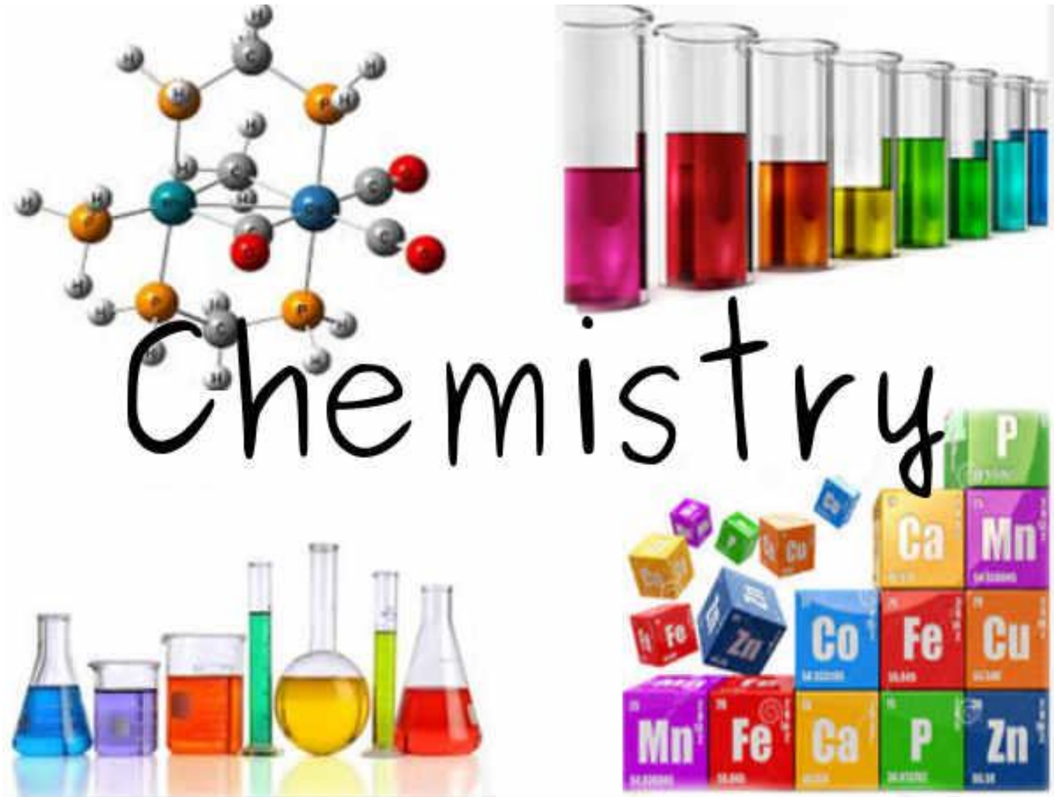

Bridging the Gap

GCSE to A Level

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Welcome to AS-Level Chemistry! This work is designed to help you revise your GCSE Chemistry over the summer to prepare you for starting AS-Level Chemistry in September. You may find it easy, not-so-easy, tricky or really tricky. There may be some questions you can't do at all. It doesn't matter. The aim is for you to practise your Chemistry and identify your strengths and weaknesses in the subject. If you would like further work, or an insight into the wonderful world of AS-Level Chemistry and beyond, there are some further reading suggestions at the end. There is also a list of websites you will undoubtedly find useful throughout the course and may need to use to complete this task.

Good luck and happy Chemis-trying!

From the Chemistry Team

IONIC BONDING

Table salt (sodium chloride, NaCl) is our most common ionic compound. It is also an excellent exemplar of how ionic substances behave. Under a microscope, or even on your kitchen table, you can see the beautiful crystalline lattice structure. Whilst it adds flavour to our food it doesn't melt when added to hot fish and chips. However, it dissolves readily in water, providing an ideal habitat for crocodiles and other marine organisms which rely on a salty aqueous environment. Brine conducts electricity and the products of its electrolysis provide us with vital chemical ingredients for our everyday life.

