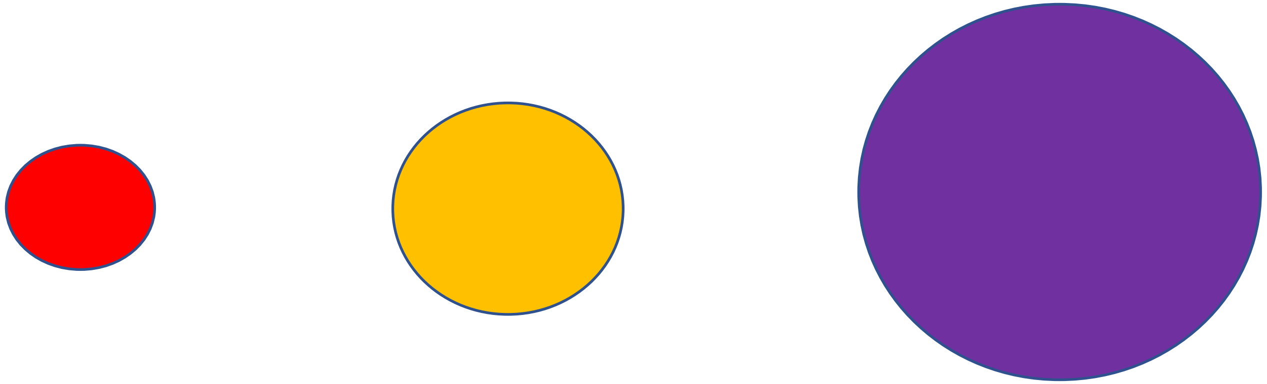
Key Concepts for
A Level
Chemistry

Introduction to Chemistry Calculations 1

Introduction

The mass of an individual atom is very small and it is much more convenient to measure atomic masses as *relative* masses.



Mass of 0.5

Mass of 1

Mass of 2

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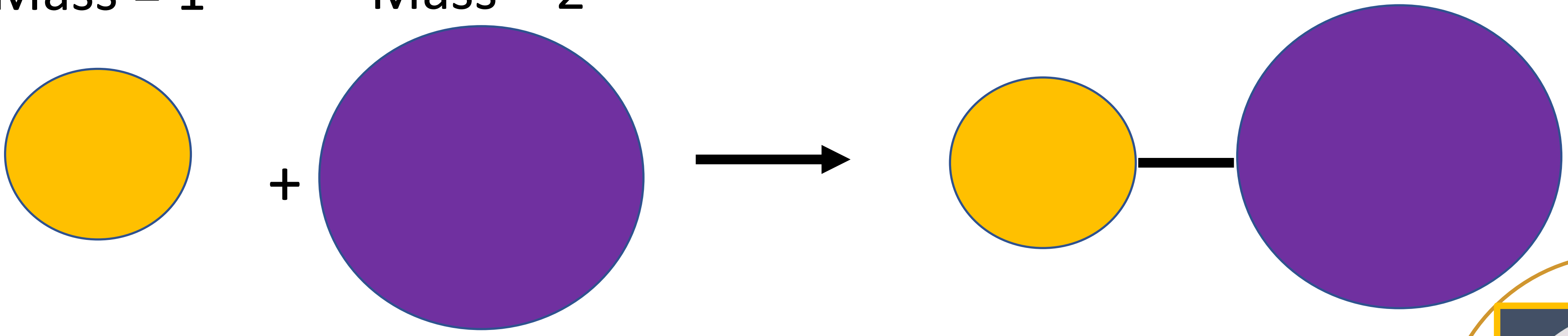
Relative Mass = 1

