

Chemistry A Level Preparation

Name: _____

GCSE Target: _____

GCSE Grade: _____

Did you attend the Taster Day in June? _____

In this pack are a few useful documents to let you know more about the A Level course you will start next term and some questions to keep your brain ticking over until September! If you have any problems please e-mail Miss Jones at jonesme@wallingfordschool.com

Many of the topics you will cover in Year 12 should feel familiar as they build on the ideas you have covered at GCSE. The work you will complete in preparation for the start of your A Level course is designed to consolidate your understanding of GCSE work. Use revision guides and online resources like BBC Bitesize to review the content and then complete the practise examples. It is important to note that we will cover all of these calculations again from September onwards.

Useful websites: Quantitative Chemistry - <https://www.bbc.co.uk/bitesize/topics/z87mw6f>, Bonding and structure - <https://www.bbc.co.uk/bitesize/topics/zq6h2nb>. I have also inserted links to useful websites throughout.

Task	Topic covered	Completed ✓	Percentage achieved
1	Atoms and ions		
2	Equations and balancing		
3	Ionic bonding and ionic formulae		
4	Drawing molecules		
5	Bonding and structure		
6	Relative formulae mass and percentage by mass		
7	Moles and molar ratios		
8	Reacting masses		
9	Limiting reagents		
10	Concentration		
11	Calculations mixture		
12	Bond energy calculations		



How to succeed in Chemistry...

When asked this question most students say “work hard”. As you have chosen to study Chemistry that is a given! Remember – you have now chosen to do Chemistry because you enjoy it, the minimum expectation is that you will complete all work set. Here are some other tips.

- 1. Stay organised** – Organisation is a huge problem for some students and a reason why many struggle. The key tip is start off well and keep it up. Bring your folder to **every lesson** and keep your notes complete, well presented and in order. File dividers will be provided to help.
- 2. Read ahead** – Get into the routine of reading ahead in the text book before a lesson and making notes on what you’ve read. This way you are coming to lessons with an idea of the content being studied and the context of when and why it is studied.
- 3. Play an active part in lessons** – Learning is very much an active process. Take a leading role in group activities and practical experiments. Participating in discussions and asking lots of questions will also help. Simply turning up to lessons will not help you progress.
- 4. Be proactive** – never be content if you do not fully understand something you have covered in lessons or in your homework. There are lots of things you can do - read your notes and text book again, ask other members of your class to explain it to you, ask the teacher to explain it again in a different way etc. You will be given a Chemistry textbook and a set of flashcards. The textbook you will receive is:
 - A Level Chemistry for OCR A Student Book (OCR A Level Sciences) Paperback – 23 July 2015 by Rob Ritchie and Dave Gent (978-0198351979)Other useful resources you may want to get to supplement this may include:
 - A-Level Chemistry: OCR A Year 1 & 2 Complete Revision & Practice - 23 Aug. 2018 by CGP Books (978-1789080384)
 - A-Level Chemistry: OCR A Year 1 & 2 Exam Practice Workbook – 23 Aug. 2018 by CGP Books (978-1782949220)
- 5. Don’t leave gaps** – Related to number 3, if you don’t get a question don’t leave it. You will still not understand it in the exam! Ask for help preferably before the work is due to be handed in.
- 6. Ask for help** – The Chemistry department has an open door policy. You can come and get help any lunch time or after school. If you are stuck on a question at home also feel free to e-mail for help.
- 7. If you have no work to do ask for more or find some!** There are always things you can do to help you progress in Chemistry. Look through your PLC (personalised learning checklist) and identify topics you found more difficult and look over these again. Read through the next few topics to prepare you for future lessons, get some more practice of common types of calculations, compile a glossary of key terms and their definitions. E-mail your teacher and ask for some extension work!
- 8. Read and listen around.** Universities are looking for more than good grades. It is important that you show an interest in the subject and can talk intelligently about Chemistry above and beyond the topics you cover in lessons. Reading around the subjects in books and journals, listening to podcasts and watching relevant TV programmes can all help you to put the work you have covered in class into context.

We study the OCR A specification. If you would like to read more about this course please look at the OCR website: <http://www.ocr.org.uk/qualifications/as-a-level-gce-chemistry-a-h032-h432-from-2015/>

Content Overview	Assessment Overview	
<p>Content is split into six teaching modules:</p> <ul style="list-style-type: none"> Module 1 – Development of practical skills in chemistry Module 2 – Foundations in chemistry Module 3 – Periodic table and energy Module 4 – Core organic chemistry Module 5 – Physical chemistry and transition elements Module 6 – Organic chemistry and analysis <p>Component 01 assesses content from modules 1, 2, 3 and 5.</p> <p>Component 02 assesses content from modules 1, 2, 4 and 6.</p> <p>Component 03 assesses content from all modules (1 to 6).</p>	<p>Periodic table, elements and physical chemistry (01)</p> <p>100 marks</p> <p>2 hours 15 minutes</p> <p>written paper</p>	<p>37%</p> <p>of total A level</p>
	<p>Synthesis and analytical techniques (02)</p> <p>100 marks</p> <p>2 hours 15 minutes</p> <p>written paper</p>	<p>37%</p> <p>of total A level</p>
	<p>Unified chemistry (03)</p> <p>70 marks</p> <p>1 hour 30 minutes</p> <p>written paper</p>	<p>26%</p> <p>of total A level</p>
	<p>Practical endorsement in chemistry (04)*</p> <p>(non exam assessment)</p>	<p>Reported separately</p> <p>(see Section 5)</p>

