Nat 5: Unit 1 Chemical Changes and Structure

Key Area: Bonding Related to Properties of Materials

Lesson 22: Covalent Bonding

Learning Outcomes

By the end of the lesson you should …

1. Be able to state what an electron bonding diagram shows.
2. Be able to draw diagrams to show how outer electrons are shared to form the covalent bond(s) in a molecule.

Success Criteria

You will have been successful in this lesson if you:

1. Successfully complete all self checks evaluating and correcting any errors made.
2. Draw bonding electron diagrams for simple molecules.

If you have any questions about the content of this lesson, you should ask your **class teacher** either through your class MS team or via email. MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge:

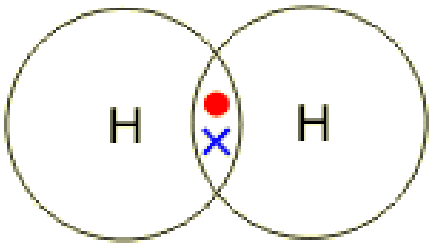
Atomic structure, naming compounds and valency.

You may wish to have a copy of the data booklet handy for this lesson.
Download from the SQA website - ChemistryDataBookletSQPN5.pdf (sqa.org.uk)

Electron Bonding Diagrams

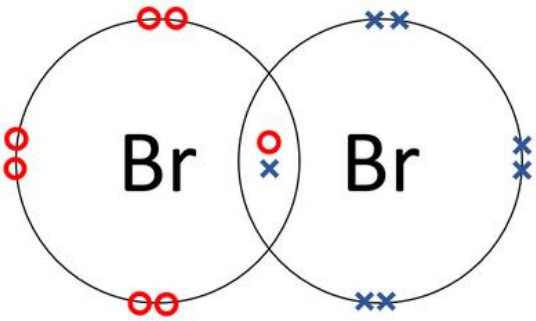
These are diagrams that show how **outer electrons** are **shared** to form the **covalent bond(s)** in a molecule.

Example 1 Hydrogen molecule (H_2)



Note that the ● and × represent outer electrons.

Example 2 Bromine molecule (Br_2)



When drawing electron bonding diagrams we only **show the outer electrons**, we are not interested in the other electrons.

Eg. Bromine's electron arrangement is 2, 8, 18, 7

We only show the **7 outer electrons** in the diagram.

Simple Steps for Drawing Electron Bonding Diagrams

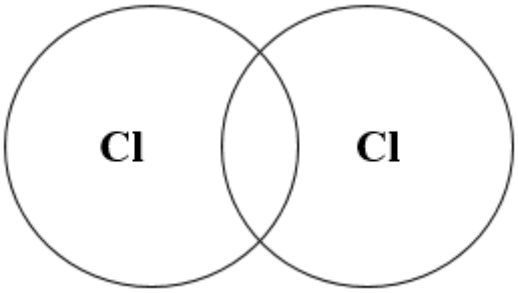
These diagrams can be easily drawn using the following steps

Example 1 **Chlorine gas**

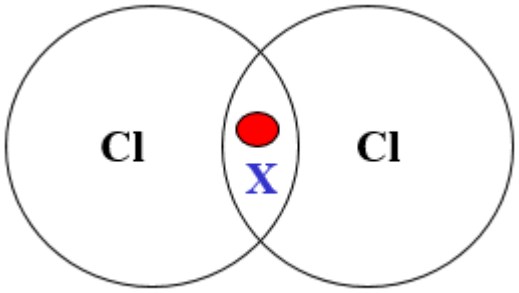
Sep 1 Write out formula **Cl_2**

Step 2 **Overlap** the required number of atoms together.

Cl_2 means overlap 2 chlorine atoms

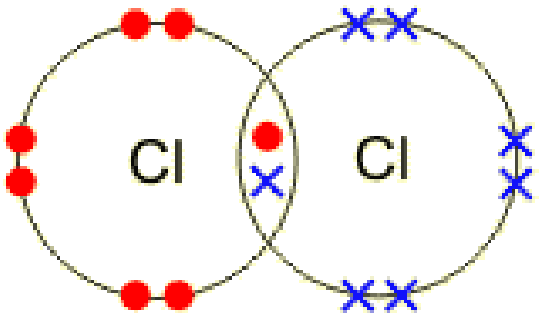


Step 3 **Place 2 electrons** (1 from each element; a cross and a circle) in **every overlap**



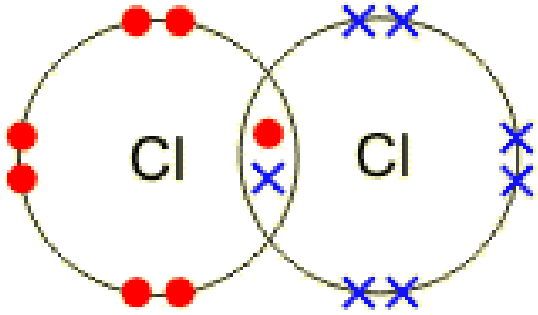
Step 4 Place the **remainder of outer electrons around** each atom

