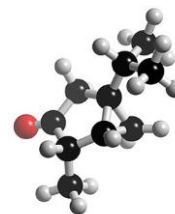




Ripon Grammar School



Chemistry Department

L6 Induction Work



Bridging the gap between GCSE and AS

Summer 2018

The Periodic Table of the Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	6.9 Li lithium 3	9.0 Be beryllium 4						1.0 H hydrogen 1					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	4.0 He helium 2
	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	[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	[267] Rf rutherfordium 104	[268] Db dubnium 105	[271] Sg seaborgium 106	[272] Bh bohrium 107	[270] Hs hassium 108	[276] Mt meitnerium 109	[281] Ds darmstadtium 110	[280] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						
	140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	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	173.1 Yb ytterbium 70	175.0 Lu lutetium 71					
	232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[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					

* 58 – 71 Lanthanides

† 90 – 103 Actinides

Advanced level Chemistry is a demanding and exciting course. In order to be prepared for your start in September a number of areas from GCSE chemistry are needed to be 'known' thoroughly. To help you make the transition as smoothly as possible we have put together this series of exercises. When you start in September you will be expected to have completed the exercises within this booklet and know the material within. It is by no means ALL you need to know but the very foundations of the exciting journey you are about to start. If you have difficulties or confusions there are a number of suggested online resources you could try. There will be opportunities to discuss concerns with staff at the beginning of the year but you should have made significant headway independently.

This booklet contains some undetailed notes to act as a reminder. If you struggle with a particular area you should investigate the suggested support resources, your GCSE notes and your local library. There are exercises for you to complete, the answers are at the end.

Contents

Periodic Table	2
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Useful resources:

Use your GCSE notes

www.chemsheets.co.uk (follow GCSE link)

<http://www.knockhardy.org.uk>

There are a few selected video clips throughout the booklet. There is a great wealth of information on the internet (and some of it is useful and/or correct). These resources have been specifically selected for your viewing pleasure!

Writing formulae

Objectives:

- Know the common ions
- Be able to construct formulae for common ionic substances
- Know the formulae of some common covalent substances

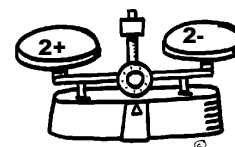
Common ions:

Here are some of the most common ions taken from the GCSE data sheet.

You need to KNOW these, they are not available on the data sheet at advanced level.

Positive ions		Negative ions	
Name	Formula	Name	Formula
Hydrogen	H ⁺	Chloride	Cl ⁻
Sodium	Na ⁺	Bromide	Br ⁻
Silver	Ag ⁺	Fluoride	F ⁻
Potassium	K ⁺	Iodide	I ⁻
Lithium	Li ⁺	Hydroxide	OH ⁻
Ammonium	NH ₄ ⁺	Nitrate	NO ₃ ⁻
Barium	Ba ²⁺	Oxide	O ²⁻
Calcium	Ca ²⁺	Sulfide	S ²⁻
Copper(II)	Cu ²⁺	Sulfate	SO ₄ ²⁻
Magnesium	Mg ²⁺	Carbonate	CO ₃ ²⁻
Zinc	Zn ²⁺		
Lead	Pb ²⁺		
Iron(II)	Fe ²⁺		
Iron(III)	Fe ³⁺		
Aluminium	Al ³⁺		

Putting together an ionic formula:



The charges must balance.

Molecular ions will need to be contained in brackets.

e.g.

Potassium Oxide

Potassium ion K⁺ Oxide ion O²⁻

There is 1+ and 2-

So we need:

K⁺ K⁺ to balance the O²⁻

Giving the formula



Aluminium Hydroxide

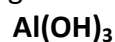
Aluminium ion Al³⁺ Hydroxide ion OH⁻

There is 3+ and 1-

So we need:

OH⁻ OH⁻ OH⁻ to balance the Al³⁺

Giving the formula



Exercise WF 1

Writing formulae from names:

1. Sodium Chloride _____

2. Sodium Hydroxide _____

3. Sodium Carbonate _____

4. Sodium Sulfate _____

5. Magnesium Chloride _____

6. Magnesium Nitrate _____

7. Magnesium Hydroxide _____

8. Aluminium Chloride _____

9. Aluminium Sulfate _____

10. Copper (II) Sulfate _____

11. Copper (I) Oxide _____

12. Zinc Nitrate _____

13. Silver Bromide _____

14. Iron (II) Oxide _____

15. Iron (III) Oxide _____

16. Ammonium Nitrate _____

17. Ammonium Sulfate _____

18. Silver Sulfide _____

19. Aluminium Oxide _____

20. Zinc Iodide _____

Some common substances you should know the formulae of:

Carbon Dioxide	CO ₂	Carbon Monoxide	CO
Nitrogen monoxide	NO	Nitrogen dioxide	NO ₂
Sulfur dioxide	SO ₂	Sulfur trioxide	SO ₃
Ammonia	NH ₃	Methane	CH ₄
Hydrogen sulphide	H ₂ S	Hydrogen peroxide	H ₂ O ₂
Hydrochloric acid	HCl	Sulphuric Acid	H ₂ SO ₄
Nitric Acid	HNO ₃		

General rules for naming compounds:

If there are two elements present the name will end in **-ide**.

eg	Na_2O	Sodium Oxide
	MgCl_2	Magnesium Chloride
	Mg_3N_2	Magnesium Nitride

If the elements concerned can form more than one ion (transition metals) you will need to give the valency in brackets.

e.g.	PbCl_2	Lead (II) Chloride
	PbCl_4	Lead (IV) Chloride

Where a compound contains a metal, a non-metal and oxygen it has a name ending in **-ate**.

e.g.	MgCO_3	Magnesium Carbonate
	FeSO_4	Iron (II) Sulphate
	KClO_3	Potassium Chlorate

