Atomic structure

Technology, Information Technology

Tutorial 1: Atomic Structure and Bonding in Solids

1.

- (a)Cite the difference between atomic mass and atomic weight.
- (b)Silicon has three naturally-occurring isotopes as shown in the table below. On the basis of this data, confirm that the average atomic weight of Si is 28. 0854 amu.

Silicon Isotope	Natural Abundance	The atomic mass of isotope (AMU)
28Si	92. 23 %	27. 9769
29Si	4. 68 %	28. 9765
30Si	3. 09 %	29. 9738

2.

- (a)Cite two important quantum-mechanical concepts associated with the Bohr model of the atom.
- (b)Cite two important additional refinements that resulted from the wave-mechanical atomic model.

3. Relative to electrons and electron states, what does each of the four quantum numbers specify?

4. Give the electron configurationsfor the following ions: P5+, P3-, Sn4+, Se2-, I- and Ni2+.

5. Potassium iodide (KI) exhibits predominantly ionic bonding.

The K+ and I- ions have electron structures that are identical to which two inert gases?

6. Without consulting the periodic table, determine whether each of the electron configurations given below is an inert gas, a halogen, an alkali metal, an alkaline earth metal, or a transition metal. Justify your choices.

- a. 1s22s22p63s23p5
- b. 1s22s22p63s23p63d74s2
- c. 1s22s22p63s23p63d104s24p6
- d. 1s22s22p63s23p64s1
- e. 1s22s22p63s23p63d104s24p64d55s2
- f. 1s22s22p63s2

7. Calculate the force of attraction between a Ca2+ and an O2- ion, the centers of which are separated by a distance of 1. 5 nm.

8. The net potential energy between two adjacent ions, EN, may be represented by the sum of the attractive energy, EA and the repulsive energy, ER; Calculate the bonding energy E0 in terms of the parameters A, B, and n usingthe following procedure: Differentiate EN withrespectto r, and then set the resulting expression equal to zero, since the curve of EN versus r is a minimum at E0. Solve for r in terms of A, B, and n, which yields r0, the equilibrium interionic spacing. Determine the expression for EN by substitution of r0 into Equation Q2.

9. For a Na+ – Cl- ion pair, attractive and repulsive energies EA and ER, respectively, depending on the distance between the ions r, according to for these expressions, energies are expressed in electron volts per Na+ – Cl- pair, and r is the distance in nanometers. The net energy EN is just the sum of the two expressions above.

- a) Superimpose on a single plot EN, ER, and EA versus r up to 1. 0 nm.
- b) On the basis of this plot, determine
- c) the equilibrium spacing r0 between the Na+ and Cl- ions, and
- d) the magnitude of the bonding energy between the two ions.
- e) Mathematically determine the r0 and E0 values using the solutions to Question 8 and compare these with the graphical results from part (b).

10.

- (a)Briefly cite the main difference between ionic, covalent, and metallic bonding.
- (b)State the Pauli exclusion principle.

11. Compute the percentage ionic character of the interatomic bond for each of the following compounds: MgO, GaP, CsF, CdS, and FeO.

12. What types of bonding would be expected for each of the following materials: solid xenon, calcium fluoride (CaF2), bronze, cadmium telluride (CdTe), rubber, and tungsten?

13. Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) (19. 4(C vs. -85(C), even though HF has a lower molecular weight.

14. Explain why covalently bonded materials are generally less dense than ionically or metallically bonded ones. Asia Pacific University College ofTechnologyand Innovation.