

ENGG*2120 Materials Science Assignments: Chapter 2

1. Define bond energy?

Answer:

The energy required to separate two atoms that are chemically bonded to each other. It may be expressed on a per-atom basis or per mole of atoms.

2. How many grams are there in one amu of a material?

Answer:

1 amu/ atom = 1gm/mole

1 mole = 6.023×10^{23} atoms

$$\frac{1 \text{ amu}}{\text{atom}} = \frac{1 \text{ gm}}{6.023 \times 10^{23} \text{ atoms}}$$

$$1 \text{ amu} = \frac{1 \text{ gm}}{6.023 \times 10^{23}}$$

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{ gm}$$

3. What is the difference between atomic mass and atomic weight?

Answer:

Atomic mass is the mass of an individual atom, whereas atomic weight is the average (weighted) of the atomic masses of an atom's naturally occurring isotopes.

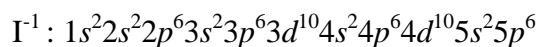
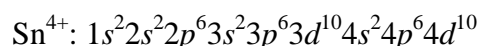
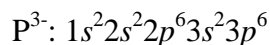
4. Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) (19.4 vs. -85°C), even though HF has a lower molecular weight.

Answer:

The intermolecular bonding for HF is hydrogen, whereas for HCl, the intermolecular bonding is van der Waals. Since the hydrogen bond is stronger than van der Waals, HF will have a higher melting temperature.

5. Give the electronic configurations for the following ions P^{3-} , Sn^{4+} , and I^{-1} .

Answer:



6. With regard to electronic configuration, what do all the elements in Group IIA of the periodic table have in common?

Answer: Each of the elements in Group IIA has two *s* electrons

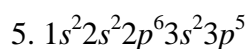
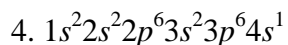
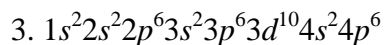
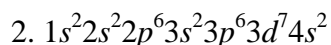
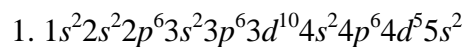
7. Sodium chloride (NaCl) exhibits predominantly ionic bonding. Na^{+} and Cl^{-} ions have electron structures that are identical to which two inert gases?

Answer:

The Na^{+} ion is just a sodium atom that has lost one electron; therefore, it has an electron configuration the same as Neon.

The Cl^{-} ion is a chlorine atom that has acquired one extra electron; therefore, it has an electron configuration the same as Argon.

8. Determine whether each of the electronic configurations given below is an inert gas, a halogen, an alkali metal, an alkaline earth metal, or a transition metal. Justify your choices.



Answer:

(1) The $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^5 5s^2$ electron configuration is that of a transition metal because of an incomplete d subshell.

(2) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$ electron configuration is that of a transition metal because of an incomplete d subshell.

(3) The $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ electron configuration is that of an inert gas because of completely filled $4s$ and $4p$ subshells.

(4) The $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ electron configuration is that of an alkali metal because of a single s electron.

(5) $1s^2 2s^2 2p^6 3s^2 3p^5$ electron configuration is that of a halogen because it is one electron deficient from having a filled p subshell.

9. Calculate the force of attraction between a Ca^{2+} and an O^{2-} ion the centers of which are separated by a distance of 1.25 nm.

Answer:

The distance between Ca^{2+} and an O^{2-} ion is 1.25nm.

Charge on Ca^{2+} ion is $2e^+$

Charge on O^{2-} ion is $2e^-$

The force of attraction between two ions is given by

$$\begin{aligned} F_A &= \frac{(Z_1 e)(Z_2 e)}{4\pi\epsilon_0 r^2} \\ &= \frac{(2)(2)(1.6 \times 10^{-19} \text{ C})^2}{(4)(\pi)(8.85 \times 10^{-12} \text{ F/m})(1.25 \times 10^{-9} \text{ m})^2} \\ &= 5.89 \times 10^{-10} \text{ N} \end{aligned}$$

10. Briefly cite the main differences between ionic, covalent, and metallic bonding.

Answer:

The main differences between the various forms of primary bonding are:

Ionic--there is electrostatic attraction between oppositely charged ions.

Covalent--there is electron sharing between two adjacent atoms such that each atom assumes a stable electron configuration.

Metallic--the positively charged ion cores are shielded from one another, and also "glued" together by the sea of valence electrons.

11. Write electronic configurations for Fe^{3+} and S^{2-} .

Answer:

The Fe^{3+} ion is an iron atom that has lost three electrons. Since the electron configuration of the Fe atom is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$, the configuration for Fe^{3+} is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

The S^{2-} ion is a sulphur atom that has gained two electrons. Since the electron configuration of the S atom is $1s^2 2s^2 2p^6 3s^2 3p^4$, the configuration for S^{2-} is $1s^2 2s^2 2p^6 3s^2 3p^6$.

