Year 11 Transition to A Level Chemistry Projects

There are 9 tasks for you to complete. The first 5 are recapping GCSE knowledge of key concepts and calculations. GCSE revision guides/websites will help you with this if necessary. The rest of the tasks give an introduction to some A level topics.

Task 1

Relative atomic mass (A_r)

The relative atomic mass of an element is the average mass of its atoms compared to 1/12th the mass of one atom of carbon-12.

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111		Elements with atomic numbers 112-116 have been reported but not fully authenticated					

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

Use the periodic table to give the A_r of the following elements.

Element	Relative atomic mass / g mol^{-1}
Sodium	
Magnesium	
Chlorine	

Argon	
Calcium	
Titanium	
Zinc	
Arsenic	
Tungsten	
Mercury	
Lead	

Task 2

Relative molecular mass (M_r)

The relative molecular mass is the average mass of one molecule of an element, or a compound compared to $1/12^{th}$ the mass of one atom of carbon-12.

It is the sum of the relative atomic masses of the elements in a molecule.

Use the periodic table to calculate the M_r of the following molecules.

Molecule	Calculation	Relative molecular mass / g mol^{-1}
O_2		
NaOH		
HCl		
H_2O		
$MgCl_2$		
Na_2CO_3		
Fe_2O_3		
$C_{10}H_{22}$		
$CuSO_4$		
$Mg(OH)_2$		
$Fe(OH)_3$		
$Fe(NO_3)_3$		
$(NH_4)_2SO_4$		

Task 3

Mass / M_r / moles

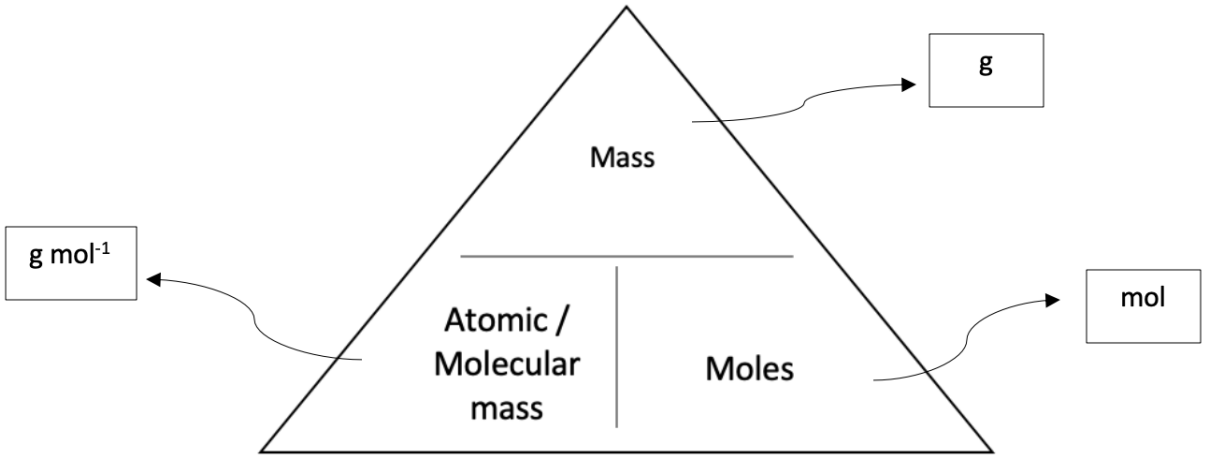
Moles is the amount of a substance. One mole of a substance contains 6.022 x10^{23} (Avogadro's constant) atoms or molecules. It is too big a number to use so instead we use moles.

23 g of sodium-23 contains 6.022 x10^{23} atoms.

24.3 g of magnesium-24.3 contains 6.022 x10^{23} atoms.

