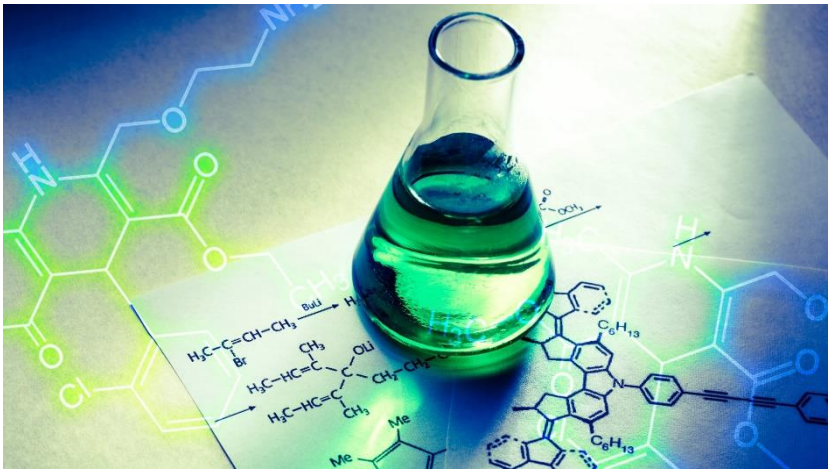
Ark Putney Academy Sixth Form

A-level Chemistry

Bridging Work Booklet



Name: _____

Chemistry A Level Bridging Work

Welcome to Chemistry!

This bridging work is designed to help you bridge the gap between your GCSE Science studies and the 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?

We want you to be successful and 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, so you can change your mind at enrolment – as long as there is space and you meet the entry criteria. We would rather you study courses that interest you and you are sufficiently qualified to study.

The first half of this booklet is subject based and will build on your chemistry knowledge, the second half is skills-based and should support you in other subjects.

Is the bridging work assessed?

Yes. In September, your subject teacher will ask you for your bridging work and it will be assessed. 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 the sixth form team will pick up on anyone with a low work ethic and support you accordingly.

This leads into the fact should you decide to change, you would need to complete the bridging work for the new course you choose.

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.

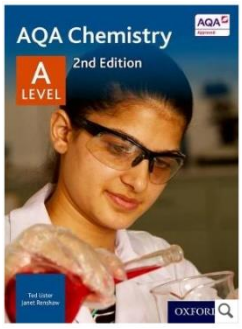
Anyone not completing the work or producing poor quality will be spoken to and asked to re-consider if this is the correct course for you. Please use resources such as the internet, library and your Chemistry GCSE notes to help you complete this booklet.

As part of your AS/A-Level studies you will have two teachers with 5 lessons a week on your timetable. In these lessons 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.

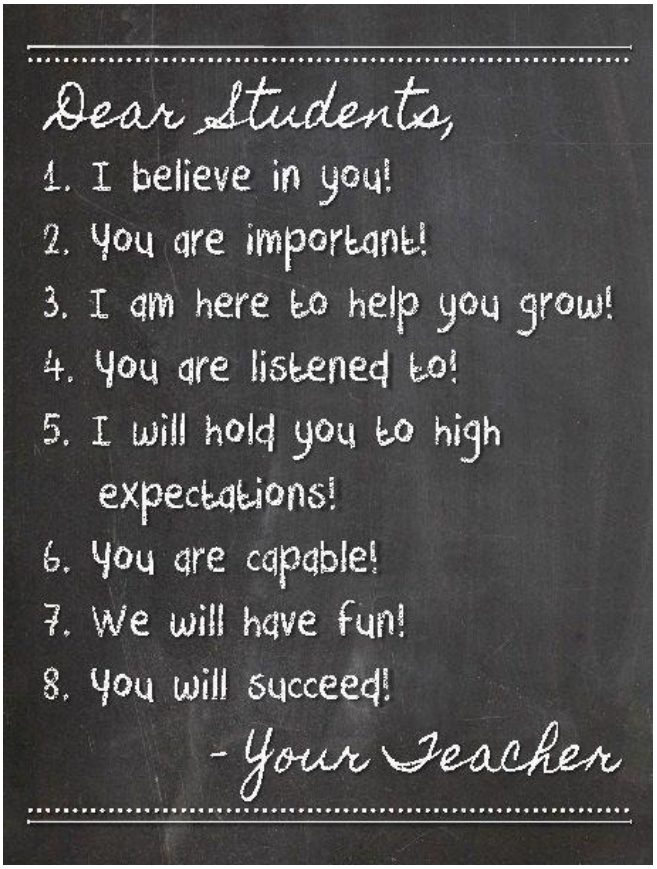
To support your learning you will need a textbook for the current A-Level course (see figure 1). Your teachers are, of course, an excellent source of support both in and out of lessons. Other support includes drop-in support classes outside of school hours and intervention sessions.

