

Home-work #2

Problems: 2.2; 2.6; 2.7; 2.10; 2.11; 2.12; 2.13; 2.14; 2.15; 2.19; 2.20; 2.22; 2.23.

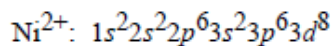
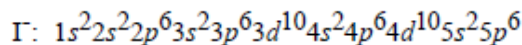
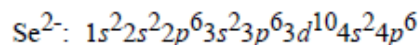
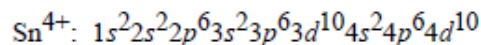
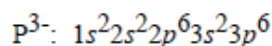
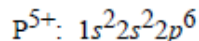
2.2 The average atomic weight of silicon (\bar{A}_{Si}) is computed by adding fraction-of-occurrence/atomic weight products for the three isotopes. Thus

$$\begin{aligned}\bar{A}_{\text{Si}} &= f_{28\text{Si}} A_{28\text{Si}} + f_{29\text{Si}} A_{29\text{Si}} + f_{30\text{Si}} A_{30\text{Si}} \\ &= (0.9223)(27.9769) + (0.0468)(28.9765) + (0.0309)(29.9738) = 28.0854\end{aligned}$$

2.6 For the L state, $n = 2$, and eight electron states are possible. Possible l values are 0 and 1, while possible m_l values are 0 and ± 1 ; and possible m_s values are $\pm \frac{1}{2}$. Therefore, for the s states, the quantum numbers are $200(\frac{1}{2})$ and $200(-\frac{1}{2})$. For the p states, the quantum numbers are $210(\frac{1}{2})$, $210(-\frac{1}{2})$, $211(\frac{1}{2})$, $211(-\frac{1}{2})$, $21(-1)(\frac{1}{2})$, and $21(-1)(-\frac{1}{2})$.

For the M state, $n = 3$, and 18 states are possible. Possible l values are 0, 1, and 2; possible m_l values are 0, ± 1 , and ± 2 ; and possible m_s values are $\pm \frac{1}{2}$. Therefore, for the s states, the quantum numbers are $300(\frac{1}{2})$, $300(-\frac{1}{2})$, for the p states they are $310(\frac{1}{2})$, $310(-\frac{1}{2})$, $311(\frac{1}{2})$, $311(-\frac{1}{2})$, $31(-1)(\frac{1}{2})$, and $31(-1)(-\frac{1}{2})$; for the d states they are $320(\frac{1}{2})$, $320(-\frac{1}{2})$, $321(\frac{1}{2})$, $321(-\frac{1}{2})$, $32(-1)(\frac{1}{2})$, $32(-1)(-\frac{1}{2})$, $322(\frac{1}{2})$, $322(-\frac{1}{2})$, $32(-2)(\frac{1}{2})$, and $32(-2)(-\frac{1}{2})$.

2.7 The electron configurations for the ions are determined using Table 2.2 (and Figure 2.6).



2.10 From the periodic table (Figure 2.6) the element having atomic number 112 would belong to group IIB. According to Figure 2.6, Ds, having an atomic number of 110 lies below Pt in the periodic table and in the right-most column of group VIII. Moving two columns to the right puts element 112 under Hg and in group IIB.

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

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

(c) 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 filled $4s$ and $4p$ subshells.

(d) 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.

(e) 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.

(f) The $1s^2 2s^2 2p^6 3s^2$ electron configuration is that of an alkaline earth metal because of two s electrons.

2.12 (a) The $4f$ subshell is being filled for the rare earth series of elements.

(b) The $5f$ subshell is being filled for the actinide series of elements.

2.13 The attractive force between two ions F_A is just the derivative with respect to the interatomic separation of the attractive energy expression, Equation 2.8, which is just

$$F_A = \frac{dE_A}{dr} = \frac{d\left(-\frac{A}{r}\right)}{dr} = \frac{A}{r^2}$$

The constant A in this expression is defined in footnote 3. Since the valences of the Ca^{2+} and O^{2-} ions (Z_1 and Z_2) are both 2, then

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

2.14 (a) Differentiation of Equation 2.11 yields

$$\begin{aligned}\frac{dE_N}{dr} &= \frac{d\left(-\frac{A}{r}\right)}{dr} + \frac{d\left(\frac{B}{r^n}\right)}{dr} \\ &= \frac{A}{r^2} - \frac{nB}{r^{n+1}} = 0\end{aligned}$$