Exercise WF 2

Writing names from formulae:

1. H_2O _____

2. CO_2 _____

3. NH_3 _____

4. NaH _____

5. CH_4 _____

6. HNO_3 _____

7. NaNO_3 _____

8. CaCl_2 _____

9. SO_2 _____

10. Li_2S _____

11. Li_2SO_4 _____

12. CuSO_4 _____

13. AgNO_3 _____

14. $(\text{NH}_4)_2\text{SO}_4$ _____

15. NH_4VO_3 _____

16. KMnO_4 _____

17. $\text{K}_2\text{Cr}_2\text{O}_7$ _____

18. KI _____

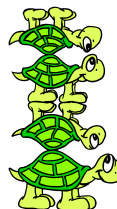
19. $\text{Co}(\text{NO}_3)_2$ _____

20. KAt _____

Equations

Objectives:

- Be able to write word equations
- Be able to balance symbol equations
- Write balanced symbol equations from descriptions



Balancing is
VERY important

Word equations:

You will very rarely be asked to write word equations at Advanced Level. This is because you are expected to **always** write balanced symbol equations. However, to be able to write the symbol equations you need to know your word equations first!

Some common reaction equations:

You can write general word equations for some common types of reaction.

Acid and alkali: **acid + alkali → salt + water**

- An example is:
hydrochloric acid + sodium hydroxide → sodium chloride + water

Acid and metal oxide: **acid + metal oxide → salt + water**

- An example is:
sulfuric acid + copper oxide → copper sulfate + water

Acid and carbonate: **acid + carbonate → salt + water + carbon dioxide**

- An example is:
hydrochloric acid + calcium carbonate → calcium chloride + water + carbon dioxide

Acid and metal: **acid + metal → salt + hydrogen**

- An example is:
sulfuric acid + zinc → zinc sulfate + hydrogen

Metal and oxygen: **metal + oxygen → oxide**

- An example is:
magnesium + oxygen → magnesium oxide

Metal and sulfur: **metal + sulfur → sulfide**

- An example is:
iron + sulfur → iron sulfide

Metal and water: **metal + water → hydroxide + hydrogen**

- An example is:
calcium + water → calcium hydroxide + hydrogen

Combustion of hydrocarbon: **fuel + oxygen → carbon dioxide + water**

- An example is:
methane + oxygen → carbon dioxide + water

Exercise Eqn 1

Write word equations for the following reactions:

1. Aluminium reacting with sulfur
2. Copper burning in oxygen
3. Ethane (C₂H₆) burning completely in oxygen
4. Ethanol (C₂H₅OH) burning completely in oxygen
5. Lithium reacting with water
6. Magnesium reacting in nitric acid
7. Potassium oxidising in the air
8. The reaction of calcium hydroxide with hydrochloric acid
9. The reaction of sodium oxide with sulphuric acid
10. Zinc carbonate reacting with hydrochloric acid

Balancing equations

In a chemical reaction atoms are rearranged. They can't disappear or appear from nowhere. You must have the same number of each type of atom on each side of the equation. For clarification see:

<http://www.sciencepass.com/2011/02/balancing-chemical-equations.html>

Exercise Eqn 2

Write balanced equations for the above reactions

Exercise Eqn 3

Write balanced equations for the following reactions (including state symbols):

Remember:	(s) solid	(l) liquid	(g) gas	(aq) aqueous - dissolved in water
------------------	------------------	-------------------	----------------	--

1. Zinc metal reacts with copper (II) sulphate solution to produce solid copper metal and zinc sulphate solution
2. Solid calcium hydroxide reacts with solid ammonium chloride on heating to produce solid calcium chloride, steam and ammonia gas.
3. When lead(II) nitrate is heated in a dry tube lead (II) oxide, nitrogen dioxide gas and oxygen are produced.
4. Silicon tetrachloride reacts with water to produce solid silicon dioxide and hydrogen chloride gas.
5. When octane (C_8H_{18}) vapour is burnt with excess air in a car engine carbon dioxide and water vapour are produced through a complete combustion reaction.
6. All the halogens apart from fluorine react with concentrated sodium hydroxide solution to produce a solution of the sodium halide (NaX) and the sodium halate ($NaXO_3$) and water.
7. The elements of group 1 of the periodic table all react with water to produce a solution of the hydroxide of the metal and hydrogen gas
8. Tin (II) chloride solution reacts with mercury (II) chloride solution to produce a precipitate of mercury (I) chloride and a solution of tin (IV) chloride. This precipitate of mercury (I) chloride then reacts with a further tin (II) chloride solution to produce liquid mercury and more tin(IV) chloride.
9. Concentrated sulphuric acid reacts with solid potassium iodide to produce solid potassium hydrogen sulphate, iodine vapour, water and hydrogen sulphide gas.

Moles

Objectives:

- Define M_r
- Be able to calculate M_r
- Calculate reacting masses in reactions involving solids
- Know what concentration is
- Be able to calculate concentrations and volumes of solutions



M_r is the sum of the A_r 's of a substance. Therefore, if you know the formula of a substance you can calculate (using your Periodic Table) the M_r .

e.g. water has the formula H_2O , H has an A_r of 1.0 and O has an A_r of 16.0.
Therefore the $M_r = 1.0 + 1.0 + 16.0 = 18.0$

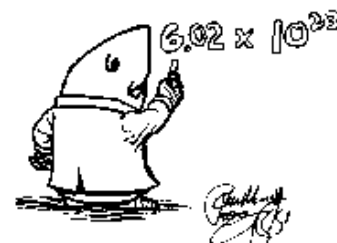
Exercise M 1 Calculate the M_r of the following substances

- Barium Chloride
- Ammonium Nitrate
- Calcium Sulphate
- Barium Nitrate
- Silver Oxide
- Aluminium Sulphate
- Fluorine
- Sulphur Dioxide
- Iron (II) Sulphate
- Sodium Carbonate
- Sodium Hydride
- Zinc Hydroxide
- Potassium Oxide
- Zinc
- Carbon Dioxide
- Hydrogen
- Sulphur trioxide
- Beryllium Hydroxide
- Vanadium (V) Oxide
- Copper (I) Oxide

Calculating the number of moles in a substance

A mole is the measurement of a given number of particles. It has the value :
e.g.

