Yr11-12 Chemistry Bridging Project - Contents

Task 1 revisits some of the topics on atoms, ions and isotopes

Task 2 is a research based task covering some of the content previously covered in C4

Task 3 allows you to practise the skills involved in independently constructing balanced chemical equations

Task 4 focuses on preparing you to meet more complex mathematical questions based on the same &/or similar chemical concepts

Please make sure for each task you complete the LO boxes by traffic lighting your understanding before & after each task!

General Guidance

You will need to know the basics as you soon as you start your AS chemistry lessons in September so make sure you arrive to your first lesson able to do the following tasks. This will allow you to focus on the skills required to master the more complex chemical concepts – giving you confidence rather than making you feeling like you are behind from the start! So come in to Yr 12 fresh but ready/fully prepared.

The way you study should change in Year 12, both in terms of the amount of independent study you do for each subject and the strategies you use/develop when studying – if it doesn't you are likely to be at risk of underperforming! You MUST keep on top of the workload from the start making regular summaries along the way and not leave revision until the end of year before the exams.

To show a positive attitude to learning in completing the following tasks you MUST....

- ✓ **avoid leaving gaps** - a big difference from GCSE to AS Level is how YOU take ownership for your learning. If you find a question difficult or challenging YOU must take action by researching the topic to help overcome any misunderstanding.
- ✓ **be thorough** – avoid cutting corners e.g. you MUST show full working in any calculations, never just give the final answer; write in full sentences so your work is meaningful during times of revision.
- ✓ **be independent** – there is a place for 'peer learning' but this can also limit your progress if you become too reliant on others to explain how to approach a question or regularly complete tasks working together. Make sure you try to overcome any barriers yourself first by being resourceful and carrying our further reading on difficult topics, then use your peers to check if you reached the same answer.
- ✓ **Prepare for lessons** – arrive to lessons ready to submit any work due in and refresh your memory of the work covered in the previous lesson by reading through your notes and possibly re-attempting one or two questions/tasks.

Task 1 – Atoms, Ions & Isotopes

1

In this task you will cover the following LO's. Traffic light your understanding 'before' & 'after'
– *note: p+ = protons; e- = electrons; n = neutrons*

Learning Outcomes (LO) or Skill Area...	Student to complete: Before	Student to complete: After	Teacher use only
1. Describe protons, neutrons and electrons in terms of relative charge and relative mass.			
2. Describe the distribution of mass and charge within an atom.			
3. Describe the contribution of p+ & n to the nucleus of an atom, in terms of atomic (proton) number & mass (nucleon) number.			
4. Deduce the numbers of protons, neutrons and electrons in an atom given its atomic and mass number			
5. Deduce the numbers of protons, neutrons and electrons in an ion given its atomic number, mass number and ionic charge.			
6. Explain the term *isotopes* as atoms of an element with different numbers of neutrons and different masses.			
7. State that ^{12}C is used as the standard measurement of relative masses.			
8. Define the terms *relative isotopic mass* and *relative atomic mass*, based on the ^{12}C scale.			
9. Calculate the relative atomic mass of an element given the relative abundances of its isotopes.			
10. Use the terms *relative molecular mass* and *relative formula mass* and calculate values from relative atomic masses.			

Complete the following tasks – remember you must avoid leaving gaps! If you find a question or task challenging you MUST be proactive and research the answer...

1. Complete the table to show the location, relative charge and relative mass of each sub-atomic particle found within an atom (LO1).

Sub-atomic particle	Location	Relative charge	Relative mass
Neutron			
Electron			
Proton			

2. Use the table to describe the distribution of mass and charge within an atom (LO2)...

_____

_____

_____

Task 1 – Atoms, Ions & Isotopes

3. Give precise definitions for the following keyterms (LO3)....

Atomic (proton) number: _____

_____

Mass (nucleon) number: _____

_____

4. Complete the missing data in the table below - use the 2 definitions above, and your understanding of atomic structure from C4a (LO4)...

Atom	Atomic No.	Mass No.	No. of protons	No. of electrons	No. of neutrons
N					
K					
	5	11			
			18		22
		40			20
				55	78

5. Complete the missing data in the table below - use the example given, and your understanding of atomic structure and how atoms become ions from C4a & C4b, to (LO5)...