(b) Now, solving for $r (= r_0)$

$$\frac{A}{r_0^2} = \frac{nB}{r_0^{n+1}}$$

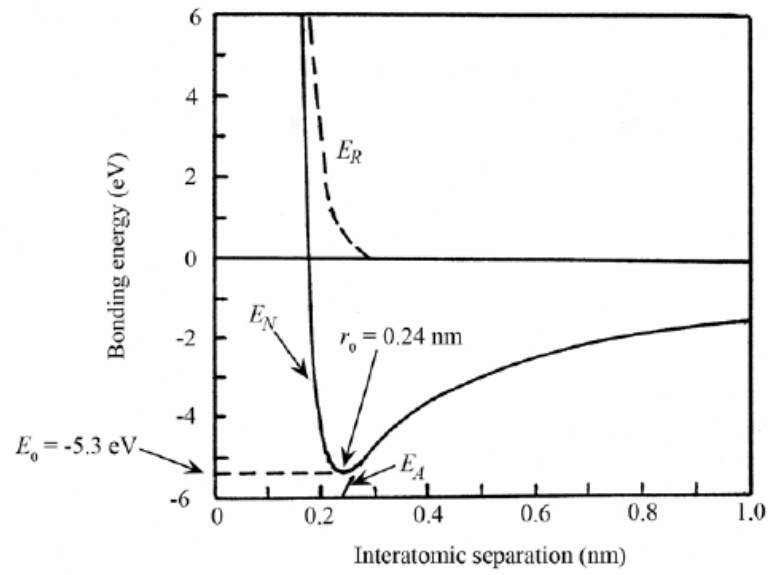
or

$$r_0 = \left(\frac{A}{nB}\right)^{1/(1-n)}$$

(c) Substitution for r_0 into Equation 2.11 and solving for $E (= E_0)$

$$\begin{aligned}E_0 &= -\frac{A}{r_0} + \frac{B}{r_0^n} \\ &= -\frac{A}{\left(\frac{A}{nB}\right)^{1/(1-n)}} + \frac{B}{\left(\frac{A}{nB}\right)^{n/(1-n)}}\end{aligned}$$

2.15 (a) Curves of E_A , E_R , and E_N are shown on the plot below.



(b) From this plot

$$r_0 = 0.24 \text{ nm}$$

$$E_0 = -5.3 \text{ eV}$$

(c) From Equation 2.11 for E_N

$$A = 1.436$$

$$B = 7.32 \times 10^{-6}$$

$$n = 8$$

Thus,

$$r_0 = \left(\frac{A}{nB} \right)^{1/(1-n)}$$

$$\left[\frac{1.436}{(8)(7.32 \times 10^{-6})} \right]^{1/(1-8)} = 0.236 \text{ nm}$$

$$E_0 = - \frac{1.436}{\left[\frac{1.436}{(8)(7.32 \times 10^{-6})} \right]^{1/(1-8)}} + \frac{7.32 \times 10^{-6}}{\left[\frac{1.436}{(8)(7.32 \times 10^{-6})} \right]^{8/(1-8)}}$$

$$= -5.32 \text{ eV}$$

2.19 The percent ionic character is a function of the electron negativities of the ions X_A and X_B according to Equation 2.10. The electronegativities of the elements are found in Figure 2.7.

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,

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

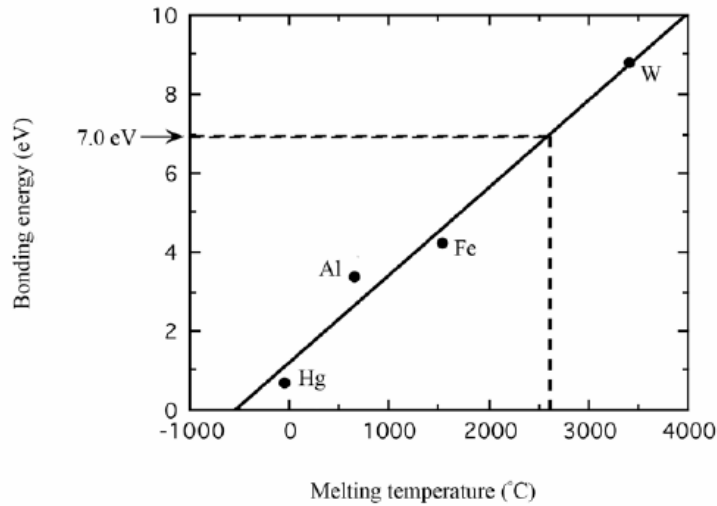
For CdS, $X_{\text{Cd}} = 1.7$ and $X_{\text{S}} = 2.5$, and therefore,

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

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

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

2.20 Below is plotted the bonding energy versus melting temperature for these four metals. From this plot, the bonding energy for molybdenum (melting temperature of 2617°C) should be approximately 7.0 eV. The experimental value is 6.8 eV.



2.22 For solid xenon, the bonding is van der Waals since xenon is an inert gas.
For CaF_2 , the bonding is predominantly ionic (but with some slight covalent character) on the basis of the relative positions of Ca and F in the periodic table.

For bronze, the bonding is metallic since it is a metal alloy (composed of copper and tin).

For CdTe, the bonding is predominantly covalent (with some slight ionic character) on the basis of the relative positions of Cd and Te in the periodic table.

For rubber, the bonding is covalent with some van der Waals. (Rubber is composed primarily of carbon and hydrogen atoms.)

For tungsten, the bonding is metallic since it is a metallic element from the periodic table.

2.23 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.