1) Complete the passage below using the following words:-

loses ions ionic protons negative electrons positive gains

Atoms are neutral because they have the same number of ………………….. and ………………… . If atoms lose or gain electrons they become electrically charged and are called ………… (they are not atoms any more). If atoms gain electrons they become ………………… ions, and if they lose electrons they become ………………… ions. When a metal reacts with a non-metal, the metal atoms …………….. electrons and the non-metal atoms …………… electrons, forming an ……………….. compound.

2) Describe the structure of sodium chloride.

3) a) Explain why ionic substances have high melting and boiling points.

b) Explain why ionic substances can conduct electricity when molten or dissolved.

c) Explain why ionic substances cannot conduct electricity when solid.

4) Name the three products from the electrolysis of brine and give one example of how each is useful to us in everyday life.

Product	**Use**

5) Deduce the chemical formulae of the following ionic compounds:-

a) calcium chloride

b) sodium oxide

c) magnesium sulfide

d) aluminium hydroxide

e) potassium carbonate

f) calcium nitrate

COVALENT BONDING

Covalently bonded molecules are everywhere! In fact, you are breathing some in (and out) as you read this. Their simple molecular structure is crucial to your survival. When you use your pencil to answer these questions you are relying on the properties of one of the World's most useful giant covalent structures, graphite. At the Brit Awards, Adele and other starlets adorn themselves with the World's strongest naturally occurring covalent structure, diamond. Which, as it just so happens, was also instrumental in the Hatten Garden robberies as a consequence of this very property!

Simple covalent molecules

1) Circle the correct answer.

Covalent bonding occurs between:-

Metal - Non-metal ; Metal – Metal ; Non-metal - Non-metal

2) How does a covalent bond form?

………

………

………

3) What are the properties of simple covalent substances such as chlorine or oxygen?

Melting point and boiling point	High/Low
Solubility in water	Soluble/Insoluble
Conduct electricity?	Conductors/Insulators
Bonding between molecules (intermolecular bonding)?	Weak/strong

4) Draw dot-and-cross diagrams of the following simple molecules:-

Methane	Water

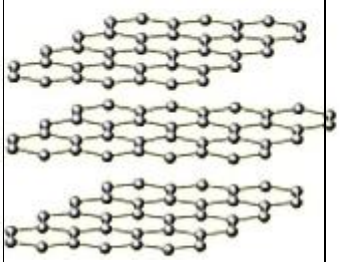
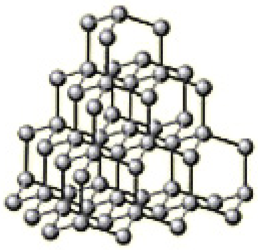
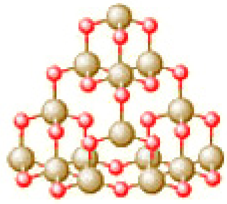
5) Describe and explain the difference in the boiling point of water compared to chlorine and oxygen.

....

....

....

<u>Giant covalent structures</u>

Structure			
Name			
Type of atoms? e.g. carbon/oxygen			
	Properties		
High or low bp and mp?			
Conductor or insulator?			
Hard or soft?			
Solubility in H_2O			
Uses			

<u>SUMMARY</u>

1) Giant covalent structures tend to have low melting and boiling points. **True/false**
2) Most intermolecular forces are strong and make it difficult to separate the molecules. **True/false**
3) Most covalent substances do not conduct electricity. **True/false**
4) Graphite conducts electricity. **True/false**
5) Graphite is slippery because the intramolecular bonds are weak covalent bonds. **True/false**

Now explain your answer to each of the above statements.

BALANCING EQUATIONS

It's a key skill in chemistry. You must be able to do it. Have a go and if you are struggling, get it sorted.