In Year 12 we will cover Modules 2, 3 and 4. Module 1 relates to skills and these will be covered across the two years, as and when, we do practical work. In Year 13 we cover Modules 5 and 6. There is no longer any coursework but over the 2 years you will take part in a number of practical experiments and if these are completed satisfactorily you will also gain a pass in the practical assessment (this is separate to the A-level grade). At the end of Year 13 you will sit 3 exams as outlined above. Practical skills and knowledge will now be assessed in the 3 written exams.

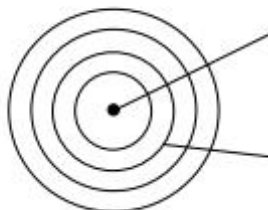
The Periodic Table of the Elements

(1)	(2)	Key										(3)	(4)	(5)	(6)	(7)	(0)						
1	2	atomic number										13	14	15	16	17	18						
Symbol		name										Symbol		name									
relative atomic mass		relative atomic mass										relative atomic mass		relative atomic mass									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
H hydrogen 1.0	He helium 4.0	Li lithium 6.9	Be beryllium 9.0	B boron 10.8	C carbon 12.0	N nitrogen 14.0	O oxygen 16.0	F fluorine 19.0	Ne neon 20.2	Na sodium 23.0	Mg magnesium 24.3	Al aluminium 27.0	Si silicon 28.1	P phosphorus 31.0	S sulphur 32.1	Cl chlorine 35.5	Ar argon 39.9						
K potassium 39.1	Ca calcium 40.1	Sc scandium 45.0	Ti titanium 47.9	V vanadium 50.9	Cr chromium 52.0	Mn manganese 54.9	Fe iron 55.8	Co cobalt 58.9	Ni nickel 58.7	Cu copper 63.5	Zn zinc 65.4	Ga gallium 69.7	Ge germanium 72.6	As arsenic 74.9	Se selenium 79.0	Br bromine 79.9	Kr krypton 83.8						
Rb rubidium 85.5	Sr strontium 87.6	Y yttrium 88.9	Zr zirconium 91.2	Nb niobium 92.9	Mo molybdenum 95.9	Tc technetium	Ru ruthenium 101.1	Rh rhodium 102.9	Pd palladium 106.4	Ag silver 107.9	Cd cadmium 112.4	In indium 114.8	Sn tin 118.7	Sb antimony 121.8	Te tellurium 127.6	I iodine 126.9	Xe xenon 131.3						
Cs caesium 132.9	Ba barium 137.3	57-71 lanthanoids	Hf hafnium 178.5	Ta tantalum 180.9	W tungsten 183.8	Re rhenium 186.2	Os osmium 190.2	Ir iridium 192.2	Pt platinum 195.1	Au gold 197.0	Hg mercury 200.6	Tl thallium 204.4	Pb lead 207.2	Bi bismuth 209.0	Po polonium	At astatine	Rn radon						
Fr francium	Ra radium	89-103 actinoids	Rf rutherfordium	Db dubnium	Sg seaborgium	Bh bohrium	Hs hassium	Mt meitnerium	Ds darmstadtium	Rg roentgenium	Cn copernicium	Fl flerovium	Lv livermorium										

57	La lanthanum 138.9	58	Ce cerium 140.1	59	Pr praseodymium 140.9	60	Nd neodymium 144.2	61	Pm promethium 144.9	62	Sm samarium 150.4	63	Eu europium 152.0	64	Gd gadolinium 157.2	65	Tb terbium 158.9	66	Dy dysprosium 162.5	67	Ho holmium 164.9	68	Er erbium 167.3	69	Tm thulium 168.9	70	Yb ytterbium 173.0	71	Lu lutetium 175.0
89	Ac actinium 232.0	90	Th thorium 232.0	91	Pa protactinium	92	U uranium 238.1	93	Np neptunium	94	Pu plutonium	95	Am americium	96	Cm curium	97	Bk berkelium	98	Cf californium	99	Es einsteinium	100	Fm fermium	101	Md mendelevium	102	No nobelium	103	Lr lawrencium

Atoms consist of a central containing protons and The nucleus is compared to the size of the whole atom. The nucleus is surrounded by in energy levels (also called). Atoms have no electric charge because they contain the same number of protons and

sub-atomic particle	relative mass	relative charge
proton		
neutron		
electron		



Atomic number = number of

Mass number = number of + number of

The number of protons, neutrons and electrons in an atom can be worked out using the atomic number and mass number.