Atom	Metal or non-metal atom	Atomic No.	Electron Configuration	Gains /loses e-	No. of e- gained/loss	Ion formula produced	Electronic configuration
Li	Metal	3	2,1	loses	1e-	Li^+	$[2]^+$
Na							
Mg							
Al							
F							
O							
S							

Atom	Atomic No.	Mass No.	Ion Formula	No. of p+	No. of e-	Electronic config.	No. of n
Ca							
Cl							

6. Use dot & cross diagrams to model the ionic bonding in a) magnesium oxide and b) aluminium oxide:
Tip – only show the ions formed (not the atoms they come from) and if more than one ion is needed show how many e.g. if 2 oxygen ions are needed, show in this format: 2 x [ ]$^{2-}$

a) magnesium oxide:

b) aluminium oxide:

7. Give a precise definition of the keyterm 'isotope' (LO6).
Tip: within your definition include the words: proton, electron, neutron, atomic number, mass number

Isotope: _____

_____

_____

8. Complete the missing data on the isotopes of carbon in the table below - use your definition above, and your understanding of atomic structure and isotopes from C4a, (LO6)...

Example	Atom	Atomic No.	Mass No.	No. of protons	No. of electrons	No. of neutrons
1		6	12			
2	C					7
3				6		8
4					7	8

Qu: Which is NOT an isotope of carbon? Justify your choice _____

_____

_____

Qu: Explain, if any, the difference in reactivity between the 3 carbon isotopes? Tip: ask yourself 'do they all react with oxygen to produce carbon dioxide or only some?'. Give a reason for your answer.

_____

_____

_____

_____

Qu: Name one physical property that may differ between the isotopes of the same element? Justify

_____

_____

_____

How would you go about weighing something that you cannot see? This is the situation with atoms. Instead of finding the mass of atoms directly we compare the masses of different atoms, using the idea of relative mass.

Qu: What isotope has been used, since 1961, as the international standard for the measurement of relative mass? (LO7) _____.

9. Give precise definitions for the following keyterms (LO8)....

Relative isotopic mass: _____

_____

_____

All the atoms in a single isotope are identical so the relative isotopic mass is the same as the mass number.

Qu: Therefore what is the relative isotopic mass of a) oxygen-16? _____ b) Sodium-23? _____

Most elements contain a mixture of isotopes, each in a different amount and with a different mass so we have to take into account the contribution made by each isotope to the overall mass of a element which we call the 'relative atomic mass'

Relative atomic mass (A_r): _____

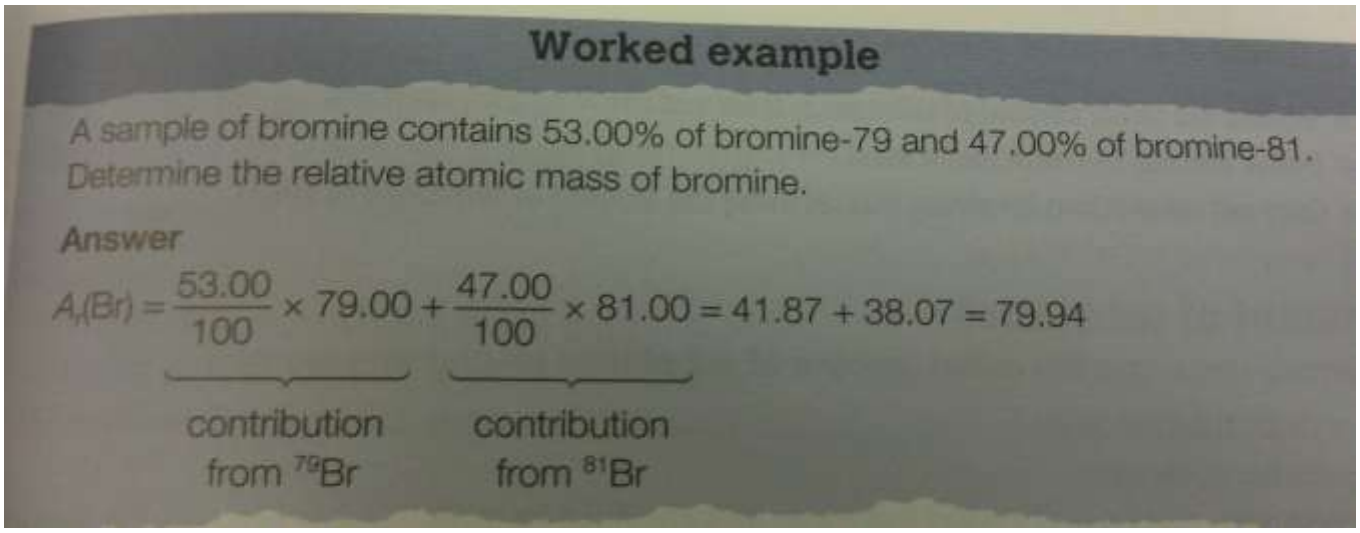
_____

_____

You will now learn how to calculate the relative atomic mass based on the element's isotopes.