Each Chlorine has 7 outer electrons, 1 electron is in the overlap, therefore 6 more electrons around each chlorine

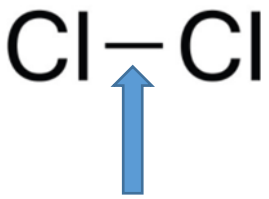


Step 5 Check **each atom** has a **full outer electron shell**

For each chlorine, 2 electrons in the overlap plus 6 surrounding = 8 (full shell)



We usually draw the simple diagram to represent the above:



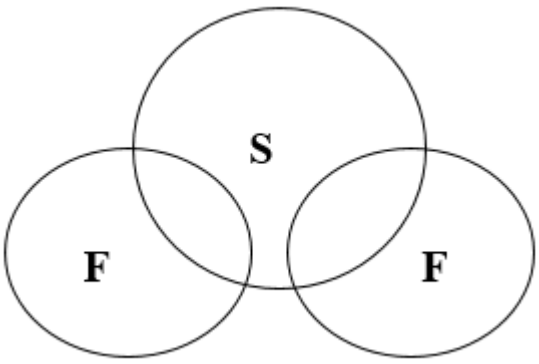
The line represents the single covalent bond with the **2 electrons being shared**

Example 2 **Sulfur fluoride**

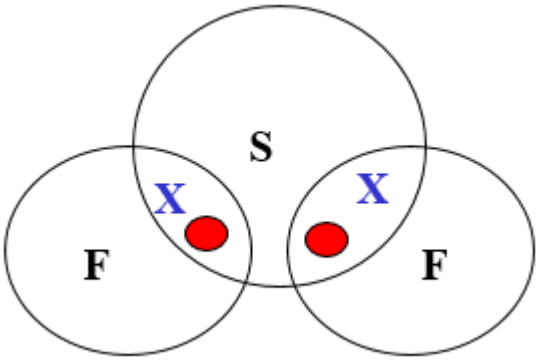
Sep 1 Write out formula **SF_2**

Step 2 Overlap the required number of atoms together.

SF_2 means overlap 1 sulfur atom with 2 fluorine atoms



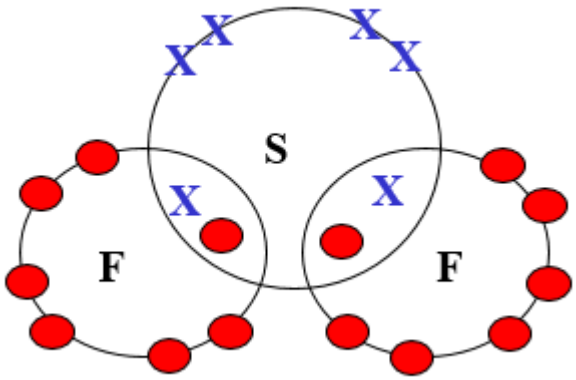
Step 3 Place 2 electrons (1 from each element; a cross and a circle) in every overlap



Step 4 Place the remainder of outer electrons around each atom

Sulfur has 6 outer electrons, 2 electron in the overlaps, therefore 4 more electrons around sulfur.

Each Fluorine has 7 outer electrons, 1 in each overlap, therefore 6 electrons around each fluorine.



Step 5 Check each atom has a full outer electron shell

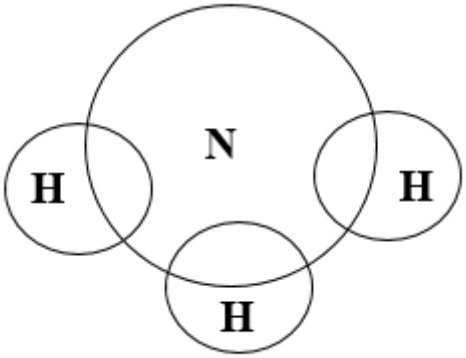
For Sulfur, 4 electrons in the overlaps plus 4 surrounding = 8 (full shell)
For Fluorines, 2 electrons in each overlap plus 6 surrounding = 8 (full shell)

Example 3 **Nitrogen hydride**

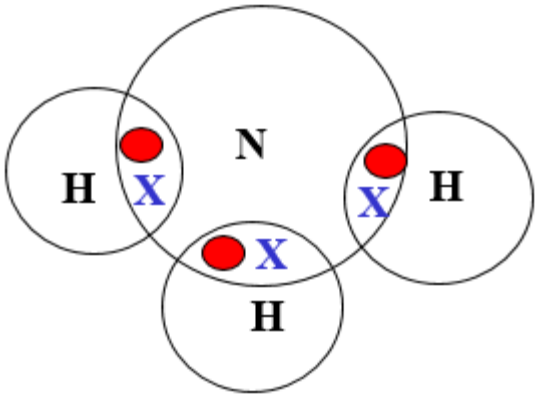
Step 1 Write out formula **NH_3**

Step 2 Overlap the required number of atoms together.