Number of protons =

Number of neutrons =

Number of electrons =

Atoms can be represented as follows:

$\begin{matrix} \text{mass number} \\ \text{atomic number} \end{matrix} \text{Symbol}$ e.g. ${}_{9}^{19}\text{F}$ protons = neutrons = electrons =

Atoms of the same element have the same number of In fact, it is the number of that determines what type of atom it is (e.g. all atoms with 6 protons are carbon atoms). Atoms of different elements have different numbers of

Isotopes are atoms with the same number of but a different number of This means they are atoms of the same with the same number but a different number.

	${}_{17}^{35}\text{Cl}$	${}_{17}^{37}\text{Cl}$
protons		
neutrons		
electrons		

Atom	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
${}_{11}^{23}\text{Na}$					
Li	3	7			
Ar		40	18		
K			19	20	
Al				14	13
${}_{92}^{235}\text{U}$					
${}_{92}^{238}\text{U}$					

Atoms are neutral because they contain the same number of positive protons as negative electrons. For example, the atom ${}_{11}^{23}\text{Na}$ is neutral because it contains 11 protons (11+ charges) and 11 electrons (11- charges).

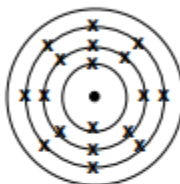

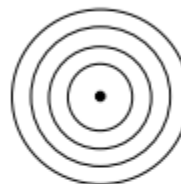
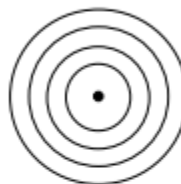
Ions are particles that contain a different number of protons and electrons. For example, an ion with 11 protons (11+ charges) and 10 electrons (10- charges) has an overall charge of 1+.



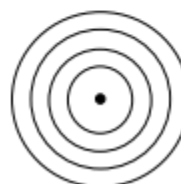
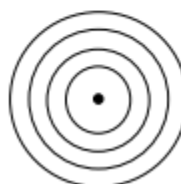
The noble gas elements (Group 0 elements) have very stable electron arrangements. Ions also have the electron structure of the noble gases (group 0 elements), except H^+ which has no electrons at all.

- 1) Complete the table below to show whether particles are atoms or ions, and for ions their charge.

Number and overall charge of protons	11+	11+	16+	4+	13+	18+	17+	15+	21+	1+	32+	35+
Number and overall charge of electrons	11-	10-	18-	2-	10-	18-	18-	18-	18-	0-	32-	36-
Atom or ion?	atom	ion	ion									
Overall charge		1+	2-									

- 2) Complete the table below to show the electronic structure of some common ions. The first one has been done for you. You will need to use the Periodic Table to help.

Ion	Cl^-	Li^+	F^-	Mg^{2+}
Protons	17			
Electrons	18			
Electron structure				
Electron structure	2,8,8			

Ion	K^+	S^{2-}	H^+	P^{3-}
Protons				
Electrons				
Electron structure				
Electron structure				

Species	Atom / ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
$^{14}_7\text{N}$	atom					
$^{31}_{15}\text{P}$	atom					
	atom	3	7			
	atom	10			10	
	atom		40	20		
	atom		40		22	
	atom			4	5	
	atom	82			126	
	atom	35			44	
	atom	35			46	
$^{23}_{11}\text{Na}^+$						
$^{16}_8\text{O}$						
$^{16}_8\text{O}^{2-}$						
		17	35			18
		19			20	19
		19			20	18
				20	20	18
		1			0	0
		53			74	54
			14		7	10

1 Complete the table about these atoms and ions.

atom / ion	protons	neutrons	electrons	electron structure
${}_{13}^{27}\text{Al}$				
${}_{13}^{27}\text{Al}^{3+}$				
${}_{8}^{17}\text{O}$				
${}_{8}^{17}\text{O}^{2-}$				

2 The electron structure of some atoms are given. Which group of the Periodic Table does each of these atoms belong to?

electron structure	2,8,7	2,8,8,1	2,8,18,3	2,8,18,18,6	2,8
group					

3 There are two isotopes of boron, which are shown in the table.

Isotope	${}_{5}^{10}\text{B}$	${}_{5}^{11}\text{B}$
Abundance	19.9%	80.1%

a Explain why they are both atoms of boron.

.....

b The radius of a boron atom is 180 pm. Write this in metres in standard form.

.....

c Calculate the relative atomic mass of boron to 3 significant figures.

.....

.....

.....

.....

.....

2

NAMING SUBSTANCES 2

https://www.ducksters.com/science/chemistry/naming_chemical_compounds.php

Name the following substances.

