PHYS 226 HW2.

1. see p.345 & 346 of Turton.

2. $E = -\left(\frac{A}{r^6}\right) + B\exp\left(\frac{-r}{\rho}\right)$ $\qquad F = 0$ @ $r_0 = 1.50\text{Å}$

$= E_A + E_R$

when $r = r_0$, $F = -\frac{dE}{dr} = 0 = \frac{-d}{dr}\left(-Ar^{-6} + B\exp\left(\frac{-r}{\rho}\right)\right)$

$$0 = -6Ar^{-7} + \frac{B}{\rho}\exp\left(\frac{-r}{\rho}\right)\Big|_{r_0}$$

$$0 = -\frac{6A}{r_0^7} + \frac{B}{\rho}\exp\left(\frac{-r_0}{\rho}\right)$$

$$\frac{B}{\rho}\exp\left(\frac{-r_0}{\rho}\right) = \frac{6A}{r_0^7}$$

$$B = \frac{6\rho A}{r_0^7}\exp\left(\frac{+r_0}{\rho}\right) \quad (*)$$

when $r = r_0$ $E = 0.9E_A$

or $-\left(\frac{A}{r_0^6}\right) + B\exp\left(\frac{-r_0}{\rho}\right) = -0.9\left(\frac{A}{r_0^6}\right)$

$$B\exp\left(\frac{-r_0}{\rho}\right) = (1 - 0.9)\left(\frac{A}{r_0^6}\right)$$

$$\frac{6\rho A}{r_0^7}\exp\left(\frac{+r_0}{\rho}\right)\exp\left(\frac{-r_0}{\rho}\right) = 0.1\frac{A}{r_0^6}$$

$$\rho = \frac{0.1}{6}r_0 = 0.025\text{Å} = 2.50\text{ pm}$$

3. $KCl \xrightarrow{E_D} K + Cl \qquad E_D = ?$

$K \xrightarrow{E_{IK}} K^+ + e^- \qquad |E_{IK}| = 4.34\ eV$

$Cl + e^- \xrightarrow{E_{ICl}} Cl^- \qquad |E_{ICl}| = 3.82\ eV$

$K^+Cl^- \xrightarrow{E_B} K^+ + Cl^- \qquad |E_B| = \frac{e^2}{4\pi\varepsilon_0 r_0} = \frac{ke^2}{r_0}(1-0.05)$

$$= \frac{\left(8.9876\times10^{9}\ \frac{N\cdot m^2}{C^2}\right)\left(1.6022\times10^{-19}\ C\right)^2}{\left(2.79\times10^{-10}\ m\right)}(0.95)$$

$$= 4.90\ eV$$

$K^+Cl^- \xrightarrow{E_B} K^+ + Cl^- \xrightarrow{-E_{IK}+E_{ICl}} K + Cl$

E_D

$E_D = E_B - E_{IK} + E_{ICl} = 4.90\ eV - 4.34\ eV + 3.82\ eV$

$= \underline{4.38\ eV}$

5. From 1.14 $E(r) = -\frac{Aa_0^6}{r^6} + \frac{Ba_0^{12}}{r^{12}}$

$$F(r) = -\frac{dE(r)}{dr} = -\frac{d}{dr}\left(-Aa_0^6 r^{-6} + Ba_0^{12} r^{-12}\right)$$

$$= -\left[6Aa_0^6 r^{-7} - 12Ba_0^{12} r^{-13}\right]$$

$$\Rightarrow F(r) = \frac{-6Aa_0^6}{r^7} + \frac{12Ba_0^{12}}{r^{13}}$$

at $r = a_0$ $F(r) = 0$ (min. of potential well).

$$\Rightarrow F(r)|_{a_0} = -\frac{6Aa_0^6}{a_0^7} + \frac{12Ba_0^{12}}{a_0^{13}} = 0$$

$$\Rightarrow -\frac{6A}{a_0} + \frac{12B}{a_0} = 0$$

$$\Rightarrow A - 2B = 0$$

or $A = 2B$ (*)

Binding energy $\varepsilon = E(r)$ at $r = a_0$

$$\Rightarrow E(r)|_{a_0} = -\frac{Aa_0^6}{a_0^6} + \frac{Ba_0^{12}}{a_0^{12}} = -A + B = -2B + B$$

$$= B$$

ie. $B = \varepsilon$

& from (*) $A = 2B = 2\varepsilon$ ie. $A = 2\varepsilon$