Relative Mass = 2

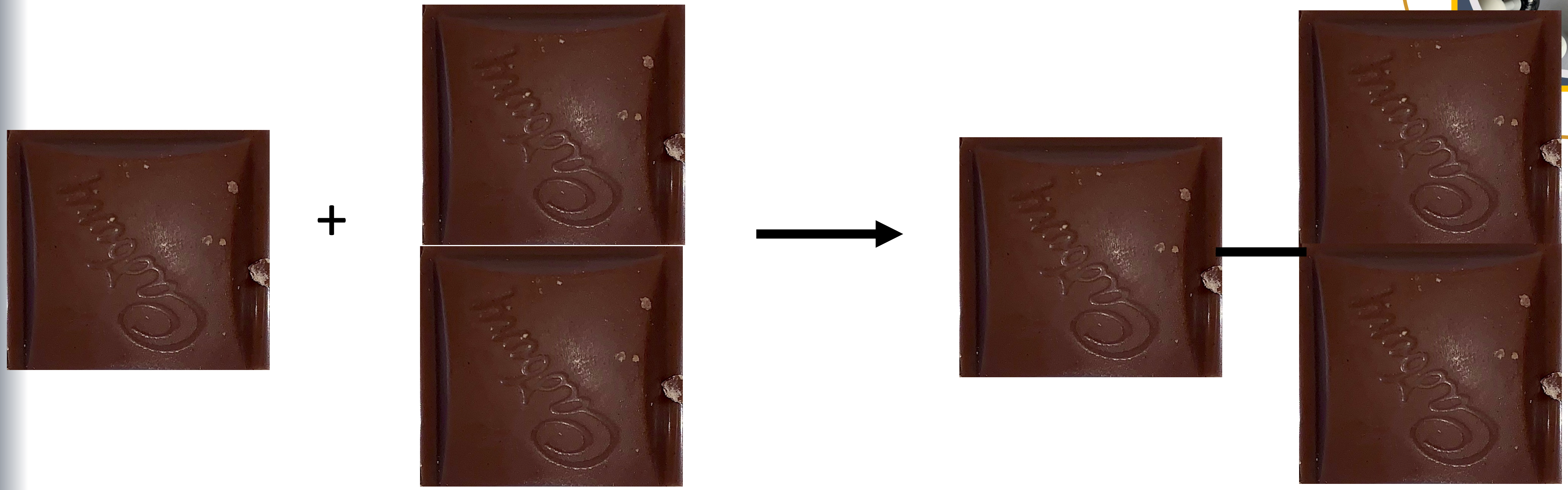
Relative Mass = 3



10 g

20 g

30 g



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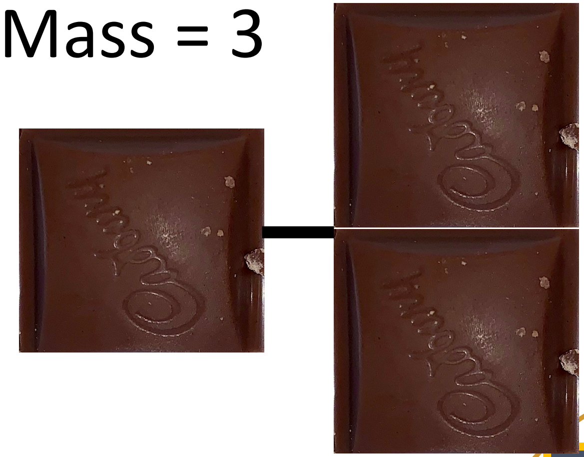
Relative Mass = 1