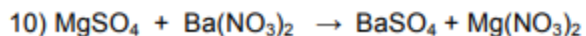
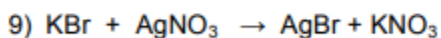
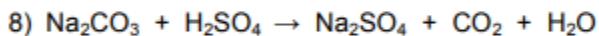
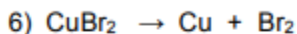
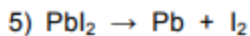
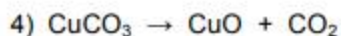
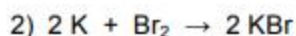
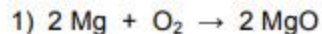
Formula	Name
O ₂	
CuO	
Cu	
CuSO ₄	
CuS	
CuCO ₃	
FeSO ₄	
Fe(NO ₃) ₂	
N ₂	
H ₂ SO ₄	
CO	
CO ₂	
NO ₂	
HCl	
KHCO ₃	
K ₂ CO ₃	
Mg	
AgF	
Ca(OH) ₂	
CaCO ₃	

Formula	Name
Al ₂ O ₃	
Na	
Al ₂ (SO ₄) ₃	
HNO ₃	
I ₂	
Ni	
Al	
Na ₂ O	
NaOH	
NaBr	
Na ₂ CO ₃	
He	
CH ₄	
NH ₃	
NH ₄ Br	
H ₂ Te	
SnCl ₄	
WO ₃	
HgO	
TiC	

Convert the following equations into word equations. Here is an example



sodium carbonate + hydrochloric acid \rightarrow sodium chloride + water + carbon dioxide

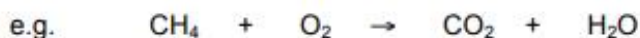


<https://www.youtube.com/watch?v=vxCyzR6uETs>

- An equation is balanced when there are the same number of atoms of each type on both sides of the equation.
- An equation can only be balanced by putting numbers in front of formulas – you cannot change the formula itself.
- Equations can be written with state symbols: (s) = solid, (l) = liquid, (g) = gas, (aq) = aqueous (dissolved in water).

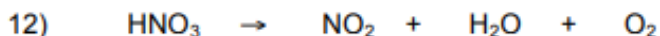
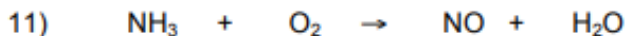
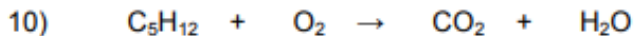
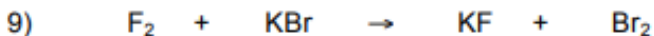
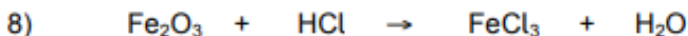
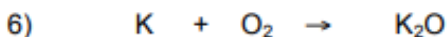
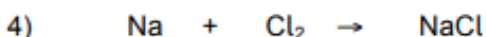
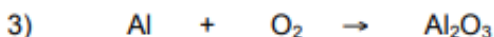
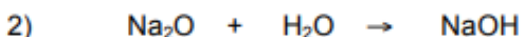
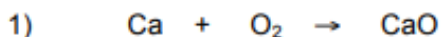
How to balance an equation:

- Calculate how many atoms of each type are on each side of the equation.
- If the numbers are the same then the equation is balanced.
- If the numbers are not the same, then numbers are put in front of the formulas (this adds more of that substance). You cannot change the formulas (this would make a different substance). Hint – start with unbalanced elements that only appear in one substance on each side of the equation.
- Keep doing this until the equation is balanced.



Questions

Put your final answers here although you may wish to do your working on a separate sheet of paper or on the back.



- 1) Fill in the missing words in the passage below.

Ions are particles that have a different number of protons and Ions are electrically charged. Ions can be formed when a metal reacts with a non-metal. Metal atoms electrons to form ions. Non metals electrons to form ions.

- 2) Which of the following compounds have ionic structures? Indicate with ✓/✗.

ethane, C_2H_6 hydrogen sulfide, H_2S copper oxide, CuO zinc bromide, $ZnBr_2$ Ammonia, NH_3

- 3) Magnesium oxide (MgO) contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

- a) Draw the electronic structure of these ions on the diagram.



magnesium ion (Mg^{2+})



oxide ion (O^{2-})

- b) Explain what the formula MgO means.

- 4) a) Explain why ionic compounds have high melting and boiling points.

- b) Explain why ionic compounds conduct electricity when melted or dissolved in water.

- c) Explain why ionic compounds do not conduct electricity as solids.

- 5) Which of the following substances are ionic?

