.0$$

$$\text{Moles} = \frac{\text{mass}}{M_r}$$

$$\text{moles} = \frac{3.2}{16.0} = 0.20$$

THINK

Does your answer seem right?

(ii) Find the mass of 0.10 mol Na_2CO_3

$$\begin{aligned} M_r &= (2 \times 23.0) + 12 + (3 \times 16.0) \\ &= 106.0 \end{aligned}$$

$$\text{mass} = \text{moles} \times M_r$$

$$\begin{aligned} 0.10 \text{ mol has mass} &= 0.1 \times 106.0 \\ &= \mathbf{10.6\text{g}} \text{ (3sig figs)} \end{aligned}$$

(iii) How many moles are in 24.5g of H_2SO_4 ?

$$M_r = (2 \times 1.0) + 32.1 + (4 \times 16.0)$$
$$= 98.1$$

$$\text{Moles} = \frac{\text{mass}}{M_r}$$

$$\text{no moles} = \frac{24.5}{98.1} = \mathbf{0.250} \text{ (3sig figs)}$$

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
																	(18)
																	4.0 He helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12											27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	96.0 Mo molybdenum 42	[97] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La * lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac † actinium 89	[267] Rf rutherfordium 104	[270] Db dubnium 105	[269] Sg seaborgium 106	[270] Bh bohrium 107	[270] Hs hassium 108	[278] Mt meitnerium 109	[281] Ds darmstadtium 110	[281] Rg roentgenium 111	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganeson 118

* 58 – 71 Lanthanides

† 90 – 103 Actinides

140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.0 Yb ytterbium 70	175.0 Lu lutetium 71
232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103

Use this for the task on the next page

MOLES REVISION – SOLIDS

1. Find the mass of each of the following:
 - (a) 4 moles of aluminium atoms
 - (b) 0.1 moles of helium atoms
 - (c) 0.05 moles of silicon atoms

2. How many moles are in each of the following ?
 - (a) 36 g carbon atoms
 - (b) 3.5 g lithium atoms
 - (c) 3.2 g copper atoms

3. What is the mass of one mole of each of the following compounds?
 - (a) carbon dioxide
 - (b) sodium chloride
 - (c) sulphur dioxide

4. What is the mass of one mole of each of the following compounds?
 - (a) nitric acid
 - (b) calcium hydroxide
 - (c) aluminium sulphate

5. Find the mass of each of the following:
 - (a) 0.1 moles calcium carbonate
 - (b) 0.02 moles iron (III) oxide
 - (c) 0.04 moles ammonium sulphate

6. Find the number of moles of each of the following:
 - (a) 8 g methane
 - (b) 13.35 g aluminium chloride
 - (c) 12.8 g ammonium nitrate

***You'll need to start with
the correct formula !***

Pause this presentation while you complete the exercise on the previous page.

When complete move to the next page where you can check your answers.

Answers: Solids

1	(a) 108g	(b) 0.4g	(c) 1.4g
2	(a) 3	(b) 0.5	(c) 0.05
3	(a) 44g	(b) 58.5g	(c) 64g
4	(a) 63g	(b) 74g	(c) 342g
5	(a) 10g	(b) 3.2g	(c) 5.28g
6	(a) 0.5	(b) 0.1	(c) 0.16

Having checked your work you will have either:

1. Completed the task correctly - well done :)
2. Made some mistakes - which you now understand (having seen the correct answer) - that's OK as you have 'learned from your mistakes'
3. Do not understand the answer - if this is the case you **must** seek assistance from your teacher (if you do not then you will **never** understand this and this may be a building block for later work!)

When you're confident with this
topic move onto part 4:

Empirical and Molecular Formula