Chemistry Bridging Work – Summer 2024

As you embark upon your study of A-level chemistry, you will begin to explore the detailed structure of atoms (Topic 1) and chemical reactions. The topics that you will extend your current knowledge on over the 2-year course are outlined below

Unit 3.1 Physical Chemistry

- 3.1.1 Atomic structure
- 3.1.2 Amount of substance
- 3.1.3 Bonding
- 3.1.4 Energetics
- 3.1.5 Kinetics
- 3.1.6 Chemical equilibria and Le Chatelier's principle and *Kc*
- 3.1.7 Oxidation, reduction and redox equations
- 3.1.8 Thermodynamics (A-level only)
- 3.1.9 Rate equations (A-level only)
- 3.1.10 Equilibrium constant *Kp* for homogeneous systems (A-level only)
- 3.1.11 Electrode potentials and electrochemical cells (A-level only)
- 3.1.12 Acids and bases (A-level only)

Unit 3.2 Inorganic Chemistry

- 3.2.1 Periodicity
- 3.2.2 Group 2, the alkaline earth metals
- 3.2.3 Group 7(17), the halogens
- 3.2.4 Properties of Period 3 elements and their oxides (A-level only)
- 3.2.5 Transition metals (A-level only)
- 3.2.6 Reactions of ions in aqueous solution (A-level only)

3.3 Organic Chemistry

- 3.3.1 Introduction to organic chemistry
- 3.3.2 Alkanes
- 3.3.3 Halogenoalkanes
- 3.3.4 Alkenes
- 3.3.5 Alcohols
- 3.3.6 Organic analysis
- 3.3.7 Optical isomerism (A-level only)
- 3.3.8 Aldehydes and ketones (A-level only)
- 3.3.9 Carboxylic acids and derivatives (A-level only)
- 3.3.10 Aromatic chemistry (A-level only)
- 3.3.11 Amines (A-level only)
- 3.3.12 Polymers (A-level only)
- 3.3.13 Amino acids, proteins and DNA (A-level only)
- 3.3.14 Organic synthesis (A-level only)
- 3.3.15 Nuclear magnetic resonance spectroscopy (A-level only)
- 3.3.16 Chromatography (A-level only)

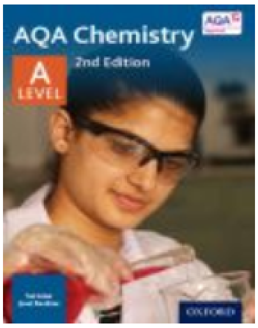
If you would like to read further into the specification you can do so using this link; https://filestore.aqa.org.uk/resources/chemistry/specifications/AQA-7404-7405-SP-2015.PDF.

Throughout the A-level course you will not only develop your knowledge and understanding of chemistry but will also develop your practical, literacy and mathematical skills. To reach the highest grades at AS and A-level chemistry, you should regularly engage in wider reading around the subject to extend your knowledge beyond the specification.

Book Recommendations

We would advise all students to purchase the practical chemistry book (£9.99). We would also recommend the course book we will be using below. A couple of copies are in the library to borrow as well as potentially buying second hand copies from the current Y13 or online.

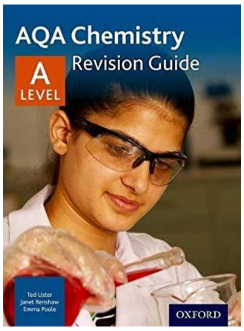
AQA A Level Chemistry (2nd edition)



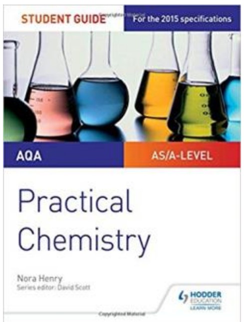
Authors: Ted Lister, Janet Renshaw
Publisher: Oxford University Press (including Nelson Thornes)
ISBN-13: 978-0-19-835182-5
Price: £42.00
Publication date: June 2015 - out now
Digital version - out now
Look inside (375.2 KB)

Others

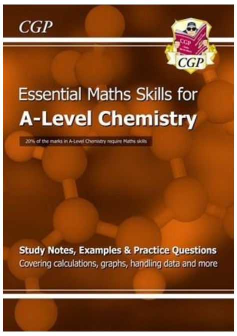
There is also an accompanying revision guide and a book on practical techniques:



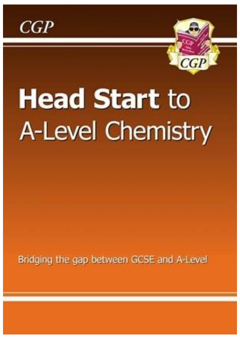
ISBN 978-0-19-835184-9 (price £14.99)



ISBN 978-1-4718-8514-3 (£9.99)



- **ISBN: 9781782944720**



ISBN: 9781782942801

- **The CGP books could be ordered through school if you speak with the science dep't or 6th form team.**

Summer Tasks to Complete

These Chemistry bridging tasks are designed to help you to review the core principles that you learnt during your GCSE's and to prepare yourself for the first topic that will be taught at the beginning of year 12. You must bring this work to your first Chemistry lesson in September.