Task 1 – Atoms, Ions & Isotopes

The relative atomic mass for an atom of a particular element can be found on the periodic table. However these are often not whole numbers (see AS Chemistry periodic table provided in this booklet, do NOT use your planner) as they have to take into account that each element is often a mixture of isotopes. Here's how the relative atomic masses on the periodic table have been derived…



Worked example

A sample of bromine contains 53.00% of bromine-79 and 47.00% of bromine-81. Determine the relative atomic mass of bromine.

Answer

$$A_r(Br) = \underbrace{\frac{53.00}{100} \times 79.00}_{\text{contribution from } {}^{79}Br} + \underbrace{\frac{47.00}{100} \times 81.00}_{\text{contribution from } {}^{81}Br} = 41.87 + 38.07 = 79.94$$

10. Use the worked example above to calculate the relative atomic mass of the following elements (LO9)….

Remember for each isotope you have to take into account it mass and its relative abundance, e.g. %

a) Boron contains: 19.77% ^{10}B & 80.23% ^{11}B

Ar: _____

b) Silicon contains: 92.18% ^{28}Si, 4.70% ^{29}Si & 3.12% ^{30}Si

Ar: _____

c) Unknown X contains: 4.31% ^{50}X, 83.76% ^{52}X, 9.55% ^{53}X & 2.38% ^{54}X

Ar: _____

Use the periodic table to work out the identity of this unknown element: _____

11. To appreciate the mass of a molecule we have to take into account the mass of each atom it contains and the number of each type of atom. We can do this by calculating its 'relative formula mass', M_r

Give precise definitions for the following keyterms (LO10)....

Relative formula mass (M_r): _____

_____

_____

To be more precise the term 'relative molecular mass' is used for molecules e.g. covalently bonded elements or compounds and the term 'relative formula mass' used for ionic compounds as they have giant lattice structures (not simple molecules)so its molecular formula is actually the empirical formula BUT effectively you are calculating the same thing!

Calculate the Mr of each compound listed below, showing full working (LO10):

a) $CaCO_3$

Mr = _____

b) $Cu(OH)_2$

Mr = _____

c) $(NH_4)_2SO_4$

Mr = _____

d) $Ca(NO_3)_2.4H_2O$

Mr = _____

Tip – in (d) work out the mass of each part either side of the dot & then add together

Task 2 – The Changing Atom…

In this task you will cover the following LO's. Traffic light your understanding 'before' & 'after'
– *note: p+ = protons; e- = electrons; n = neutrons*

	Student to complete:		Teacher use only
Learning Outcomes (LO) or Skill Area…	**Start**	**End**	
1. Describe how the model of the atom has changed over the years.			
2. Understand that scientific knowledge is always evolving.			
3. Describe how new theories are accepted by scientists.			

You must complete the research task, detailed below, and clearly present your findings. How you choose to present your work is up to you – a written report; series of cue cards; create a podcast or video; PowerPoint presentation; poster or factsheet.

OBJECTIVE 1: How the idea of the atom has changed from the Greeks to the present day.

Within this task you MUST meet the following criteria:

1. Key philosophers/scientists: Democritus, **Dalton**, **Thomson**, **Rutherford**, **Bohr**, Moseley, de Broglie, Schrodinger & Chadwick. Those shown in **bold MUST be included in your findings** but you may also like to research some or all of the others.
2. Describe each proposed model of the atom, using labelled diagrams where appropriate.
3. Highlight the limitations of each model
4. Full bibliography: list of ***reliable*** reference materials used to compile your research.

OBJECTIVE 2: Provide a brief history of the periodic table.

Within this task you MUST meet the following criteria:

1. An annotated copy of the modern day periodic table - clearly label or list as a key the information which we can obtain from it *e.g. group names; how it is arranged; how certain elements are grouped together; any patterns shown within the periodic table etc.*
2. A timeline of philosophers/scientists that helped to develop the periodic table to how the know it today e.g. Döbereiner; Newland; Mendeleev.