NH_3 means overlap 1 nitrogen with 3 hydrogen atoms



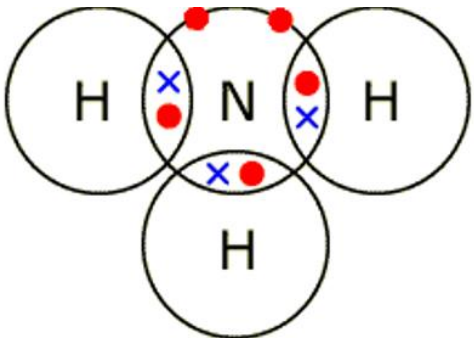
Step 3 Place 2 electrons (1 from each element; a cross and a circle) in every overlap



Step 4 Place the remainder of outer electrons around each atom

Nitrogen has 5 outer electrons, 3 electrons in the overlaps, therefore 2 more electrons around nitrogen.

Each Hydrogen has 1 outer electron, 1 in each overlap, therefore no electrons around each hydrogen.



Step 5 Check each atom has a full outer electron shell

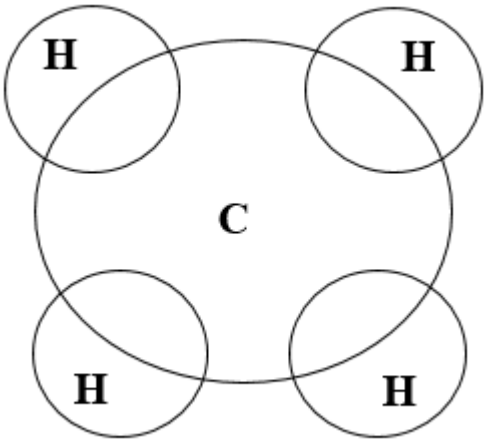
For nitrogen, 6 electrons in the overlaps plus 2 surrounding = 8 (full shell)
For hydrogens, 2 electrons in each overlap plus 0 surrounding = 2 (full shell)

Example 4 Methane

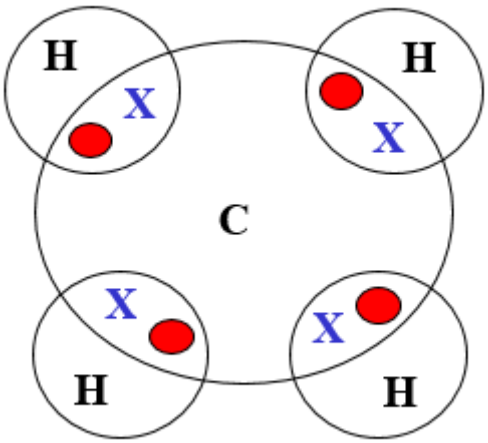
Step 1 Write out formula **CH_4**

Step 2 Overlap the required number of atoms together.

CH_4 means overlap 1 carbon with 4 hydrogen atoms



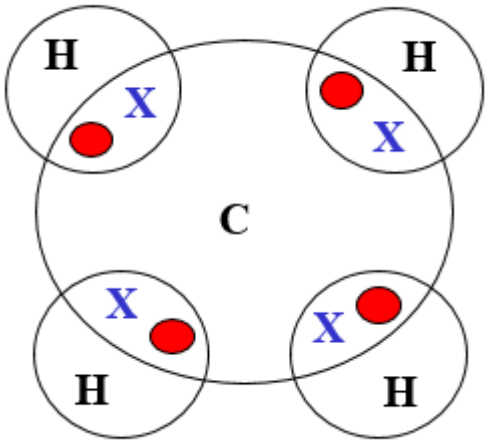
Step 3 Place 2 electrons (1 from each element; a cross and a circle) in every overlap



Step 4 Place the remainder of outer electrons around each atom

Carbon has 4 outer electrons, 4 electrons in the overlaps, therefore no electrons around carbon.

Each Hydrogen has 1 outer electron, 1 in each overlap, therefore no electrons around each hydrogen.



Step 5 Check each atom has a full outer electron shell

For carbon, 8 electrons in the overlaps plus 0 surrounding = 8 (full shell)
For hydrogens, 2 electrons in each overlap plus 0 surrounding = 2 (full shell)

Practice Makes Perfect

Once you have read and fully understand the previous information please attempt the following self checks in your jotter.

Self Check 20

1. Draw a diagram showing how the outer electrons are shared to form covalent bonds(electron bonding diagram) in the following molecules:

(a) Silicon hydride (SiH_4)

(b) Water (H_2O)

(c) Nitrogen chloride (NCl_3)

d) Iodine (I_2)

2. For the elements below give

(i) The number of electrons in the outer electron shell.
(ii) The number of covalent bonds made by the element (which is equal to the valency of the element)

(a) Boron
(b) Bromine
(c) Selenium
(d) Iodine
(e) Iodine
(f) Arsenic
(g) Xenon
(h) Tellurium

3. Draw electron bonding diagrams for the molecules produced when the following elements react together.
Use valency rules to work out formula first!

(a) sulphur and iodine

(b) silicon and chlorine

(c) fluorine and fluorine

(d) arsenic and bromine