12. Write the equation for potential energy and force relationship.

Answer:

Force–potential energy relationship for two atoms is given by

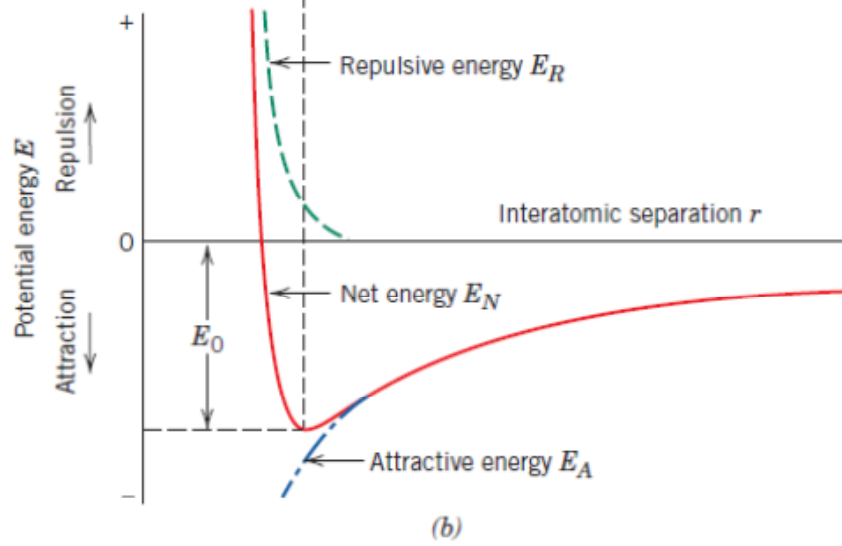
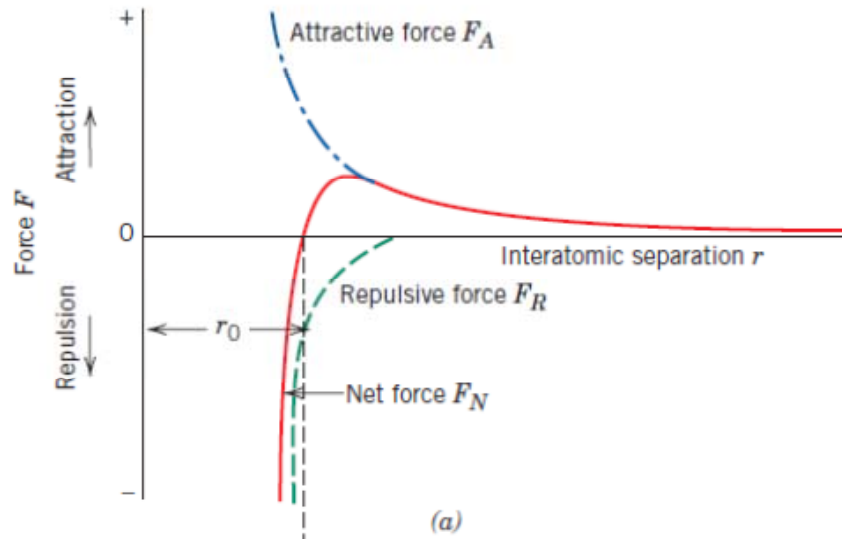
$$E = \int F dr$$

13. What type(s) of electron subshell (s) does an M shell contain?

Answer: s , p and d

14. Schematically plot attractive, repulsive, and net energies versus interatomic separation for two atoms or ions.

Answer:



For MgO, $X_{\text{Mg}} = 1.2$ and $X_{\text{O}} = 3.5$, and therefore,

$$\%IC = \left[1 - e^{(-0.25)(3.5-1.2)^2} \right] \times 100 = 73.4\%$$

For GaP, $X_{\text{Ga}} = 1.6$ and $X_{\text{P}} = 2.1$, and therefore,

$$\%IC = \left[1 - e^{(-0.25)(2.1-1.6)^2} \right] \times 100 = 6.1\%$$

For CsF, $X_{\text{Cs}} = 0.7$ and $X_{\text{F}} = 4.0$, and therefore,

$$\%IC = \left[1 - e^{(-0.25)(4.0-0.7)^2} \right] \times 100 = 93.4\%$$

For CdS, $X_{\text{Cd}} = 1.7$ and $X_{\text{S}} = 2.5$, and therefore,

$$\%IC = \left[1 - e^{(-0.25)(2.5-1.7)^2} \right] \times 100 = 14.8\%$$

For FeO, $X_{\text{Fe}} = 1.8$ and $X_{\text{O}} = 3.5$, and therefore,

$$\%IC = \left[1 - e^{(-0.25)(3.5-1.8)^2} \right] \times 100 = 51.4\%$$