- -

Teacher use only: **Overall ATL** ☐ **= 1** ☐ **= 2** ☐ **= 3** ☐ **= 4**

ATL criteria/score:	**1**	**2**	**3**	**4**
✓ Quality of work:	☐	☐	☐	☐
✓ Thoroughness:	☐	☐	☐	☐
✓ Creativity:	☐	☐	☐	☐
✓ Reliability of references:	☐	☐	☐	☐

Task 3: Representing Chemical Reactions using Equations

Balancing equations becomes a little more challenging at AS level only because you are expected to independently derive a balanced chemical equation using given named reactants, sometimes for reactions that will be unfamiliar to you (not studied in class). However this becomes alot easier if you LEARN your general equations!

In this task you will cover the following LO's. Traffic light your understanding 'before' & 'after'

	Student to complete:		Teacher use only
Learning Outcomes (LO) or Skill Area...	**Start**	**End**	
1. I can balance equations when correct molecular formula is provided			
2. I can give the correct molecular formula based on ion charges.			
3. I can convert word equations to balanced chemical equations.			
4. I can give the correct balanced equation by applying a general eq.			
5. I can predict the correct equation to represent an unfamiliar reaction.			

1. Practise the concept of balancing equations using the chemical equations below (LO1):

Unbalanced equations: a) $C + O_2 \rightarrow CO$

b) $Na + O_2 \rightarrow Na_2O$

c) $Fe_2O_3 + CO \rightarrow Fe + CO_2$

d) $NH_3 + O_2 \rightarrow NO + H_2O$ (a toughy!)

2. Use the common ion bank (for ionic compounds only) provided and your understanding of C4a-c, to practise deducing (working out) the correct molecular formula for these named (LO2):

Ionic Compounds		Covalent elements or compounds	
Copper sulphate:		Iodine:	
Ammonium nitrate:		Carbon monoxide:	
Aluminium sulphate:		Methane:	
Ammonium carbonate:		Hexane:	
Calcium phosphate:		Ammonia:	

Help: Ion Formulae Bank *(Tip – if any are missing Google search or Wikipedia the ion charge)*

Cations (positive ions)	
Group 1 e.g. Li^+	1+
Group 2 e.g. Mg^{2+}	2+
Copper	Cu^{2+}
Lead	Pb^{2+}
Ammonium	NH_4^+

Anions (negative ions)			
Group 7 e.g. F^-	1-	Hydroxide	OH^-
Group 6 e.g. O^{2-}	2-	Phosphate	PO_4^{3-}
Nitrate	NO_3^-	Ethanoate	CH_3COO^-
Carbonate	CO_3^{2-}		
Sulphate	SO_4^{2-}		

3. Convert these word equations into balanced chemical equations:

a) Magnesium + hydrochloric acid → magnesium chloride + hydrogen

_____

b) Calcium hydroxide + sulphuric acid → calcium sulphate + water

_____

4. Select the correct general equation from the box below to complete the balanced chemical equations.

Tip – you may wish to construct word equation first and then convert it into a balanced equation

1. Metal + water → metal hydroxide + hydrogen
2. Metal + Acid → Salt + Hydrogen
3. Metal carbonate + acid → salt + carbon dioxide + water
4. Neutralisation: Metal oxide/hydroxide + acid → salt + water
5. Thermal decomposition: metal carbonate → metal oxide + carbon dioxide
6. Thermal decomposition: metal hydrogen carbonate → metal carbonate + water + carbon dioxide

a) Potassium is a group 1 metal that reacts vigorously with water.

_____

b) Thermal decomposition of baking powder (sodium hydrogen carbonate).

_____

c) The reaction that takes place when acid rain (sulphuric acid) corrodes buildings made of limestone.

_____

5. Predict the correct word and balanced chemical equation to represent these possibly unfamiliar reactions.

Tip - You may find the ion bank table on the previous page and the general equations above helpful.

d) The action of vinegar (ethanoic acid) on copper cans.