Use this equation and rearrange to answer the questions. Make sure you give the units

$$\text{Mass} = \text{M}_\text{r} \times \text{moles}$$



Convert the following masses into mg, g or kg:

Mass		
mg	g	Kg
	1000	
	750	
2000	2	0.002
250000		
		0.4

		0.003

Calculating moles

1. Calculate the number of moles of 2 g of sodium hydroxide (NaOH)

2. Calculate the number of moles of 50 g of decane ($C_{10}H_{22}$)

3. Calculate the number of moles of 20 mg of sodium carbonate (Na_2CO_3)

4. Calculate the number of moles of 43 mg of oxygen (O_2)

5. Calculate the number of moles of 0.05 Kg of copper sulphate ($CuSO_4$)

6. Calculate the number of moles of 0.025 Kg of iron (II) oxide (Fe_2O_3)

Calculating mass

1. Calculate the mass of 0.5 moles of sodium carbonate (Na_2CO_3). Give your answer in g.

2. Calculate the mass of 0.25 moles of decane ($C_{10}H_{22}$). Give your answer in g.

3. Calculate the mass of 0.1 moles of magnesium chloride ($MgCl_2$). Give your answer in mg.

4. Calculate the mass of 0.125 moles of copper sulphate ($CuSO_4$). Give your answer in mg.

5. Calculate the mass of 1.25 moles of oxygen (O_2). Give your answer in kg.

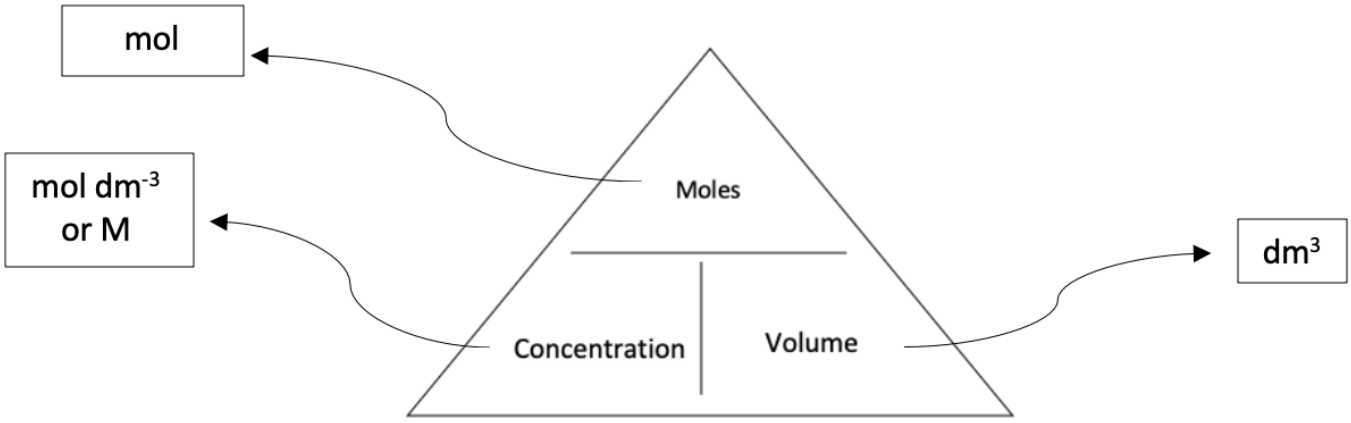
6. Calculate the mass of 0.75 moles of sodium hydroxide (NaOH). Give your answer in kg.

Task 4

Moles/ Concentration/ Volume

Use this equation and rearrange to answer the questions.

$$\text{Moles} = \text{Concentration} \times \text{Volume}$$



Convert the following volumes into cm^3 or dm^3

Volume	
cm^3	dm^3
75	
400	
660	
1230	
	0.005
	0.15

	0.7
	1.567

Calculating moles

1. A sodium hydroxide solution has a volume of 0.25 dm^3 and a concentration of 2 mol dm^{-3}. Calculate the moles of sodium hydroxide.

2. A sodium hydroxide solution has a volume of 500 cm^3 and a concentration of 0.5 mol dm^{-3}. Calculate the moles of sodium hydroxide.

3. A hydrochloric acid solution has a volume of 300 cm^3 and a concentration of 1 mol dm^{-3}. Calculate the moles of hydrochloric acid.

4. A sodium carbonate solution has a volume of 450 cm^3 and a concentration of 0.125 mol dm^3. Calculate the moles of sodium carbonate.

5. A nitric acid solution has a volume of 100 cm^3 and a concentration of 0.75 mol dm^3. Calculate the moles of nitric acid.

Calculating concentration

1. A solution of hydrochloric acid contains 0.2 moles in 2 dm^3. Calculate the concentration of the solution in mol dm^{-3}.

