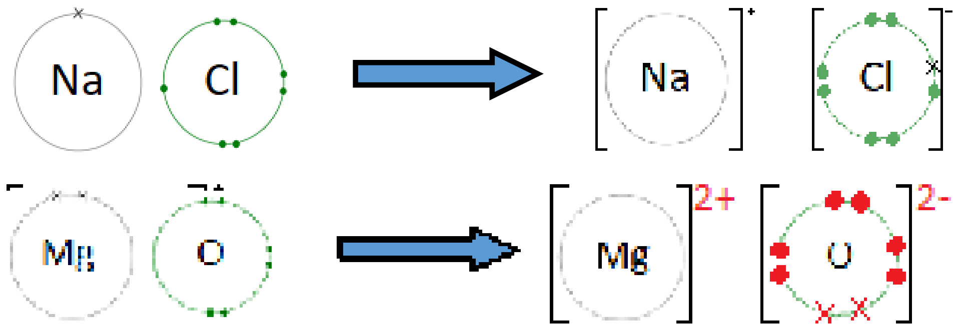
Atomic Structure, Bonding and Types of Substance

1.21 — Formation of ionic bonds

Ionic bonds form when metals react with non-metals. In order to get a full outer shell of electrons, the metal will **transfer** electron(s) to the non-metal. Metals will form positive cations, and non-metals form negative anions.

Examples of dot-and-cross diagrams* (We only need to show the outer shell electrons, as these are the only ones involved in bonding)



1.22 — Definition of ion

An ion is an atom or group of atoms with a positive or negative charge.

1.23 — Calculating PEN numbers in ions*

This is the same process as for atoms, but remembering that positive ions have lost electrons, and negative have gained electrons. All ions with have full outer shells of electrons, and so will have either 2, 10 or 18 electrons in total.

Ion	Protons	Electrons	Neutrons
$^{7}_{3}Li^{+}$	3	2	4
$^{19}_{9}F^{-}$	9	10	10
$^{27}_{13}Al^{3+}$	13	10	14
$^{32}_{16}S^{2-}$	16	18	16
$^{40}_{20}Ca^{2+}$	20	18	20

1.24 — Formation of ions

The charge formed by an ion from a single atom can be worked out using its position in the periodic table.

Group number	1	2	3	5	6	7
Electron transfer	*Lose 1*	Lose 2	Lose 3	Gain 3	*Gain 2*	Gain 1
Charge of ion	+1	*+2*	+3	-3	-2	*-1*

1.25 — -ide and –ate

Polyatomic ions contain more than 1 atom. We can use an ion's name toidentify whether it is polyatomic or not.

Ions whose names end in –ide contain only the non-metal atom (e.g. sulfide is S^{2-})

Ions whose names end in –ate contain the non-metal AND oxygen (e.g. sulfate is SO_4^{2-})

1.26—Deducing ionic formulae*

Name	Formula
Ammonium	NH_4^+
Hydroxide	OH^-
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}

From the periodic table, you need to be able to work out the formula of a monoatomic ion. Using these, and the table of common polyatomic ions to the right, you need to be able to work out the formulae of ionic compounds.

To work these out, use the crossover method. Here, the size of the charge is 'crossed over' to be the number of the other ion in the formula. You then need to simplify the ratio.

Example: magnesium hydroxide—Mg^{2+} OH^- becomes $Mg(OH)_2$.
NB: If we have more than one polyatomic ion, we put it in brackets.
NB: Roman numerals in brackets represent the size of the positive charge.

Potassium carbonate:
K_2CO_3
Magnesium chloride:
$MgCl_2$
Iron (III) oxide:
Fe_2O_3
Aluminium nitrate:
$Al(NO_3)_3$
Ammonium sulfate:
$(NH_4)_2SO_4$

1.27—Ionic lattices

Ionic lattices consist of a regular arrangement of ions.

These ions are held together by electrostatic forces between oppositely charged ions.

These forces are extremely strong.

1.28—Covalent bonds

A covalent bond consists of a shared pair of electrons.
Covalent bonds form when non-metal atoms bond together.

1.29—Molecules

The particles made when covalent bonds are formed are called molecules.

1.30—Size of atoms and molecules

Typically, atoms and molecules are measured using the unit of nanometres (x 10^{-9} m).

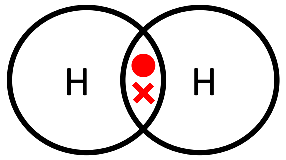
1.31—Formation of simple molecular, covalent substances

Similarly to ionic bonding, we can use the group number to determine **valency** of non-metals, and hence how many electrons they need to share to get a full outer shell.

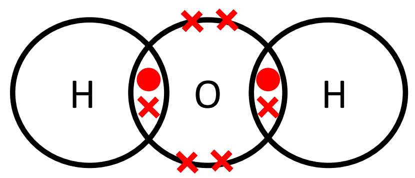
Group	5	6	7
Valency	*3*	2	1
Number of shared pairs of e^-	3	*2*	1

Example dot-and-cross diagrams (these are the ones identified in the specification):

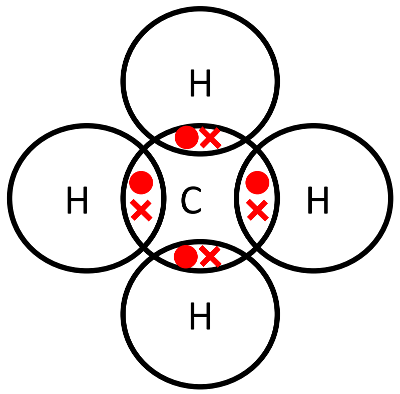
Hydrogen, H_2



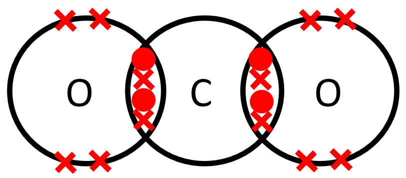
Water, H_2O



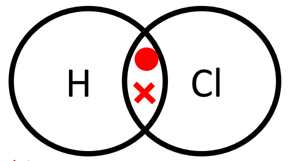
Methane, CH_4



Carbon dioxide, CO_2



Hydrogen chloride, HCl



Oxygen, O_2