

Dot and cross diagrams

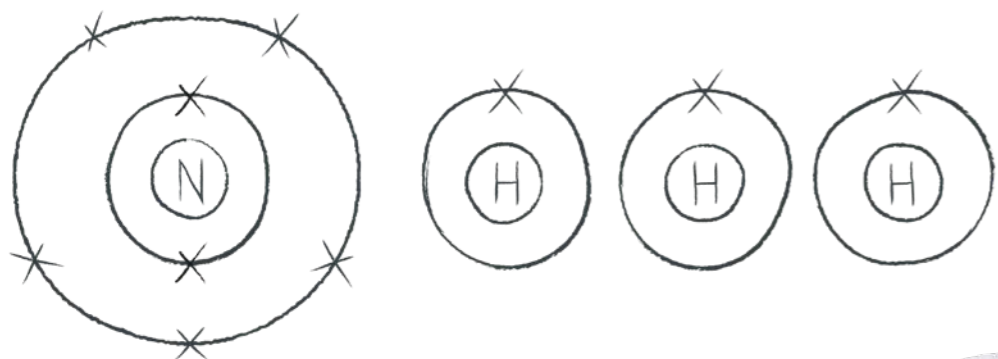
Once you have mastered **electron configuration diagrams**, you can adapt them to show structure and bonding in **covalent** and **ionic compounds**. These structural diagrams depict only the outer, or **valence**, shell electrons and are known as **dot and cross diagrams**. Electrons from different atoms use alternating symbols, usually a dot and a cross, to show which atom the electrons have come from. There are three ways to draw these diagrams. Which will you choose?

Let's take a closer look at some simple covalent molecules containing **nitrogen**. Remember nitrogen has **five electrons in its outer shell**.

How to draw a dot and cross diagram for ammonia

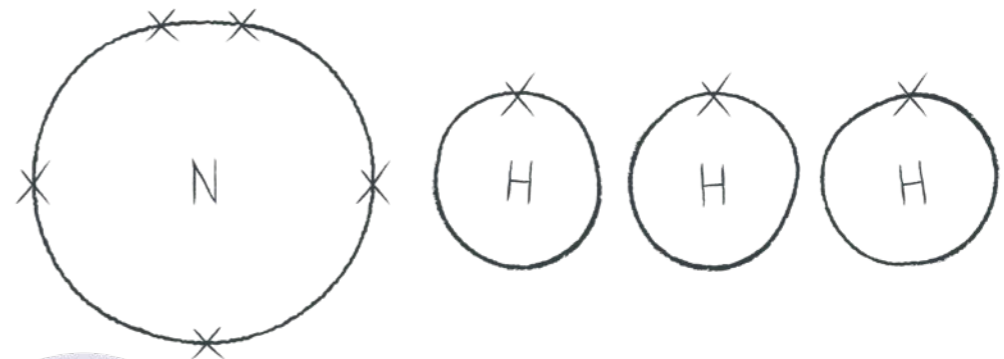
In NH_3 , commonly known as **ammonia**, nitrogen forms three single **covalent bonds** with three hydrogen atoms.

Step 1



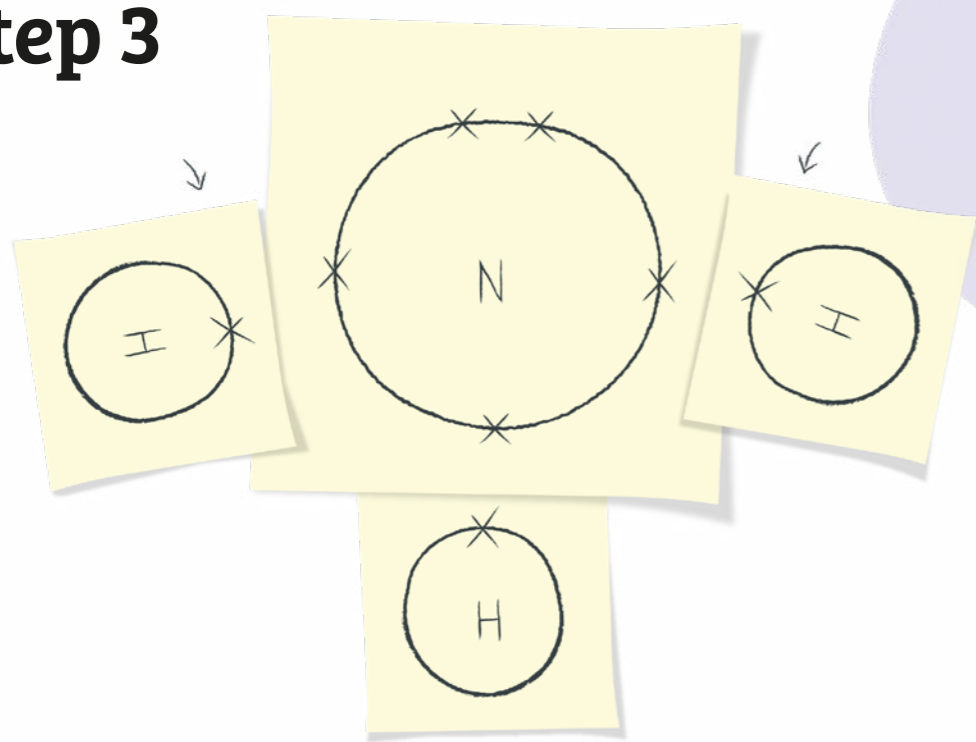
While you are learning how to draw dot and cross diagrams it's useful to start with something you are already familiar with: electron configuration diagrams. Sketch out the electron configuration diagram for each of the atoms.