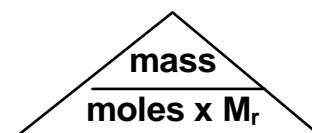
- 1 mole of hydrogen molecules is 6.02×10^{23} H_2 Molecules
- 2 moles of electrons, 12.04×10^{23} electrons
- 10 moles of lead(II) ions, 6.02×10^{24} Pb^{2+}
- 0.1 moles of zinc atoms, 6.02×10^{22} Zn atoms



To calculate the number of moles in a given mass:

$$\text{Moles} = \text{Mass} / M_r$$

e.g. how many moles are there in 320g of oxygen gas
moles = $320/32 = 10$ moles of O_2 molecules



Further help

http://www.knockhardy.org.uk/ppoints_htm_files/molespps.pps#256,1,Slide 1

Exercise M 2 Calculate the number of moles in the following:

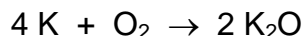
1. 9.00 g of H_2O
2. 88.0 g of CO_2
3. 1.70 g of NH_3
4. 230 g of $\text{C}_2\text{H}_5\text{OH}$
5. 560 g of C_2H_4
6. 0.640 g of SO_2
7. 80.0 g of SO_3
8. 18.0 g of HBr
9. 0.0960 g of H_2SO_4
10. 3.15 g of HNO_3
11. 19.3 g of NaCl
12. 21.25 g of NaNO_3
13. 2.25 g of Na_2CO_3
14. 0.800 g of NaOH
15. 17.75 g of Na_2SO_4
16. 3.16 g of KMnO_4
17. 32.33 g of K_2CrO_4
18. 100 g of KHCO_3
19. 7.63 g of potassium iodide
20. 3.90 g of caesium nitrate

Exercise M 3 Calculate the mass of the following:

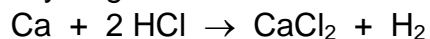
1. 2 moles of H_2O
2. 3 moles of CO_2
3. 8 moles of NH_3
4. 0.50 moles of $\text{C}_2\text{H}_5\text{OH}$
5. 1.2 moles of C_2H_4
6. 0.64 moles of SO_2
7. 3 moles of SO_3
8. 1 mole of HBr
9. 0.012 moles of H_2SO_4
10. 0.15 moles of HNO_3
11. 0.45 moles of NaCl
12. 0.70 moles of NaNO_3
13. 0.11 moles of Na_2CO_3
14. 2.0 moles of NaOH
15. 0.90 moles of Na_2SO_4
16. 0.050 moles of KMnO_4
17. 0.18 moles of K_2CrO_4
18. 0.90 moles of KHCO_3
19. 1.5 moles of KI
20. 0.12 moles of CsNO_3

Exercise M 4:

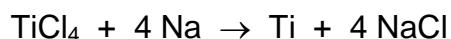
- 1) What mass of potassium oxide is formed when 9.75 g of potassium is burned in oxygen?



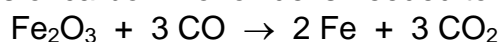
- 2) What mass of hydrogen is formed when 0.2 g of calcium reacts with hydrochloric acid?



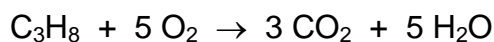
- 3) What mass of sodium is needed to reduce 1 kg of titanium chloride?



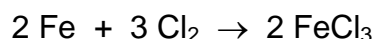
- 4) What mass of carbon monoxide is needed to reduce 1 kg of iron oxide to iron?



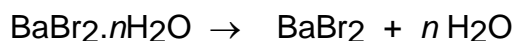
- 5) What mass of oxygen is needed to burn 110 g of propane (C_3H_8)?



- 6) What mass of iron reacts with 14.2 g of chlorine?



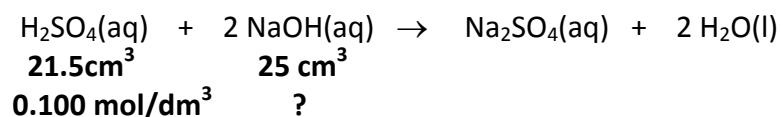
- 7) 4.17 g of hydrated barium bromide crystals ($\text{BaBr}_2 \cdot n\text{H}_2\text{O}$) gave 3.72 g of anhydrous barium bromide on heating to constant mass. Work out the relative molecular mass (M_r) of the hydrated barium bromide and the value of n .



Solution worked example

Question 1

- 1) 25.0 cm³ of a solution of sodium hydroxide solution required 21.50 cm³ of 0.100 mol/dm³ sulphuric acid for neutralisation. Find the concentration of the sodium hydroxide solution.



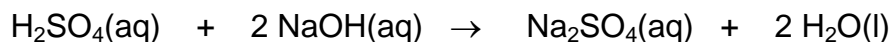
$$\begin{aligned} \text{Moles of sulphuric acid} &= \text{conc} \times \text{vol}/1000 \\ &= 0.100 \times 21.5/1000 \\ &= 2.15 \times 10^{-3} \text{ mol} \end{aligned}$$

$$\text{Moles of sodium hydroxide} = 4.30 \times 10^{-3} \text{ mol (from the equation 2:1 ratio of NaOH to H}_2\text{SO}_4)$$

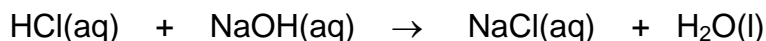
$$\begin{aligned} \text{Concentration of sodium hydroxide} &= \text{mol/vol} \\ &= 4.30 \times 10^{-3} / (25/1000) \\ &= \mathbf{0.172 \text{ mol/dm}^3} \end{aligned}$$

Exercise M 5

- 1) 25.0 cm³ of a solution of sodium hydroxide solution required 21.50 cm³ of 0.100 mol/dm³ sulphuric acid for neutralisation. Find the concentration of the sodium hydroxide solution.



