

## Level 3 BTEC National in Forensic Investigation

**Task 1:** You need to produce an in depth presentation on "Waves in Communication". This will require you research this topic with references of sources. This work needs to reflect **at least 3 hours work**.

This work will be graded using Ungraded, Pass, Merit and Distinction.

### FOR YOUR INFORMATION:

#### Report Sections:

- Title page
- Contents page
- Pictures and or diagrams
- Clearly labelled sub sections
- Bibliography

#### Report sub-sections:

- The features common to all waves
- Graphical representations of these features
- The difference between the two different types of waves.
- Show an understanding and manipulation of the wave equation
- Show an understanding of the concepts; displacement, coherence, path difference, phase difference, superposition as applied to diffraction gratings.

**Task 2:** You need to produce an in depth research essay on the structure and function of epithelial tissue, to include:

- squamous as illustrated by the role of alveolar epithelium in gas exchange to include the effect of chronic obstructive pulmonary disease (COPD) in smokers
- columnar as illustrated by goblet cells and ciliated cells in the lungs to include their role in protecting lungs from pathogens.

This work needs to reflect **at least 3 hours work**

**Task 3:** You will need to be able to carry out a variety of calculations in chemistry, throughout this course. For this part of your induction assignment you are to carry out the following exercises; these will test your ability to

- ✓ Calculate molar mass
- ✓ Balance equations
- ✓ Calculate the number of moles in a given mass of a substance
- ✓ Calculate reacting quantities

This work needs to reflect **at least 3 hours work**

## Calculating molar mass

Read the following examples then complete the questions set.

The definition of *Relative Molecular Mass*  $M_r$  (also referred to as *molar mass*) is:

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

The relative molecular mass of a molecule is calculated by adding together the relative atomic masses of the atoms in the chemical formulae.

When you carry out experiments you will weigh chemicals in grams. Molar Mass has the same numerical value as *Relative Molecular Mass*. It is calculated by adding together the relative atomic masses of the elements in the molecule. The total is expressed in units of grams per mol or  $\text{g mol}^{-1}$ .

### Example 1

Calculate the Molar Mass of sulfuric acid  $\text{H}_2\text{SO}_4$

This molecule contains

2 atoms of <b>hydrogen</b> each of mass 1	= 2 x 1	= 2 $\text{g mol}^{-1}$
1 atom of <b>sulfur</b> of mass 32.1	= 1 x 32.1	= 32.1 $\text{g mol}^{-1}$
4 atoms of <b>oxygen</b> of mass 16	= 4 x 16	= 64 $\text{g mol}^{-1}$
<b>Total mass</b>		<b>= 98.1 <math>\text{g mol}^{-1}</math></b>

### Example 2

Calculate the Molar Mass of lead nitrate  $\text{Pb}(\text{NO}_3)_2$

Care! This molecule contains **TWO** nitrate groups.

1 atom of <b>lead</b> of mass 207.2	= 1 x 207.2	= 207.2 $\text{g mol}^{-1}$
2 atoms of <b>nitrogen</b> of mass 14	= 2 x 14	= 28 $\text{g mol}^{-1}$
6 atoms of <b>oxygen</b> of mass 16	= 6 x 16	= 96 $\text{g mol}^{-1}$
<b>Total mass</b>		<b>= 331.2 <math>\text{g mol}^{-1}</math></b>

Now complete these calculations of molar mass

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1 H<sub>2</sub>O

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2 CO<sub>2</sub>

---

3 NH<sub>3</sub>

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4 C<sub>2</sub>H<sub>5</sub>OH

---

5 C<sub>2</sub>H<sub>4</sub>

---

6 SO<sub>2</sub>

---

7 SO<sub>3</sub>

---

8 HBr

---

9 H<sub>2</sub>SO<sub>4</sub>

---

10 HNO<sub>3</sub>

---

11 NaCl

---

12 NaNO<sub>3</sub>

---

13 Na<sub>2</sub>CO<sub>3</sub>

---

14 NaOH

---

15 Na<sub>2</sub>SO<sub>4</sub>

---

16 KMnO<sub>4</sub>

---

17 K<sub>2</sub>CrO<sub>4</sub>

---

18 KHCO<sub>3</sub>

---

19 KI

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20 CsNO<sub>3</sub>

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21 CaCl<sub>2</sub>

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22 Ca(NO<sub>3</sub>)<sub>2</sub>