1. **Check out mathematical requirements for the course at https://www.aqa.org.uk/subjects/science/as-and-a-level/chemistry-7404-7405/mathematical-requirements-and-exemplifications**

2. **Complete the activities 1- 8 below.**

3. **Watch the video "Atom 1: The Clash of the Titans" https://www.youtube.com/watch?v=Y-AiqCp7Vlc and make notes on key scientists involved and their contribution to the development of current theories. Be prepared to discuss and share these ideas during the first week in September.**

4. **Revise key ideas on atomic structure, bonding and mole calculations and complete the tasks from the "pre-knowledge topics" below (topics 1-4).**

Understanding and applying the correct terms are key for practical science. Much of the vocabulary you have used at GCSE for practical work will not change but some terms are dealt with in more detail at A-level so are more complex.

Activity 1 Scientific vocabulary: Designing an investigation

Link each term on the left to the correct definition on the right.

Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right.

Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

Understanding and using SI units

Every measurement has a size (e.g. 2.7) and a unit (e.g. metres or kilograms). Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass.

There is a standard system of units, called the SI units, which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

All other units can be derived from the SI base units. For example, area is measured in metres square (written as m^2) and speed is measured in metres per second (written as $m\ s^{-1}$: not that this is a change from GCSE, where it would be written as m/s).

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (the SI unit for length) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 4 SI units and prefixes

1. What would be the most appropriate unit to use for the following measurements?

    a. The mass of water in a test tube.
    b. The volume of water in a burette.
    c. The time taken for a solution to change colour.
    d. The radius of a gold atom.
    e. The number of particles e.g. atoms in a chemical.
    f. The temperature of a liquid.

2. Re-write the following quantities using the correct SI units.

    a. 0.5 litres
    b. 5 minutes
    c. 20 °C
    d. 70 °F
    e. 10 ml (millilitres)
    f. 5.5 tonnes
    g. 96.4 microlitres (µl)

3. Scientists have been developing the production of a new material through the reaction of two constituents.

    Before going to commercial production, the scientists must give their data in the correct SI units.

a. The flow rate of the critical chemical was reported as 240 grams per minute at a temperature of 20 °C.

Re-write this flow rate using the correct SI units. Show your working.

Activity 5 Converting data

Re-write the following.

1. 0.1 metres in millimetres
2. 1 centimetre in millimetres
3. 104 micrograms in grams
4. 1.1202 kilometres in metres
5. 70 decilitres in millilitres
6. 70 decilitres in litres
7. 10 cm^3 in litres
8. 2140 pascals in kilopascals

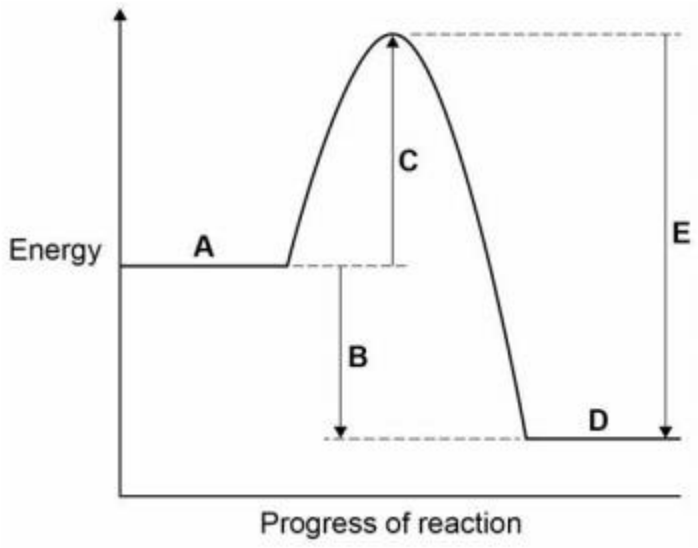
The delta symbol (Δ)

The delta symbol (Δ) is used to mean 'change in'. You might not have seen this symbol before in your GCSE Chemistry course, although it is used in some equations in GCSE Physics.

Activity 6 Using the delta symbol

In exothermic and endothermic reactions there are energy changes.

The diagram below shows the reaction profile for the reaction between zinc and copper sulfate solution.



