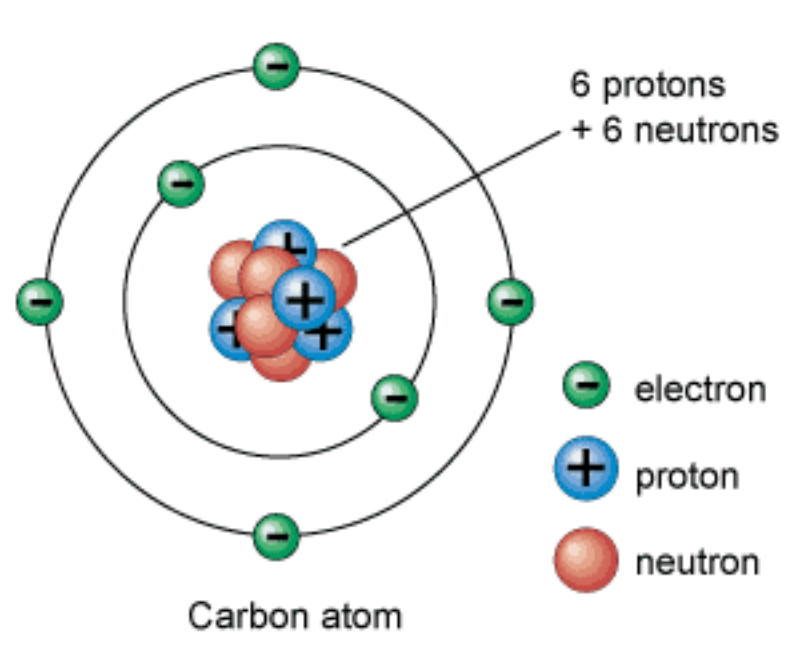
4.1 Atomic Theory and Bonding

- **An atom is the smallest particle of an element that still has the properties of that element**
  - **50 million atoms, lined up end to end = 1 cm**
  - **An atom = proton(s) + neutron(s) + electron(s)**
  - **Crash Course In Chemistry**



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- **Atoms join together to form compounds.**
  - **A compound is a pure substance that is composed of two or more atoms combined in a specific way.**
  - **Oxygen and hydrogen are atoms/elements; H_2O is a compound.**

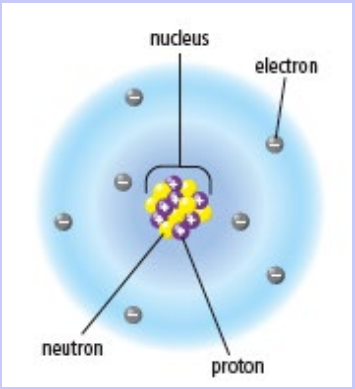
- **A chemical change occurs when the arrangement of atoms in compounds changes to form new compounds.**

Atomic Theory

- **Atoms are made up of smaller particles called subatomic particles.**

Table 4.1 Subatomic Particles

Name	Symbol	Electric Charge	Location in the Atom	Relative Mass
Proton	p	1+	Nucleus	1836
Neutron	n	0	Nucleus	1837
Electron	e	1−	Surrounding the nucleus	1



- **The nucleus is at the centre of an atom.**
  - **The nucleus is composed of protons and neutrons.**
  - **Electrons exist in the space surrounding the nucleus.**
  - **# of protons = # of electrons in every atom, therefore atoms have NO CHARGE**
  - **Nuclear charge = charge on the nucleus = # of protons**
  - **Atomic number = # of protons = # of electrons**

See page 170

- **How do I figure out how many protons an atom of carbon has?**
- **Electrons?**
- **Neutrons?**

Break

- **Pg 60 in workbook**

Organization of the Periodic Table

- In the periodic table elements are listed in order by their atomic number.
  - Metals are on the left (the transition metals range from group 3 to group 12), non-metals are on the right, and the metalloids form a "staircase" toward the right side.
  - Rows of elements (across) are called periods.
    - All elements in a period have their electrons in the same general area around their nucleus.
  - Columns of elements are called groups, or families.
    - All elements in a family have similar properties and bond with other elements in similar ways.
    - Group 1 = alkali metals
    - Group 2 = alkaline earth metals
    - Group 17 = the halogens
    - Group 18 = noble gases

