Edexcel GCSE Chemistry

Topic 1: Key concepts in chemistry

Calculations involving masses

Notes

1.41 Describe the limitations of particular representations and models, to include dot and cross, ball and stick models and two- and three-dimensional representations

- Main limitation is that it applies really well only to the small class of solids composed of Group 1 and 2 elements with highly electronegative elements such as the halogens
- In covalent molecular, the dot-cross diagrams don't express the relative attraction of shared electrons due to electronegativity (learn about this at A-level more)
- 2d diagrams don't show the 3d arrangement of atoms, and 3d diagrams don't show the share or transfer of electrons

1.42 Describe most metals as shiny solids which have high melting points, high density and are good conductors of electricity whereas most non-metals have low boiling points and are poor conductors of electricity

1.43 Calculate relative formula mass given relative atomic masses

- Relative formula mass (Mr) of a compound: sum of the relative atomic masses of the atoms in the numbers shown in the formula (remember you could have more than 1 atom of a certain element in a compound e.g. in $CaCl_2$,there are 2 atoms of chlorine so you need to add on 35.5 x2)
- In a balanced chemical equation:
  sum of Mr of reactants in quantities shown = sum of Mr of products in quantities shown

1.44 Calculate the formulae of simple compounds from reacting masses and understand that these are empirical formulae

	Fe	O
Mass (g)	7.83	3.37
Moles	(7.83/55.85) = 0.140197	(3.37/16)= 0.210625
Ratio	(0.140197/0.140197) = 1	(0.210625/0.140197) = 1.5
Simplified	2	3
Empirical Formula	Fe_2O_3	

- to calculate formula from reacting masses:
  a. work out moles of each using moles = mass ÷ molar mass
  b. work out the ratio of moles
  c. times the ratio so that you get the smallest whole numbers possible
  d. find the formula by timesing each element by their number in the ratio (remember to use little numbers not a big number at the front)

- This is an empirical formula because it shows the simplest ratio of the number of atoms of different types of elements in a compound

1.45 Deduce: the empirical formula of a compound from the formula of its molecule, and the molecular formula of a compound from its empirical formula and its relative molecular mass

- Empirical formula from the formula of molecule:
  - if you have a common multiple e.g. Fe_2O_4, the empirical formula is the simplest whole number ratio, which would be FeO_2
  - if there is no common multiple, you already have the empirical formula
- Molecular formula from empirical formula and relative molecular mass
  - Find relative molecular mass of the empirical formula
  - Divide relative molecular mass of compound by that of the empirical formula
  - Multiply the number of each type of atom in the empirical formula by this number
  - e.g. if answer was 2 and the empirical formula was Fe_2O_3 then the molecular formula would be empirical formula x 2 = Fe_4O_6

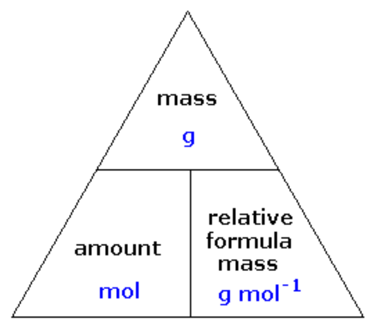
1.46 Describe an experiment to determine the empirical formula of a simple compound such as magnesium oxide

- weigh some pure magnesium
- Heat magnesium to burning in a crucible to form magnesium oxide, as the magnesium will react with the oxygen in the air
- weigh the mass of the magnesium oxide
- Known quantities: mass of magnesium used & mass of magnesium oxide produced
- Required calculations:
  - mass oxygen = mass magnesium oxide - mass magnesium
  - moles magnesium = mass magnesium ÷ molar mass magnesium
  - moles oxygen = mass oxygen ÷ molar mass oxygen
  - calculate ratio of moles of magnesium to moles of oxygen
  - use ratio to form empirical formula (same method as 1.44)

1.47 Explain the law of conservation of mass applied to: a closed system including a precipitation reaction in a closed flask and a non-enclosed system including a reaction in an open flask that takes in or gives out a gas