Substance	Melting point ($^{\circ}C$)	Boiling point ($^{\circ}C$)	Electrical conductivity as		
			solid	liquid	solution (aq)
A	650	1107	conducts	conducts	insoluble
B	114	184	does not conduct	does not conduct	does not conduct
C	801	1467	does not conduct	conducts	conducts
D	2040	2980	does not conduct	conducts	insoluble
E	119	445	does not conduct	does not conduct	insoluble
F	1610	2230	does not conduct	does not conduct	insoluble

- | | | | |
|--------------------------|-------|-------------------------|-------|
| 1 a) sodium iodide | ..... | 2 a) sodium sulfate | ..... |
| b) potassium oxide | ..... | b) calcium sulfate | ..... |
| c) aluminium chloride | ..... | c) magnesium hydroxide | ..... |
| d) magnesium bromide | ..... | d) zinc(II) nitrate | ..... |
| e) aluminium oxide | ..... | e) copper(II) carbonate | ..... |
| f) iron(II) oxide | ..... | f) sodium hydroxide | ..... |
| g) iron(III) oxide | ..... | g) potassium carbonate | ..... |
| h) magnesium sulfide | ..... | h) iron(III) hydroxide | ..... |
| i) copper(II) fluoride | ..... | i) ammonium nitrate | ..... |
| j) lithium iodide | ..... | j) ammonium hydroxide | ..... |
| k) barium bromide | ..... | k) iron(III) sulfate | ..... |
| l) zinc(II) sulfide | ..... | l) aluminium nitrate | ..... |
| m) lead(II) iodide | ..... | m) silver(I) nitrate | ..... |
| n) iron(III) sulfide | ..... | n) calcium carbonate | ..... |
| o) magnesium oxide | ..... | o) magnesium nitrate | ..... |
| p) rubidium bromide | ..... | p) ammonium astatide | ..... |
| q) strontium chloride | ..... | q) caesium nitrate | ..... |
| r) caesium selenide | ..... | r) strontium hydroxide | ..... |
| s) calcium astatide | ..... | s) platinum(II) nitrate | ..... |
| t) radium polonide | ..... | t) cobalt(II) carbonate | ..... |
| u) gallium fluoride | ..... | u) copper(I) oxide | ..... |
| v) scandium(III) bromide | ..... | v) copper(II) oxide | ..... |
| w) chromium(III) oxide | ..... | w) francium telluride | ..... |
| x) strontium iodide | ..... | x) gold(I) fluoride | ..... |
| y) lithium arsenide | ..... | y) rubidium sulfate | ..... |

When non-metals combine with other non-metals, the atoms share electrons to form a molecule. The atoms are held together by these shared electrons which are known as covalent bonds.

Molecule = a particle made up of atoms joined by covalent bonds

Covalent bond = 2 shared electrons

How many covalent bonds?

Atoms	Number of electrons in outer shell	Number of extra electrons needed to fill the outer shell	Number of covalent bonds formed
Group 7 (e.g. F, Cl, Br, I)	7	1	1
Group 6 (e.g. O, S)	6	2	2
Group 5 (e.g. N, P)	5	3	3
Group 4 (e.g. C, Si)	4	4	4
H	1	1	1

Drawing stick diagrams & dot-cross diagrams

Stick diagrams – these show each covalent bond as a stick.

Dot-cross diagrams – these show the outer shell electrons only

- 1 Draw a stick diagram
- 2 Re-draw the stick diagram without the sticks
- 3 Replace the stick with a **X●** which represents the two electrons in the bond (**X** represents electrons from one atom, and **●** represents the electron from the other atom).
- 4 Add in any other outer shell electrons from each atom (electrons are always in pairs)
- 5 CHECK that there are 8 electrons around each atom (except H where there should be 2 electrons)

Stick diagram	Molecule	Dot-cross diagram
$ \begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{H} \\ | \\ \text{H} \end{array} $	CH ₄	
	NH ₃	$ \begin{array}{c} \bullet \bullet \\ \text{H} \times \text{N} \times \text{H} \\ \times \\ \text{H} \end{array} $
	O ₂	

	HCl	
	Br ₂	
	PH ₃	
	CO ₂	
	SiH ₄	
	H ₂ O	
	N ₂	
	C ₂ H ₄	
	C ₂ H ₂	
	C ₆ H ₆	

5

<https://www.bbc.co.uk/bitesize/topics/zq6h2nb>

PROPERTIES OF STRUCTURE TYPES

Complete the table to show the properties of the five different types of substances. The answers to choose from are in the last column.

Property	Monatomic	Ionic	Simple molecular	Giant covalent	Metallic	
Melting and boiling points						Very high High High Low Very low
Conductivity as solid						conducts some conduct, some don't does not conduct does not conduct does not conduct
Conductivity when melted						conducts conducts does not conduct does not conduct does not conduct
Solubility in water						soluble (usually) insoluble (usually) insoluble insoluble insoluble
Conductivity of solution						conducts insoluble (usually) insoluble insoluble insoluble

1) Which type of structure do the following substances have?

	K ₂ O	K	O ₂	CH ₂ O	Ar	S ₈	Br ₂	Cr	FeI ₃	MgSO ₄	N ₂ H ₄
ionic											
simple molecular											
metallic											
monatomic											
giant covalent											

2) Look at the properties of the following substances.

