Task 2 - GCSE Summary sheets

KS4 – Atomic structure

Subatomic particles: nucleus (protons and neutrons), electrons in shells.

Describe the particles in terms of their relative masses and relative charges:

- Protons – mass 1, charge +1.
- Electrons – mass = negligible ($\frac{1}{1840}$), charge –1.
- Neutrons – mass = 1, charge = 0.

Notes

- Number of protons = number of electrons (uncharged/neutral atoms).
- Proton number = atomic number.
- Mass number = protons + neutrons.

KS4 – Isotopes and calculating relative isotopic mass

Isotopes are *atoms* of the same elements which have different numbers of *neutrons* but the same number of *protons*.

$$\text{Relative isotopic mass} = \frac{\text{sum of (\% abundance} \times \text{isotopic mass)}}{100}$$

KS4 – Ionic compounds

Formation of ions

Atoms of metallic elements in Groups 1,2 and 3 can form positive ions when they take part in reactions since they are readily able to lose electrons.

Atoms of Group 1 metals lose one electron and form ions with a 1+ charge, e.g. Na^+

Atoms of Group 2 metals lose two electrons and form ions with a 2+ charge, e.g. Mg^{2+}

Atoms of Group 3 metals lose three electrons and form ions with a 3+ charge, e.g. Al^{3+}

Atoms of non-metallic elements in Groups 5, 6 and 7 can form negative ions when they take part in reactions since they are able to gain electrons.

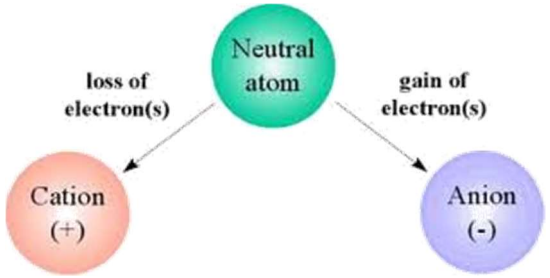
Atoms of Group 5 non-metals gain three electrons and form ions with a 3– charge, e.g. N^{3-}

Atoms of Group 6 non-metals gain two electrons and form ions with a 2– charge, e.g. O^{2-}

Atoms of Group 7 non-metals gain one electrons and form ions with a 1– charge, e.g. Cl^-

A**N**ions = **N**egative

Ca**+**ions = **+**ive



Why are ions negative or positive?

- Find the atomic number (the smaller number with the symbol).
- This equals the number of protons, which equals the number of electrons in an uncharged/neutral atom.
- If electrons are lost from the atom, there are now more protons than electrons, so the ion is positively charged.
- If electrons are gained by the atom, there are now fewer protons than electrons, so the ion is negatively charged.

KS4 – Electron configuration

Filling electron shells

- *1st shell*, maximum = $2e^-$
- *2nd and further shells*; maximum = $8e^-$

Representing electron configurations

- Write as, e.g. 2.8.3 or 2,8,3

Using the Periodic Table

- Period number (row) = number of shells
- Group number (column) = number of electrons in the outer (last) shell

Group number	**1**		**2**		**3**				**5**		**6**		**7**	
	Li		**Be**		**B**				**N**		**O**		**F**	
	Atom	Ion	Atom	Ion	Atom	Ion			Atom	Ion	Atom	Ion	Atom	Ion
Electrons	–3	–2	–4	–2	–5	–2			–7	–10	–8	–10	–9	–10
Protons	+3	+3	+4	+4	+5	+5			+7	+7	+8	+8	+9	+9
Overall charge	0	1+	0	2+	0	3+			0	3–	0	2–	0	1–
Electron configuration	2.1	2	2.2	2	2.3	2			2.5	2.8	2.6	2.8	2.7	2.8
Name of ions	lithium		beryllium		boron				nitride		oxide		fluoride	
	Lose electrons, charge = +group number								Gain electrons, charge = group number – 8					

KS4 – Dot-and-cross diagrams for ionic bonding

Hints and tips

Always …

… count the electrons!

… remember that ions should have full outer shells.

… make sure that when an ion is formed, you put square brackets round the diagram and show the charge.