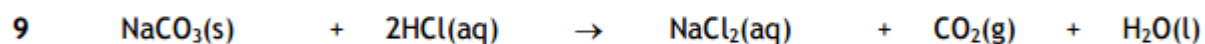
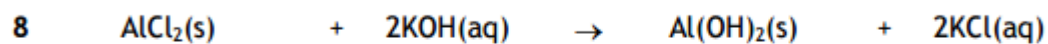
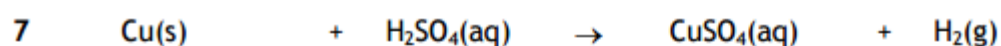
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23 Ca(OH)<sub>2</sub>

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## Balancing equations

### Balance the following equations



## Calculation of the number of moles in a given mass

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.

### Example calculations using moles

These calculations form the basis of many of the calculations you will meet in your Advanced Level course.

#### Example 1

##### Calculation of the number of moles of material in a given mass of that material

- a Calculate the number of moles of oxygen atoms in 64 g of oxygen atoms. *You need the mass of one mole of oxygen atoms. This is the Relative Atomic Mass in grams and in this case it is 16 g mol<sup>-1</sup>.*

$$\text{number of moles of atoms} = \frac{\text{mass in grams}}{\text{molar mass of atoms}}$$

$$\begin{aligned}\therefore \text{number of moles of oxygen} &= \frac{64 \text{ g of oxygen atoms}}{\text{molar mass of oxygen of } 16 \text{ g mol}^{-1}} \\ &= 4 \text{ moles of oxygen atoms}\end{aligned}$$

- b Calculate the number of moles of chlorine molecules in 142 g of chlorine gas.

$$\text{number of moles of atoms} = \frac{\text{mass in grams}}{\text{molar mass of atoms}}$$

The first stage of this calculation is to calculate the molar mass of chlorine molecules.  
Molar mass of Cl<sub>2</sub> = 2 x 35.5 = 71 g mol<sup>-1</sup>

$$\begin{aligned}\therefore \text{number of moles of chlorine} &= \frac{142 \text{ g of chlorine gas}}{\text{molar mass of chlorine of } 71 \text{ g mol}^{-1}} \\ &= 2 \text{ moles of chlorine molecules}\end{aligned}$$

c Calculate the number of moles of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  in 100 g of the solid.

The Relative Molecular Mass of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  =

$$[63.5 + 32.1 + (4 \times 16) + 5\{(2 \times 1) + 16\}] = 249.6 \text{ g mol}^{-1}$$

$$\begin{aligned} \therefore \text{number of moles of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O} &= \frac{100 \text{ g of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O}}{\text{molecular mass of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O of } 249.5 \text{ g mol}^{-1}} \\ &= 0.4006 \text{ moles of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O} \text{ molecules} \end{aligned}$$

### Now complete the following calculations

In each case calculate the number of moles of the material in the mass stated.

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1 9.00 g of  $\text{H}_2\text{O}$

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2 88.0 g of  $\text{CO}_2$

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3 1.70 g of  $\text{NH}_3$

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4 230 g of  $\text{C}_2\text{H}_5\text{OH}$

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5 560 g of  $\text{C}_2\text{H}_4$

---

6 0.641 g of  $\text{SO}_2$

---

7 80.1 g of  $\text{SO}_3$

---

8 18.20 g of  $\text{HBr}$

---

9 0.0981 g of  $\text{H}_2\text{SO}_4$

---

10 3.15 g of  $\text{HNO}_3$

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11 19.3 g of NaCl

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12 21.25 g of NaNO<sub>3</sub>

