

## PHYS 226 HW2.

1. see p.345 & 346 of Turtton.

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

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

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

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

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

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

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

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

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

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

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

3.  $KCl \xrightarrow{E_0} K + Cl \quad E_0 = ?$

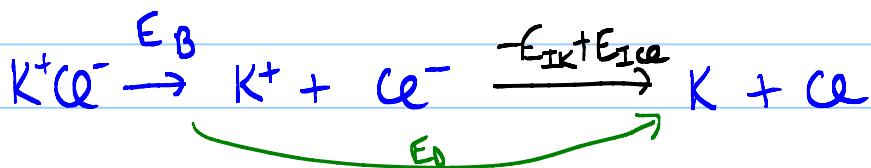
$$K \xrightarrow{E_{IK}} K^+ + e^- \quad |E_{IK}| = 4.34 \text{ eV}$$

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

$$K^+ Cl^- \xrightarrow{E_0} K^+ + Cl^- \quad |E_B| = \frac{e^2}{4\pi\epsilon_0 r_0} = \frac{ke^2}{r_0} (1 - 0.05)$$

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

$$= 4.90 \text{ eV}$$



$$E_0 = E_B - E_{IK} + E_{ICl} = 4.90 \text{ eV} - 4.34 \text{ eV} + 3.82 \text{ eV}$$

$$= \underline{\underline{4.38 \text{ eV}}}$$

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

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

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

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

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

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

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

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

$$\text{or } A = 2B \quad (*)$$

Binding energy  $\epsilon = E(r)$  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.  $B = \epsilon$

† from  $(*)$   $A = 2B = 2\epsilon$  ie.  $A = 2\epsilon$