Relative Formula Mass

1. **Formulae** show which elements are in compounds and the ratio of each element in the compound. For example:
   $CaCO_3$ contains one calcium atom, one carbon atom and 3 oxygen atoms
2. Chemical reactions always involve the formation of one or more new substances
3. The **relative atomic mass** of an element can be found as the mass number of an element on the periodic table
4. Relative atomic mass has the symbol $\mathbf{A_r}$
5. The **relative formula mass** of a compound is the **sum** of the relative atomic masses of the atoms in the numbers shown in the formula
6. Relative formula mass has the symbol $\mathbf{M_r}$
7. For example, the M_r of CaCO3 is 40+12+(16x3) = 100
8. In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown
9. The percentage by mass of an element in a compound can be calculated using the relative atomic mass and the relative formula mass, using the formula:

$$\%\text{ by mass} = \frac{\text{mass of element}}{\text{mass of compound}} \times 100$$

The Mole (HT only)

10. *Chemical amounts are measured in **moles***
11. *The symbol for the unit mole is mol*
12. *The **mass of one mole** of a substance in grams is numerically **equal** to its **relative formula mass***
13. *One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance*
14. ***One mole** of a substance contains **6.02 x 10^{23}** particles*
15. *This number is the Avogadro constant or Avogadro's number*
16. *The measurement of amounts in moles can apply to atoms, molecules, ions, electrons, formulae and equations*
17. *The mass of a substance can be calculated from the number of moles, using the relative formula mass:*

$$\text{number of moles} = \frac{\text{mass}}{\text{Mr}}$$

18. *This equation can also be written as:*

$$\text{mass} = \text{number of moles} \times \text{Mr}$$

19. *The masses of reactants and products can be calculated from balanced symbol equations*
20. *Chemical equations can be interpreted in terms of **moles**. For example:*
    $Mg + 2HCl \rightarrow MgCl_2 + H_2$
    shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.
21. *The **coefficients** show the **molar ratio** in which reactants react and products are made which can be*

used to calculate the mass of a reactant or product

22. *The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.*
23. *A reaction finishes when one of the reactant is all used up. The other reactant has nothing left to react with, so some of it is left over*
24. *The* ***reactant*** *that is completely* ***used up*** *is called the* ***limiting reactant*** *because it limits the amount of products*
25. *The reactant that is* ***left over*** *is described as being* ***in excess***
26. *In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used*
27. *The mass of a product formed in a reaction depends upon the mass of the* ***limiting reactant***
28. *The maximum mass of a product formed in a reaction can be calculated using the balanced equation, the mass of the limiting reactant and the relative formula mass of the limiting reactant and the product*

Acids, Alkalis and Neutralisation

29. **Acids** are **neutralised** by **alkalis** (e.g. soluble metal hydroxides) and bases (e.g. insoluble metal hydroxides and metal oxides) to produce **salts** and **water**, and by metal carbonates to produce salts, water and carbon dioxide.
30. The particular salt produced in any reaction between an acid and a base or alkali depends on:
    - the acid used (hydrochloric acid produces chlorides, nitric acid produces nitrates, sulfuric acid produces sulfates)
    - the positive ions in the base, alkali or carbonate.
31. Acids also react with metals to produce a salt and hydrogen gas This is not a neutralisation reaction
32. **Acids** produce **hydrogen ions (H^+)** in aqueous solutions
33. Aqueous solutions of **alkalis** contain **hydroxide ions (OH^-)**
34. The pH scale, from 0 to 14, is a measure of the **acidity** or **alkalinity** of a **solution**, and can be measured using **universal indicator** or a **pH probe**
35. A solution with **pH 7** is **neutral**. Aqueous solutions of **acids** have pH values of **less than 7** and aqueous solutions of **alkalis** have pH values **greater than 7**
36. In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water
37. A neutralisation reaction can be represented by the equation **$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$**

Strong and Weak Acids (HT only)

38. A **strong** acid is **completely ionised** in aqueous solution. This means that the acid splits up into its ions. Another word for ionised is dissociated.
39. Examples of strong acids are hydrochloric, nitric and sulfuric acids.

