Science at Nobel

Getting ready for A-Level Chemistry @ Nobel

Bridging the gap between GCSE and A-Level Chemistry

This bridging work is designed to help you bridge the gap between your GCSE Science studies and the AS/A Level Chemistry course. It includes a list of topics from GCSE that will be helpful for you to review and practice.

Why do bridging work?
What it takes to be successful at GCSE is different from being successful at A-level. Although you have fewer subjects there are different skills at post 16 and the volume of work is greater because the detail and depth is more demanding.

Bridging work should help you gauge whether the subject is for you. We would rather you study courses that interest you and you are sufficiently qualified to study.

This booklet is designed to recap GCSE knowledge you will need to be successful in A-Level Chemistry as well as introduce simple topics that you will cover in more detail throughout the course. These should give you an idea of the course as well as your suitability for it.

Is the bridging work assessed?
In September, your subject teacher will ask you for your bridging work and it will be looked at. Teachers can diagnose your strengths and weaknesses and begin to support you in a more targeted way. Bridging work also assesses your work ethic and so that your teachers can will pick up on anyone with a low work ethic and support you accordingly.

Chemistry A-level
Studying Chemistry at A-level will require you to be highly organised and effective with your own independent work. Not only will you have to balance the workload of this subject and the other subjects you have chosen, we require you to commit and do the very best that you can.

Anyone not completing the work or producing poor quality will be spoken to and asked to re-consider if this is the correct course for you. Please use resources such as the internet, library and your Chemistry GCSE notes to help you complete this booklet.

As part of your AS/A-Level studies you will have lessons in which you will cover all the theory and practical work required for the course. You are also expected to spend at least five and a half hours a week on your Chemistry work outside of lessons. This will include homework tasks, pre-reading, independent study tasks, making additional notes, reviewing lesson materials and reading around the subject.

To support your learning you will be provided with a access to the online textbook for the current AS/A-Level course. Your teachers are, of course, an excellent source of support both in and out of lessons.

Finally, you should bring all the work with you to your first year 12 Chemistry lesson in September. *[Note: optional research task should be completed on a separate sheet and handed in with the booklet]*

PART 1: 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) $Mg(s) + O2(g) \rightarrow MgO(s)$

2) $H2(g) + 02(g) \rightarrow H2O(l)$

3) $Fe(s) + HCl(aq) \rightarrow FeCl2(aq) + H2(g)$

4) $CuO(s) + HNO3(aq) \rightarrow Cu(NO3)2\ (aq) + H2O(l)$

5) $Ca(OH)2(aq) + HCl(aq) \rightarrow CaCl2(aq) + H2O(l)$

6) $KHCO3(s) + H2SO4(aq) \rightarrow K2SO4(aq) + CO2(g) + H2O(l)$

7) $Al(s) + Cl2(g) \rightarrow AlCl3(s)$

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-

A chemical equation balancing game.
http://education.jlab.org/elementbalancing/

PART 2: MEASURING AMOUNT OF SUBSTANCE

Mass

Convert the following into grams:

a) 0.25 kg
b) 15 kg
c) 100 tonnes
d) 2 tonnes

Helpful conversions
1 tonne = 1000kg
1 dm^3 = 1000 cm^3

Volume

Convert the following into dm^3:

a) 100 cm^3
b) 25 cm^3
c) 50 m^3
d) 50000 cm^3

Tip – always use standard form for very large and very small numbers!

Moles

Atoms and molecules are very small – far too small to count individually!

It is important to know how much of something we have, but we count particles in MOLES because you get simpler numbers

1 mole = 6.02×10^{23} particles

(6.02×10^{23} is known as Avogadro's number)

a) If you have 2.5×10^{21} atoms of magnesium, how many moles do you have?

b) If you have 0.25 moles of carbon dioxide, how many molecules do you have?