10 g

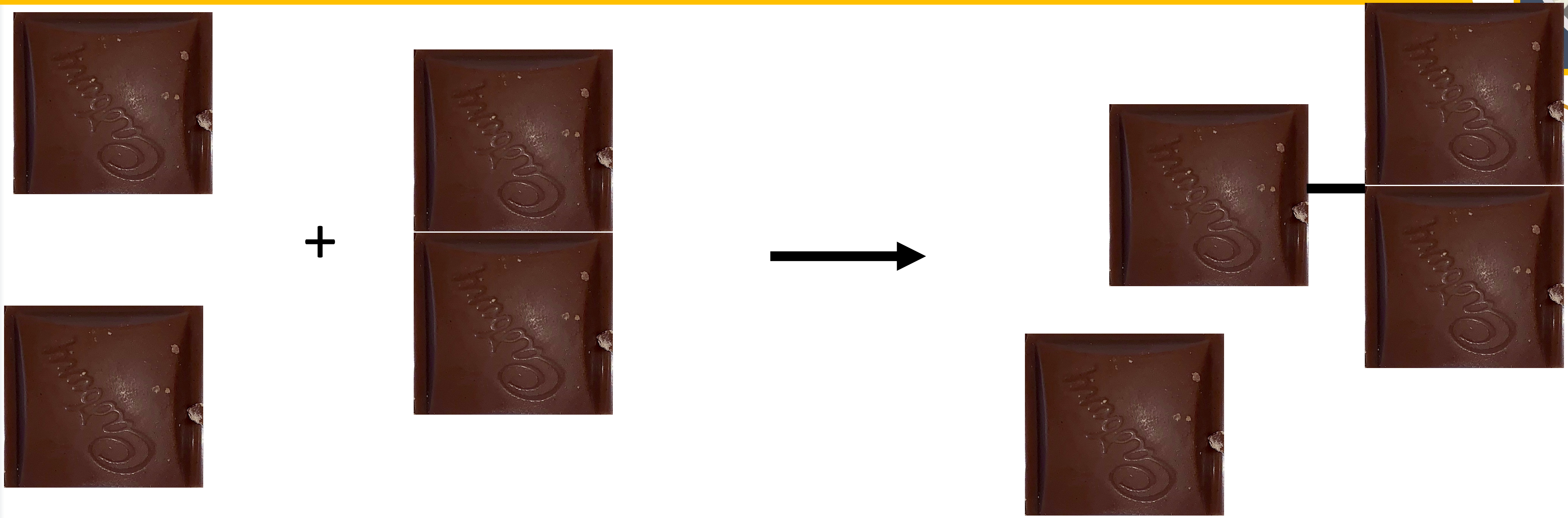
Relative Mass = 2

20 g

Relative Mass = 3



30 g



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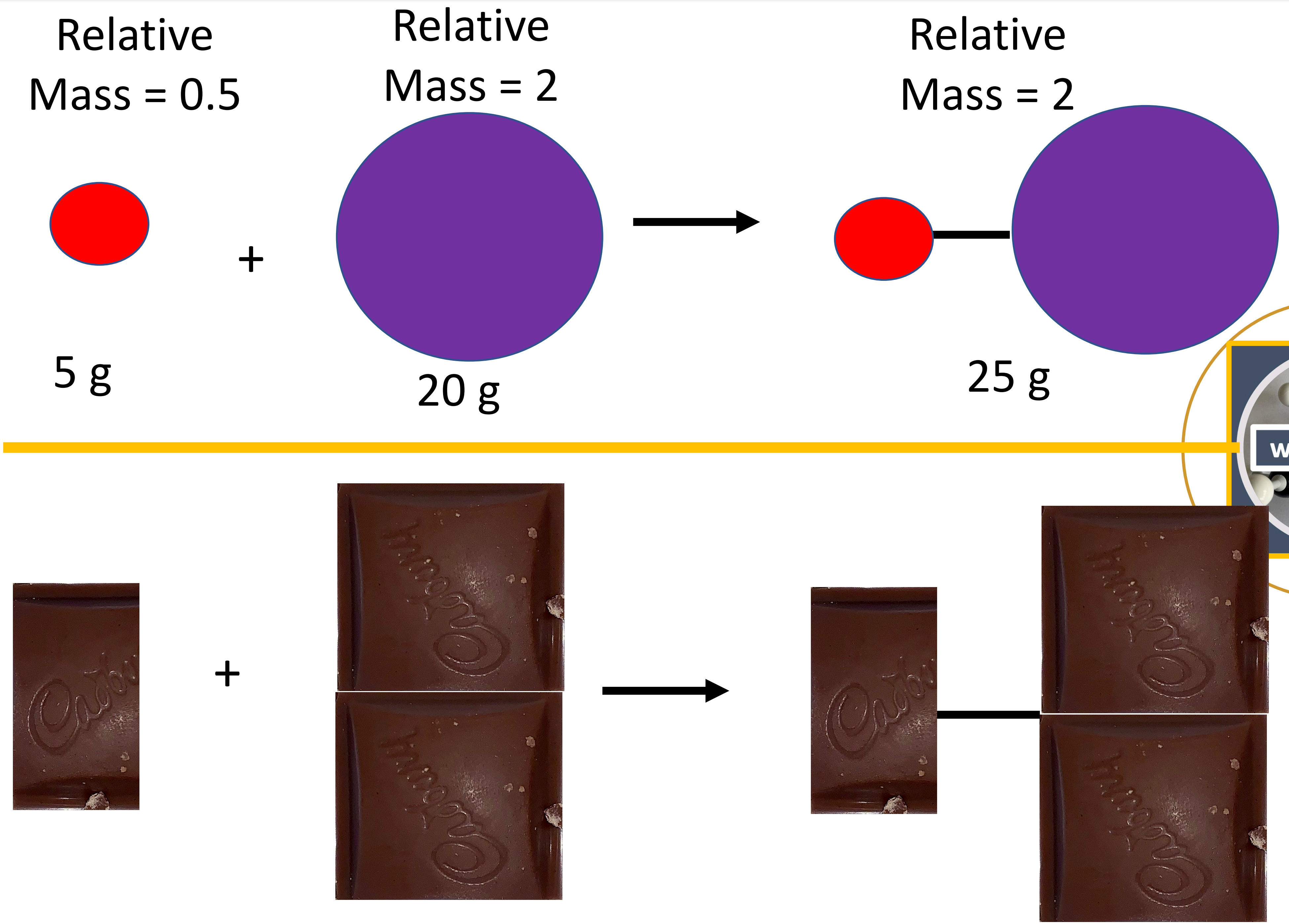

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