1. Which letter represents the products of the reaction?

2. Which letter represents the activation energy?

3. Complete the sentence using the words below.

The reaction is ____________________ and therefore ΔH is ____________________

endothermic exothermic negative positive

The Periodic Table of the Elements

Key

relative atomic mass **symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1.0 **H** hydrogen 1										*(18)* 4.0 **He** helium 2
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											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											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	96.0 **Mo** molybdenum 42	[97] **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	[267] **Rf** rutherfordium 104	[270] **Db** dubnium 105	[269] **Sg** seaborgium 106	[270] **Bh** bohrium 107	[270] **Hs** hassium 108	[278] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[281] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

*** 58 – 71** Lanthanides	140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.0 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
† 90 – 103 Actinides	232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

Activity 7 Atoms

1. Give the atomic number of:

    a. Osmium
    b. Lead
    c. Sodium
    d. Chlorine

2. Give the relative atomic mass (A_r) of:

    a. Helium
    b. Francium
    c. Barium
    d. Oxygen

3. What is the number of neutrons in each of the following elements?

    a. Fluorine
    b. Beryllium
    c. Gold

Activity 8 Ions and ionic compounds

The table below lists the formulae of some common ions.

Positive ions		Negative ions	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^-
Ammonium	NH_4^+	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^-
Calcium	Ca^{2+}	Fluoride	F^-
Copper(II)	Cu^{2+}	Iodide	I^-
Hydrogen	H^+	Hydroxide	OH^-
Iron(II)	Fe^{2+}	Nitrate	NO_3^-
Iron(III)	Fe^{3+}	Oxide	O_2^-
Lead	Pb^{2+}	Sulfate	SO_4^{2-}
Lithium	Li^+	Sulfide	S^{2-}
Magnesium	Mg^{2+}		
Potassium	K^+		
Silver	Ag^+		
Sodium	Na^+		
Zinc	Zn^{2+}		

Use the table to state the formulae for the following ionic compounds.

1. Magnesium bromide
2. Barium oxide
3. Zinc chloride
4. Ammonium chloride
5. Ammonium carbonate
6. Aluminium bromide
7. Calcium nitrate
8. Iron (II) sulfate
9. Iron (III) sulfate

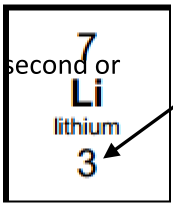
Pre-Knowledge Topics

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://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:

$1s^2$, $2s^2$, $2p^6$ etc.

Q1.1 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

Q1.2 Extension question, can you write out the electron arrangement of the following ***ions***:

a) K^+ b) O^{2-} c) Zn^{2+} d) V^{5+} e) Co^{2+}

2 – Isotopes and mass

You will remember that an isotopes are elements that have differing numbers of neutrons.
Hydrogen has 3 isotopes; H_1^1 H_1^2 H_1^3

Isotopes occur naturally, so in a sample of an element you will have a mixture of these isotopes. We can accurately measure the amount of an isotope using a **mass spectrometer**. You will need to understand what a mass spectrometer is and how it works at A level. You can read about a mass spectrometer here:

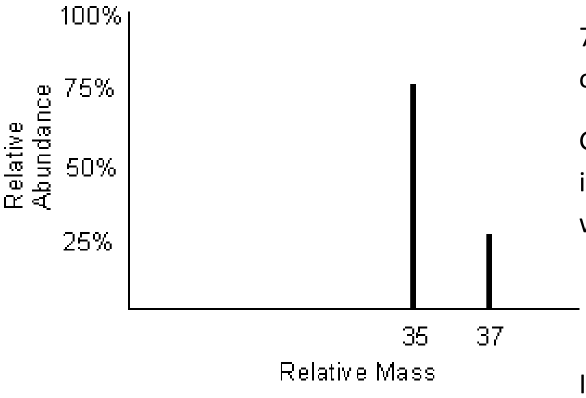
http://www.kore.co.uk/tutorial.htm

http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF

Q2.1 What must happen to the atoms before they are accelerated in the mass spectrometer?

Q2.2 Explain why the different isotopes travel at different speeds in a mass spectrometer.

A mass spectrum for the element chlorine will give a spectrum like this:



75% of the sample consist of chlorine-35, and 25% of the sample is chlorine-37.

Given a sample of naturally occurring chlorine ¾ of it will be Cl-35 and ¼ of it is Cl-37. We can calculate what the **mean** mass of the sample will be:

$$\text{Mean mass} = \frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$$

If you look at a periodic table this is why chlorine has an atomic mass of 35.5.

http://www.avogadro.co.uk/definitions/ar.htm

An A level periodic table has the masses of elements recorded much more accurately than at GCSE. Most elements have isotopes and these have been recorded using mass spectrometers.

