C5a Calculations using moles (part II)

Use the correct equation, a calculator and a copy of the periodic table (see last page).
Use the number of decimal places in the question as a guide in deciding how many to include in the answer (if the Q has a mass of 2.37grams, then the answer in moles should be to 2dp !)

Ratios from equations

The number of moles of each substance in the balanced symbol equation gives you a lot of information.

eg/ ***in the equation below, sulphuric acid is neutralising the strong alkali sodium hydroxide***.

$$\_H_2SO_4 + \mathbf{2}NaOH \rightarrow \_\ Na_2SO_4 + \mathbf{2}H_2O$$

It takes 1 mole of sulphuric acid (we don't write the number 1 in the equation), to neutralise 2 moles of sodium hydroxide.

From this you could also say that:
it takes 2moles of sulphuric acid to neutralise 4 moles of NaOH
and it takes 0.5moles of sulphuric acid to neutralise 1 mole of NaOH

We could also say (from the equation) that:
When 1 mole of sulphuric acid reacts completely with NaOH, it forms 2 moles of water !

Question 1:
Below is the equation showing the reduction of iron ore (Fe_2O_3) in a blast furnace to form iron.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

a) How many moles of Fe_2O_3 react with 3 moles of CO ?

b) How many moles of iron (Fe) are formed when 1 mole of iron ore Fe_2O_3 is reduced in the blast furnace ?

c) How many moles of iron oxide would react with 6 moles of CO ?

d) How many moles of carbon dioxide (CO_2) would be formed if 3 moles of Fe_2O_3 reacted completely in the blast furnace ?

Using balanced equations & moles to work out how much product is made …

This is known as "reacting masses"

You can predict how much product you'll make, if you know the balanced symbol equation for the reaction and you know the mass of one of the reactants. **[these calculations were covered on the part 1 worksheet]**

Example:

Below is the equation for a reaction where chlorine displaces iodine from a compound.

$$1Cl_2 + 2KI \rightarrow 2KCl + 1I_2$$

a) What are the Relative Formula Masses of Cl_2 and I_2 ?

Ans : Cl_2 = 2 x 35.5 = **71g** I_2 = 2 x 127 = **254g**

b) How many moles of Chlorine Cl_2 are present in 3.5grams ?

Ans : Number of moles = $\frac{3.5g}{71g}$ = **0.05moles** Cl_2

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of I_2 would be produced from this number (your answer to part b) of moles Cl_2 ?

Ans: the balanced equation says that 1 mole Cl_2 makes 1 mole I_2
So, 0.05moles Cl_2 makes **0.05moles** of I_2

d) What is the mass of this many moles (*answer to c*) of I_2 ?

Ans: Mass = 0.05moles x 254 = **12.7g** of I_2

Mass = Number of moles x RFM

So,…… **3.5grams of chlorine Cl_2 will make 12.7grams of Iodine I_2**

Q2/ Below is the equation for a reaction where fluorine displaces bromine from a compound.

$$F_2 + 2KBr \rightarrow 2KF + Br_2$$

a) What are the Relative Formula Masses of F_2 and Br_2 ?

b) How many moles of Fluorine F_2 are present in 1.75grams ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of Br_2 would be produced from this number (*your answer to part b*) of moles F_2 ?

d) What is the mass of this many moles (*answer to c*) of Br_2 ?

Mass = Number of moles x RFM

Q3/ Below is the equation for a reaction where fluoride ions form a brilliant white precipitate after reacting with silver nitrate (this is the test for halide ions).

$$KF + AgNO_3 \rightarrow KNO_3 + AgF$$

a) What are the Relative Formula Masses of KF and AgF ?

b) How many moles of Potassium fluoride are present in 3.33grams of KF ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of AgF would be produced from this number (*your answer to part b*) of moles KF ?

d) What is the mass of this many moles (*answer to c*) of AgF ?