Step 2



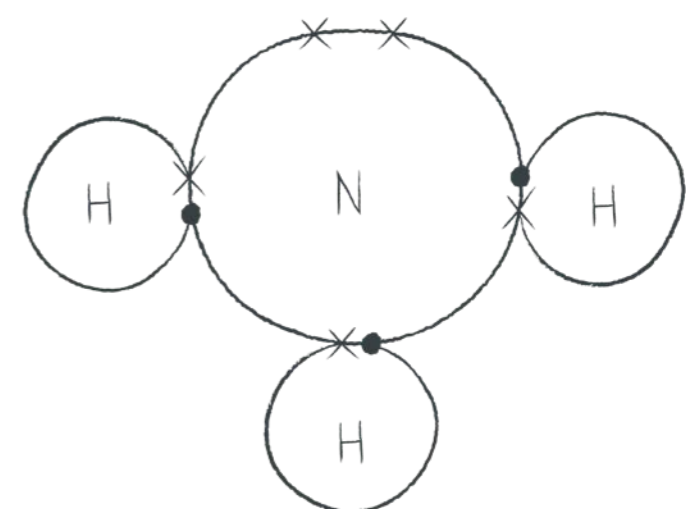
Draw the outer shell of each atom. It's a good idea to draw the **electrons in pairs** but remember to use a pencil as you may have to move the electrons around to fit the structure. You don't need to put a circle around the symbol for the nucleus.

Step 3



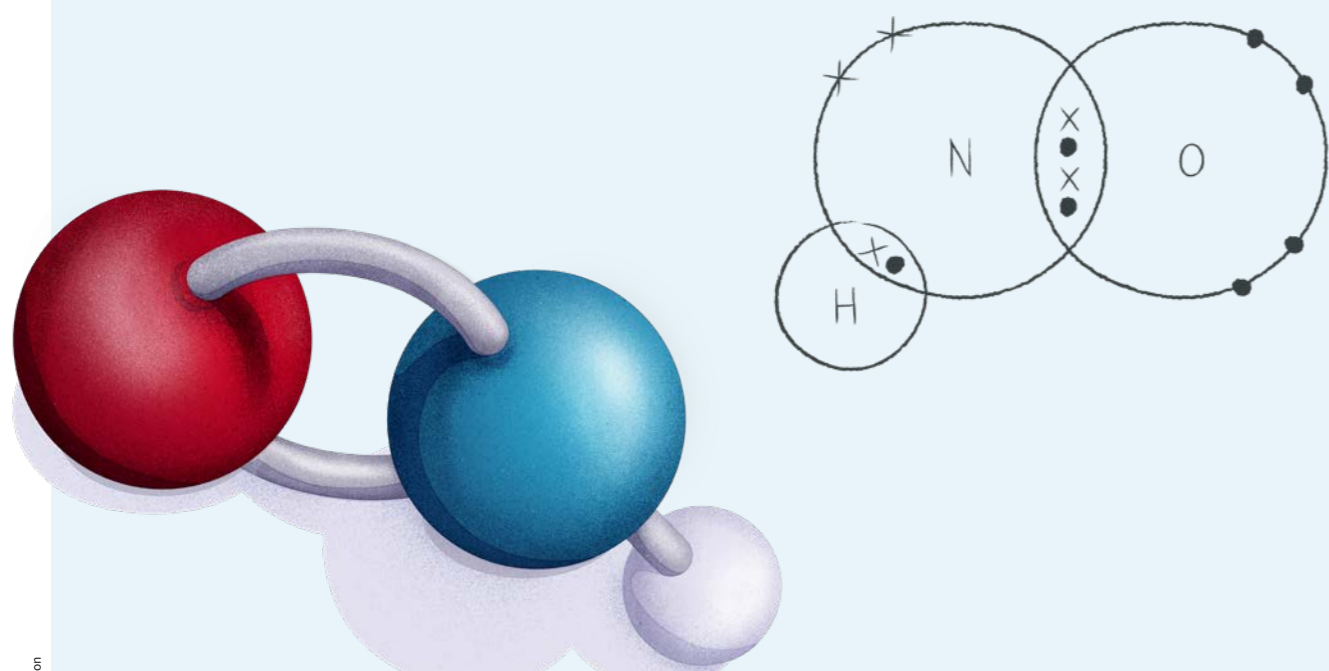
Arrange the atoms so that the **valence electrons** will complete the outer shells of all the atoms in the simple covalent molecule. While you are learning, you could draw each atom on a small piece of paper so you can easily rearrange them.

Step 4



Draw the completed dot and cross diagram. Here we have changed the electrons on the hydrogen atoms to be dots. You can alternate the dots and crosses in simple diagrams or use other colours or symbols for larger diagrams. This dot and cross diagram shows the outer shells touching. This method is easiest for single covalent bonds as there is not much room where the atoms' shells touch for drawing lots of electron pairs.

How to draw double bonds



Nitroxyl contains a single covalent bond between hydrogen and nitrogen and a **double covalent bond** between nitrogen and oxygen. Draw the dot and cross diagram with the outer shells overlapping. Then draw the shared electrons inside the overlapping section. This method is useful for double and triple bonds as it gives more space for drawing electrons.

How to draw triple bonds

Nitrogen gas occurs naturally as a **diatomic molecule**. The bond between the two nitrogen atoms is a **triple bond**. Again, draw the dot and cross diagram with the outer shells overlapping. However, this time draw the electrons on the lines rather than in the space between. This alternative method is useful for checking that you have drawn the right number of electrons in the outer shell of each atom.