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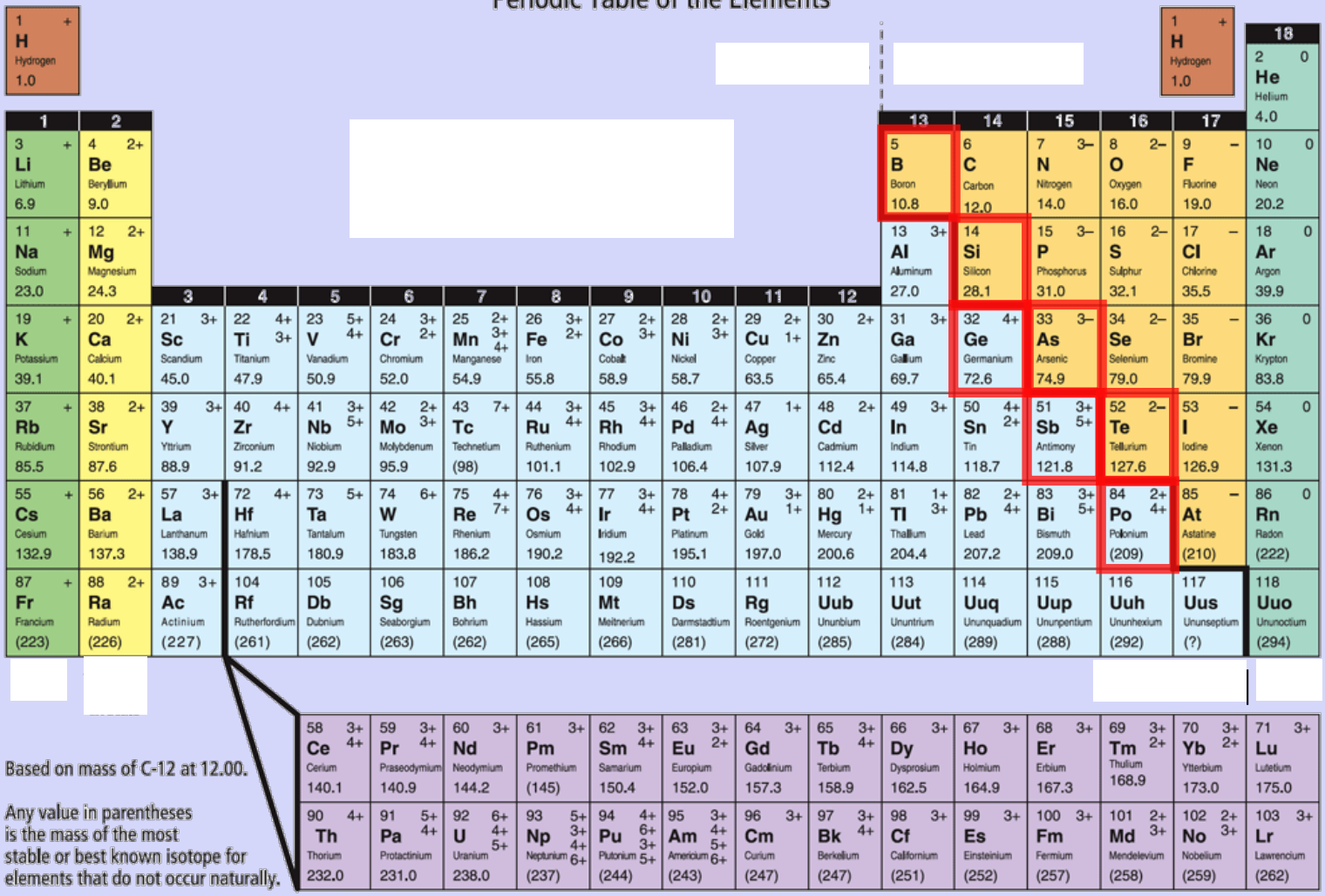
The Periodic Table

Periodic Table of the Elements



Where are the following?