Mass = Number of moles x RFM

Q4/ Below is the equation for a reaction where sodium bromide solution (or more specifically, just the Br^- ions in it) react with silver nitrate to form an off-white white precipitate of silver bromide.

$$NaBr + AgNO_3 \rightarrow NaNO_3 + AgBr$$

a) What are the Relative Formula Masses of NaBr and AgBr ?

b) How many moles of sodium bromide are present in 1.05 grams of NaBr ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of AgBr would be produced from this number (*your answer to part b*) of moles NaBr ?

d) What is the mass of this many moles (*answer to c*) of AgBr ?

Mass = Number of moles x RFM

Q5/ *Now a slightly more complicated reaction where* **1 mole** *makes* **2 moles** !
Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

a) What are the Relative Formula Masses of H_2SO_4 and H_2O ?

b) How many moles of sulphuric acid are present in 0.75 grams of H_2SO_4 ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, where 1 mole of H_2SO_4 produces 2 moles of H_2O, how many moles of H_2O would be produced from this number (*your answer to part b*) of moles H_2SO_4 ? *remember to double your part b answer*

d) What is the mass of this many moles (*answer to c*) of H_2O ?

Mass = Number of moles x RFM

Q6/ Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$\underline{2}NaOH + H_2SO_4 \rightarrow Na_2SO_4 + \underline{2}H_2O$$

a) What are the Relative Formula Masses of H_2SO_4 and H_2O ?

b) How many moles of sulphuric acid are present in 3.15 grams of H_2SO_4 ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, where 1 mole of H_2SO_4 produces 2 moles of H_2O, how many moles of H_2O would be produced from this number (*your answer to part b*) of moles H_2SO_4 ? *remember to double your part b answer*

d) What is the mass of this many moles (*answer to c*) of H_2O ?

Mass = Number of moles x RFM

Q7/ Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$\underline{2}HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$$

a) What are the Relative Formula Masses of $CaCO_3$, HCl **&** CO_2 **?**

b) How many moles of Calcium carbonate ($CaCO_3$) are present in 1.75 grams ?

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio in the balanced equation, how many moles of HCl would react with …..

i) 1 mole of $CaCO_3$?

ii) 0.0175moles of $CaCO_3$?

d) What is the mass of this many moles (*answer to c ii*) of HCl ?

Mass = Number of moles x RFM

END

(Answers on following pages)

ANSWERS

Q1/ a) **1mole** Fe_2O_3 b) **2moles** Fe c) **2moles** Fe_2O_3 d) **9moles** CO_2

Q2/ Below is the equation for a reaction where fluorine displaces bromine from a compound.

$$F_2 + 2KBr \rightarrow 2KF + Br_2$$

a) What are the Relative Formula Masses of F_2 and Br_2 ?

RFM F_2 = 38 RFM Br_2 = 160

b) How many moles of Fluorine F_2 are present in 1.75grams ?

Moles F_2 = $\frac{1.75}{38}$ = 0.046 moles

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of Br_2 would be produced from this number (*your answer to part b*) of moles F_2 ?

1 mole F_2 produces 1 mole Br_2 (equation)
So, 0.046 moles F_2 produces 0.046 moles Br_2

d) What is the mass of this many moles (*answer to c*) of Br_2 ?

Mass Br_2 = 0.046m x 160 = 7.36grams

Mass = Number of moles x RFM

Q3/ Below is the equation for a reaction where fluoride ions form a brilliant white precipitate after reacting with silver nitrate (this is the test for halide ions).

$$KF + AgNO_3 \rightarrow KNO_3 + AgF$$

a) What are the Relative Formula Masses of KF and AgF ?

RFM KF = 58 RFM AgF = 127

b) How many moles of Potassium fluoride are present in 3.33grams of KF ?

Moles KF = $\frac{3.33g}{58}$ = 0.057 moles

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of AgF would be produced from this number (*your answer to part b*) of moles KF ?

[From the symbol equation] **1 mole KF forms 1 mole AgF**
So, …… **0.057 moles KF forms 0.057 moles AgF**

d) What is the mass of this many moles (*answer to c*) of AgF ?