Figure 1:



Additional texts will be available in the school library and a full copy of the specification, past papers etc. can be accessed through the AQA website (A level Chemistry specification A): https://www.aqa.org.uk/subjects/science/as-and-a-level/chemistry-7404-7405/specification-at-a-glance

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]*



Key areas from your GCSE Science work that you will need for AS/A Level Chemistry

1) Atomic structure – protons, neutrons, electrons, mass number, isotopes etc.

2) Electron arrangement – how many electrons each shell can hold etc.

3) Ionic compounds – dot and cross diagrams, properties, examples.

4) Covalent compounds – dot and cross diagrams, properties, examples, diamond vs graphite.

5) Metallic bonding – diagram, properties of metals.

6) Calculations – relative atomic mass, relative molecular mass, atom economy, percentage yield.

7) Organic compounds – alkanes and alkenes.

8) Fractional distillation and cracking.

9) Rates of reaction – collision theory, how to speed up reactions, catalysts etc.

10) Endothermic and exothermic reactions.

11) Periodic table – overall arrangement in groups and periods.

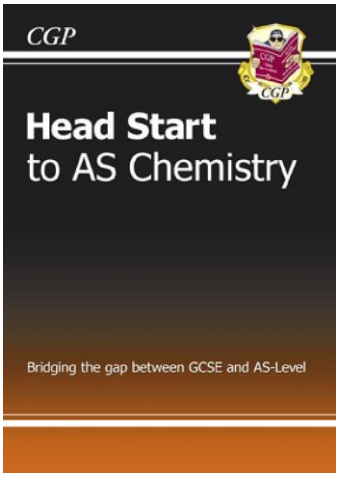
It would be beneficial to prepare revision notes on these topics as a starting point for your folder (or use the ones you prepared for GCSE revision). This will help support you through the year.

If you need to do more preparation……

- Try '**Head Start**' to AS Chemistry
- Buy on line at:

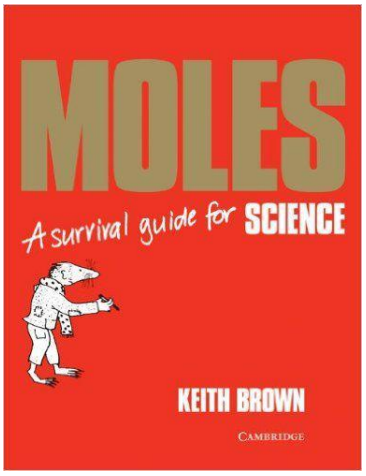
https://www.cgpbooks.co.uk/ or from amazon.

- ISBN 978 1 84762 116 0



If you studied double science or struggle with Moles a highly recommended book is….

- Moles, a survival guide for Science By Keith Brown.
- Buy online at Amazon. New for £9.95 or used from £2.81.
- ISBN 978 0 521 42409 7



Useful websites:

CGP books
https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science?sort=best_selling&quantity=36&page=1&view=grid&currentFilter=ExamBoard_511&filter_exa m%20board=ExamBoard_511%2CExamBoard_512

Maths Made Easy website
https://mathsmadeeasy.co.uk/a-level-chemistry-revision/#vc-infobox-icts

Snap Revise videos
https://www.youtube.com/results?search_query=A+level+chemistry+ocr+new+specification+snap+revise

Fuseschool videos
https://www.youtube.com/results?search_query=fuseschool+chemistry

Crash Course videos
https://www.youtube.com/watch?v=uVFCOfSuPTo&list=PL8dPuuaLjXtPHzzYuWy6fYEaX9mQQ8oGr

Knockhardy website
http://www.knockhardy.org.uk/

Chemguide website
https://www.chemguide.co.uk/

Uplearn – exclusive for APA chemistry students (will receive login details when you join)
https://web.uplearn.co.uk/learn

Year 11 to Year 12 Chemistry A-Level Bridging Unit

Section A Questions

- **Try to answer these questions using your GCSE knowledge.**
- **You need to bring this completed booklet to your first Chemistry lesson in September**

1. (a) Define the term *atomic number* of an element.

.....

(1)

(b) Give the symbol, including mass number and atomic number, for an atom of an element which contains 12 neutrons and 11 electrons.

