Types of Materials

- Metals:
  - Strong, ductile
  - high thermal & electrical conductivity
  - opaque, reflective.
- Polymers/plastics: Covalent bonding
  - Soft, ductile, low strength, low density
  - thermal & electrical insulators
  - Optically translucent or transparent.
- Ceramics: ionic bonding (refractory)
  - compounds of metallic & non-metallic elements (oxides, carbides, nitrides, sulfides)
  - Brittle, glassy, elastic
  - non-conducting (insulators)

Element	Atomic #	Electron configuration	
Hydrogen	1	$1s^1$	
Helium	2	$1s^2$	(stable)
Lithium	3	$1s^2 2s^1$	
Beryllium	4	$1s^2 2s^2$	
Boron	5	$1s^2 2s^2 2p^1$	
Carbon	6	$1s^2 2s^2 2p^2$	
...		...	
Neon	10	$1s^2 2s^2 2p^6$	(stable)
Sodium	11	$1s^2 2s^2 2p^6 3s^1$	
Magnesium	12	$1s^2 2s^2 2p^6 3s^2$	
Aluminum	13	$1s^2 2s^2 2p^6 3s^2 3p^1$	
...		...	
Argon	18	$1s^2 2s^2 2p^6 3s^2 3p^6$	(stable)
...	...	...	
Krypton	36	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$	(stable)

- Most elements: Electron configuration not stable.

- Metals are electropositive – they can give up their few valence electrons to become positively charged ions.

$$\chi_A - \chi_B = (eV)^{-1/2} \sqrt{E_d(AB) - \frac{[E_d(AA) + E_d(BB)]}{2}}$$

Type	Bond Energy	Comments
Ionic	Large	Nondirectional (ceramics)
Covalent	Variable large-Diamond small-Bismuth	Directional (semiconductors, ceramics polymer chains)
Metallic	Variable large-Tungsten small-Mercury	Nondirectional (metals)
Secondary	Smallest	Directional inter-chain (polymer) inter-molecular

Q.4 Compute the % ionic character of the ZnTe, CsCl, InSb, and $MgCl_2$.

$$\% \text{ ionic character} = \{1 - e^{(-0.25(X_A - X_B)^2)}\} \times 100$$

electronegativity

Q.5 What type(s) of bonding would be expected for each of the following materials: brass (a metalic

Body Centered Cubic Structure (BCC)

The hard spheres touch one another along cube diagonal

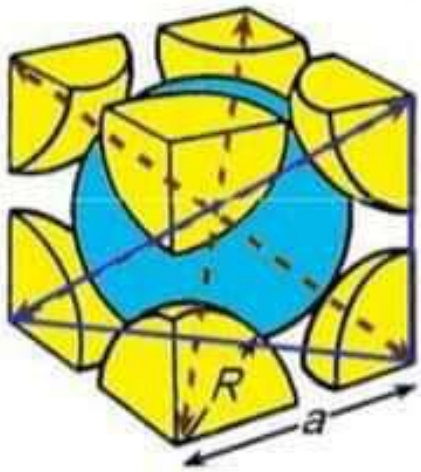
The coordination number, CN = 8

Number of atoms per unit cell, n = 2

1 center atom shared by no other cells: 1 x 1 = 1

8 corner atoms shared by eight cells: 8 x 1/8 = 1

Corner and center atoms are equivalent

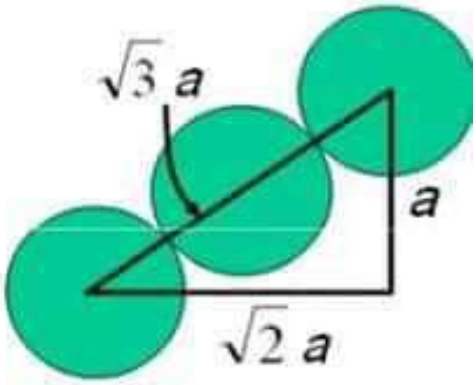


⇒ the cube edge length, a= 4R/√3

$$\text{Volume of sphere} = 2\times\frac{4}{3}\times\frac{22}{7}\times\left(\frac{\sqrt{3}a}{4}\right)^3$$

$$Volume of cell = (a)^3$$

$$\therefore P.E. = \frac{914.5}{1344} = 0.6805$$



The higher coordination number and packing efficiency mean that this lattice uses space more efficiently than simple cubic.