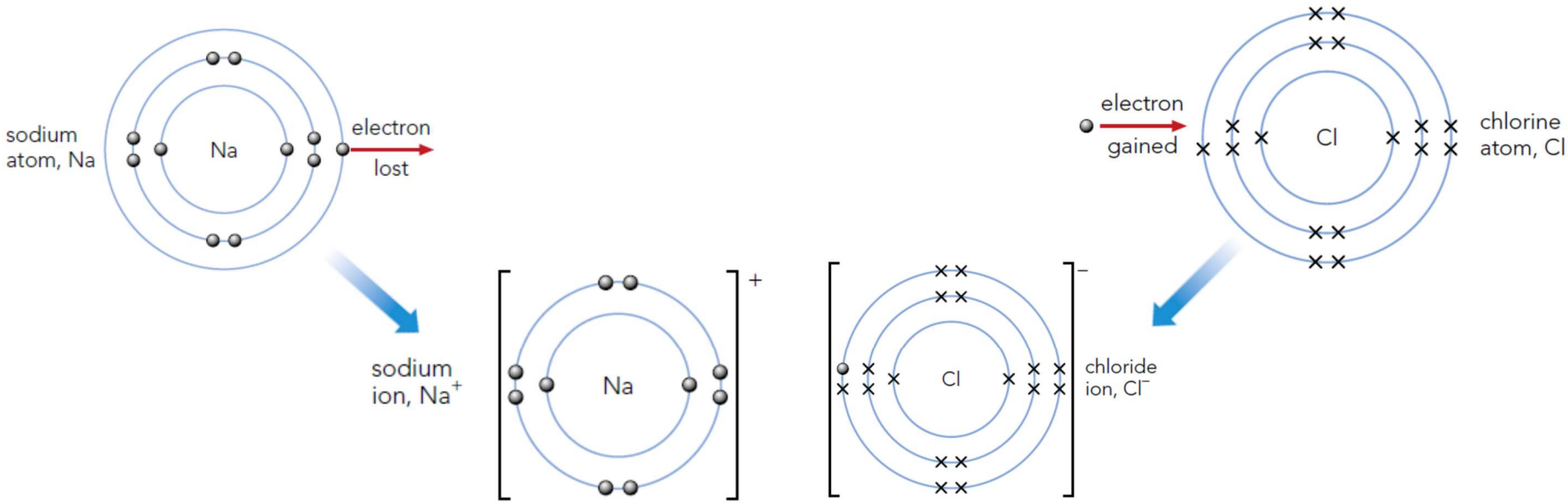
Never …

… show the electron shells overlapping.

… show electrons being shared (ions are formed by the **transfer** of electrons!).

… remove electrons from the inner shell.

… give metals a negative charge.



KS4 – Covalent compounds (simple covalent bonding)

Distinguish between:

'How a covalent bond is formed': A covalent bond is formed when a pair of electrons is shared between two atoms.

'What is a covalent bond?': Electrostatic attraction between a shared pair of electrons and the nuclei of the atoms.

Covalent bonding results in the formation of molecules.

Hints and tips

Always …

… show the shells touching or overlapping where the covalent bond is formed.

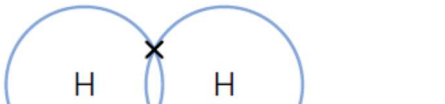
… count the final number of electrons around each atom to make sure that the outer shell is full.

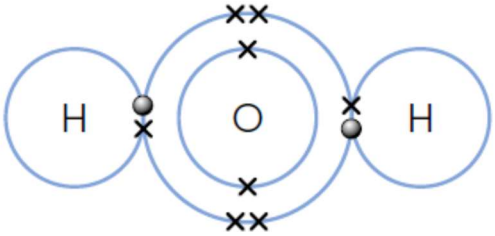
Never …

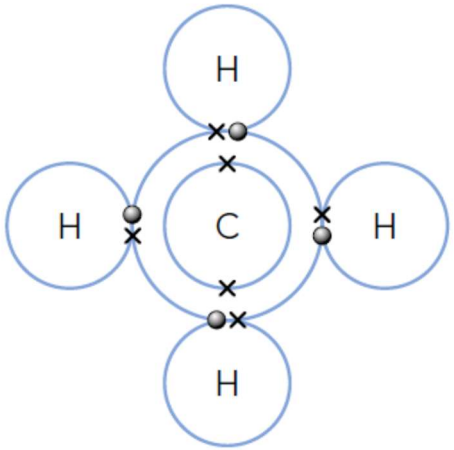
… include a charge on the atoms.

… draw the electron shells separated.

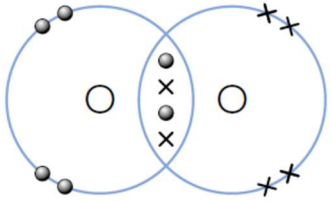
… draw unpaired electrons in the region of overlap.

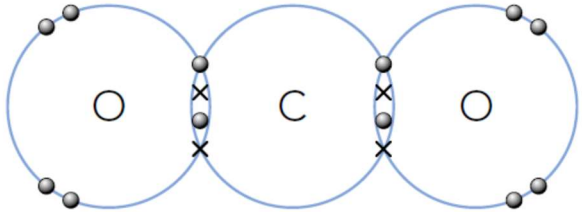






The two diagrams below only show the outer-shell electrons.