2. A solution of hydrochloric acid contains 0.5 moles in 500 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

3. A solution of sodium hydroxide contains 1 mole in 250 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

4. A solution of nitric acid contains 0.6 moles in 1200 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

5. A solution of sulfuric acid contains 0.125 moles in 200 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

Calculating volume

1. A solution of sulfuric acid has a concentration of 2 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.05 mol. Give your answer in $dm^{3.}$

2. A solution of hydrochloric acid has a concentration of 0.5 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.25 mol. Give your answer in $cm^{3.}$

3. A solution of nitric acid has a concentration of 1 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.25 mol. Give your answer in $cm^{3.}$

4. A solution of sodium hydroxide has a concentration of 2 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.125 mol. Give your answer in $cm^{3.}$

5. A solution of hydrochloric acid has a concentration of 0.25 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.5 mol. Give your answer in $cm^{3.}$

Task 5

Using two equations simultaneously

1. A sodium hydroxide (NaOH) solution has a volume of 0.1 dm^3 and a concentration of 0.5 mol dm^{-3}. Calculate the mass of sodium hydroxide needed in g.

2. A sodium hydroxide (NaOH) solution has a volume of 400 cm^3 and a concentration of 0.25 mol dm^{-3}. Calculate the mass of sodium hydroxide needed in g.

3. 2 g of sodium chloride (NaCl) is dissolved in 0.25 dm^3 of water. Calculate the concentration of the solution in mol dm^{-3}.

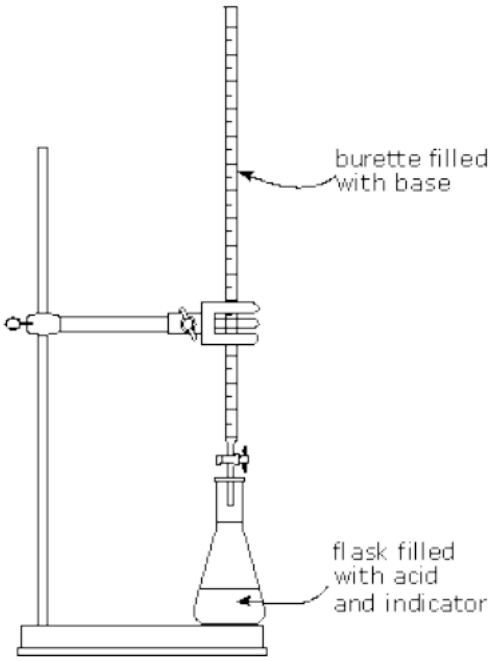
4. 10.6 g of sodium carbonate (Na_2CO_3) is dissolved in 0.1 dm^3 of water. Calculate the concentration of the solution in mol dm^{-3}.

5. A solution of copper sulphate ($CuSO_4$) has a concentration of 0.5 mol dm^{-3}. 12 g of copper sulphate was needed to make it. Calculate the volume of water needed in dm^3.

6. A solution of sodium carbonate (Na_2CO_3) has a concentration of 2 mol dm^{-3}. 5 g of sodium carbonate was needed to make it. Calculate the volume of water needed in cm^3.

Task 6

Acid-alkali titrations



Titration is a required practical that students have to do as part of the BTEC course. The experiment and the write-up make up Task A of Unit 2 in Year 12. Your task is to research titrations using the questions below to help.

Research questions

1. What is titration?

2. What are titrations used for?

3. What equipment do you need?

4. How would you calibrate a balance, burette and pipette?

5. What mass of sodium carbonate (Na_2CO_3) would be needed to make a solution with a concentration is 0.2 mol dm^3 in 250 cm^3?

6. How would you prepare the sodium carbonate standard solution?

7. What is the method for the titration of 0.2 mol dm^{-3} sodium carbonate and an unknown concentration of hydrochloric acid?

8. How would you calculate the concentration of HCl?

9. How do you know when the experiment has reached endpoint?

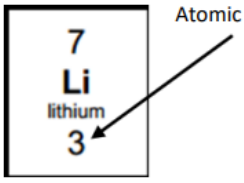
Task 7

Chemistry Topic 1 – Electronic structure, how electrons are arranged around the nucleus

A periodic table can give you the proton / atomic number of an element, this also tells you how many electrons are in the atom.

You will have used the rule of electrons shell filling, where:

The first shell holds up to 2 electrons, the second up to 8, the third up to 8 and the fourth up to 18 (or you may have been told 8).