.....

(2)

(c) How many neutrons are there in one $_{27}Al$ atom?

.....

(1)

(d) Define the term *relative atomic mass* of an element.

.....

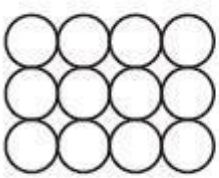
.....

(2)

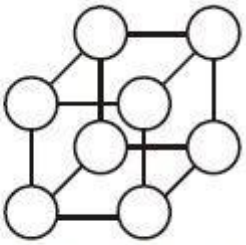
(Total 6 marks)

2. At room temperature, both sodium metal and sodium chloride are crystalline solids which contain ions.

(a) On the diagrams for sodium metal and sodium chloride below, mark the charge for each ion.



Sodium metal



Sodium chloride

(2)

(b) (i) Explain how the ions are held together in solid sodium metal.

.....

.....

(ii) Explain how the ions are held together in solid sodium chloride.

.....

.....

(iii) The melting point of sodium chloride is much higher than that of sodium metal. What can be deduced from this information?

.....

.....

(3)

(c) Explain why sodium metal is malleable (can be hammered into shape).

.....

.....

(1)

(d) Sodium chlorate, $NaClO_3$, contains 21.6% by mass of sodium, 33.3% by mass of chlorine and 45.1% by mass of oxygen.

(i) Use the above data to show that the empirical formula of sodium chlorate is $NaClO_3$

.....

.....

.....

.....

..... **(2)**

(ii) Sodium chlorate may be prepared by passing chlorine into hot aqueous sodium hydroxide. Balance the equation for this reaction below.

..... Cl_2 + ... NaOH → ..... NaCl + $NaClO_3$ + $3H_2O$

(1)

(Total 9 marks)

3. (a) Give the relative mass and relative charge of a neutron. *Relative mass* .....
Relative charge.....
(2)

(b) In terms of the number of their fundamental particles, what do two isotopes of an element have in common and how do they differ?

In common .....
Difference .....
(2)

(c) Give the complete atomic symbol, including mass number and atomic number, for an atom of the isotope with 22 neutrons and 19 electrons.

..... **(2)**

(Total 6 marks)

4. (a) Describe the bonding in metals.

.....

.....

.....

(2)

(b) Explain why the melting point of magnesium is higher than that of sodium.

.....

.....

.....

.....

(3)

(c) Explain how metals conduct electricity.

.....

.....

.....

(2)

(Total 7 marks)

Year 11 to Year 12 Chemistry A-Level Bridging Unit Section B Tasks

Significant figures and standard form task

Significant Figures

You need to be able to quote answers to the correct number of significant figures.

1) Write the following numbers to the quoted number of significant figures.

a) 345789 4 sig figs ..... d) 6 3 sig figs .....

b) 297300 3 sig figs ..... e) 0.001563 3 sig figs .....

c) 0.07896 3 sig figs ..... f) 0.01 4 sig figs .....

2) Complete the following sums and give the answers to 3 significant figures.

a) 6125 x 384..... d) 750 ÷ 25 .....

b) 25.00 x 0.01..... e) 0.000152 x 13 .....

c) 13.5 + 0.18..... f) 0.0125 x 0.025 .....

Standard Form

You need to be able to work with numbers in standard form.

3) Write the following numbers in non standard form.

a) 1.5×10^{-3} ..... d) 0.0534×10^{4}.....

b) 0.046×10^{-2} ..... e) 10.3×10^{5} .....

c) 3.575×10^{5}..... f) 8.35×10^{-3} .....

4) Write the following numbers in standard form.

a) 0.000167 ..... d) 34500.....

b) 0.0524..... e) 0.62.....

c) 0.000000015..... f) 87000000 .....

5) Complete the following calculations and give the answers to 3 significant figures.

a) $6.125 \times 10^{-3} \times 3.5$ .....

b) $4.3 \times 10^{-4} \div 7.0$.....

c) $4.0 \times 10^{8} + 35000$.....

d) $0.00156 + 2.4 \times 10^{3}$.....

e) $6.10 \times 10^{-2} - 3.4 \times 10^{-5}$ .....

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.

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

- Explain why ionic substances cannot conduct electricity when solid.

(c) 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

(d) Circle the correct answer.