Balance the following equations:-

1) $Mg(s) + O_2(g) \rightarrow MgO(s)$

2) $H_2(g) + O_2(g) \rightarrow H_2O(l)$

3) $Fe(s) + HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$

4) $CuO(s) + HNO_3(aq) \rightarrow Cu(NO_3)_2\ (aq) + H_2O(l)$

5) $Ca(OH)_2(aq) + HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$

6) $KHCO_3(s) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + CO_2(g) + H_2O(l)$

7) $Al(s) + Cl_2(g) \rightarrow AlCl_3(s)$

Useful websites

Khan Academy

Khan Academy produce lovely on-line tutorials. Brief, clear and informative. If you are struggling with equation balancing, this tutorial is well worth watching.

https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/balancing-chemical-equations/v/balancing-chemical-equations-introduction

A chemical equation balancing game.

http://education.jlab.org/elementbalancing/

Acids and Alkalis

Acids and alkalis play a crucial part in our everyday lives. Indigestion is caused by excess stomach acid. Gaviscon contains an alkali to neutralise the excess acid. Our breathing is controlled by the pH of our blood. Bee stings hurt thanks to formic acid. The effects can be neutralised by bicarbonate of soda. Chemists often carry out titrations to determine unknown concentrations of acids or alkali, particularly when quality checking products. A good example is checking the concentration of alkali in fertilisers before they go on shop shelves for us to buy; too much alkali can be just as bad (if not worse) than too much acid (caused by acid rain).

1) Acids have a pH of ………………. than 7.

   Alkalis have a pH of …………. than 7.

   Neutral substances have a pH of …………. .

2) Acid + Metal → …………………. + …………………….

   Acid + Metal Oxide → ……………………… + ………………………

   Acid + Metal Hydroxide → ………………………. + ……………………….

   Acid + Metal Carbonate → …………………………. + ………………………. + ………………………….

3) Mr Withers needs to know how acidic the soil is in the school grounds. He decides to ask the chemistry A Level students to find out by doing a titration. They decide to use sodium hydroxide as their alkali of known concentration.

   a) Fill in the boxes to balance the equation for this reaction.

   $\square\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + \square\ H_2O$

   b) The chemistry students use 24.2 cm^3 of sulfuric acid, extracted from the soil, to neutralise 25.0 cm^3 of 0.010 $moldm^{-3}$ sodium hydroxide. Determine the concentration of sulfuric acid in the school soil.

REDOX

Without redox we wouldn't be able to get energy from our food. On a slightly less essential level, batteries and hydrogen fuel cells rely on redox to switch on torches and power modern cars. The key rule to remember in redox is that "the electrons have got to go somewhere!"…more on that in lesson time.

1) What is "redox"?

……

2) Give two examples of useful redox reactions in everday life excluding those mentioned above (there are millions!).

1)

2)

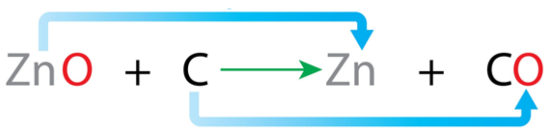
3) What does oxidation mean?

……

4) What does reduction mean?

……

5) Which element is oxidised and which is reduced in the reaction below?



Oxidised ………………………………………………

Reduced ………………………………………………

6) Many elements have variable oxidation states. What does this mean and how is it useful to us?

……

……

7) The ore haematite contains iron(III) oxide. Iron is extracted from this ore by reduction with carbon.

The products of this reaction are iron and carbon dioxide.

(a) Finish this **symbol** equation for the reaction.

………… Fe_2O_3 + ………… C → ………… + …………

(b) A haematite ore contains 80% by mass of iron(III) oxide.

Calculate the maximum mass of iron that can be extracted from each tonne of this ore.

Show each step of your calculation as indicated below.

HINTS: 1 tonne = 1000 kg; relative atomic mass (A_r) Fe = 56, O = 16

mass of iron(III) oxide in 1 tonne of haematite = ……………… kg

formula mass of iron(III) oxide = ………………

mass of iron in 1 tonne of haematite = ……………… kg

CALCULATIONS

Calculations are a part of every chemist's world. They are sometimes something that A Level students find tricky but you can do it! The key is to sort out anything you don't understand and get plenty of practice to improve your confidence. These calculations build up in difficulty to those found on AS Level papers. Give them a shot; you may be surprised by how much you can do.