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity as	
			solid	liquid
A	587	843	does not conduct	conducts
B	28	201	does not conduct	does not conduct
C	-39	357	conducts	conducts
D	-189	-101	does not conduct	does not conduct
E	2157	2895	does not conduct	does not conduct
F	1024	1598	does not conduct	conducts

- a) Which of these compounds could have an ionic structure?
- b) Which of these compounds could have a simple molecular structure?
- c) Which of these compounds could have a metallic structure?
- d) Which of these compounds could have a giant covalent structure?

3) Write the formula of the following ionic compounds.

- a) potassium oxide
- b) magnesium nitrate
- c) aluminium hydroxide
- d) copper carbonate
- e) ammonium hydroxide
- f) iron (III) oxide

- 4) a) Aluminium oxide is an ionic substance with formula Al_2O_3 . Explain what this formula means.
.....
.....
- b) Explain why aluminium oxide has a high melting point.
.....
.....
- c) Explain why aluminium oxide does not conduct electricity as a solid but does when melted.
.....
.....
- 5) a) Aluminium is a metal. Explain why it has a high melting point.
.....
- b) Explain why aluminium conducts electricity.
.....
- 6) a) Ammonia is a simple molecular substance with formula NH_3 . Explain what this formula means.
.....
.....
- b) Explain why ammonia has a low melting point.
.....
.....
- c) Explain why ammonia does not conduct electricity in any state.
.....
.....
- 7) a) Explain why diamond is hard but graphite is soft.
.....
.....
- b) Explain why graphite conducts electricity but diamond does not.
.....
.....

<https://www.youtube.com/watch?v=q49NwlrjaFw>

Calculate the relative formula mass of the following substances.

- 1 F₂
- 2 Fe
- 3 H₂SO₄
- 4 Al₂O₃
- 5 Mg(OH)₂
- 6 Al(NO₃)₃
- 7 (NH₄)₂SO₄
- 8 CuCO₃
- 9 AgNO₃
- 10 NH₄NO₃
- 11 CuSO₄·5H₂O
- 12 magnesium
- 13 oxygen
- 14 sodium bromide
- 15 calcium fluoride
- 16 potassium sulfate
- 17 chlorine
- 18 chromium(III) oxide
- 19 sodium
- 20 iron(III) sulfate

You can find the percentage by mass of an element in a compound.

e.g. % by mass of Fe in $\text{Fe}_2\text{O}_3 = 100 \times \frac{2(56)}{160} = 70\%$

- 1 % by mass of O in H_2O
- 2 % by mass of O in SO_3
- 3 % by mass of Na in Na_2CO_3
- 4 % by mass of N in $\text{Ca}(\text{NO}_3)_2$
- 5 % by mass of O in $\text{Ca}(\text{NO}_3)_2$
- 6 % by mass of Cl in FeCl_3
- 7 % by mass of N in NH_4NO_3
- 8 % by mass of S in $\text{Al}_2(\text{SO}_4)_3$
- 9 % by mass of Li in lithium oxide
- 10 % by mass of Cr in chromium(III) oxide
- 11 % by mass of O in calcium hydroxide
- 12 % by mass of N in ammonium iodide
- 13 % by mass of O in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

1) Calculate the number of moles of each of the following substances. Give your answers to 3 sig figs.

a) 90.0 g of H_2O

.....
.....

b) 20.0 g of C_4H_{10}

.....
.....

c) 685 g of NH_3

.....
.....

d) 102 tons of O_2

.....
.....

e) 2.00 kg of Al_2O_3

.....
.....

f) 20.6 mg of Au

.....
.....

2) Calculate the mass of each of the following substances. Give your answers to 3 sig figs.

a) 4.00 moles of N_2

.....
.....

b) 0.100 moles of HNO_3

.....
.....

c) 0.0200 moles of K_2O

.....
.....

d) 2.50 moles of PH_3

.....
.....

e) 0.400 moles of $\text{C}_2\text{H}_5\text{OH}$

.....
.....

f) 10.0 moles of $\text{Ca}(\text{OH})_2$

.....
.....

3) 0.0200 moles of a compound is found to have a mass of 1.64 g. Find the formula mass of the compound. Give your answers to 3 sig figs.

.....
.....

A balanced equation shows us how many moles of each substance are used or produced in a chemical reaction. Complete the questions in a similar way to the example which has been done for you.