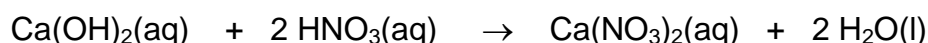
- 2) Find the volume of 1.0 mol/dm³ hydrochloric acid that reacts with 25.00 cm³ of 1.50 mol/dm³ sodium hydroxide.



- 3) 25.0 cm³ of 0.100 mol/dm³ sodium hydroxide neutralises 19.0 cm³ of hydrochloric acid. Find the concentration of the acid.



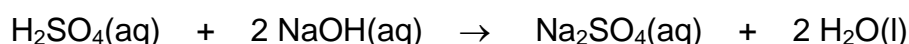
- 4) What volume of 0.040 mol/dm³ calcium hydroxide solution just neutralises 25.0 cm³ of 0.100 mol/l nitric acid?



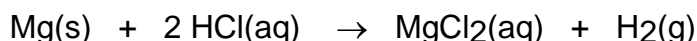
- 5) Find the mass of CaCO₃ that is required to neutralise 2 dm³ of 2 mol/dm³ nitric acid.



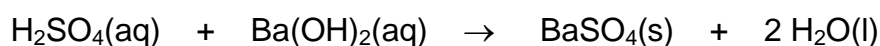
- 6) 25.0 cm³ of 1.00 mol/dm³ sodium hydroxide neutralises 21.2 cm³ of sulphuric acid. Find the concentration of the acid.



- 7) What mass of magnesium metal just reacts with 100.0 cm³ of 2.00 M hydrochloric acid?



- 8) 25.0 cm³ of 0.020 M sulphuric acid neutralises 18.6 cm³ of barium hydroxide solution. Find the concentration of the barium hydroxide solution.



- 9) Calculate the concentration of the following solutions in mol/litre.

- 3 moles of H₂SO₄ in 12 dm³ of water,
- 36.5 mg of HCl in 10 cm³ of water,
- 120 g of sodium hydroxide in 6 litres of water.

- 10) Calculate the number of moles of solute in:

- 2500 cm³ of 0.1 mol/dm³ nitric acid,
- 2 dm³ of 0.05 mol/dm³ potassium hydroxide.

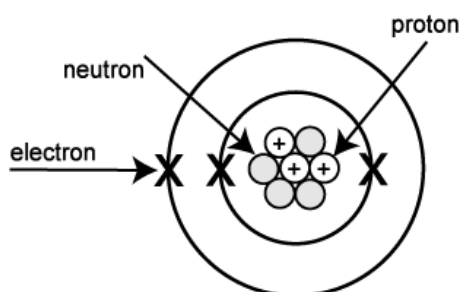
Atomic Structure (GCSE level)

Objectives:

- Identify the position, relative mass and relative charge of the three sub-atomic particles
- Give the number of any of the sub-particles for a given element (atom or ion)
- Define Atomic Number (Z)
- Define Mass Number (A)
- Give the simple electron arrangement for the first 38 elements on the periodic table
- Know how the periodic table is arranged
- Know the links between electronic structure and periodic table arrangement
- Know how ions are formed

GCSE Atomic Structure

The model of atomic structure you have been working with at GCSE will be developed further at Advanced Level. This does not mean the GCSE model is no longer of use. A thorough understanding and familiarity with this model is essential for you to be able to develop a number of Advanced Level concepts. But be warned, it will be developed, it is a model, it is not wrong, it just has limitations.



The atom is made up of three types of fundamental particles: protons, neutrons and electrons.

sub-atomic particle	relative mass	relative charge
proton	1	+1
neutron	1	0
electron	1/1840	-1

The atom is mostly empty space. It consists of a nucleus of protons and neutrons surrounded by electrons in orbitals/shells. Information about the number of particles in each atom can be found using the atomic number and mass number. What makes an atom individual is its atomic number and therefore its number of protons.

Atomic Number: Number of protons

Mass Number: Number of protons + Number of neutrons

Atoms can be represented as follows:



In a neutral atom the number of electrons will be the same as the number of protons. In an ion there are an altered number of electrons from the original number in the atom. For example Al^{3+} has lost 3 electrons so has 13 protons and 10 electrons, O^{2-} has gained 2 electrons so has 8 protons and 10 electrons.

WARNING: YOUR PERIODIC TABLE DOES NOT TELL YOU THE MASS NUMBER.

Exercise AS 1

Atom / ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
${}^{19}_{9}\text{F}$					
${}^{19}_{9}\text{F}^{-}$					
${}^{27}_{13}\text{Al}$					
${}^{27}_{13}\text{Al}^{3+}$					
	15	31			15
			5	6	5
			8	8	10
		23	11		10
	18			22	18
	12	24			10

To see how the model of the atom has been developed and where you are heading if you can watch the following video clips:

The Atom – Clash of the Titans BBC Four with Professor Jim Al-Khalili

<http://video.google.com/videoplay?docid=-4974977412862654856>

Brian (oh so smiley) Cox on why atoms are full of space (hitting the physics-only for the very interested)

<http://www.bbc.co.uk/news/science-environment-16200089>

Electron arrangement:

The electrons are arranged in shells/energy levels/orbitals.