_____

_____

e) The action of the acid in coke (phosphoric acid) on an aluminium can

_____

_____

Task 4: Chemical Mathematics

10

In this task you will cover the following LO's. Traffic light your understanding 'before' & 'after'

	Student to complete:		Teacher use only
Learning Outcomes (LO) or Skill Area…	**Start**	**End**	
1. Explain the term *empirical formula.*			
2. Explain the term *molecular formula*.			
3. Calculate empirical formulae using composition by mass or %			
4. Calculate molecular formulae using composition by mass or %			

1. Give precise definitions for the following keyterms (LO1&2)….

Molecular formula: _____

_____

Empirical formula: _____

_____

Use your understanding from C5b & the table below to help practise calculating the empirical formula.

1. **List all of the elements in the compound**
2. **Underneath, write the mass or % given in the question**
3. **Calculate moles - ÷ each mass or % from step 2 by the Ar for each element**
   If the numbers are not ALL whole numbers….
4. **Identify the element in the smallest amount and divide each answer to step 3 by this.**
5. **Use this whole number ratio to give the simplest ratio of atoms of each element in the formula**

2. A hydrocarbon has 80% carbon and 20 %hydrogen. Calculate its empirical formula.

Ratio of atoms: ___ : ____ Empirical Formula: _____

3. 2.70g of aluminium is combined with 10.65g of chlorine. What is the empirical formula of this product?

Ratio of atoms: ___ : ____ Empirical Formula: _____

Task 4: Chemical Mathematics

The **mole** is a **unit** for an **amount of substance** (and is given the symbol **'n'**) – it is a standard pack (number) of particles.
This count of atoms is called the **Avogadro constant (N_A)** & is equal to **6.02×10^{23} mol^{-1}**

IMPORTANT DEFINITIONS
The **Avogadro constant** (N_A) is the number of atoms per mole of the carbon-12 isotope (6.02×10^{23} mol^{-1}).
A **mole** is the amount of any substance containing as many particles as there are carbon atoms in exactly 12g of the carbon-12 isotope.

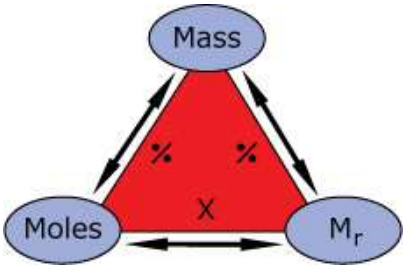
Basically if the amount of substance you want is 1 mole you would need to count out 6.02×10^{23} mol^{-1} atoms/molecules of that substance.

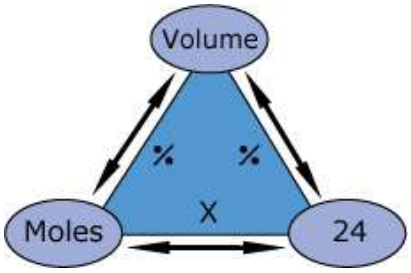
However, because atoms weigh different amounts (depending on the element) one mole of substance will have a different mass. For example:
1 mole of carbon-12 would contain 6.02×10^{23} carbon -12 atoms and weigh 12g
...but...
1 mole of sodium-23 would also contain 6.02×10^{23} carbon -12 atoms but weigh 23g

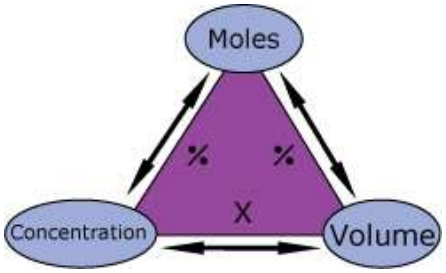
The **mass of one mole** is easy to work out as it is the **relative formula mass in grams** for that substance.
This is referred to as **molar mass, M**, and has **the units $gmol^{-1}$.**

	Student to complete:		Teacher use only
Learning Outcomes (LO) or Skill Area...	**Start**	**End**	
1. Explain the term '*amount of substance*'.			
2. Explain the term *mole* as the unit for amount of substance.			
3. Explain the term *Avogadro constant*, N_A, (6.02×10^{23} mol^{-1}).			
4. Define the term *molar mass* (units g mol^{-1})			
5. Use the term *molar mass* (units g mol^{-1})			
6. Carry out mole-based calculations involving mass			
7. Carry out mole-based calculations involving gas volume			
8. Carry out mole calculations involving solution vol. & concentration			
9. Deduce stoichiometric relationships (molar ratio) from calculations.			