- Law of conservation of mass: no atoms are lost or made during a chemical reaction so the mass of the products = mass of the reactants
    - Therefore, chemical reactions can be represented by symbol equations, which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation.
- With a precipitation reaction – precipitate that forms is insoluble and is a solid, as all the reactants and products remain in the sealed reaction container then it is easy to show that the total mass is unchanged
- Does not hold for a reaction in an open flask that takes in or gives out a gas, since mass will change from what it was at the start of the reaction as some mass is lost when the gas is given off

1.48 Calculate masses of reactants and products from balanced equations, given the mass of one substance



- Find moles of that one substance: moles = mass / molar mass
- Use balancing numbers to find the moles of desired reactant or product (e.g. if you had the equation: $2NaOH + Mg \rightarrow Mg(OH)_2 + 2Na$, if you had 2 moles of Mg, you would form 2x2=4 moles of Na)
- Mass = moles x molar mass(of the reactant/product) to find mass

1.49 Calculate the concentration of solutions in g dm^{-3}

- Concentration of a solution can be measured in mass per given volume of solution e.g. grams per dm^3 (g/dm^3)
- to calculate concentration of a solution use the equation

  concentration (g dm^{-3}) = mass of solute (g) ÷ volume (dm^3)
- To calculate mass of solute in a given volume of a known concentration use the equation: mass = conc x vol i.e. g = g/dm^3 x dm^3 (think about the units!)

1.50 (higher tier) Recall that one mole of particles of a substance is defined as: the Avogadro constant number of particles (6.02×10^{23} atoms, molecules, formulae or ions) of that substance and a mass of 'relative particle mass' g

- The number of atoms, molecules or ions in one mole of a given substance is the Avogadro constant: 6.02×10^{23} per mole.
- the mass of one mole of particles is the 'relative particle mass' in grams

1.51 (higher tier) Calculate the number of: moles of particles of a substance in a given mass of that substance and vice versa, particles of a substance in a given number of moles of that substance and vice versa and particles of a substance in a given mass of that substance and vice versa

- Chemical amounts are measured in moles. The symbol for the unit mole is mol.
- The mass of one mole of a substance in grams is numerically equal to its relative formula mass.
    - For example, the Ar of Iron is 56, so one mole of iron weighs 56g.
    - The Mr of nitrogen gas (N_2) is 28 (2 x 14), so one mole is 28g.
- One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance
- You can convert between moles and grams by using this equation:

  moles = mass (g) ÷ relative atomic mass

    - E.g how many moles are there in 42g of carbon?
        - Moles = Mass / Mr = 42/12 = 3.5 moles
- The number of particles, atoms, molecules or ions in a mole of a given substance is the Avogadro constant: 6.02×10^{23} per mole.
    - this means the number of particles in a given number of moles of a substance= moles x avogadro's constant
    - e.g. for 5 moles = $6.02 \times 10^{23} \times 5$

1.52 (higher tier) Explain why, in a reaction, the mass of product formed is controlled by the mass of the reactant which is not in excess

- In a chemical reaction with 2 or more reactants you will often use one in excess to ensure that all of the other reactant is used
    - The reactant that is used up / not in excess is called the limiting reactant since it limits the amount of products
- if a limiting reagent is used, the amount reactant in excess that actually reacts is limited to the exact amount that reacts with the amount of limiting reagent you have, so you need to use the moles/mass of the limiting reagent for any calculations

1.53 (higher tier) Deduce the stoichiometry of a reaction from the masses of the reactants and products

- Stoichiometry refers to the balancing numbers in front of compounds/elements in reaction equations
- Balancing numbers in a symbol equation can be calculated from the masses of reactants and products:
  - convert the masses in grams to amounts in moles (moles = mass/Mr)
  - convert the numbers of moles to simple whole number ratios
- e.g. for the reaction: $Cu + O_2 \rightarrow CuO$ (not balanced), 127 g Cu react, 32g of oxygen react and 159g of CuO are formed. Work out the balanced equation using the masses given:
  - moles: (moles = mass/Mr)
    Cu: moles = 127 / 63.5 = 2
    O_2: moles= 32 / (16 x 2) = 32/32 = 1
    CuO moles = 159 / (16 + 63.5) = 2
  - therefore you have a ratio of 2:1:2 for $Cu:O_2:CuO$, making the overall balanced equation $2Cu + O_2 \rightarrow 2CuO$