- Atomic number
- Period
- Group/Family
- Metals
- Non-metals
- Transition metals
- Metalloids
- Alkali metals
- Alkaline earth metals
- Halogens
- Noble gases

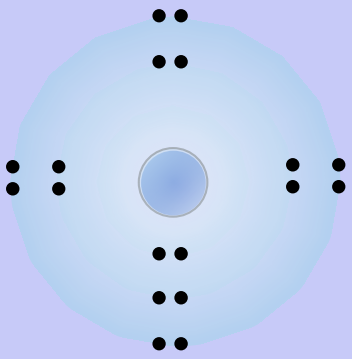
See page 172

Colour Periodic Table

- **Use different colours to highlight the main groups of the periodic table.**

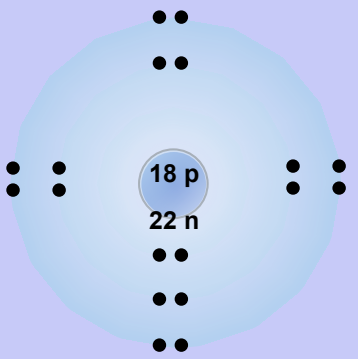
Bohr Diagrams

- **Bohr diagrams show how many electrons appear in each electron shell around an atom.**
  - **Electrons in the outermost shell are called valence electrons.**
  - **Think of the shells as being 3-D like spheres, not 2-D like circles.**



What element is this?

- It has 2 + 8 + 8 = 18 electrons, and therefore, 18 protons.
- It has three electron shells, so it is in period 3.
- It has eight electrons in the outer (valence) shell.