Mole formulae – you will need to learn these equations as they are not provided in the exam

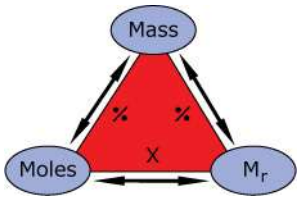






4. Use the formula triangle given to deduce the formula required to calculate mass (LO5&6):

Mass =



5. Use this formula to calculate the mass of each of the following (LO5&6)...

(a) 2.50 mol of hydrogen, H_2

Mass of H_2: _____ g

(b) 0.500 mol of sodium chloride, NaCl.

Mass of NaCl: _____ g

6. Again, use the formula triangle given to deduce the formula required to calculate the amount of substance (LO5&6):

Moles(n) =

7. Use this formula to calculate the amount (in mol) of each substance listed below....

a) 31.0 g of phosphorus molecules, P_4

Amount of P_4: _____ mol

b) 50.0 g of calcium carbonate, $CaCO_3$.

Amount of $CaCO_3$: _____ mol

8. Again, use the formula triangle given to deduce the formula required to calculate molar mass of an unknown substance

Molar mass (M_r) =

9. Use this formula to calculate the molar mass of an 11g gas sample of compound X, which is 0.25mol.

Molar mass: _____ $gmol^{-1}$

Possible identity of the gas sample X: _____

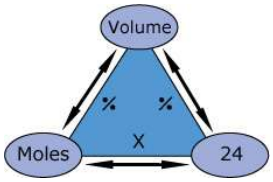
10. Use the formula triangle given to deduce the formula for calculating the amount of gas in mols …

When volume is in dm^3…

Moles (n) =

When volume is in cm^3…

Moles (n) =



11. Use this formula to calculate the amount of gas (in mol) of….

(a) 3600cm^3 of hydrogen gas, H_2

Amount of H_2 gas: _____ mol

(b) 4dm^3 of hydrogen gas, CO_2

Amount of CO_2 gas: _____ mol

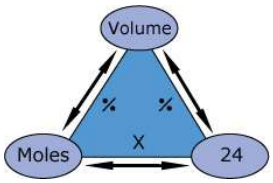
12. Use the formula triangle given to deduce the formula for calculating the volume of gas…

When volume is in dm^3…

Volume (V) =

When volume is in cm^3…

Volume (V) =



13. Use this formula to calculate the volume of gas….

(a) 6 mol of hydrogen gas, SO_2

Volume of SO_2 gas: _____ dm^3

(b) 0.25mol of oxygen gas, O_2

Volume of CO_2 gas: _____ cm^3

14. Complete the following tasks which is more representative of a *simple AS chemistry question*

Tip – you will need to use both mole formulas introduced so far (on pages 12-13)

(a) What is the mass of 84cm^3 of N_2O?

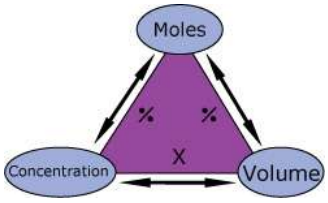
Mass of N_2O gas: _____ g

(b) What is the volume of 1.26g of propene, C_3H_6

Volume of C_3H_6 gas: _____ dm^3

15. Use the formula triangle given to deduce the formula for calculating the amount of moles in solution …

When volume is in dm^3…	When volume is in cm^3…
Moles (n) =	Moles (n) =



16. Use this formula to calculate the amount of substance (in mol) for the following solutions….

(a) $4dm^3$ of a 2 $moldm^{-3}$ solution

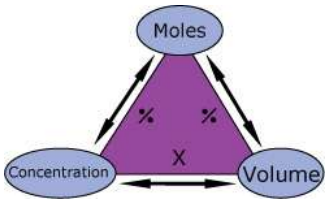
Amount of solution: _____ mol

(b) $25.0dm^3$ of a 0.15 $moldm^{-3}$ solution

Amount of solution: _____ mol

17. Use the formula triangle given to deduce the formula for calculating the volume of solution needed…

When volume is in dm^3…	When volume is in cm^3…
Volume (V) =	Volume (V) =



18. Use this formula to calculate the volume produced in the following solutions….

(a) a solution with a concentration of 2 $moldm^{-3}$ that contains 2 moles of solute.

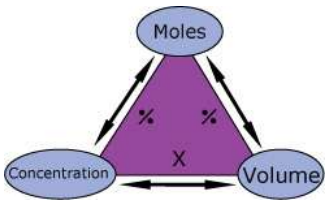
Volume of solution: _____ dm^3

(b) a solution with a concentration of 0.25 $moldm^{-3}$ that contains 0.005 moles of solute.