1) Magnesium sulfate is one of the chemicals in detergent powder.

Ana makes some magnesium sulfate using this reaction.

magnesium carbonate + sulfuric acid → magnesium sulfate + water + carbon dioxide

$$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$$

a) The theoretical yield for Ana's experiment is 12.0 g.

Ana dries and weighs the magnesium sulfate she makes. This is her actual yield.

Actual yield = 10.8 g.

Work out the percentage yield for Ana's experiment.

percentage yield = ...

b) The relative formula mass of magnesium carbonate is 84.

The relative formula mass of magnesium sulfate is 120.

Calculate the mass of magnesium carbonate that must react with sulfuric acid to produce 12.0 g of magnesium sulfate.

mass of magnesium carbonate = ... g

2) A compound containing magnesium, silicon and oxygen is also present in rock types in Italy. A sample of this compound weighing 5.27 g was found to have the following composition by mass:

Mg 1.82 g; Si 1.05 g; O 2.40 g

Calculate the empirical formula of the compound.

Show your working.

3) A student heats 12.41 g of hydrated sodium thiosulfate, $Na_2S_2O_3.5H_2O$, to remove the water of crystallisation. A white powder called anhydrous sodium thiosulfate forms.

a) What does the term "anhydrous" mean?

b) What is the relative formula mass of $Na_2S_2O_3.5H_2O$?

c) Calculate the expected mass of anhydrous sodium thiosulfate that forms.

FURTHER READING

These are some textbooks which you may find interesting and useful before and during your AS-Level Chemistry course.

*Essential Maths Skills for AS/A-Level Chemistry
By Nora Henry
Published by Philip Allan for Hodder Education
ISBN 978 1 4718 6349 3

*A-Level Year 1, Chemistry, OCR A
Complete Revision and Practice
Published by CGP
ISBN 9781782943402

*A-Level Year 1, Chemistry, OCR A
Complete Revision and Practice
Published by CGP
ISBN 978 1 78294 340 2

*Aspirin. The Story of a Wonder Drug
By D.Jeffreys
Published by Bloomsbury
ISBN 9781582346007

*Periodic Tales, The Curious Lives of the Elements
By Hugh Aldersey-Williams
Published by Penguin
ISBN 978-0141041452

USEFUL WEBSITES

Chemguide	www.chemguide.co.uk
Rod's pages	http://rod.beavon.org.uk/index.htm
Knockhardy	http://www.knockhardy.org.uk/sci.htm
Amazing grades	www.amazing-grades.com
Memrise	https://www.memrise.com/

ANSWERS

Page 3

1) Complete the passage below using the following words:

loses ions ionic protons negative electrons positive gains

Atoms are neutral because they have the same number of **protons** and **electrons**. If atoms lose or gain electrons they become electrically charged and are called **ions** (they are not atoms any more). If atoms gain electrons they become **negative** ions, and if they lose electrons they become **positive** ions. When a metal reacts with a non-metal, the metal atoms **lose** electrons and the non-metal atoms **gain** electrons, forming an **ionic** compound.

2) Sodium chloride is a giant ionic lattice. It contains sodium ions (Na^+) and chloride ions (Cl^-). The ionic bonds in sodium chloride are strong and are created by the attraction between the oppositely charged ions.

3) a) Ionic substances form giant ionic lattices containing oppositely charged ions. Strong ionic bonds between the ions result in high melting and boiling points because a lot of energy is needed to break these bonds.

b) The ions are charged particles. When molten or dissolved the **ions** are free to move enabling them to conduct electricity.

c) In solid crystal lattices the ions are **not** free to move therefore they cannot conduct electricity.