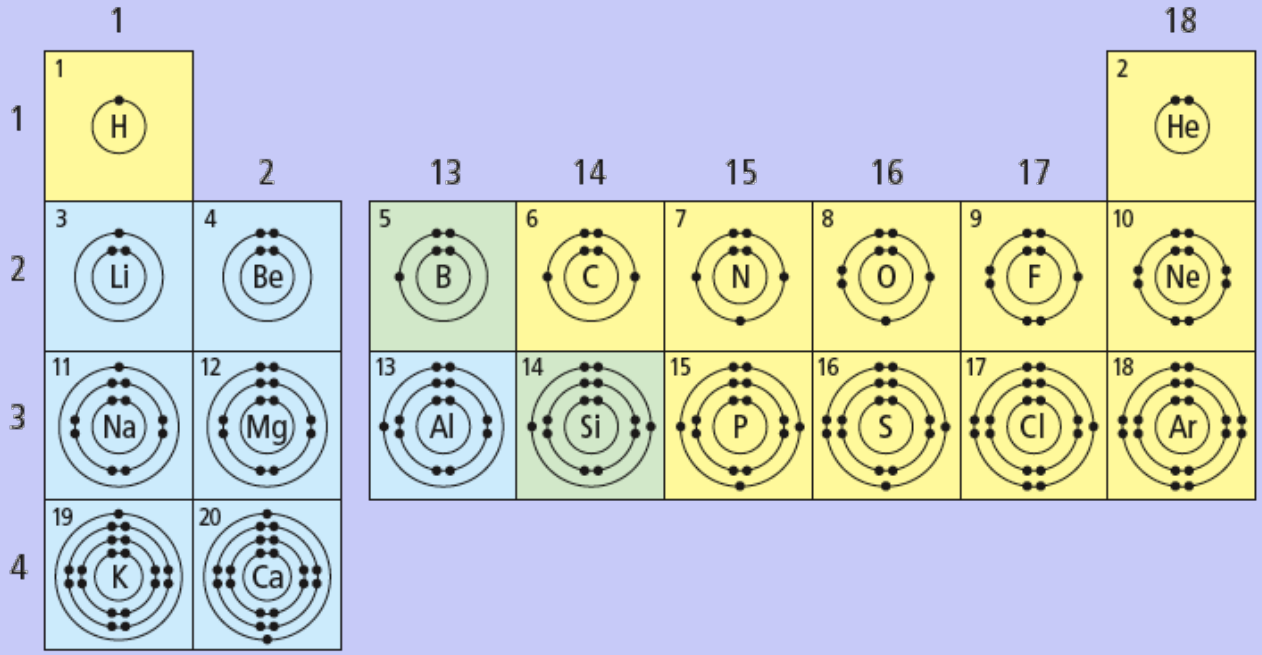


argon

See page 174

Patterns of Electron Arrangement in Periods and Groups

- Electrons appear in shells in a very predictable manner.
- There is a maximum of two electrons in the first shell, eight in the 2nd shell, and eight in the 3rd shell.
  - The period number = the number of shells in the atom.
  - Except for the transition elements, the last digit of the group number = the number of electrons in the valence shell.



- The noble gas elements have full electron shells and are very stable.

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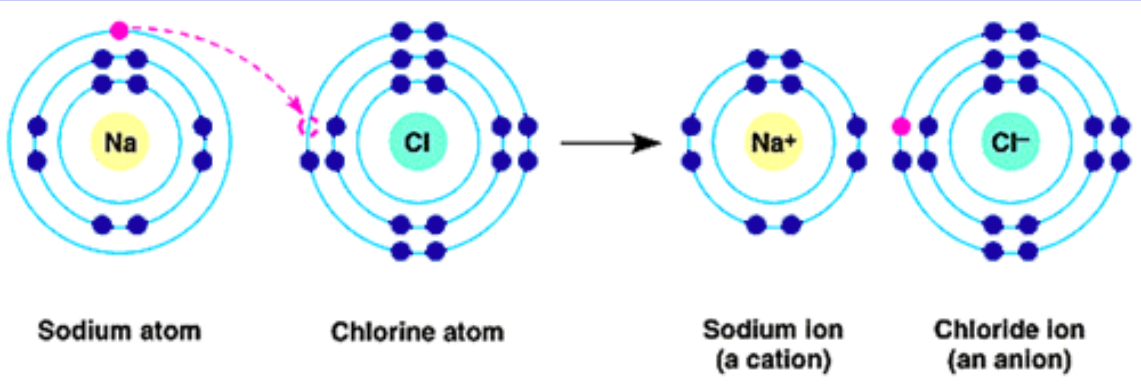
Practice Drawing Bohr Diagrams

- **Bohr diagram worksheet**
  - **Atoms vs Ions**
    - **Remember, atoms are neutral and ions are charged!**

Periodic Table and Ion Formation

- **Atoms gain and lose electrons to form bonds.**
  - The atoms become electrically charged particles called ions.
  - Metals lose electrons and become positive ions (cations).
    - Some metals (multivalent) lose electrons in different ways.
    - For example, iron, Fe, loses either two (Fe^{2+}) or three (Fe^{3+}) electrons
  - Non-metals gain electrons and become negative ions (anions).
  - Atoms gain and lose electrons in an attempt to have the same number of valence electrons (electrons farthest from the nucleus) as the nearest noble gas in the periodic table.



