

Core questions – Chemistry unit 3 – Quantitative chemistry

No.	Question	Answer
1	What is conservation of mass?	No atoms are lost or made during a chemical reaction - mass of the reactant = the mass of the products
2	Why can it appear that mass is not conserved?	If an experiment is completed in an open system, then gases can either enter or leave the system
3	Give an example of a reaction where mass may appear to increase	When a metal reacts with oxygen (gas) in an unsealed container, the mass of the container increases Metal (s) + oxygen (g) → metal oxide (s)
4	Give an example of a reaction where mass may appear to increase	When a metal carbonate thermally decomposes, carbon dioxide (gas) is given off Metal carbonate (s) → metal oxide (s) + carbon dioxide (g)
5	What is a word equation?	A way of using the names of substances to show what is happening during a chemical reaction
6	What are the products in a chemical reaction?	The new substances formed in a chemical reaction
7	What are the reactants in a chemical reaction?	The substances required for a chemical reaction
8	Why must all symbol equations be balanced?	All atoms must be conserved
	What does a balanced symbol equation show?	The number of moles of each compound that takes part in a chemical reaction
9	How do we know a symbol equation is balanced?	There is the same number of each atom on both sides of the arrow
10	What do the big numbers before the molecules in a symbol equation represent?	The number of units (or moles) of that molecule
11	Why must equations be balanced?	Because atoms cannot be created or destroyed
12	What is relative formula mass?	The sum of the relative atomic masses of the atoms in the numbers shown in the formula (e.g. O ₂ = 16 +16 = 32)
13	What is the symbol for relative formula mass?	M _r
14H	What is the definition molar mass? (Higher tier only)	The mass of one mole of a substance in grams
15H	What is the symbol for the unit mole? (Higher tier only)	Mol
16H	What is the definition of Avogadro's constant? (Higher tier only)	The number of particles (atoms, molecules or ions) in one mole of a given substance
17H	What number is Avogadro's constant? (Higher tier only)	6.02 x 10 ²³ per mole
18H	How many particles are there in 1 mole of any substance? (Higher tier only)	6.02 x 10 ²³

19H	What is the formula for calculating the number of moles? (Higher tier only)	number of moles = $\frac{\text{actual mass (g)}}{M_r}$	
20H	How can chemical equations be interpreted in terms of moles? (Higher tier only) E.g. $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$	This shows us 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	
21H	What is a limiting reactant? (Higher tier only)	If one reactant gets completely used up in a reaction before the rest, then the reaction will stop. This is the limiting reactant	
22H	What does it mean when a reactant is in 'excess'? (Higher tier only)	There is reactant left over (unreacted) at the end of the chemical reaction	
23H	Why might we add reactants to 'excess'? (Higher tier only)	To ensure that all of the other reactant is used up	
24H	How can we calculate the masses of reactants and products from a balanced symbol equation? (Higher tier only) e.g. <i>If we have a solution containing 100g of sodium hydroxide (NaOH), how much chlorine gas (Cl₂) should we pass through the solution to make bleach?</i>	<p>STEP 1 : Balance the equation:</p> <p>STEP 2 : Work out the M_r of the substances involved in the question:</p> <p>STEP 3 : Calculate the number of moles of the mass in the question: (Moles = mass / M_r)</p> <p>STEP 4: Look at the ratio of moles in the question:</p> <p>STEP 5 : Calculate the mass of 1.25 moles of chlorine:</p>	<p>$2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$</p> <p>NaOH = 40 Cl₂ = 71</p> <p>100g of sodium hydroxide is $100 \div 40 = \mathbf{2.5 \text{ moles}}$</p> <p>The chemical equation tells us that for every 2 moles of sodium hydroxide we need one mole of chlorine So we need $2.5 \div 2 = 1.25$ moles of chlorine</p> <p>$1.25 \times 71\text{g} = \mathbf{88.75\text{g}}$ of chlorine to react with 100g of sodium hydroxide</p>

25H	<p>How can we balance equations using reacting masses? (Higher tier only)</p> <p>e.g <i>8.1g of zinc oxide (ZnO) reacts completely with 0.60g of carbon to form 2.2g of carbon dioxide and 6.5g of zinc. Write a balanced symbol equation for this reaction.</i> <i>(C = 12), (O = 16), (Zn = 65)</i></p>	<p>STEP 1 : Work out M_r for each of the substances in the reaction</p> <p>STEP 2 : Divide the mass of each substance by its M_r to calculate how many moles of each substance reacted or were produced</p> <p>STEP 3 : Divide by the smallest number of moles (0.050)</p> <p>STEP 4 : The numbers are all the whole numbers, so you can use them to write the balanced symbol equation</p> <p>Tip: if any of the number aren't whole numbers, multiply all the numbers by the same amount so that they all become whole numbers</p>	<p>ZnO: $65 + 16 = 81$, C: 12, CO₂: $12 + (2 \times 16) = 44$, Zn: 65</p> <p>ZnO: $8.1 / 81 = 0.10$ mol, CO₂: $2.2 / 44 = 0.050$ mol C: $0.60 / 12 = 0.050$ mol, Zn: $6.5 / 65 = 0.10$ mol</p> <p>ZnO: $0.10 / 0.050 = 2.0$, CO₂: $0.050 / 0.050 = 1.0$, C: $0.050 / 0.050 = 1.0$, Zn: $0.10 / 0.050 = 2.0$</p> <p>$2\text{ZnO} + \text{C} \rightarrow \text{CO}_2 + 2\text{Zn}$</p>
26	What is a solvent?	A liquid that dissolves a solute	
27	What is a solute?	The solid that is being dissolved	
28	What is a solution?	A mixture of a solute dissolved in a solvent	
29	What is concentration?	The amount of substance in a certain volume of a solution	
30	What is the formula for calculating concentration (g/dm ³)?	$\text{concentration (g/dm}^3\text{)} = \frac{\text{mass of solute (g)}}{\text{volume of solvent (dm}^3\text{)}}$	
31T	What is percentage yield? (Triple only)	The percentage of theoretical yield actually obtained in a chemical reaction	
32T	What is the formula for calculating percentage yield? (Triple only)	$\% \text{ Yield} = \frac{\text{Mass of product actually made (g)}}{\text{Maximum theoretical mass of product (g)}} \times 100$	
33T	Why is it not possible to obtain the calculated theoretical yield in a reaction? (Triple only)	<ul style="list-style-type: none"> the reaction may not go to completion because it is reversible some of the product may be lost when it is separated from the reaction mixture some of the reactants may react in ways different to the expected reaction 	
34T	What is atom economy? (Triple only)	A measure of the amount of starting materials that end up as useful products.	
35T	Why is it important for sustainable development and for economic reasons to use reactions with high atom economy? (Triple only)	<ul style="list-style-type: none"> Less waste made that needs to be disposed of Resources used up less quickly More profitable 	