KS4 – Bonding and structure

Words used to describe structure and bonding:

- ions, atoms, molecules, intermolecular forces, electrostatic forces, delocalised electrons, cations, anions, outer electrons, shielding

Metallic bond: electrostatic attraction between the nuclei of cations (positive ions) and delocalised electrons.

Strength of the metallic bonding increases with the number of valence electrons (outer electrons in the atoms) and with decreasing size of the cation.

Ionic bonds and ionic compounds

Explain why NaCl has a high melting point and only conducts electricity when molten or in solution. (6 marks)

An answer should cover the following points.

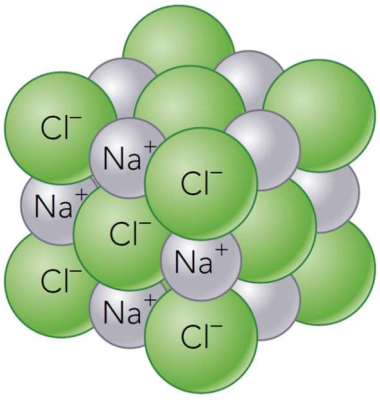
1 The Na^+ and Cl^- ions are held by strong electrostatic forces.

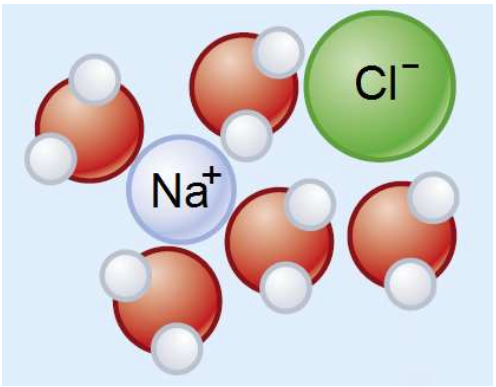
1 To melt solid NaCl, energy is needed to separate overcome the forces of attraction sufficiently for the lattice structure to break down and for the ions to be free to slide past one another.

2 Even though the ions are charged, the solid cannot conduct electricity because the ions are not mobile (free to move).

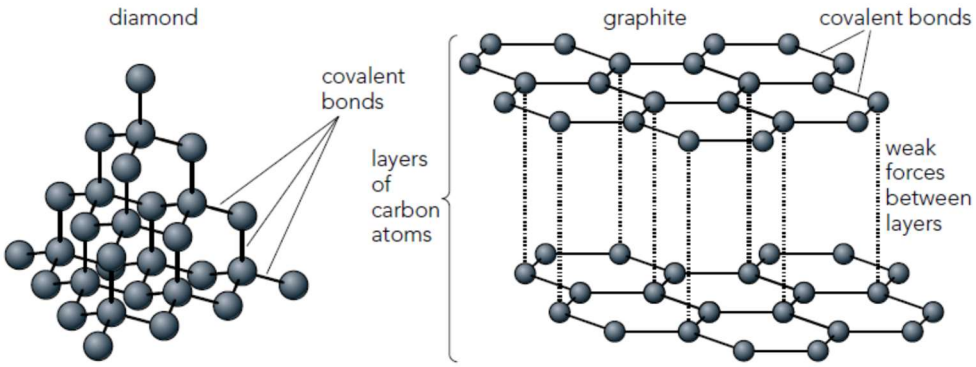
3 If the solid is melted, the ions can move freely and allow the liquid to conduct electricity.

4 Also, when dissolved in water the *ions* are separated by the water molecules and so are free to move, hence the aqueous solution can conduct electricity.





KS4 – Structure of diamond and graphite



Property	Diamond	Graphite
Melting point	High – atoms held by <u>strong</u> covalent bonds. <u>Many</u> covalent bonds must be broken to melt it. Lots of energy required. Is solid at room temp.	High – atoms held by <u>strong</u> covalent bonds. <u>Many</u> covalent bonds must be broken to melt it. Lots of energy required. Is a solid at room temp.
Electrical conductivity	Poor – no mobile electrons available. All four outer electrons of each carbon are used in bonding.	Good – each carbon only uses three of its outer electron to form covalent bonds. 4th electron form each atom contributes to a delocalised electron system. These delocalised electrons can flow when a potential difference is applied parallel to the layers.
Lubricant	Poor – structure is rigid.	Gas molecules are trapped between the layers and allow the layers to slide past one another. Same reason for its use in pencils.