- Moles from a measurement of **MASS**: (GCSE)

You can find the number of moles of a substance if you are given its **mass** and you know its **molar mass**:

number of moles = mass (g)/molar mass ($gmol^{-1}$)

$n = m/m_r$

Mass must be measured in grams. Molar mass has units of $gmol^{-1}$

1. Calculate the number of moles present in:	2. Calculate the mass of:	3. Calculate the molar mass of the following substances:
a) 2.3 g of Na	a) 0.05 moles of Cl_2	a) 0.015 moles, 0.42 g
b) 2.5 g of O_2	b) 0.125 moles of KBr	b) 0.0125 moles, 0.50 g
c) 240000 g of CO_2	c) 0.075 moles of $Ca(OH)_2$	c) 0.55 moles, 88 g
d) 12.5 g of $Al(OH)_3$	d) 250 moles of Fe_2O_3	d) 2.25 moles, 63 g
e) 5.2 g of PbO_2	e) 0.02 moles of $Al_2(SO_4)_3$	e) 0.00125 moles, 0.312 g

- Moles from a measurement of AQUEOUS VOLUME:

You can find the number of moles of a substance dissolved in water (aqueous) if you are given the **volume** of solution and you know its **molar concentration**:

number of moles = aqueous volume x molar concentration

n = V x C

Aqueous volume must be measured in dm^3! Concentration has units of $moldm^{-3}$.

a) What is a dm?

If you know the molar mass of the substance, you can convert the molar concentration into a mass concentration:

Molar concentration ($moldm^{-3}$) x m_r = mass concentration (gdm^{-3})

1. Calculate the number of moles of substance present in each of the following solutions:	2. Calculate the molar concentration and the mass concentration of the following solutions:	3. Calculate the molar concentration and the mass concentration of the following solutions:
a) 25 cm^3 of 0.1 $moldm^{-3}$ HCl	a) 0.05 moles of HCl in 20 cm^3	a) 35 g of NaCl in 100 cm^3
b) 40 cm^3 of 0.2 $moldm^{-3}$ HNO_3	b) 0.01 moles of NaOH in 25 cm^3	b) 20 g of $CuSO_4$ in 200 cm^3
c) 10 cm^3 of 1.5 $moldm^{-3}$ NaCl	c) 0.002 moles of H_2SO_4 in 16.5 cm^3	c) 5 g of HCl in 50 cm^3
d) 5 cm^3 of 0.5 $moldm^{-3}$ $AgNO_3$	d) 0.02 moles of $CuSO_4$ in 200 cm^3	d) 8 g of NaOH in 250 cm^3
e) 50 cm^3 of 0.1 $moldm^{-3}$ H_2SO_4	e) 0.1 moles of NH_3 in 50 cm^3	e) 2.5 g of NH_3 in 50 cm^3

- From a measurement of GASEOUS VOLUME:

You can find the number of moles of a gas if you are given the **volume** of the gas:

number of moles = volume / 24

n = V / 24

24 dm^3 is the volume occupied by 1 mole of any gas at room temperature and pressure

Volume MUST be measured in dm^3!

1. Calculate the number of moles present in:	2. Calculate the volume of gas occupied by:	3. Calculate the mass of the following gas samples:
a) 48 dm^3 of O_2	a) 0.05 moles of Cl_2	a) 48 dm^3 of O_2
b) 1.2 dm^3 of CO_2	b) 0.25 moles of CO_2	b) 1.2 dm^3 of CO_2
c) 200 cm^3 of N_2	c) 28 g of N_2	c) 200 cm^3 of N_2
d) 100 dm^3 of Cl_2	d) 3.2 g of O_2	d) 100 dm^3 of Cl_2
e) 60 cm^3 of NO_2	e) 20 g of NO_2	e) 60 cm^3 of NO_2

PART 3: USING CHEMICAL EQUATIONS

How many moles?

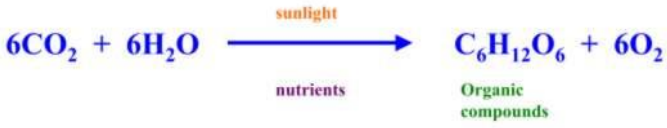
1) John weighs a sample of $CaCO_3$ and records a mass of 5.0 g. How many moles of calcium carbonate are present?

2) Fatima measures out 50 cm^3 of 0.1 $moldm^{-3}$ hydrochloric acid. How many moles of hydrochloric acid are present?

3) Hussain collects 48 cm^3 of carbon dioxide in a gas syringe. How many moles of carbon dioxide are present?

Using Chemical Equations

Chemical Equations show the ratio in which different species react in a chemical equation.



This equation shows that **6** moles carbon dioxide of react with **6** mole of water to make **1** mole of glucose and **6** moles of oxygen.