40. A **weak** acid is only **partially ionised** in aqueous solution.
41. Examples of weak acids are ethanoic, citric and carbonic acids.
42. The **higher the concentration of H^+ ions** in a solution, the **lower the pH**
43. The higher the concentration of OH^- ions in an alkaline solution, the higher the pH
44. For a **given concentration** of aqueous solutions, the **stronger** an **acid**, the **lower** the **pH**
45. As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10
46. In a **dilute** acid, the acid molecules are mixed with a **large volume** of **water**, so there is a low concentration of H^+ ions
47. In a **concentrated** acid, **few** or no **water molecules** are mixed with the acid molecules. This means the concentration of H^+ ions is high.

Concentration

48. Many chemical reactions take place in **solutions**
49. The concentration of a solution tells you how much solute is dissolved in a given volume of solution
50. Concentration can be defined as the **mass of solute per unit volume** of solvent.
51. Volume means the amount of space that a substance takes up, and can be measured in cm^3, dm^3, m^3, L or mL.
52. 1 dm^3 is equal to 1 L and equal to 1000 cm^3
53. To convert from dm^3 to cm^3 the number should be multiplied by 1000
54. To convert from cm^3 to dm^3 the number should be divided by 1000
55. The concentration of a solution can be measured in mass per given volume of solution, e.g., grams per dm^3 (**g/dm^3**)
56. The mass in grams of solute in a given volume of solution can be calculated from its concentration in g/dm^3
57. The equation that links concentration, mass of solute and volume is:

$$\text{Concentration} = \frac{\text{mass}}{\text{volume}}$$

Concentration (Chemistry only)

58. The concentration of a solution can be measured in **mol/dm^3**
59. The **amount in moles** of solute or the **mass** in grams of solute in a **given volume** of solution can be calculated from its **concentration** in mol/dm^3
60. The equation that links concentration, amount of substance and volume is:

$$\text{Concentration} = \frac{\text{number of moles}}{\text{volume}}$$

61. The concentration of a solution in mol/dm^3 is related to the **mass** of the solute and the **volume** of the solution
62. If the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated

Titration (Chemistry only)

63. The volumes or concentrations of acid and alkali solutions that react with each other can be measured by **titration** using a suitable **indicator**
64. A titration is an example of **quantitative** analysis
65. A **pipette** is used to accurately measure a **certain volume** of acid or alkali
66. A pipette filler is used to fill the pipette safely
67. A conical flask is used to contain the liquid from the pipette
68. A **burette** is used to add small, **measured volumes** of one reactant to the other reactant in the conical flask
69. Before starting the titration, the burette should be rinsed with the solution it is going to contain and clamped vertically. Once filled the tap should be flushed to remove any air bubbles
70. Only a **few drops** of **indicator** should be added to conical flask. This is because many indicators are weak acids or alkalis, and too much would affect the outcome of the titration
71. The indicator shows by a **colour change** when all of the alkali in the conical flask has been neutralised. This is called the **end point**
72. A **white tile** is placed under the conical flask so that any colour change can be seen clearly
73. An appropriate indicator to use for an acid-alkali titration is **phenolphthalein**.
74. Phenolphthalein is **pink** in **alkaline** solutions and **colourless** in **acidic** solutions
75. The difference between the burette reading at the start and the reading at the end of the titration gives the volume of acid (or alkali) added.
76. This **volume** is called a **titre**.
77. The first titre is usually ignored, as it is a rough result.
78. Results that are within 0.2 cm^3 of each other are called **concordant** results.
79. Multiple titrations are usually carried out, and an average (mean) titre is calculated for any that are within 0.2 cm^3 of each other.

Volumes of Gases (Chemistry only)

80. **Equal amounts in moles** of gases **occupy** the **same volume** under the same conditions of temperature and pressure.
81. Room temperature is 20 ºC
82. Room pressure is 1 atmosphere
83. Rtp' means 'at room temperature and pressure'
84. The **volume** of **one mole** of any gas at room temperature and pressure is **24 dm^3**
85. This volume (24 dm^3) is called the **molar volume** of a gas
86. The volume of gas at rtp can be calculate using the equation:

$$\text{Volume} = \text{number of moles} \times 24$$

87. The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction.
88. The volume of a gas at room temperature and pressure can be calculated from its **mass** and **relative formula mass**