GCSE

11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9
27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17

A level

10.8 5 **B** boron	12.0 6 **C** carbon	14.0 7 **N** nitrogen	16.0 8 **O** oxygen	19.0 9 **F** fluorine
27.0 13 **Al** aluminium	28.1 14 **Si** silicon	31.0 15 **P** phosphorus	32.1 16 **S** sulphur	35.5 17 **Cl** chlorine

Given the percentage of each isotope you can calculate the mean mass which is the accurate atomic mass for that element.

Q2.3 Use the percentages of each isotope to calculate the accurate atomic mass of the following elements.

a) Antimony has 2 isotopes: ^{121}Sb 57.25% and ^{123}Sb 42.75%
b) Gallium has 2 isotopes: ^{69}Ga 60.2% and ^{71}Ga 39.8%
c) Silver has 2 isotopes: 107Ag 51.35% and ^{109}Ag 48.65%
d) Strontium has **4** isotopes: ^{84}Sr 0.56%, ^{86}Sr 9.86%, ^{87}Sr 7.02% and ^{88}Sr 82.56%

3 – Measuring chemicals using relative mass and the mole

From this point on you need to be using an A level periodic table, not a GCSE one you can view one here:

https://secondaryscience4all.files.wordpress.com/2014/08/filestore_aqa_org_uk_subjects_aqa-2420-w-trb-ptds_pdf.png

Now that we have our chemical equations balanced, we need to be able to use them in order to work out masses of chemicals we need or we can produce.

The ***mole*** is the chemists equivalent of a dozen, atoms are so small that we cannot count them out individually, we weigh out chemicals.

For example: magnesium + sulfur → magnesium sulfide

$$Mg + S \rightarrow MgS$$

We can see that one atom of magnesium will react with one atom of sulfur, if we had to weigh out the atoms we need to know how heavy each atom is.

From the periodic table: Mg = 24.3 and S = 32.1

If I weigh out exactly 24.3g of magnesium this will be 1 mole of magnesium, if we counted how many atoms were present in this mass it would be a huge number (6.02×10^{23}!!!!), if I weigh out 32.1g of sulfur then I would have 1 mole of sulfur atoms.

So 24.3g of Mg will react precisely with 32.1g of sulfur, and will make 56.4g of magnesium sulfide.

Here is a comprehensive page on measuring moles, there are a number of descriptions, videos and practice problems.

You will find the first 6 tutorials of most use here, and problem sets 1 to 3.

http://www.chemteam.info/Mole/Mole.html

Q3.1 Answer the following questions on moles.

a) How many moles of phosphorus pentoxide (P_4O_{10}) are in 85.2g?
b) How many moles of potassium chlorate ($KClO_3$) in 73.56g?
c) How many moles of water are in 249.6g of hydrated copper sulfate(VI) ($CuSO_4.5H_2O$)? For this one, you need to be aware the dot followed by $5H_2O$ means that the molecule comes with 5 water molecules so these have to be counted in as part of the molecules mass.
d) What is the mass of 0.125 moles of tin sulfate ($SnSO_4$)?
e) If I have 2.4g of magnesium, how many g of oxygen (O_2) will I need to react completely with the magnesium? $2Mg + O_2 \rightarrow 2MgO$

4 – Solutions and concentrations

In chemistry a lot of the reactions we carry out involve mixing solutions rather than solids, gases or liquids.

You will have used bottles of acids in science that have labels saying 'Hydrochloric acid 1M', this is a solution of hydrochloric acid where 1 mole of HCl, hydrogen chloride (a gas) has been dissolved in $1dm^3$ of water.

The dm^3 is a cubic decimetre, it is actually 1 litre, but from this point on as an A level chemist you will use the dm^3 as your volume measurement.

http://www.docbrown.info/page04/4_73calcs11msc.htm

Q4

a) What is the concentration (in $moldm^{-3}$) of 9.53g of magnesium chloride ($MgCl_2$) dissolved in $100cm^3$ of water?

b) What is the concentration (in $moldm^{-3}$) of 13.248g of lead nitrate ($Pb(NO_3)_2$) dissolved in $2dm^3$ of water?

c) If I add $100cm^3$ of 1.00 $moldm^{-3}$ HCl to $1.9dm^3$ of water, what is the molarity of the new solution?

d) What mass of silver is present in $100cm^3$ of $1moldm^{-3}$ silver nitrate ($AgNO_3$)?

e) The Dead Sea, between Jordan and Israel, contains 0.0526 $moldm^{-3}$ of Bromide ions (Br^-), what mass of bromine is in $1dm^3$ of Dead Sea water?