6: 6: 1: 6

a) How many moles of water are needed to react with 0.03 moles of carbon dioxide?

b) How many moles of glucose can you make from 0.03 moles of carbon dioxide?

c) How many moles of oxygen can you make from 0.03 moles of carbon dioxide?

Equation 1: $Mg + 2\,HCl \rightarrow MgCl_2 + H_2$

a) How many moles of magnesium would be needed to react with 0.01 moles of hydrochloric acid?

b) How many moles of hydrogen could be produced from 0.01 moles of hydrochloric acid?

Equation 2: $2\,H_2S + 3\,O_2 \rightarrow 2\,SO_2 + 2\,H_2O$

a) How many moles of oxygen is needed to react with 0.5 moles of hydrogen sulphide?

b) How many moles of sulphur dioxide can be made from 0.5 moles of hydrogen sulphide?

Equation 3: $4\,K + O_2 \rightarrow 2\,K_2O$

a) How many moles of oxygen are needed to react with 0.05 moles of potassium?

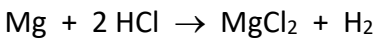
b) How many moles of potassium oxide can be made from 0.05 moles of potassium?

Calculating Reacting Quantities from Chemical Equations

You perform these calculations in three steps:

- calculate the number of moles of one of the substances (you will either be given the mass, or the aqueous volume and the concentration, or the gaseous volume)
- use the equation to work out the number of moles of the other substance
- use one of the mole relationships to work out the quantity you need

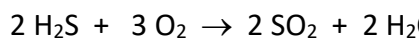
1) What mass of hydrogen is produced when 192 g of magnesium is reacted with hydrochloric acid?



$$Mg + 2\,HCl \rightarrow MgCl_2 + H_2$$

(3)

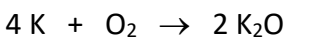
2) What mass of oxygen is needed to react with 8.5 g of hydrogen sulphide (H_2S)?



$$2\,H_2S + 3\,O_2 \rightarrow 2\,SO_2 + 2\,H_2O$$

(3)

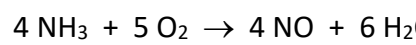
3) What mass of potassium oxide is formed when 7.8 g of potassium is burned in oxygen?



$$4\,K + O_2 \rightarrow 2\,K_2O$$

(3)

4) What mass of oxygen is required to oxidise 10 g of ammonia to NO?



$$4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$$

(3)

5) What mass of aluminium oxide is produced when 135 g of aluminium is burned in oxygen?

$$2\ Al + 3\ O_2 \rightarrow Al_2O_3 \qquad (3)$$

6) What mass of iodine is produced when 7.1 g of chlorine reacts with excess potassium iodide?

$$Cl_2 + 2\ KI \rightarrow 2\ KCl + I_2 \qquad (3)$$

7) What volume of hydrogen is needed to react with 32 g of copper oxide?

$$CuO + H_2 \rightarrow Cu + H_2O \qquad (3)$$

8) What volume of oxygen is formed when 735 g of potassium chlorate decomposes?

$$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2 \qquad (3)$$

9) What volume of hydrogen is produced when 195 g of potassium is added to water?

$$2\ K + 2\ H_2O \rightarrow 2\ KOH + H_2 \qquad (3)$$

10) What mass of calcium carbonate is required to produce 1.2 dm^3 of carbon dioxide?

$$CaCO_3 \rightarrow CaO + CO_2 \qquad (3)$$

11) What mass of magnesium oxide is formed when magnesium reacts with 6 dm^3 of oxygen?

$$2\ Mg\ +\ O_2\ \rightarrow\ 2\ MgO \qquad (3)$$

12) What volume of carbon dioxide is produced when 5.6 g of butene (C_4H_8) is burnt?

$$C_4H_8\ +\ 6\ O_2\ \rightarrow\ 4\ CO_2\ +\ 4\ H_2O \qquad (3)$$

13) The pollutant sulphur dioxide can be removed from the air by reaction with calcium carbonate in the presence of oxygen. What mass of calcium carbonate is needed to remove 480 dm^3 of sulphur dioxide?

$$2\ CaCO_3\ +\ 2\ SO_2\ +\ O_2\ \rightarrow\ 2\ CaSO_4\ +\ 2\ CO_2 \qquad (3)$$

14) 25 cm^3 of a solution of sodium hydroxide reacts with 15 cm^3 of 0.1 mol/dm^3 HCl. What is the molar concentration of the sodium hydroxide solution?

$$HCl + NaOH \rightarrow NaCl + H_2O \qquad (3)$$

Using state symbols

1) What are the 4 state symbols?