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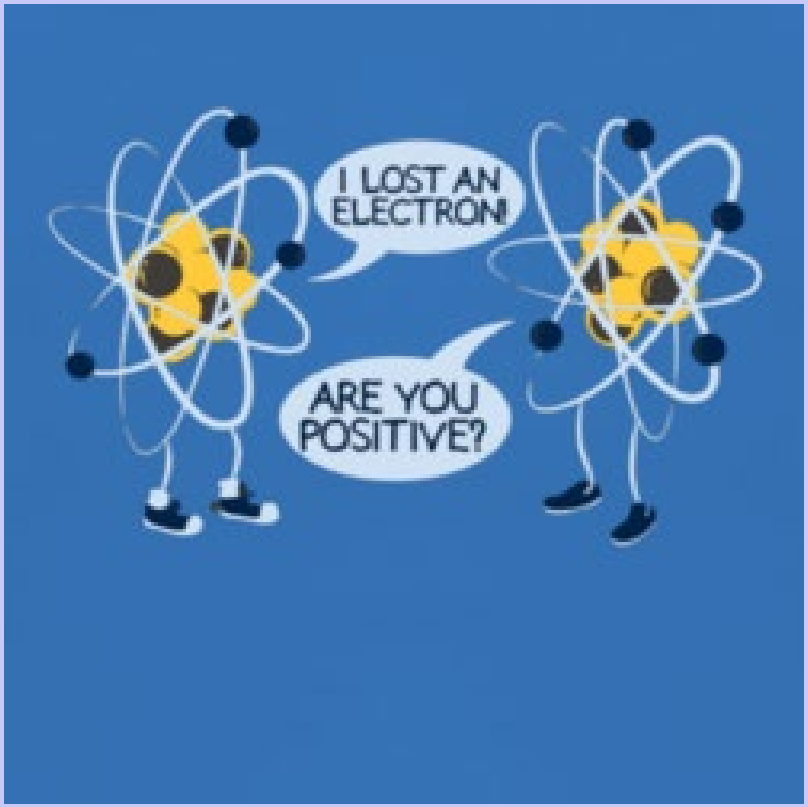
Forming Compounds

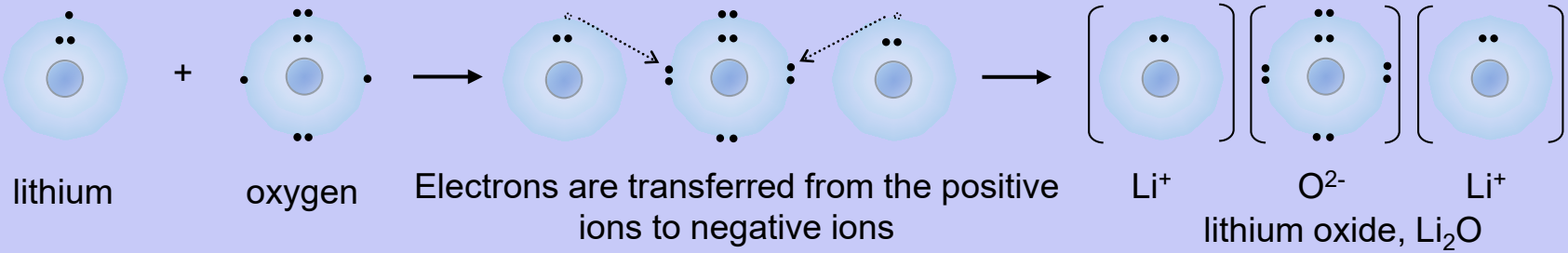
- When two atoms get close together, their valence electrons interact.
  - If the valence electrons can combine to form a low-energy bond, a compound is formed.
  - Each atom in the compound attempts to have the stable number of valence electrons as the nearest noble gas.
  - Metals may lose electrons and non-metals may gain electrons (ionic bond), or atoms may share electrons (covalent bond).
- Ionic bonds form when electrons are transferred from positive ions to negative ions.
- Covalent bonds form when electrons are shared between two non-metals.
  - Electrons stay with their atom but overlap with other shells.