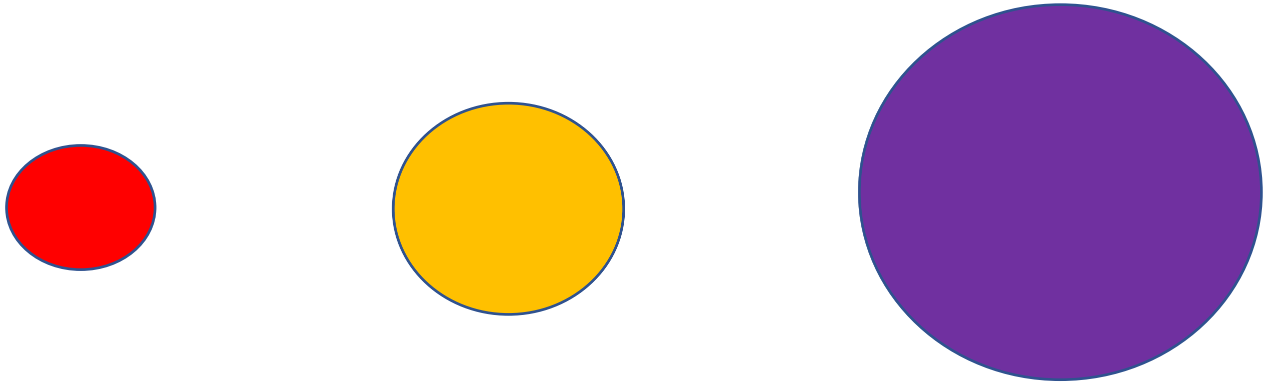
We use a method called **relative atomic mass** to measure the mass of atoms.

The mass of a single atom on a scale on which the mass of an atom of carbon-12 has a mass of 12 atomic mass units.