4)

Product	Use
Hydrogen	Making margarine Hydrogen fuel cells
Chlorine	Killing micro-organisms in e.g. swimming pool water and drinking water
Sodium hydroxide	Making soap

5) a) Calcium chloride $\mathbf{CaCl_2}$

b) Sodium oxide $\mathbf{Na_2O}$

c) Magnesium sulfide **MgS**

d) Aluminium hydroxide $\mathbf{Al(OH)_3}$

e) Potassium carbonate $\mathbf{K_2CO_3}$

f) Calcium nitrate $\mathbf{Ca(NO_3)_2}$

<u>Page 5</u>

1) Circle the covalent bond:-

Metal - Non-metal ; Metal – Metal ; Non-metal - Non-metal

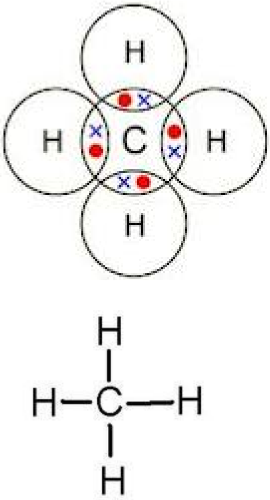
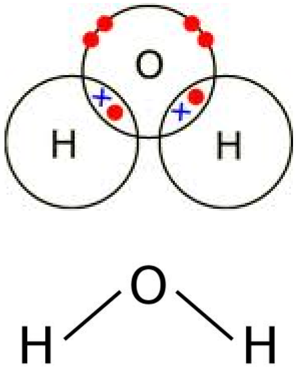
2) How does a covalent bond form?

Covalent bonds are predominantly a result of two non-metal atoms sharing a pair of electrons. There is then an attraction between the shared electron pair (negative) and the oppositely charged (positive) nuclei. The electrons involved are in the highest occupied energy levels (outer shells) of the atoms. Sometimes atoms form multiple covalent bonds by sharing more than one electron pair. The number of covalent bonds formed tends to depend on the group number (8 – group number).

3) Properties of simple covalent molecules such as chlorine and oxygen:-

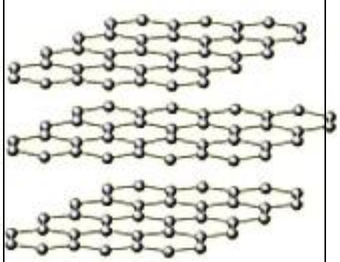
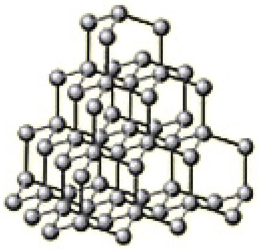
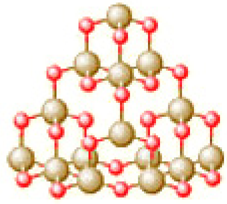
Melting point and boiling point	High/Low
Solubility in water	Soluble/Insoluble
Conduct electricity?	Conductors/Insulators
Bonding between molecules (intermolecular bonding)?	Weak/strong

4)

<u>Methane</u>	<u>Water</u>
	

<u>Page 6</u>

4) Water has a relatively high boiling point compared to other simple covalent molecules such as chlorine and oxygen. This is because hydrogen bonds form between water molecules. These bonds are much stronger than the weak Van der Waals forces (London dispersion forces) between molecules such as chlorine and oxygen. Therefore a lot more energy is needed to break the hydrogen bonds between water molecules than is required to overcome the weak forces of attraction between chlorine or oxygen molecules.

Structure			
Name	Graphite	Diamond	Silicon dioxide
Type of atoms? e.g. carbon/oxygen	Carbon	Carbon	Silicon Oxygen
	Properties		
High or low bp and mp?	High	High	High
Conductor or insulator?	Conductor	Insulator	Semi-conductor
Hard or soft?	Hard	Soft and slippery	Hard
Uses	Pencil "lead"	Jewellery Cutting and precision tool	Electronics (Transistors)

SUMMARY

1) **False** – giant covalent structures have strong bonds which need large amounts of energy to break them.
2) **False** – intermolecular forces are weak
3) **True** – covalent molecules do not have free electrons or ions to carry a charge (with the exception of graphite)
4) **True** – Graphite contains delocalised electrons which can carry a charge through the hexagonal layers.
5) **False** – Intramolecular covalent bonds are strong. Graphite is slippery due to the weak intermolecular forces.