The first shell holds a maximum of 2 electrons, the second shell holds a maximum of 8 electrons. The third shell initially holds a maximum of 8 electrons, you then add 2 electrons to the fourth shell, then come back and add a further 10 electrons to the 3rd shell.

For example:

Sodium	2,8,1
Chlorine	2,8,7
Calcium	2,8,8,2
Scandium	2,8,9,2
Iron	2,8,14,2

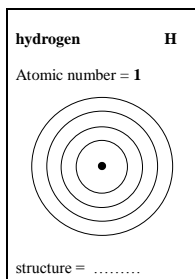
On the periodic table:

The group number tells us how many electrons are in the outer shell.

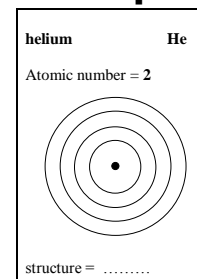
The period number tells us how many shells there are.

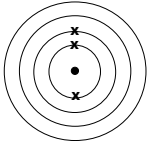
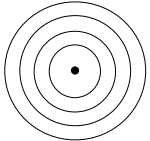
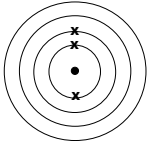
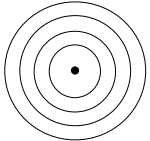
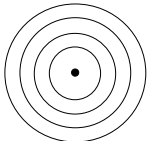
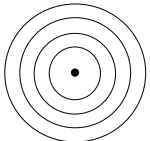
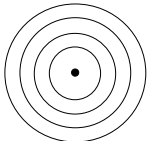
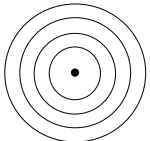
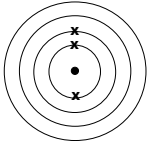
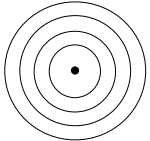
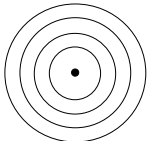
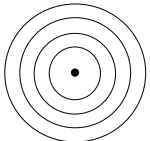
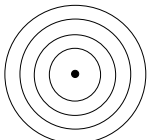
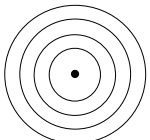
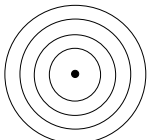
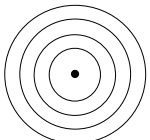
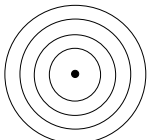
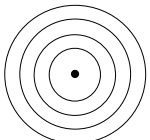
ELECTRONIC STRUCTURE Exercise AS 2

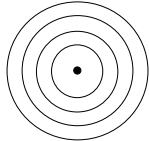
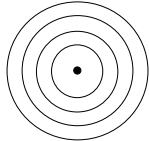
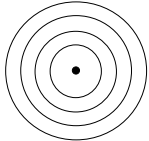
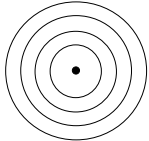
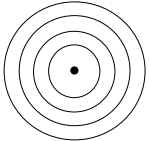
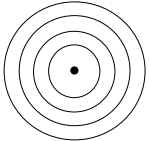
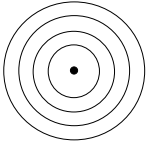
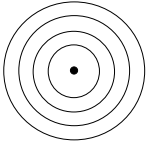
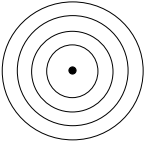
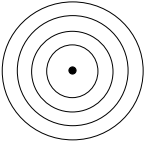
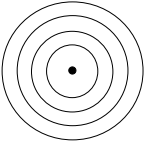
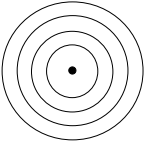
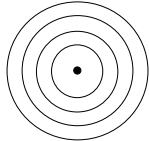
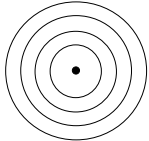
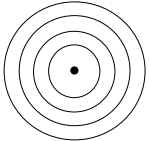
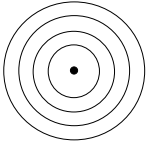
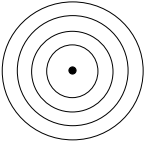
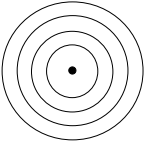
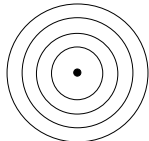
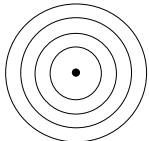
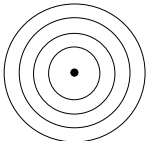
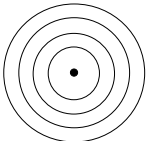
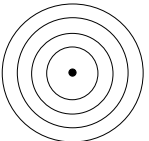
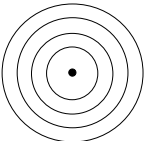
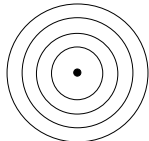
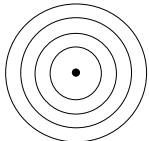
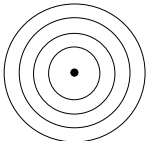
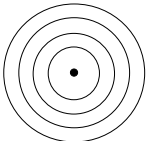
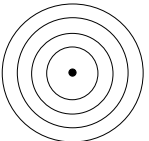
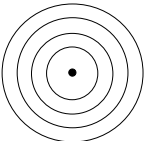
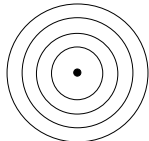
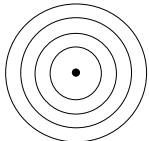
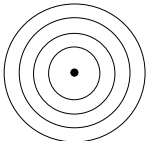
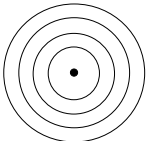
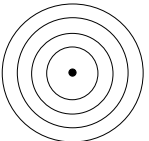
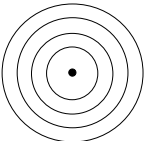
Group 1 Group 2