Mass AgF = 0.057 moles x 127 = 7.24grams

Mass = Number of moles x RFM

Q4/ Below is the equation for a reaction where sodium bromide solution (or more specifically, just the Br^- ions in it) react with silver nitrate to form an off-white white precipitate of silver bromide.

$$NaBr + AgNO_3 \rightarrow NaNO_3 + AgBr$$

a) What are the Relative Formula Masses of NaBr and AgBr ?

RFM NaBr = 103 **RFM AgBr = 188**

b) How many moles of sodium bromide are present in 1.05 grams of NaBr ?

Moles NaBr = $\frac{1.05g}{103}$ = 0.0102 moles

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, how many moles of AgBr would be produced from this number (*your answer to part b*) of moles NaBr ?

[From the symbol equation] **1 mole NaBr forms 1 mole AgBr**
So……. **0.0102 moles NaBr forms 0.0102 moles AgBr**

d) What is the mass of this many moles (*answer to c*) of AgBr ?

Mass AgBr = 0.0102moles x 188 = 1.92grams

Mass = Number of moles x RFM

Q5/ *Now a slightly more complicated reaction where* **1 mole** *makes* **2 moles** !
Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

a) What are the Relative Formula Masses of H_2SO_4 and H_2O ?

RFM H_2SO_4 = 98 and RFM H_2O = 18

b) How many moles of sulphuric acid are present in 0.75 grams of H_2SO_4 ?

Moles H_2SO_4 = $\frac{0.75g}{98}$ = 0.0077moles (or/ **7.7×10^{-3} moles** in standard form)

Number of moles = $\frac{\text{Mass}}{\text{RFM}}$

c) Using the ratio from the balanced equation, where 1 mole of H_2SO_4 produces 2 moles of H_2O, how many moles of H_2O would be produced from this number (*your answer to part b*) of moles H_2SO_4 ? *remember to double your part b answer*

[From the equation] **1 mole of H_2SO_4 produces 2 moles of H_2O**
So……. **0.0077moles of H_2SO_4** produces (2 x 0.0077moles=) **0.0154moles of H_2O**

d) What is the mass of this many moles (*answer to c*) of H_2O ?

Mass = 0.0154moles x 18 = 0.28grams of H_2O

Mass = Number of moles x RFM

Q6/ Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

a) What are the Relative Formula Masses of H_2SO_4 and H_2O ?

RFM H_2SO_4 = 98 and RFM H_2O = 18

b) How many moles of sulphuric acid are present in 3.15 grams of H_2SO_4 ?

Moles = $\frac{3.15g}{98}$ = 0.032 moles H_2SO_4

Number of moles = $\frac{Mass}{RFM}$

c) Using the ratio from the balanced equation, where 1 mole of H_2SO_4 produces 2 moles of H_2O, how many moles of H_2O would be produced from this number (*your answer to part b*) of moles H_2SO_4 ? *remember to double your part b answer*

[From the equation] **1 mole of H_2SO_4 produces 2 moles of H_2O**
So…… **0.032moles of H_2SO_4** produces (2 x 0.032moles=) **0.064moles of H_2O**

d) What is the mass of this many moles (*answer to c*) of H_2O ?

Mass = 0.064moles x 18 = 1.152grams of H_2O

Mass = Number of moles x RFM

Q7/ Below is the equation for a neutralisation reaction between sodium hydroxide and sulphuric acid

$$2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$$

a) What are the Relative Formula Masses of $CaCO_3$ & HCl **?**

RFM $CaCO_3$ = 100 RFM HCl = 36.5

b) How many moles of Calcium carbonate ($CaCO_3$) are present in 1.75 grams ?

Moles = $\frac{1.75g}{100}$ = 0.0175 moles $CaCO_3$

Number of moles = $\frac{Mass}{RFM}$

c) Using the ratio in the balanced equation, how many moles of HCl would react with …..

i) 1 mole of $CaCO_3$? **2 moles HCl**

ii) 0.0175moles of $CaCO_3$? **0.035 moles HCl**

d) What is the mass of this many moles (*answer to c ii*) of HCl ?

Mass = 0.035moles x 36.5 = 1.28grams HCl

Mass = Number of moles x RFM

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germenium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **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	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number