See pages 176 - 177

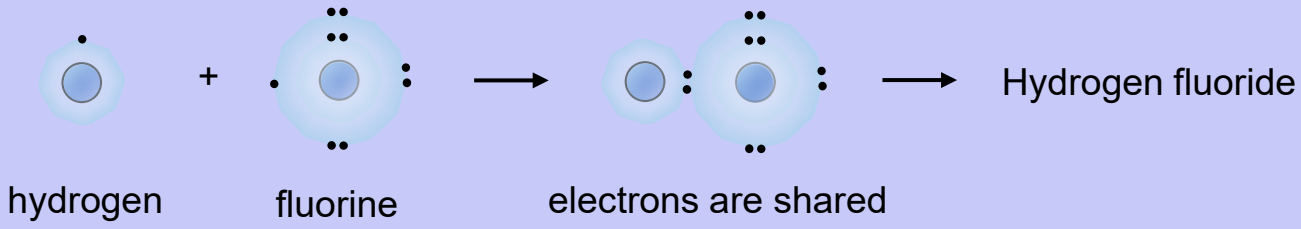


Forming Compounds (continued)

- **Ionic bonds are formed between positive ions and negative ions.**
  - **Generally, this is a metal (+) and a non-metal (-) ion.**
  - **For example, lithium and oxygen form an ionic bond in the compound Li_2O.**



- **Covalent bonds are formed between two or more non-metals.**
  - **Electrons are shared between atoms.**



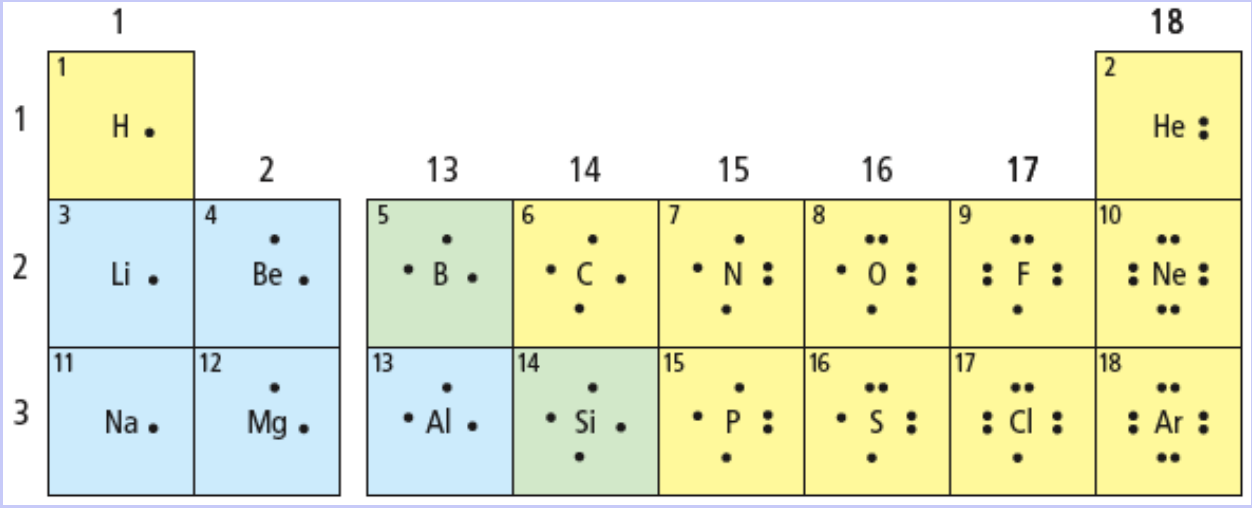
See pages 176 - 177

Bohr Diagram

- **Pg 61 in workbook**

Lewis Diagrams

- **Lewis diagrams illustrate chemical bonding by showing only an atom's valence electrons and the chemical symbol.**
  - **Dots representing electrons are placed around the element symbols at the points of the compass (north, east, south, and west).**
  - **Electron dots are placed singly until the fifth electron is reached then they are paired.**