The *relative* atomic mass does not have units.



6

Carbon
= 12

24

For molecules and compounds we use Relative Molecular Mass is which is calculated by adding together the relative atomic masses of the atoms in the chemical formulae.

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Key
atomic number
Symbol
name
relative atomic mass

1 (1)	2 (2)	3	4	5	6	7	8	9	10	11	12	13 (3)	14 (4)	15 (5)	16 (6)	17 (7)	18 (0)
1 **H** hydrogen 1.0																	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3											13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

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Working out Relative Molecular Masses

H_2O	(2 x 1) + 16	=	18
CO_2	12 + (2 x 16)	=	44
NH_3	14 + 3	=	17
C_2H_5OH	(2 x 12) + 5 + 16 + 1	=	46
$Ca(NO_3)_2$	40 + (2 x 14) + (6 x 16)	=	164
$Ca(OH)_2$	40 + (2 x 16) + (2 x 1)	=	74

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The Mole

The mole is the amount of substance, which contains the same number of particles (atoms, ions, molecules, formulae or electrons) as there are carbon atoms in 12 g of carbon -12

This **number** is known as the *Avogadro constant, L,* and is equal to 6.02 x 10^{23}

The **molar mass** of a substance is the mass, in grams, of one mole

What does this mean in practice?

The relative atomic mass and relative molecular mass tells us how much of a substance to weigh out on grams to obtain 1 mole of it.

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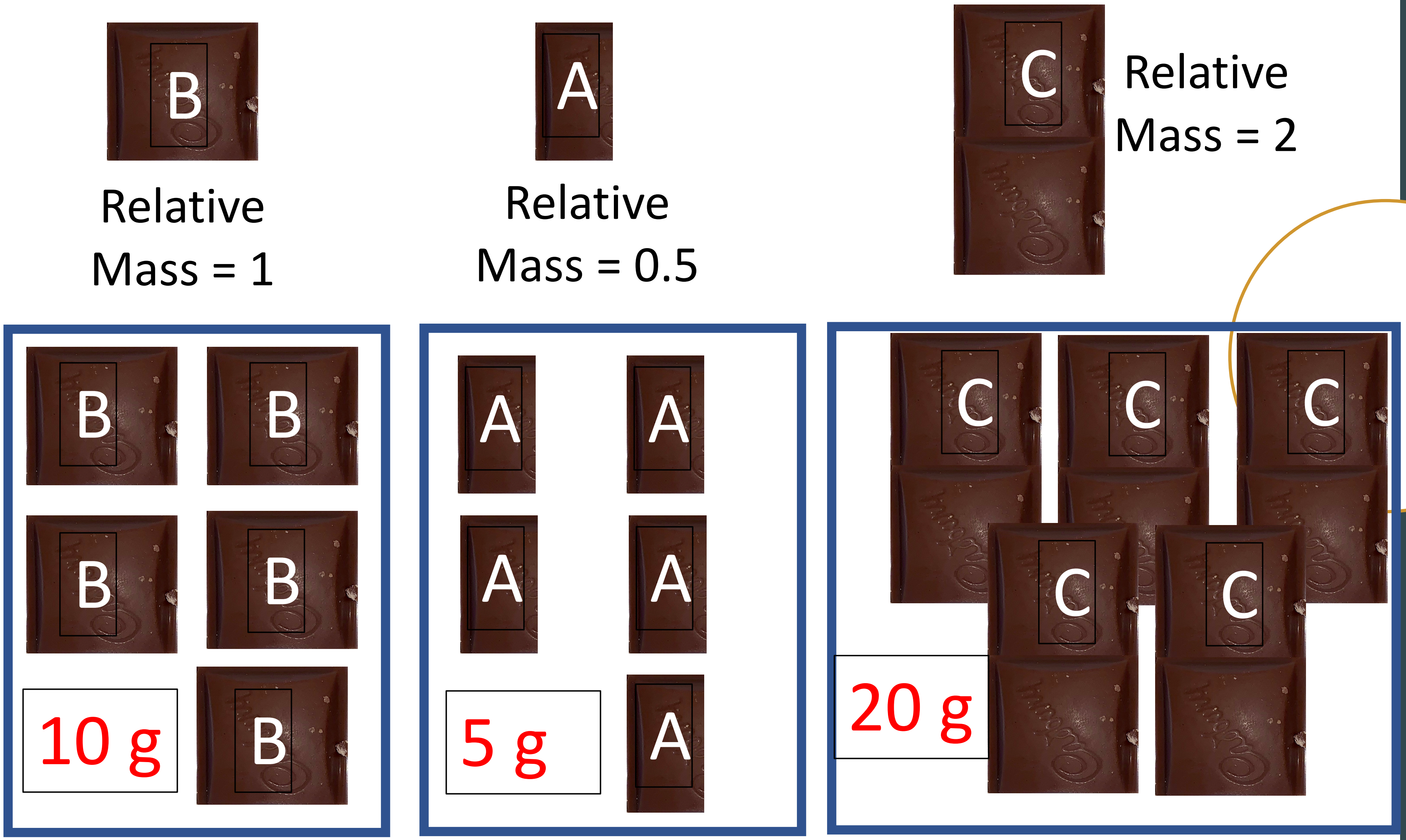
'The Otter' = Number of particles in 10 g of B