Atomic number =3, electrons = 3, arrangement 2 in the first shell and 1 in the second or
Li = 2,1

At A level you will learn that the electron structure is more complex than this and can be used to explain a lot of the chemical properties of elements.

The 'shells' can be broken down into 'orbitals', which are given letters: 's' orbitals, 'p' orbitals and 'd' orbitals.

You can read about orbitals here:

http://bit.ly/pixlchem1

http://www.chemguide.co.uk/atoms/properties/atomorbs.html#top

Now that you are familiar with s, p and d orbitals try these problems. Write your answer in the format:

1s2, 2s2, 2p6 etc.

Q1. Write out the electron configuration of:

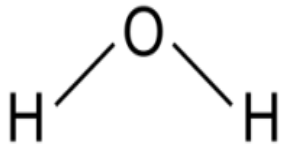
a) Ca b) Al c) S d) Cl e) Ar f) Fe g) V h) Ni i) Cu j) Zn k) As

Q2. Extension question, can you write out the electron arrangement of the following ions:

a) K+ b) O2- c) Zn2+ d) V5+ e) Co2+

Task 8

Have you ever wondered why your teacher drew a water molecule like this?
The lines represent a covalent bond, but why draw them at an unusual angle?
If you are unsure about covalent bonding, read about it here:



http://bit.ly/pixlchem5
http://www.chemguide.co.uk/atoms/bonding/covalent.html#top

At A level you are also expected to know how molecules have certain shapes and why they are the shape they are.
You can read about shapes of molecules here:

http://bit.ly/pixlchem6
http://www.chemguide.co.uk/atoms/bonding/shapes.html#top

Q1. Draw a dot and cross diagram to show the bonding in a molecule of aluminium chloride ($AlCl_3$)
Q2. Draw a dot and cross diagram to show the bonding in a molecule of ammonia (NH_3)
Q3. What is the shape and the bond angles in a molecule of methane (CH_4)?

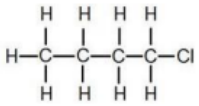
Task 9

At GCSE you would have come across **hydrocarbons** such as alkanes (ethane etc) and alkenes (ethene etc). You may have come across molecules such as alcohols and carboxylic acids. At A level you will learn about a wide range of molecules that have had atoms added to the carbon chain. These are called functional groups, they give the molecule certain physical and chemical properties that can make them incredibly useful to us.
Here you are going to meet a selection of the functional groups, learn a little about their properties and how we give them logical names.
You will find a menu for organic compounds here:

http://bit.ly/pixlchem13
http://www.chemguide.co.uk/orgpropsmenu.html#top

And how to name organic compounds here:
http://bit.ly/pixlchem14
http://www.chemguide.co.uk/basicorg/conventions/names.html#top

Using the two links see if you can answer the following questions:
Q1. Halogenoalkanes
a. What is the name of this halogenoalkane?
b. How could you make it from butan-1-ol?



Q2. Alcohols
a. How could you make ethanol from ethene?
b. How does ethanol react with sodium and in what ways is this a) similar to the reaction with water, b) different to the reaction with water?
Q3. Aldehydes and ketones
a. Draw the structures of a) propanal, b) propanone
b. How are these two functional groups different?

Task 7

Titration calculations

$$\text{Moles} = \text{Concentration} \times \text{Volume}$$

$$\text{Concentration} = \frac{\text{Moles}}{\text{Volume}}$$

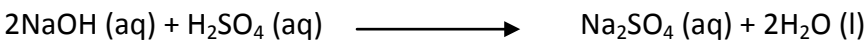
1. 25 cm^3 of 0.1 M NaOH is needed to titrate 12.5 cm^3 of a solution of hydrochloric acid. Calculate the concentration of the acid.

   $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

2. 23.15 cm^3 of 0.125 M NaOH is needed to titrate 25 cm^3 of a solution of hydrochloric acid. Calculate the concentration of the acid.

   $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

3. 25 cm^3 of 0.2 M NaOH is needed to titrate 25 cm^3 of a solution of sulphuric acid (H_2SO_4). Calculate the concentration of the acid.



4. 10 cm^3 of a solution of hydrochloric acid (HCl) was titrated with a 0.5 M solution of sodium carbonate. 30 cm^3 of the carbonate was required for neutralisation. Calculate the concentration of hydrochloric acid.