Group 3 Group 4 Group 5 Group 6 Group 7 Group 0



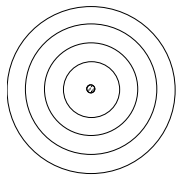
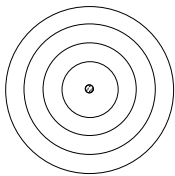
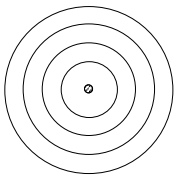
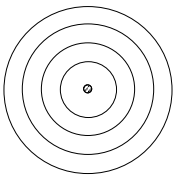
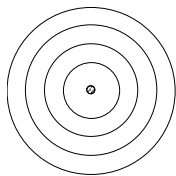
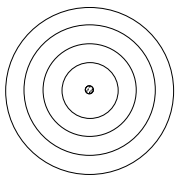
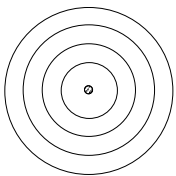
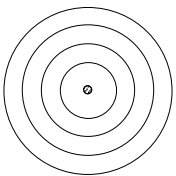
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: left; padding: 5px;">aluminium Al</td> <td style="text-align: left; padding: 5px;">silicon Si</td> <td style="text-align: left; padding: 5px;">phosphorus P</td> <td style="text-align: left; padding: 5px;">sulfur S</td> <td style="text-align: left; padding: 5px;">chlorine Cl</td> <td style="text-align: left; padding: 5px;">argon Ar</td> </tr> <tr> <td style="text-align: left; padding: 5px;">Atomic number =</td> <td style="text-align: left; padding: 5px;">Atomic number =</td> <td style="text-align: left; padding: 5px;">Atomic number =</td> <td style="text-align: left; padding: 5px;">Atomic number =</td> <td style="text-align: left; padding: 5px;">Atomic number =</td> <td style="text-align: left; padding: 5px;">Atomic number =</td> </tr> <tr> <td style="text-align: center; padding: 10px;">  </td> <td style="text-align: center; padding: 10px;">  </td> <td style="text-align: center; padding: 10px;">  </td> <td style="text-align: center; padding: 10px;">  </td> <td style="text-align: center; padding: 10px;">  </td> <td style="text-align: center; padding: 10px;">  </td> </tr> <tr> <td style="text-align: left; padding: 5px;">structure =</td> <td style="text-align: left; padding: 5px;">structure =</td> <td style="text-align: left; padding: 5px;">structure =</td> <td style="text-align: left; padding: 5px;">structure =</td> <td style="text-align: left; padding: 5px;">structure =</td> <td style="text-align: left; padding: 5px;">structure =</td> </tr> </table>	aluminium Al	silicon Si	phosphorus P	sulfur S	chlorine Cl	argon Ar	Atomic number =	Atomic number =	Atomic number =	Atomic number =	Atomic number =	Atomic number =							structure =	structure =	structure =	structure =	structure =	structure =					
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- 1) The first 20 elements in the Periodic Table are shown below. The elements are arranged in order of increasing atomic number. Fill in the atomic number for each element. The first three have been done for you.
- 2) Complete the boxes to show the electronic structure of the first 20 elements. The box for lithium has been done for you.

Exercise AS 3

For each of the following, (a) draw the electrons in their shells and (b) state the electronic structure.

1 Na  structure:	2 Na ⁺  structure:	3 Al  structure:	4 Al ³⁺  structure:
5 F  structure:	6 F ⁻  structure:	7 O  structure:	8 O ²⁻  structure:

For each of the following particles, state what the particle is. The first one has been done for you.

9 protons = 8 neutrons = 8 electrons = 10 particle = O ²⁻	10 protons = 16 neutrons = 16 electrons = 16 particle =	11 protons = 16 neutrons = 16 electrons = 18 particle =	12 protons = 17 neutrons = 18 electrons = 17 particle =
13 protons = 17 neutrons = 20 electrons = 17 particle =	14 protons = 17 neutrons = 20 electrons = 18 particle =	15 protons = 12 neutrons = 12 electrons = 10 particle =	16 protons = 9 neutrons = 10 electrons = 10 particle =
17 protons = 26 neutrons = 30 electrons = 24 particle =	18 protons = 82 neutrons = 126 electrons = 82 particle =	19 protons = 7 neutrons = 7 electrons = 10 particle =	20 protons = 53 neutrons = 74 electrons = 54 particle =

Complete the table below:

Question	Particle	Atomic number	Mass number	Protons	Neutrons	Electrons	Electron structure
21			31	15		15	
22		20			20	18	
23		6			8	6	

Identifying structure and bonding types (GCSE)

Objectives:

- ‡ Identify the most likely type of bonding in a substance
- ‡ Identify the most likely structure type of a substance from a) formulae, b) properties

At GCSE level we are introduced to the concept that non-metals are held together (usually) by covalent bonds and that metal and non-metals are (usually) held together by ionic bonds. This will be developed further at advanced level. But let's get the GCSE sorted first!