Page 7

1) $\mathbf{2}Mg(s) + O_2(g) \rightarrow \mathbf{2}MgO(s)$

2) $\mathbf{2}H_2(g) + O_2(g) \rightarrow \mathbf{2}H_2O(l)$

3) $Fe(s) + \mathbf{2}HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$

4) $CuO(s) + \mathbf{2}HNO_3(aq) \rightarrow Cu(NO_3)_2 (aq) + H_2O(l)$

5) $Ca(OH)_2(aq) + \mathbf{2}HCl(aq) \rightarrow CaCl_2(aq) + \mathbf{2}H_2O(l)$

6) $\mathbf{2}KHCO_3(s) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + \mathbf{2}CO_2(g) + \mathbf{2}H_2O(l)$

7) $\mathbf{2}Al(s) + \mathbf{3}Cl_2(g) \rightarrow \mathbf{2}AlCl_3(s)$

<u>Page 8</u>

1) Acids have a pH of **less** than 7.

Alkalis have a pH of **more** than 7.

Neutral substances have a pH of **7**.

2) Acid + Metal → **salt** + **hydrogen**

Acid + Metal Oxide → **salt** + **water**

Acid + Metal Hydroxide → **salt** + **water**

Acid + Metal Carbonate → **salt** + **water** + **carbon dioxide**

3a) $\mathbf{2}\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + \mathbf{2}\ H_2O$

b) Moles NaOH = 0.025 x 0.01

= 0.00025

Moles H_2SO_4 = 0.000125

Concentration of H_2SO_4 = 0.000125/0.0242

= 0.00517 M

Page 9

1) Redox is the oxidation of one element together with the reduction of another element during a chemical reaction.

2) Two examples of useful redox reactions in everyday life:-

1) Combustion of fossil fuels

2) Respiration

3) Photosynthesis

3) An element losing electrons.

4) An element gaining electrons.

5)

Oxidised: **Carbon**

Reduced: **Zinc**

6) Elements with variable oxidation states are able to lose or gain different numbers of electrons depending on their environment. For example, iron can exist as Fe^{2+} and Fe^{3+} ions.

7 (a) **2** Fe_2O_3 + **3** *C* → **3** CO_2 + **4 Fe**

(b)

Mass of Fe_2O_3 = 80/100 x 1000

= 800 kg

Moles Fe_2O_3 = 800/160

= 5

Moles Fe = 5 x 2

= 10

Mass Fe = 10 x 56

= 560 kg

Page 11

1a) Percentage yield = 10.8/12 x 100

= 90%

1b) $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

Moles $MgSO_4$ = 12.0/120

= 0.1

Moles $MgCO_3$ = 0.1

Mass $MgCO_3$ = 0.1 x 84

= 8.4 g

2) Mg 1.82/24 : Si 1.05/28 : O 2.4/16

Mg 0.07583 : Si 0.0375 : O 0.15

Mg 0.07583/0.0375 : Si 0.0375/0.0375 : O 0.15/0.0375

Mg 2 : Si 1 : O 4

Empirical formula = Mg_2SiO_4

3a) Anhydrous means without water.

b) RFM $Na_2S_2O_3.5H_2O$ = 23 x 2 + 32 x 2 + 16 x 3 + 5 x 18

= 248

c) $Na_2S_2O_3.5H_20 \rightarrow Na_2S_2O_3 + 5H_2O$

Moles $Na_2S_2O_3.5H_20$ = 12.41/248

= 0.05

Moles $Na_2S_2O_3$ produced = 0.05

Mass $Na_2S_2O_3$ = 0.05 x 158

= 7.9 g