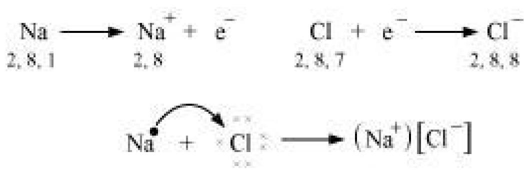
13. Chemical Change and Chemical Bond

- Changes can broadly be classified into two types − physical and chemical.
  - The characteristics of physical and chemical changes

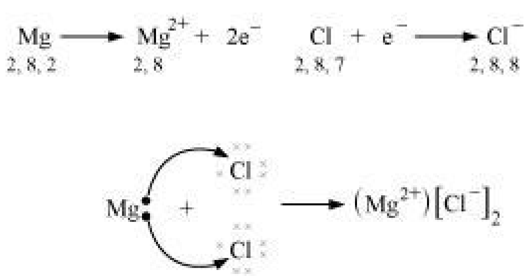
Physical Change	Chemical Change
1. The chemical composition of a substance does not change. **2.** Most changes are reversible. **3.** No new substances are formed. For example, Ice → Water → Steam	**1.** The chemical composition of a substance changes. **2.** Most changes are irreversible. **3.** New substances are formed. For example, Paper → Ashes

- Burning a candle is a combination of physical and chemical change.

- **Metals + Non-metals**
  - **1)**



  - **2)**



- **Physical Properties of Ionic compounds**

1. Solid

2. Hard [because of strong attraction force]

3. Brittle

4. High melting and boiling points

5. Soluble in H_2O; insoluble in kerosene, petrol

6. Conduct electricity in H_2O solution

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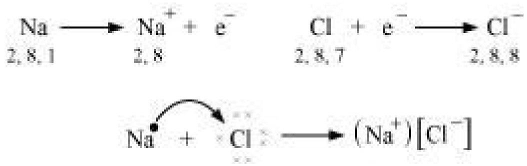
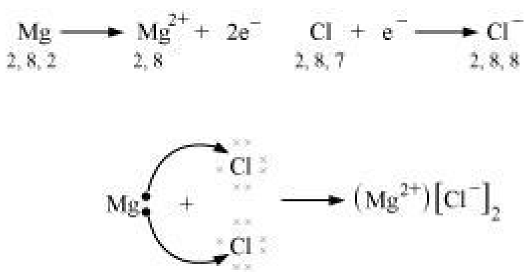
    - **1)**



    - **2)**



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Chemical bond:

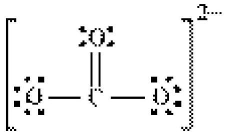
Chemical bond is the attractive force, which holds various constituents (such as atoms, ions) together in different chemical species.

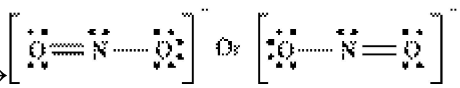
Octet rule:

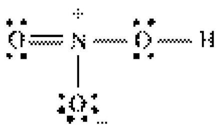
Atoms tend to gain, lose, or share electrons so as to have eight electrons in their valence shells.

Lewis dot Structure:

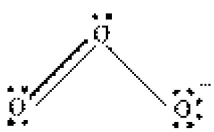
Representation of molecules and ions in terms of the shared pairs of electrons and the octet rule

$CO_3^{2-} \rightarrow$ 

$NO_2^{-} \rightarrow$ 

$HNO_3 \rightarrow$ 

Formal charge:

Lewis structure of $O_3 \rightarrow$ 

$$\begin{bmatrix}\text{Formal charge (F.C)} \\ \text{on an atom in a} \\ \text{Lewis structure}\end{bmatrix} = \begin{bmatrix}\text{Total number of} \\ \text{valence electrons} \\ \text{in the free atom}\end{bmatrix} - \begin{bmatrix}\text{Total number of} \\ \text{nonbonding (lone} \\ \text{pair electrons)}\end{bmatrix} - \frac{1}{2}\begin{bmatrix}\text{Total number of} \\ \text{bonding (shared} \\ \text{electrons)}\end{bmatrix}$$

F.C. on the $O^{-1} = 6 - 2 - \frac{1}{2}(6) = +1$

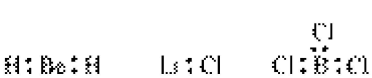
F.C. on the $O^{-2} = 6 - 4 - \frac{1}{2}(4) = 0$

F.C. on the $O^{-3} = 6 - 6 - \frac{1}{2}(2) = -1$

Limitations of the octet rule:

- Incomplete octet of the central atom

E.g. BeH_2, LiCl, BCl_3

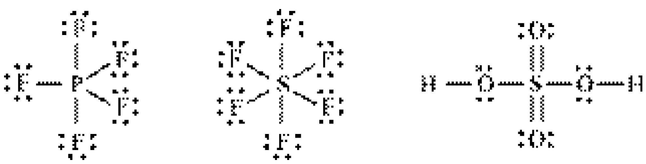


- Odd electron molecules

E.g. NO, NO_2

- Expanded octet

E.g. PF_5, SF_6, H_2SO_4



- Some other drawbacks:

1. It is based upon chemical inertness of noble gases. However, some noble gases can combine to form compounds such as XeF_2, KrF_2, $XeOF_2$, etc.
2. Does not account for the shape of molecules
3. Does not explain the relative stability of molecules

Conditions for Formation of Covalent Bond

- Presence of four or more electrons in the outermost shell of an atom (exception H, Be, B and Al)
- High electronegativity of both the atoms
- High electron affinity for both the atoms
- High ionisation energy of both the atoms
- Electronegativity difference between combining atoms should be zero or very low