EXAMPLE

	C₃H₈	+	5O₂	→	3CO₂	+	4H₂O
what it means	1 mol of C ₃ H ₈		5 mol of O ₂		3 mol of CO ₂		4 mol of H ₂ O
a)	2 mol		10 mol		6 mol		8 mol
b)	10 mol		50 mol		30 mol		40 mol
c)	0.5 mol		2.5 mol		1.5 mol		2.0 mol

1

	2Ca	+	O₂	→	2CaO
what it means					
a)	4 mol				
b)			5 mol		
c)	0.10 mol				

2

	2Fe	+	3Cl₂	→	2FeCl₃
what it means					
a)	10 mol				
b)			9 mol		
c)			0.60 mol		

3

	TiCl₄	+	4Na	→	Ti	+	4NaCl
what it means							
a)	3 mol						
b)			10 mol				
c)	0.020 mol						

4

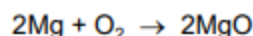
	2Al₂O₃	→	4Al	+	3O₂
what it means					
a)	5 mol				
b)			0.100 mol		
c)					60 mol

5

	C₂H₅OH	+	3O₂	→	2CO₂	+	3H₂O
what it means							
a)			12 mol				
b)	0.25 mol						
c)					0.10 mol		

- Step 1** Write ✓ for the substance whose mass is given and ? for the substance whose mass is to be calculated on the balanced equation
- Step 2** Find the moles of the ✓ substance (using $moles = \frac{mass}{M_r}$)
- Step 3** Use the balanced equation and your answer from step 2 to find the moles of the ? substance
- Step 4** Find the mass of the ? substance (using $mass = M_r \times moles$)

1) What mass of oxygen reacts with 12 g of magnesium?



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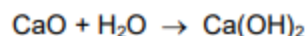
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2) What mass of calcium hydroxide is made from 14 kg of calcium oxide?



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3) What mass of aluminium is needed to react with 640 g of iron oxide?



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4) What mass of titanium chloride reacts with 460 g of sodium?



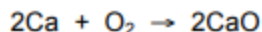
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- 1) Calculate the mass of calcium that can react with 40 g of oxygen.



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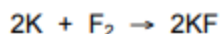
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- 2) Calculate the mass of fluorine that reacts with 3.9 g of potassium.



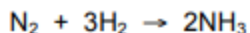
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- 3) Calculate the mass of nitrogen that reacts with 30 g of hydrogen.



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- 4) What mass of carbon dioxide is made when 7.2 g of pentane (C_5H_{12}) burns in oxygen?



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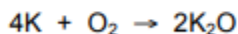
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- 5) What mass of potassium can react with 4.0 g of oxygen?



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In each example one of the reactants is in excess. Work out how many moles of the products are formed in each case.



- a) 2 mol 3 mol
 b) 10 mol 8 mol
 c) 0.40 mol 0.50 mol



- a) 2 mol 2 mol
 b) 10 mol 2 mol
 c) 0.50 mol 0.20 mol



- a) 3 mol 3 mol
 b) 12 mol 15 mol
 c) 20 mol 40 mol



- a) 4 mol 4 mol
 b) 2 mol 10 mol
 c) 0.5 mol 1 mol



- a) 15 mol 30 mol
 b) 0.25 mol 1 mol
 c) 3 mol 6 mol



- a) 3 mol 6 mol
 b) 0.5 mol 0.9 mol
 c) 6 mol 20 mol

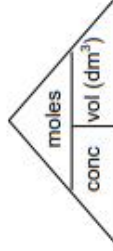


- a) 10 mol 2 mol
 b) 6 mol 4 mol
 c) 0.50 mol 0.20 mol

The concentration of a solution is usually measured in moles per cubic decimetre (mol/dm^3). This is a measure of the number of moles in one cubic decimetre.

The volume must be in dm^3 (there are 1000 cm^3 in 1 dm^3). $\text{vol in dm}^3 = \frac{\text{vol in cm}^3}{1000}$

$$\text{concentration (mol/dm}^3\text{)} = \frac{\text{moles}}{\text{volume (dm}^3\text{)}}$$



Concentration can also be measured in grams per cubic decimetre (g/dm^3). This is a measure of the number of grams in one cubic decimetre. [remember that $\text{mass} = M_r \times \text{moles}$]

1 dm³

2 moles of H₂SO₄
196 g of H₂SO₄

Concentration = 2 mol/dm^3

M_r of H₂SO₄ = 98

Concentration = $2 \times 98 = 196 \text{ g/dm}^3$

A simple conversion is: $\text{conc (g/dm}^3\text{)} = \text{conc (mol/dm}^3\text{)} \times M_r$

3) Calculate the concentration of the following solutions in g/dm^3 .

a) $0.100 \text{ mol/dm}^3 \text{ NaOH}$

b) $0.250 \text{ mol/dm}^3 \text{ CH}_3\text{COOH}$

c) $1.50 \text{ mol/dm}^3 \text{ HNO}_3$

4) 0.20 moles of NaOH is dissolved in 250 cm^3 of water.

a) Calculate the concentration in mol/dm^3

b) Calculate the concentration in g/dm^3

5) 5.0 g of KNO₃ is dissolved in 100 cm^3 of water.

a) Calculate the concentration in g/dm^3

b) Calculate the concentration in mol/dm^3

1) Calculate the concentration of the following solutions in mol/dm^3 .

a) 0.10 moles of NaCl in 200 cm^3

b) 0.20 moles of H₂SO₄ in 100 cm^3

c) 0.020 moles of NaOH in 25 cm^3

2) Calculate the number of moles in the following solutions.

a) 100 cm^3 of $0.20 \text{ mol/dm}^3 \text{ HNO}_3$

b) 25 cm^3 of $1.50 \text{ mol/dm}^3 \text{ KOH}$

c) 50 cm^3 of $0.10 \text{ mol/dm}^3 \text{ H}_2\text{SO}_4$

- 1) Sodium reacts with oxygen as shown: $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$

Find the M_r of the following substances involved in this reaction.