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The Mole

12 grams of carbon-12

6.02×10^{23} carbon atoms

18 grams of H_2O

6.02×10^{23} water molecules

63.5 grams of Copper

6.02×10^{23} copper atoms

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$$\text{Number of moles of atoms} = \frac{\text{Mass in grams}}{\text{Relative Atomic Mass}}$$

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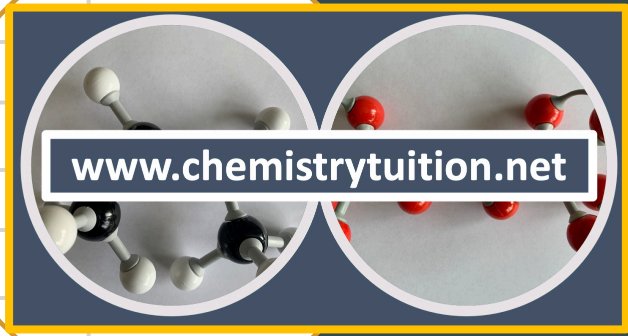
For example, if you have 16 g of phosphorus, this is

$$\text{Number of moles of atoms} = \frac{\text{Mass in grams}}{\text{Relative Atomic Mass}}$$

$$= \frac{16}{31} = 0.52 \text{ moles}$$

$$\text{number of moles} = \frac{\text{Mass in grams}}{\text{Relative Molecular Mass}}$$

	Relative Molecular Mass				
3.90 g of $NaNO_3$	85	3.90/85	=	0.0459	mols
0.111 g of $CaCl_2$	111	0.111/111	=	0.001	mols
41.0 g of $Ca(NO_3)_2$	164	41/164	=	0.25	mols
13.76 g of $(NH_4)_2SO_4$	132	13.76/132	=	0.104	mols
10.7 g of KIO_3	214	10.7/214	=	0.05	mols
100 g of NaClO	74.5	100/74.5	=	1.34	mols



Mass in grams = number of moles X Relative Molecular Mass

	Relative Molecular Mass				
2 mols of $NaNO_3$	85	2 x 85	=	170	g
0.25 mols of $CaCl_2$	111	0.25 x 111	=	27.75	g
2.95 mols of $Ca(NO_3)_2$	164	2.95 x 164	=	483.8	g
0.27 mols of $(NH_4)_2SO_4$	132	0.27 x 132	=	35.64	g
2.1 mols of KIO_3	214	2.1 x 214	=	449.4	g
0.135 mols of NaClO	74.5	0.135 x 74.5	=	10.1	g

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