Volume of solution: _____ dm^3

19. Use the formula triangle given to deduce the formula for calculating the concentration of the solution…

When volume is in dm^3…	When volume is in cm^3…
Concentration (c) =	Concentration (c) =



20. Use this formula to calculate the concentration (in $moldm^{-3}$) for the following solutions….

(a) 0.5 moles of solid dissolved in $250cm^3$ of solution

Concentration: _____ $moldm^{-3}$

(b) 0.00875 moles of solid dissolved in $25cm^3$ solution

Concentration: _____ $moldm^{-3}$

Task 4: Chemical Mathematics (LO9)

Complete the following tasks, which is more representative of a *simple AS chemistry question…*

Tip – you will need to use more than one of the mole formulas introduced so far & use the balanced equation to find the molar ratio

21. Find the mass concentration, in gdm^{-3}, for the following solutions:

    (a) 0.0042 moles of HNO_3 dissolved in $250cm^{-3}$ of solution

    Mass concentration: _____ gdm^{-3}

    (b) 0.5 moles of HCl dissolved in $4dm^3$ of solution

    Mass concentration: _____ gdm^{-3}

22. The following reaction can take place, shown in this equation: $NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$

    (a) Balance the equation shown above

    (b) What volume of CO_2 is formed by the decomposition of 5.04g of $NaHCO_3$?

    Volume of CO_2: _____ dm^3

23. The following reaction can take place, shown in this equation:

    $$MgCO_{3(s)} + HNO_{3(aq)} \rightarrow Mg(NO_3)_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$$

    (a) Balance the equation shown above

    (b) 2.529g of $MgCO_3$ reacts with an excess of HNO_3. What volume of CO_2 is formed?

    Volume of CO_2: _____ dm^3

    (c) The final volume of the solution is $50.0cm^3$. What is the concentration of $Mg(NO_3)_{2(aq)}$ formed?

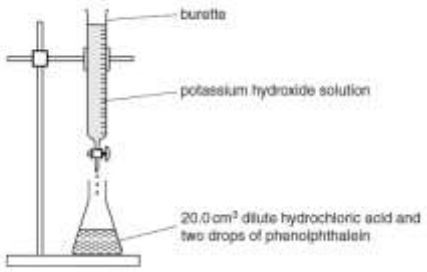
    Concentration: _____ $moldm^{-3}$

Task 4: GCSE Past Exam Qu's related to moles

Look at the equation for the reaction between potassium hydroxide and hydrochloric acid.

$$KOH + HCl \rightarrow KCl + H_2O$$

Look at the apparatus she uses.



Calculate the **concentration** of potassium hydroxide in mol/dm^3.

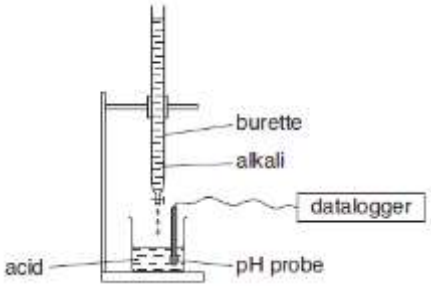
These steps may help.

Work out the:

- number of moles in 20.0 cm^3 of 0.200 mol/dm^3 hydrochloric acid
- number of moles of potassium hydroxide neutralised
- average titre, in cm^3, using titration numbers **2**, **3** and **4**.

titration number	1	2	3	4
final burette reading in cm^3	26.9	27.6	27.0	28.2
initial burette reading in cm^3	0.5	2.5	2.0	3.3
titre (volume of alkali used) in cm^3	26.4	25.1	25.0	24.9

Concentration of KOH: _____ moldm^{-3}



Tina does another experiment.

This time she uses

- 25.0 cm^3 of dilute hydrochloric acid in the beaker
- sodium hydroxide solution of concentration 0.100 mol/dm^3 in the burette.

The hydrochloric acid is exactly neutralised by 20.0 cm^3 of this sodium hydroxide solution.

Look at the balanced symbol equation for the reaction.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Calculate

- the number of moles of sodium hydroxide in 20.0 cm^3 of a 0.100 mol/dm^3 solution
- the number of moles of hydrochloric acid that reacted with this amount of sodium hydroxide
- the concentration, in mol/dm^3, of the hydrochloric acid.

Concentration of HCl: _____ $moldm^{-3}$