2) Select 3 equations from the calculations in the previous section and write them out, in full, including the correct state symbol for each substance in the equation.

PART 4: CALCULATIONS

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.

PART 4: STRUCTURE AND BONDING

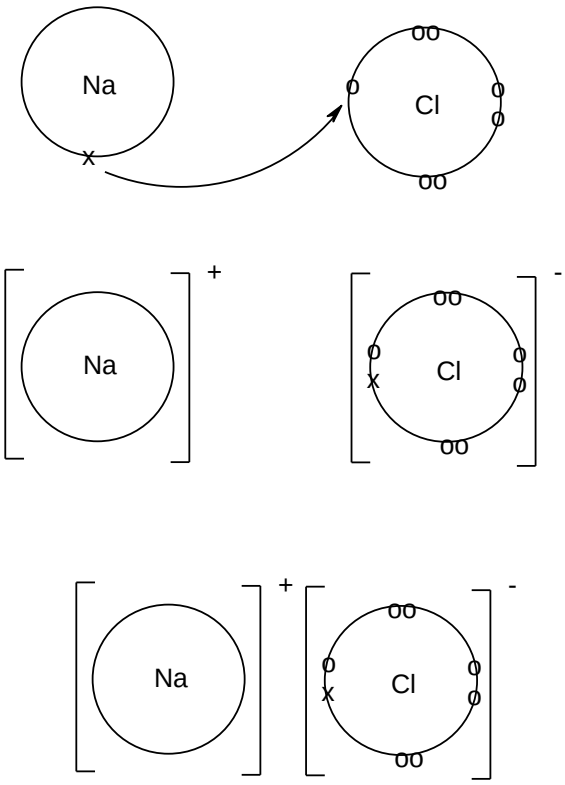
TYPES OF BOND

Atoms bond to each other in one of four ways:

Ionic bonding

An ionic bond is a electrostatic attraction between oppositely charged ions, which are formed by the transfer of electrons from one atom to another.

E.g. In sodium chloride, each sodium atom transfers an electron to a chlorine atom. The result is a sodium ion and a chloride anion. These two ions attract each other to form a stable compound.



a. 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.

b. Describe the structure of sodium chloride.

c. 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

d. 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

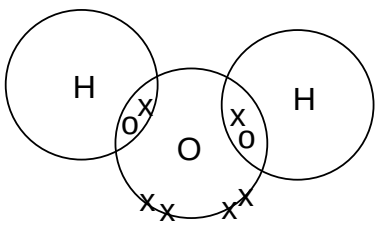
e. Deduce the chemical formulae of the following ionic compounds:-
   a) Calcium chloride
   b) Sodium oxide
   c) Magnesium sulphide
   d) Aluminium hydroxide
   e) Potassium carbonate
   f) Calcium nitrate

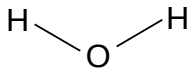
Covalent bonding

A covalent bond is a pair of electrons shared between two atoms.

In a normal covalent bond, each atom provides one of the electrons in the bond. A covalent bond is represented by a short straight line between the two atoms.

E.g. water





Covalent bonds should not be regarded as shared electron pairs in a fixed position; the electrons are in a state of constant motion and are best regarded more as **charge clouds**.

TASK

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

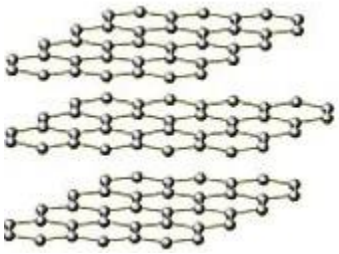
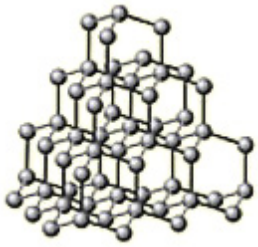
4) Describe the difference between the boiling point of water compared to chlorine and oxygen

Draw dot and cross diagrams for the following compounds:

1. NaCl
2. $MgCl_2$
3. Na_2O
4. MgO
5. Cl_2
6. NH_3
7. CH_4
8. $AlCl_3$
9. CO_2

Remember- ionic bonds are between a metal and a non-metal, covalent bonds between non-metals only.