Exercise SB 1

Substance	Type of elements within substance	Most likely bonding type
H ₂ O	<i>Non-metal and Non-metal</i>	<i>Covalent</i>
Hydrogen fluoride	<i>Non-metal and Metal</i>	<i>ionic</i>
K ₂ O		
CH ₄		
Magnesium Oxide		
Carbon Dioxide		
Fe ₂ O ₃		

We can identify the most likely structure type (crystal structure) of a substance from its properties or its formula. If you are rusty on structure types:

Essential:

<http://www.chemsheets.co.uk/GCSEstructure11.doc>

Helpful:

http://www.knockhardy.org.uk/gcse_htm_files/gbandspps.pps#366,1,Slide 1

Exercise SB 2

What is the most likely structure type of these substances:

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity as			Type of structure
			solid	liquid	solution (aq)	
A	963	1560	does not conduct	conducts	conducts	
B	1063	2967	conducts	conducts	insoluble	
C	123	187	does not conduct	does not conduct	insoluble	
D	-7	59	does not conduct	does not conduct	does not conduct	
E	3527	4027	does not conduct	does not conduct	insoluble	
F	30	2397	conducts	conducts	insoluble	
G	1713	2230	does not conduct	does not conduct	insoluble	
H	-138	0	does not conduct	does not conduct	insoluble	

ANSWERS TO EXERCISES

Answers WF 1

Writing formulae from names:

- | | | | |
|--------------------------|---|-----------------------|---|
| 1. Sodium Chloride | NaCl | 11. Copper (I) Oxide | Cu ₂ O |
| 2. Sodium Hydroxide | NaOH | 12. Zinc Nitrate | Zn(NO ₃) ₂ |
| 3. Sodium Carbonate | Na ₂ CO ₃ | 13. Silver Bromide | AgBr |
| 4. Sodium Sulphate | Na ₂ SO ₄ | 14. Iron (II) Oxide | FeO |
| 5. Magnesium Chloride | MgCl ₂ | 15. Iron (III) Oxide | Fe ₂ O ₃ |
| 6. Magnesium Nitrate | Mg(NO ₃) ₂ | 16. Ammonium Nitrate | NH ₄ NO ₃ |
| 7. Magnesium Hydroxide | Mg(OH) ₂ | 17. Ammonium Sulphate | (NH ₄) ₂ SO ₄ |
| 8. Aluminium Chloride | AlCl ₃ | 18. Silver Sulfide | Ag ₂ S |
| 9. Aluminium Sulphate | Al ₂ (SO ₄) ₃ | 19. Aluminium Oxide | Al ₂ O ₃ |
| 10. Copper (II) Sulphate | CuSO ₄ | 20. Zinc Iodide | ZnI ₂ |

Answers WF 2

Writing names from formulae:

- | | | | |
|-----------------------|------------------|---|---------------------|
| 1. H ₂ O | Water | 11. Li ₂ SO ₄ | Lithium Sulfate |
| 2. CO ₂ | Carbon Dioxide | 12. CuSO ₄ | Copper Sulfate |
| 3. NH ₃ | Ammonia | 13. AgNO ₃ | Silver nitrate |
| 4. NaH | Sodium Hydride | 14. (NH ₄) ₂ SO ₄ | Ammonium sulphate |
| 5. CH ₄ | Methane | 15. NH ₄ VO ₃ | Ammonium vanadate |
| 6. HNO ₃ | Nitric Acid | 16. KMnO ₄ | Potassium Manganate |
| 7. NaNO ₃ | Sodium Nitrate | 17. K ₂ CrO ₄ | Potassium Chromate |
| 8. CaCl ₂ | Calcium chloride | 18. KI | Potassium Iodide |
| 9. SO ₂ | Sulphur Dioxide | 19. Co(NO ₃) ₂ | Cobalt Nitrate |
| 10. Li ₂ S | Lithium Sulfide | 20. Kat | Potassium Astatide |

Answers Eqn 1 and 2

Aluminium + Sulfur → Aluminium Sulfide

Copper + Oxygen → Copper (II) Oxide

Ethane + Oxygen → Carbon dioxide + Water

Ethanol + Oxygen → Carbon dioxide + Water

Lithium + Water → Lithium hydroxide + Hydrogen

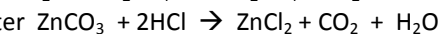
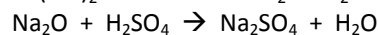
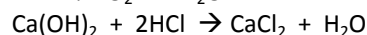
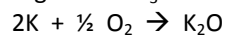
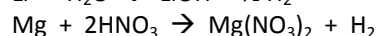
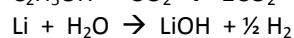
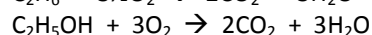
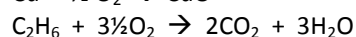
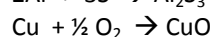
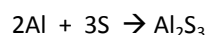
Magnesium + Nitric acid → Magnesium nitrate + Hydrogen

Potassium + Oxygen → Potassium Oxide

Calcium Hydroxide + Hydrochloric acid → Calcium chloride + Water

Sodium Oxide + Sulphuric acid → Sodium Sulphate + Water

Zinc Carbonate + Hydrochloric acid → Zinc chloride + Carbon dioxide + Water



Answers Eqn 3

- $\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$
- $\text{Ca(OH)}_2(\text{s}) + 2\text{NH}_4\text{Cl} \rightarrow \text{CaCl}_2(\text{s}) + 2\text{H}_2\text{O(g)} + 2\text{NH}_3(\text{g})$
- $\text{Pb(NO}_3)_2(\text{s}) \rightarrow \text{PbO(s)} + 2\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$
- $\text{SiCl}_4(\text{l}) + 2\text{H}_2\text{O(l)} \rightarrow \text{SiO}_2(\text{s}) + 4\text{HCl(g)}$
- $\text{C}_8\text{H}_{18}(\text{g}) + 12\frac{1}{2}\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 9\text{H}_2\text{O(g)}$
- $3\text{X}_2 + 6\text{NaOH(aq)} \rightarrow 5\text{NaX(aq)} + \text{NaXO}_3(\text{aq}) + 3\text{H}_2\text{O(l)}$
Where X represents a halogen, no state symbol l given for X as it varies down the group.
- $2\text{M(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{MOH(aq)} + \text{H}_2(\text{g})$ Where M represents a Group 1 metal.
- STAGE 1: $\text{SnCl}_2(\text{aq}) + 2\text{HgCl}_2(\text{aq}) \rightarrow 2\text{HgCl(s)} + \text{SnCl}_4(\text{aq})$
STAGE 2: $2\text{HgCl(s)} + \text{SnCl}_2(\text{aq}) \rightarrow 2\text{Hg(l)} + \text{SnCl}_4(\text{aq})$
OVERALL: $\text{SnCl}_2(\text{aq}) + \text{HgCl}_2(\text{aq}) \rightarrow \text{Hg(l)} + \text{SnCl}_4(\text{aq})$
- $3\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KI(s)} \rightarrow 2\text{KHSO}_4(\text{s}) + \text{I}_2(\text{g}) + \text{H}_2\text{O(l)} + \text{H}_2\text{S(g)}$

