Chemistry 20 – Lesson 14
Ionic bonding

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For questions 1 through 3 assume a metallic element M with two valence electrons chemically reacts with a non-metallic element X with seven valence electrons.

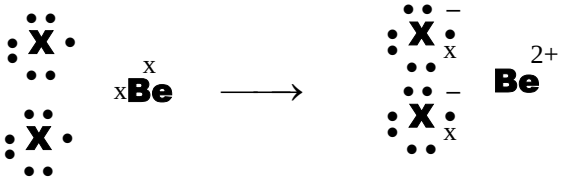
1. What kind of bond is most likely to form between M and X?

/1 **A metal and a non-metal form an <u>ionic bond</u>.**

2. The resulting compound between M and X would form what characteristic kind of solid?

/1 **Ionic compounds exist in a <u>crystal lattice</u>.**

3. Using Lewis diagrams show the electron rearrangement that occurs to form a chemical bond between M and X.

/2 

4. Describe the difference between a polar covalent bond and an ionic bond.

/2 **A polar covalent bond involves an unequal sharing of electrons, while ionic bonds involve a transfer of electrons**.

5. Discuss the statement, "An ionic bond results from the transfer of electrons".

2/ **When electrons are transferred from one atom to another, the atom losing electrons becomes a positive ion and the atom receiving the electrons becomes a negative ion**.

Classify the bonds in the following compounds as predominately covalent or predominately ionic using both the "staircase" line on the periodic table as the dividing line for classification <u>and</u> their difference in electronegativities.

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6. KCl	**staircase → ionic**	**electronegativity difference = 2.4 → ionic**
7. LiBr	**staircase → ionic**	**electronegativity difference = 2.0 → ionic**
8. CaS	**staircase → ionic**	**electronegativity difference = 1.6 → covalent**
9. HI	**staircase → covalent**	**electronegativity difference = 0.5 → covalent**
10. CH_4	**staircase → covalent**	**electronegativity difference = 0.4 → covalent**
11. H_2S	**staircase → covalent**	**electronegativity difference = 0.4 → covalent**

Identify the bond types (ionic, non-polar covalent or polar covalent) for each of the following substances.

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12. BrCl	**polar covalent**	16. CCl_4	**polar covalent**
13. P_4	**non-polar covalent**	17. $FeCl_3$	**ionic/polar covalent**
14. CsF	**ionic**	18. K_2S	**ionic**
15. CO_2	**polar covalent**	19. SiF_4	**polar covalent**

20. Discuss the idea that **all** bonding can be described in terms of simultaneous attractions.

/2 **All bonding is the result of simultaneous attractions between the nuclei (protons) of one atom or molecule for the electrons of a different atom or molecule. This applies to <u>both</u> inter and intra molecular forces**.

21. Explain why oxidation and reduction always occur at the same time.

/2 **Atoms cannot lose or gain electrons on their own. In order for one atom to lose electrons and undergo oxidation, another atom must receive the electrons resulting in the reduction in charge for the other atom**.

22.

A.

/3

$$\left(Al \longrightarrow Al^{3+} + 3e^-\right)\times 2 \quad \text{(oxidation)}$$

$$+ \quad \left(F_2 + 2e^- \longrightarrow 2\,F^-\right)\times 3 \quad \text{(reduction)}$$

$$2\,Al + 3F_2 + 6e^- \longrightarrow 2\,Al^{3+} + 6\,F^- + 6e^-$$

$$2\,Al + 3\,F_2 \longrightarrow 2\,AlF_3$$

B.

/3

$$\left(Li \longrightarrow Li^+ + e^-\right)\times 2 \quad \text{(oxidation)}$$

$$+ \quad \left(Cl_2 + 2e^- \longrightarrow 2\,Cl^-\right)\times 1 \quad \text{(reduction)}$$

$$2\,Li + Cl_2 + 2e^- \longrightarrow 2\,Li^+ + 2\,Cl^- + 2e^-$$

$$2\,Li + Cl_2 \longrightarrow 2\,LiCl$$

C.

/3

$$\left(Fe \longrightarrow Fe^{3+} + 3e^-\right)\times 4 \quad \text{(oxidation)}$$

$$+ \quad \left(O_2 + 4e^- \longrightarrow 2\,O^{2-}\right)\times 3 \quad \text{(reduction)}$$

$$4\,Fe + 3\,O_2 + 12e^- \longrightarrow 4\,Fe^{3+} + 6\,O^{2-} + 12e^-$$

$$4\,Fe + 3\,O_2 \longrightarrow 2\,Fe_2O_3$$

D.

$$\left(Mn \longrightarrow Mn^{2+} + 2e^{-}\right)\times 3 \qquad \text{(oxidation)}$$

/3 + $$\left(N_2 + 6e^{-} \longrightarrow 2\ N^{3-}\right)\times 1 \qquad \text{(reduction)}$$

$$3Mn + N_2 + 6e^{-} \longrightarrow 3Mn^{2+} + 2\ N^{3-} + 6e^{-}$$

$$3\ Mn + N_2 \longrightarrow Mn_3N_2$$

E.

$$\left(Cu \longrightarrow Cu^{2+} + 2e^{-}\right)\times 8 \quad \text{(oxidation)}$$

/3 + $$\left(S_8 + 16e^{-} \longrightarrow 8\ S^{2-}\right)\times 1 \quad \text{(reduction)}$$

$$8Cu + S_8 + 16e^{-} \longrightarrow 8Cu^{2+} + 8\ S^{2-} + 16e^{-}$$

$$8\ Cu + S_8 \longrightarrow 8\ CuS$$

F.

$$\left(Mg \longrightarrow Mg^{2+} + 2e^{-}\right)\times 3 \qquad \text{(oxidation)}$$

/3 + $$\left(As + 3e^{-} \longrightarrow As^{3-}\right)\times 2 \qquad \text{(reduction)}$$

$$3Mg + 2As + 6e^{-} \longrightarrow 3Mg^{2+} + 2\ As^{3-} + 6e^{-}$$

$$3Mg + 2As \longrightarrow Mg_3As_2$$

G. W + Se →

$$\left(W \longrightarrow W^{6+} + 6e^{-}\right)\times 1 \quad \text{(oxidation)}$$

/3 + $$\left(Se + 2e^{-} \longrightarrow Se^{2-}\right)\times 3 \quad \text{(reduction)}$$

$$W + 3Se + 6e^{-} \longrightarrow W^{6+} + 3\ Se^{2-} + 6e^{-}$$

$$W + 3\ Se \longrightarrow WSe_3$$