10. H_2O

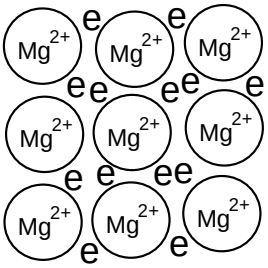
Structure			
Name			
Elements involved			
Properties			
High or low bp			
Conductor or insulator			
Hard or soft			
Solubility in H_2O			
Uses			

Metallic bonding

A metallic bond is an attraction between positive ions and a sea of electrons.

Metallic bonds are formed when atoms lose electrons and the resulting electrons are attracted to all the resulting positive ions.

E.g. Magnesium atoms lose two electrons each, and the resulting electrons are attracted to all the positive ions.



Metallic bonding happens because the electrons are attracted to more than one nucleus and hence more stable. The electrons are said to be delocalized – they are not attached to any particular atom but are free to move between the atoms.

SUMMARY OF DIFFERENT TYPES OF COMPOUND AND THEIR PROPERTIES

Task: Complete the table to summarize the bonding and properties of each type of substance. The first row has been done for you. The numbers indicate the quantity of responses required in each box.

SUBSTANCE	Nature of bonding	Physical properties
IONIC **E.g. NaCl**	Electrostatic ttraction between oppositely charged ions. Infinite lattice of oppositely charged ions in three dimensions	High mpt, bpt Good conductors in liquid state Poor conductors in solid state Hard, strong, brittle.
METALLIC **E.g.**	1) 2)	1) 2) 3) 4)
GIANT COVALENT **E.g.**	1) 2)	1) 2) 3) 4)
MOLECULAR **E.g.**	1) 2)	1) 2) 3) 4)

GIANT COVALENT LAYERED **E.g.**	1) 2) 3)	1) 2) 3) 4)

<u>Structure and bonding summary exercises</u>

Predict which of the following pairs of substances is likely to have the higher melting point, giving reasons for your choice:

1. Na and Mg

2. Na and K

3. NaCl and NaBr

4. NaCl and MgO

5. C and Si

6. Ne and Ar

7. F_2 and Cl_2

8. NH_3 and PH_3

9. NaCl and HCl

10. SiO_2 and CO_2

Describe the bonding in the following compounds, and briefly describe their main physical properties (limited to melting point and electrical conductivity).

1. magnesium

2. diamond

3. silicon dioxide

4. magnesium oxide

5. carbon dioxide

6. graphite

7. sodium nitrate

8. water

9. sulphur dioxide

10. helium

PART 5: 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) Mrs Bartle needs to know how acidic the soil is in the school grounds. She 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) Balance the equation for this reaction.

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

   b) The chemistry students use 24.2 cm3 of sulfuric acid, extracted from the soil, to neutralise 25.0 cm3 of 0.010 moldm-3 sodium hydroxide. Determine the concentration of sulfuric acid in the school soil.

PART 6: REDOX

1) What is “redox”?

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

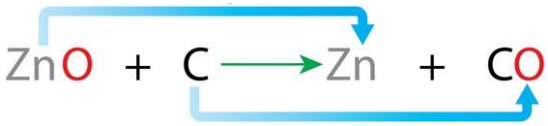
   a)

   b)

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

Well done for completing this transition course!

If you have any questions or concerns about A Level Chemistry please contact Mrs Bartle (zoe.bartle@nobel.hert.sch.uk) or Mrs Pearson (amy.person@nobel.herts.sch.uk)

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

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

USEFUL WEBSITES

Chemguide	www.chemguide.co.uk
Knockhardy	http://www.knockhardy.org.uk/sci.htm
Physics and Maths tutor	https://www.physicsandmathstutor.com/chemistry-revision/
A-Level Chemistry	https://www.a-levelchemistry.co.uk/
Youtube	• Science with Hazel • Dr Beattie's Chemistry Essentials • Free Science lessons – you will need to search out the A-Level Chemistry ones • Snaprevise