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13 2.25 g of Na<sub>2</sub>CO<sub>3</sub>

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14 0.800 g of NaOH

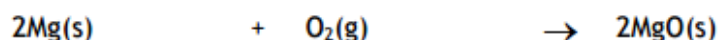
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## Calculating reacting quantities

### Example 1

a What mass of magnesium oxide would be produced from 16 g of magnesium in the reaction between magnesium and oxygen?

i Write out the full balanced equation



ii Read the equation in terms of moles

*2 moles of magnesium reacts to give 2 moles of magnesium oxide*

iii Convert the moles to masses using the  $M_r$  values

$$\therefore (2 \times 24.3\text{g}) \text{ of magnesium gives } 2 \times (24.3 + 16) = 80.6 \text{ g of Magnesium oxide}$$

$$\therefore 16 \text{ g of magnesium gives } \frac{80.6 \times 16}{2 \times 24.3} = 26.5 \text{ g of Magnesium oxide}$$

b What volume of oxygen would react with 16 g of magnesium in the above reaction?

*In this case the oxygen is a gas so the volume of each mole is 24 000 cm<sup>3</sup> at room temperature and pressure and you do not have to worry about the molecular mass of the gas.*

From the equation:

2 moles of Mg react with 1 mole of O<sub>2</sub>

$\therefore 2 \times 24.3 \text{ g of Mg react with } 1 \times 24\,000 \text{ cm}^3 \text{ of O}_2\text{(g)}$

$$\therefore 16 \text{ g of Mg react with } \frac{1 \times 24\,000 \times 16}{2 \times 24.3} = 7901 \text{ cm}^3 \text{ of oxygen}$$

## Example 2

What mass of lead(II) sulfate would be produced by the action of excess dilute sulfuric acid on 10 g of lead nitrate dissolved in water?



∴ 1 mole of lead nitrate gives 1 mole of lead sulfate

∴ 331.2 g of lead nitrate gives 303.2 g of lead sulfate

∴ 10 g of lead nitrate gives  $\frac{303.2 \times 10 \text{ g of lead sulfate}}{331.2} = 9.15 \text{ g of lead sulfate}$

Now answer the following questions; you should always write the balanced equation first, if it is not given

- 
- 1 What mass of barium sulfate would be produced from 10 g of barium chloride in the following reaction?

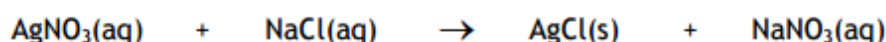


- 2 What mass of potassium chloride would be produced from 20 g of potassium carbonate?
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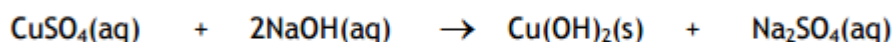
- 3 What masses of ethanol and ethanoic acid would need to react together to give 1 g of ethyl ethanoate?
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- 4 What mass of iron(III) oxide would need to be reduced to produce 100 tonnes of iron in a blast furnace?
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- 5 What mass of silver nitrate as a solution in water would need to be added to 5 g of sodium chloride to ensure complete precipitation of the chloride?



- 6 A solution of copper sulfate reacts with sodium hydroxide solution to produce a precipitate of copper hydroxide according to the following equation:



What mass of sodium hydroxide would be needed to convert 15.96 g of copper sulfate to copper hydroxide and what mass of copper hydroxide would be produced?



**Suggested websites:**

- <https://www.brightstorm.com/science/physics/vibration-and-waves/wave-characteristics/>
- [http://theory.uwinnipeg.ca/mod\\_tech/node120.html](http://theory.uwinnipeg.ca/mod_tech/node120.html)
- <http://www.healthline.com/health/copd/smoking#2>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2672326/>

If you have any questions about the assignment, then please email [achandler@onslow.herts.sch.uk](mailto:achandler@onslow.herts.sch.uk) or [jburgess@onslow.herts.sch.uk](mailto:jburgess@onslow.herts.sch.uk)

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