Exercise M 1

1. Barium Chloride	208.3	11. Sodium Hydride	24.0
2. Ammonium Nitrate	80.0	12. Zinc Hydroxide	99.4
3. Calcium Sulphate	136.2	13. Potassium Oxide	94.2
4. Barium Nitrate	261.3	14. Zinc	65.4
5. Silver Oxide	231.8	15. Carbon Dioxide	44.0
6. Aluminium Sulphate	342.3	16. Hydrogen	2.0
7. Fluorine	38.0	17. Sulphur trioxide	80.1
8. Sulphur Dioxide	64.1	18. Beryllium Hydroxide	43.0
9. Iron (II) Sulphate	151.9	19. Vanadium (V) Oxide	181.8
10. Sodium Carbonate	106.0	20. Copper (I) Oxide	143.0

Answer M2

1 0.50	14 0.020
2 2.0	15 0.125
3 0.10	16 0.020
4 5.0	17 0.167
5 20	18 1.0
6 0.010	19 0.046
7 1.0	20 0.020
8 0.22	21 0.0010
9 0.0010	22 0.25
10 0.050	23 0.02
11 0.33	24 0.0025
12 0.25	25 0.20
13 0.021	26 0.10

Answers M3

- | | |
|------------|------------|
| 1 36 g | 14 80.0 g |
| 2 132 g | 15 127.8 g |
| 3 47.6 g | 16 7.9 g |
| 4 23 g | 17 34.92 g |
| 5 33.6 g | 18 90 g |
| 6 40.96 g | 19 249 g |
| 7 240 g | 20 23.4 g |
| 8 81 g | 21 12.2 g |
| 9 1.152 g | 22 672.4 g |
| 10 9.45 g | 23 0.296 g |
| 11 26.3 g | 24 13.6 g |
| 12 59.5 g | 25 43.68 g |
| 13 11.66 g | 26 14.95 g |

Answers M4 (Answers 1 to 6 to 3 sig fig)

- 11.7g
- $9.98 \times 10^{-3} \text{g}$
- 484g
- 526g
- 400g
- 7.44g
- n=2

Answers M5

Exercise AS 1

Atom / ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
${}_{9}^{19}\text{F}$	9	19	9	10	9
${}_{9}^{19}\text{F}^{-}$	9	19	9	10	10
${}_{13}^{27}\text{Al}$	13	27	13	14	13
${}_{13}^{27}\text{Al}^{3+}$	13	27	13	14	10
${}^{31}\text{P}$	15	31	15	16	15
${}^{11}\text{B}$	5	11	5	6	5
${}^{16}\text{O}^{2-}$	8	16	8	8	10
${}^{23}\text{Na}^{+}$	11	23	11	12	10
Ar	18	40	18	22	18
${}^{24}\text{Mg}^{2+}$	12	24	12	12	10

Answers AS 3

- | | | | |
|----------|--------------------|----------------------|----------------------|
| 1. 2,8,1 | 6. 2,8 | 11. S^{2-} | 16. F^{-} |
| 2. 2,8 | 7. 2,6 | 12. Cl | 17. Fe^{2+} |
| 3. 2,8,3 | 8. 2,8 | 13. Cl | 18. Pb |
| 4. 2,8 | 9. O^{2-} | 14. Cl^{-} | 19. N^{3-} |
| 5. 2,7 | 10. S | 15. Mg^{2+} | 20. I^{-} |

Question	Particle	Atomic number	Mass number	Protons	Neutrons	Electrons	Electron structure
----------	----------	---------------	-------------	---------	----------	-----------	--------------------

21	^{31}P	15	31	15	16	15	2,8,5
22	$^{40}\text{Ca}^{2+}$	20	40	20	20	18	2,8,8
23	^{14}C	6	14	6	8	6	2,4

Answers SB 1

Substance	Type of elements within substance	Most likely bonding type
H ₂ O	Non-metal and Non-metal	Covalent
Hydrogen fluoride	Non-metal and Metal	Ionic
K ₂ O	Metal and Non-metal	Ionic
CH ₄	Non-metal and Non-metal	Covalent
Magnesium Oxide	Metal and Non-metal	Ionic
Carbon Dioxide	Non-metal and Non-metal	Covalent
Fe ₂ O ₃	Metal and Non-metal	Ionic

Answers SB 2

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity as			Type of structure
			solid	liquid	solution (aq)	
A	963	1560	does not conduct	conducts	conducts	IONIC
B	1063	2967	conducts	conducts	insoluble	METALLIC
C	123	187	does not conduct	does not conduct	insoluble	SIMPLE MOLECULAR
D	-7	59	does not conduct	does not conduct	does not conduct	SIMPLE MOLECULAR
E	3527	4027	does not conduct	does not conduct	insoluble	GIANT COVALENT
F	30	2397	conducts	conducts	insoluble	METALLIC
G	1713	2230	does not conduct	does not conduct	insoluble	GIANT COVALENT
H	-138	0	does not conduct	does not conduct	insoluble	SIMPLE MOLECULAR