Engr. 161, FALL 2019

HW #1: Callister, 9th Ed., Chapter 2: 1, 3, 6, 16, 18, 19, 22a, 26, 27

USE YOUR OWN WORDS for Explanations. Make all plots to scale.

2.1 Cite the difference between *atomic mass* and *atomic weight*. **USE YOUR OWN WORDS**.

2.3 Zinc has five naturally occurring isotopes: 48.63% of ^{64}Zn, with an atomic weight [mass] of 63.929 amu; 27.90% of ^{66}Zn, with an atomic weight of 65.926 amu; 4.10% of ^{67}Zn, with an atomic weight of 66.927 amu; 18.75% of ^{68}Zn, with an atomic weight of 67.925 amu; 0.62% of ^{70}Zn, with an atomic weight of 69.925 amu. Calculate the average atomic weight of Zn.

2.6 (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.

2.16 The atomic (ionic) radii of Mg^{2+} and F^- ions are 0.072 and 0.133 nm, respectively.
(a) Calculate the force of attraction between these two ions at their equilibrium interionic separation (i.e., when the ions just touch one another.
(b) What is the force of repulsion at this same separation distance?

2.18 The net potential energy between two adjacent ions, E_N, may be represented by the sum of Equations 2.9 and 2.11; that is,

$$E_N = -\frac{A}{r} + \frac{B}{r^n} \qquad (2.17)$$

Calculate the **bonding energy** E_0 (which is the minimum value of E_N) in terms of the parameters *A*, *B*, and *n* using the following procedure:

1. Differentiate E_N with respect to *r*, and then set the resulting expression equal to zero, since the curve of E_N versus *r* is a minimum at E_0, **[and thus its slope is zero there].**
2. Solve for *r* in terms of *A*, *B*, and *n*, which yields r_o, the equilibrium inter-ionic spacing.
3. Determine the expression for E_o by substitution of r_o into Equation 2.17.

2.19 For a Na^+–Cl^- ion pair, attractive and repulsive energies E_A and E_R, respectively, depend on the distance between the ions *r*, according to

$$E_A = -\frac{1.436}{r}$$

$$E_R = \frac{7.32 \times 10^{-6}}{r^8}$$

For these expressions, energies are expressed in electron volts per Na^+–Cl^- pair, and *r* is the distance in nanometers. The net energy E_N is just the sum of the preceding two expressions.

Use EXCEL to plot a smooth curve.

(a) Superimpose on a single plot E_N, E_R, and E_A versus *r* up to 1.0 nm. **[Plot three curves on one plot. The increment of *r* should made small enough so that the curve is smooth… use 0.05 nm.] Limit the energy values (vertical axis) so you can clearly see and measure the minimum value.**

(b) On the basis of this plot [**reading your graph**], determine (i) the equilibrium spacing r_o between the Na^+ and Cl^- ions, and (ii) the magnitude of the bonding energy E_o between the two ions.

(c) Mathematically determine the r_o and E_o values using the solutions to Problem 2.18 and compare these with the graphical results from part (b).

[Hint: <u>Use Microsoft EXCEL to make the plot</u>. The increment of *r* should made small enough so that the curve is smooth... do not plot markers, but a smooth curve through many points. In general, when plotting by hand <u>or</u> by Excel, make all plots to scale, label axes correctly, title plots.]

2.22a (a) Briefly cite the main differences among ionic, covalent and metallic bonding.

2.26 (a) Calculate the %IC of the interatomic bonds for the intermetallic compound Al_6Mn.
(b) On the basis of this result, what type of interatomic bonding would you expect to be found in Al_6Mn?

2.27 What type(s) of bonding would be expected for each of the following materials: solid xenon, calcium fluoride (CaF_2), bronze, cadmium telluride (CdTe), rubber, and tungsten? **[justify your answer].**