Covalent bonding occurs between:-

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

(e) 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

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

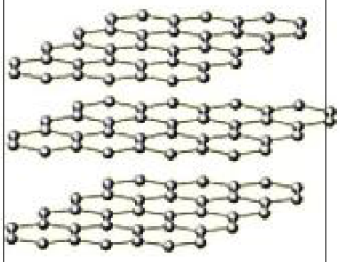
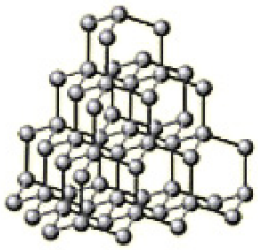
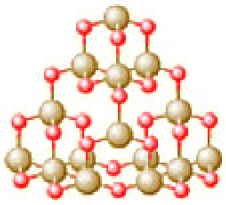
.....

.....

.....

....

Giant covalent structures

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**			

SUMMARY

3. Giant covalent structures tend to have low melting and boiling points. **True/false**
4. Most intermolecular forces are strong and make it difficult to separate the molecules. **True/false**
5. Most covalent substances do not conduct electricity. **True/false**
6. Graphite conducts electricity. **True/false**
7. 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:-

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

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

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

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

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

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

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

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).

(c) Acids have a pH of ..... than 7.

Alkalis have a pH of ..... than 7. Neutral

substances have a pH of ..... .

(d) Acid + Metal → ..... + ...

Acid + Metal Oxide → ..... + ...

Acid + Metal Hydroxide → ..... + ...

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

(e) 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.

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

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

(jj) 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.

(iv) What is "redox"?

.....

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

1)

2)

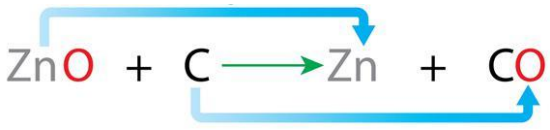
(e)What does oxidation mean?

.....

(f) What does reduction mean?

.....

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



Oxidised .....

Reduced .....

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

.....

.....

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

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

..... Fe_2O_3 + ... C → ..... + ...

(iv) 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

4. 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.

5. 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.

(c) What does the term “anhydrous” mean?

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

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

Bond enthalpies task

1) How can endothermic and exothermic reactions be explained in terms of breaking and making of chemical bonds? (1 mark)

2) Draw the energy level diagram for an endothermic reaction. Label the diagram with products, reactants, activation energy and energy absorbed. (3 marks)

3) The bond enthalpies for some common bonds are shown below.

C-H: +413 kJ mol^{-1}, C-C: +347 kJ mol^{-1}, C-O: +358 kJ mol^{-1}, O=O: +497 kJ mol^{-1}, C=O: +805 kJ mol^{-1}, O-H: +463 kJ mol^{-1}, C=C: +612 kJ mol^{-1}, H-H: +436 kJ mol^{-1}, NΞN: +945 kJ mol^{-1}, N-H: +391 kJ mol^{-1}

Calculate the enthalpy changes of reaction for each of the following reactions. (1 mark each)

a. $C_2H_4(g) + H_2(g) \rightarrow C2H_6(g)$

b. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

c. $N_2(g) + 3H_2(g) \rightarrow 2\ NH_3(g)$

d. $CH_2CH_2(g) + H_2O(g) \rightarrow CH_3CH_2OH(g)$

Ions

+1		+2		+3		+4/-4		-3		-2		-1	
Lithium	Li^+	Magnesium	Mg^{2+}	Aluminium	Al^{3+}	**Carbon**	C^{4+}	Nitride	N^{3-}	Oxide	O^{2-}	Fluoride	F^-
Sodium	Na^+	Calcium	Ca^{2+}	Iron (III)	Fe^{3+}	**Silicon**	Si^{4+}	Phosphide	P^{3-}	Sulphide	S^{2-}	Chloride	Cl^-
Potassium	K^+	Barium	Ba^{2+}									Bromide	Br^-
Rubidium	Rb^+	Strontium	Sr^{2+}									Iodide	I^-
Caesium	Cs^+	Copper	Cu^{2+}										
Silver	Ag^+	Iron (II)	Fe^{2+}										
Hydrogen	H^+	Lead	Pb^{2+}										
		Zinc	Zn^{2+}										

Complex ions

Ammonium	NH_4^+							Carbonate	CO_3^{2-}			Hydrogen-carbonate	HCO_3^-
								Phosphate	PO_4^{3-}	Sulphate	SO_4^{2-}	Nitrate	NO_3^-
												Hydroxide	OH^-
												Ethanoate	CH_3COO^-

The Periodic Table of the Elements

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)
1																	18
1 **H** hydrogen 1.0	2											13	14	15	16	17	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

Key
atomic number
Symbol
name
relative atomic mass

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	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