- a) sodium
- b) oxygen
- c) sodium oxide

- 2) a) How many moles in the following:

i) 21.3 g of chlorine, Cl_2

ii) 5.34 kg of aluminium bromide, AlBr_3

b) What is the mass of 0.25 moles of sulfur dioxide, SO_2 ?

- 3) What mass of bromine reacts with 2.3 g of sodium to form sodium bromide? $2\text{Na} + \text{Br}_2 \rightarrow 2\text{NaBr}$

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- 4) What mass of oxygen reacts with 280 g of iron to form iron oxide? $2\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$

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- 5) What is the percentage atom economy to make tungsten (W) from tungsten oxide in this reaction? $\text{WO}_3 + 3\text{H}_2 \rightarrow \text{W} + 3\text{H}_2\text{O}$

.....

.....

- 6) a) What is the maximum mass of calcium hydroxide that can be formed by reaction of 2.8 g of calcium oxide with water? $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$

- b) In a reaction, 2.6 g of calcium hydroxide was formed from 2.8 g of calcium oxide. Calculate the percentage yield.

- 7) 1.95 g of potassium is reacted with 5.08 g of iodine. Work out which is the limiting reagent and then calculate the mass of potassium iodide formed. $2\text{K} + \text{I}_2 \rightarrow 2\text{KI}$

- 8) 1.20 g of hydrated tin chloride decompose to form 1.01 g of anhydrous tin chloride on heating. Calculate the value of x . $\text{SnCl}_2 \cdot x\text{H}_2\text{O} \rightarrow \text{SnCl}_2 + x\text{H}_2\text{O}$

<https://www.youtube.com/watch?v=it0HGXhxD-s>

Bond	N-N	C-C	C-O	N-H	C-H	H-H
Bond energy (kJ/mol)	158	348	360	388	412	436

Bond	O-H	O=O	C=C	C=O	N≡N
Bond energy (kJ/mol)	463	498	612	743	944

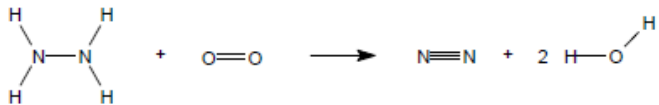
For each of the following reactions, use the bond energy data to:

- calculate the energy required to break the bonds in the reactants
- calculate the energy released when the bonds in products are made
- calculate the energy change for the reaction
- state whether the reaction is exothermic or endothermic

1	$2 \text{ H}-\text{H} + \text{O}=\text{O} \longrightarrow 2 \text{ H}-\text{O}-\overset{\text{H}}{\text{O}}$			
	Break	Make	Energy change	Exo/endothermic (& reason)

2	$\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}=\text{C}-\text{H} \end{array} + 3 \text{ O}=\text{O} \longrightarrow 2 \text{ O}=\text{C}=\text{O} + 2 \text{ H}-\text{O}-\text{H}$			
	Break	Make	Energy change	Exo/endothermic (& reason)

3



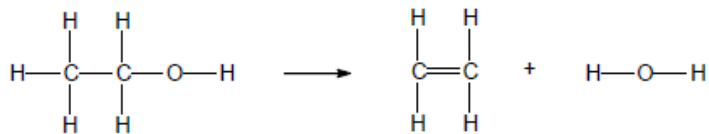
Break

Make

Energy change

Exo/endothermic (& reason)

4



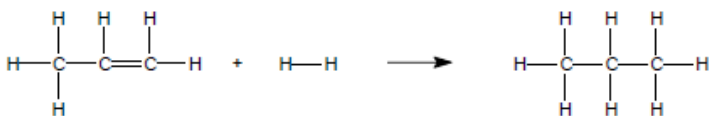
Break

Make

Energy change

Exo/endothermic (& reason)

5



Break

Make

Energy change

Exo/endothermic (& reason)



BOND ENERGY CALCULATIONS 1

Bond	Br-Br	Cl-Cl	C-Br	C-C	C-O	C-H	H-Cl
Bond energy (kJ/mol)	193	242	276	348	360	412	431

Bond	S=O	H-H	O-H	O=O	C=C	C=O	H-Br
Bond energy (kJ/mol)	435	436	463	498	612	743	366

For each of the following reactions, use the bond energy data to:

- calculate the energy required to break the bonds in the reactants
- calculate the energy released when the bonds in products are made
- calculate the energy change for the reaction
- state whether the reaction is exothermic or endothermic
- explain why the reaction is exothermic or endothermic in terms of bond breaking and making