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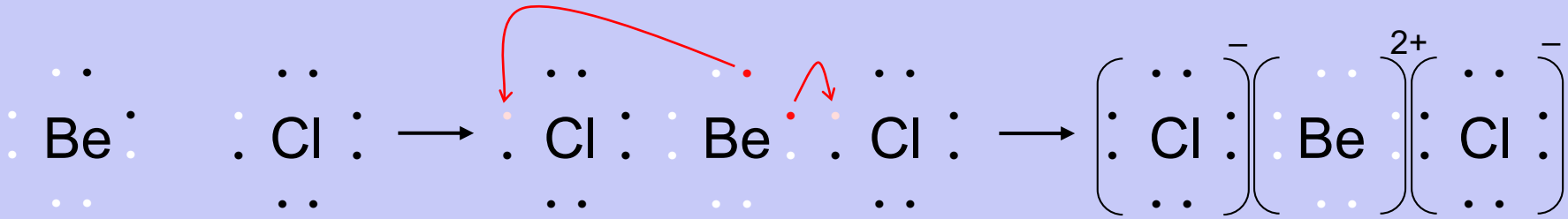
Lewis Diagrams of Ions

- **Lewis diagrams can be used to represent ions and ionic bonds.**
  - **For positive ions, one electron dot is removed from the valence shell for each positive charge.**
  - **For negative ions, one electron dot is added to each valence shell for each negative charge.**
  - **Square brackets are placed around each ion to indicate transfer of electrons.**



Each beryllium has two electrons to transfer away, and each chlorine can receive one more electron.

Since Be^{2+} can donate two electrons and each Cl^- can accept only one, two Cl^- ions are necessary.

beryllium chloride

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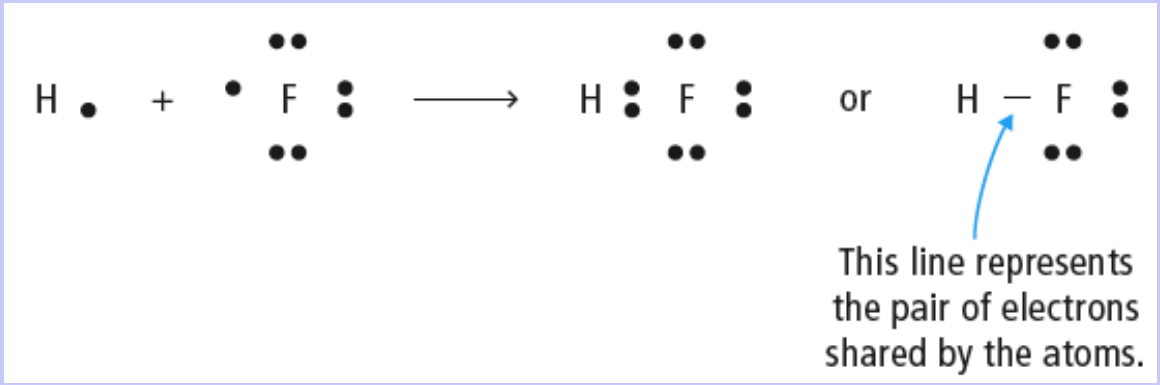
Lewis Diagrams of Covalent Bonds

- **Lewis diagrams can also represent covalent bonds.**
  - **Like Bohr diagrams, valence electrons are drawn to show sharing of electrons.**
  - **The shared pairs of electrons are usually drawn as a straight line.**



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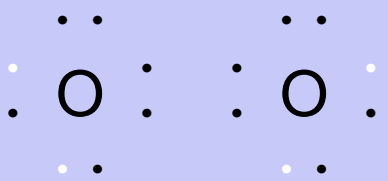
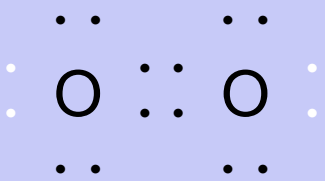
Lewis Diagrams of Diatomic Molecules

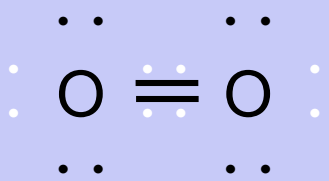
- **Diatomic molecules, like O_2, are also easy to draw as Lewis diagrams.**



Several non-metals join to form diatomic molecules.



Valence electrons are shared, here in two pairs.



This is drawn as a double bond.

Take the Section 4.1 Quiz

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