36T	What is the formula for calculating atom economy? (Triple only)	Atom economy = $\frac{\text{Relative formula mass of desired product}}{\text{relative formula mass of all reactants}} \times 100$	
37T	How do you calculate atom economy? (Triple only) e.g. calculate the atom economy of the following reaction to produce hydrogen gas $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{CO}(\text{g}) + 3\text{H}_2(\text{g})$	STEP 1: Identify the desired product STEP 2: Work out the Mr of all the reactants STEP 3: Work out the total Mr of the desired product STEP 4: Use formula to calculate the atom economy	Hydrogen gas CH₄: 16, H₂O: 18 TOTAL Mr = 34 3H₂ = 6 $(6 \div 34) \times 100 = \underline{\underline{17.6\%}}$
38T	What is the formula for calculating concentration (mol/dm ³)? (Triple only)	concentration (mol/dm ³) = $\frac{\text{number of moles of solute (mol)}}{\text{volume of solvent (dm}^3\text{)}}$	
39T	How many cm ³ are in 1 dm ³ ? (Triple only)	1 dm ³ = 1000cm ³	
40T	How can you convert cm ³ into dm ³ ? (Triple only)	Divide by 1000	
41T	What are the 6 steps for carrying out a titration? (Triple only)	<ol style="list-style-type: none"> 1. Use the pipette and pipette filler to add 25 cm³ of alkali (or acid) to a clean conical flask. 2. Add a few drops of indicator and put the conical flask on a white tile (so you can see the colour of the indicator more easily). 3. Fill the burette with acid (or alkali) and note the starting volume. 4. Slowly add the acid from the burette to the alkali in the conical flask, swirling to mix. 5. Stop adding the acid when the end-point is reached (the appropriate colour change in the indicator happens). Note the final volume reading. 6. Repeat steps 1 to 5 until you get consistent readings 	

42T	<p>If the volumes of two solutions that react completely are known and the concentration of one solution is known, how can the concentration of the other solution be calculated? (Triple only)</p> <p><i>e.g</i> <i>A student started with 30.0cm³ of sulfuric acid (H₂SO₄) of unknown concentration in a flask. She found that it took an average of 25.0cm³ of 0.100 mol/dm³ sodium hydroxide (NaOH) to neutralise the sulfuric acid. Find the concentration of the acid in mol/dm³. The balanced symbol equation for the reaction is:</i></p> $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$	<p>STEP 1: Convert all volumes to dm³</p> <p>STEP 2: Calculate the number of moles of the substance where the volume and concentration are known (moles = conc. x volume)</p> <p>STEP 3: Use the reaction equation to work out how many moles of the 'unknown' stuff you must have had</p> <p>STEP 4: Work out the concentration of the 'unknown' stuff (conc. = moles ÷ volume)</p>	<p>30.0 cm³ = 30.0 ÷ 1000 = 0.030 dm³ 25.0 cm³ = 25.0 ÷ 1000 = 0.025 dm³</p> <p>0.100 mol/dm³ x 0.025 dm³ = 0.00250 moles of NaOH</p> <p>Two moles of sodium hydroxide reacts with one mole of sulfuric acid. So 0.00250 moles of NaOH must have reacted with 0.00250 ÷ 2 = 0.00125 moles of H₂SO₄</p> <p>0.00125 mol ÷ 0.030 dm³ = 0.04166666 mol/dm³ = 0.0417 mol/dm³</p>
43T	What is a meniscus? (Triple only)	The curved upper surface of a liquid in a tube	
44T	What are concordant results? (Triple only)	The volume of three or more titres lie within 0.10cm ³ of each other	
45T	How do you calculate a mean? (Triple only)	Add up all the numbers, then divide by how many numbers there are	
46T	What volume does one mole of any gas occupy at 20°C? (Triple only)	24 dm ³ (24000 cm ³)	
47T	At what temperature does one mole of any gas occupy 24 dm ³ ? (Triple only)	20°C	
48T	What is the formula for calculating volume of gases? (Triple only)	Volume of gas (dm ³) = $\frac{\text{mass of gas (g)}}{M_r \text{ of gas}} \times 24 \text{ dm}^3$	Volume of gas (dm ³) = moles of gas x 24 dm ³