HW9 Solutions

ch9 #5 a) $U_{coulomb} = \frac{k_e q_1 q_2}{r} = \frac{k_e \cdot +e \cdot -e}{0.267\,nm} = -\frac{1.44\,eV\cdot nm}{0.267\,nm} = -5.39\,eV$

b) $U_{ion} = (4.18 - 3.62)\,eV = 0.56\,eV$

$E_d' = (-5.39 + 0.56)\,eV = -4.83\,eV$

c) $E_{ex} = E_d - E_d' = -4.37\,eV - (-4.83)\,eV = 0.46\,eV$

#6 $E_{ex} = E_d - E_{coul.} - E_{ion} = -3.94\,eV - \frac{-ke^2}{0.282\,nm} - (4.34 - 3.36)\,eV$

$= 0.186\,eV$ @ $0.282\,nm$

#7 $E_d = E_{ex} + E_{coulomb} + E_{ion} = A/r^n + \frac{-ke^2}{r} + E_{ion}$

$F = 0: \quad \frac{d}{dr}\left(\frac{A}{r^n} + -\frac{ke^2}{r}\right) = -nAr^{-n-1} + \frac{ke^2}{r^2} = 0$

$Ar^{1-n} = \frac{ke^2}{n}$

also $Ar^{-n} = E_{ex}$

taking the ratio, $\frac{r^{1-n}}{r^{-n}} = \frac{ke^2/n}{E_{ex}}$ ~~or~~

$n = \frac{ke^2}{r \cdot E_{ex}} = \frac{1.44\,eV\cdot nm}{0.282\,nm \cdot 0.186\,eV} = 27.4$

$A = E_{ex} \cdot r^n = 0.186\,eV \cdot (0.282\,nm)^{27} = 2.668 \times 10^{-16}\,eV \cdot nm^{27}$

#11 a) ionic b) covalent c) covalent.

#37 $P = \frac{E}{t} = \frac{nhf}{t} = \frac{n}{t}\frac{hc}{\lambda}$ $\quad \frac{n}{t} = \frac{P \cdot \lambda}{hc} = \frac{4\,mW \cdot 632.8\,nm}{1240\,eV \cdot nm} = 1.27 \times 10^{16}/s$

ch10 #10. $\rho = \frac{m_e \langle v \rangle}{ne^2 \lambda} = \frac{9.11\times10^{-31}\,kg \cdot 1.17\times10^{5}\,m/s}{8.47\times10^{28}/m^3\,(1.6\times10^{-19}C)^2(0.4\,nm)} = 12.25\,\mu\Omega\cdot cm$

$\rho[100K] = \rho[300] \times \sqrt{\frac{100}{300}} = 7.07\,\mu\Omega\cdot cm$

#16. a) $\langle E \rangle = \frac{3}{5} E_F = \frac{3}{5}(7.06) = 4.24\,eV$

b) $\langle E \rangle = 3/5 \cdot 4.77\,eV = 2.86\,eV$

#27. a) $\lambda = \frac{hc}{\Delta E} = \frac{1240\,eV\cdot nm}{1.14\,eV} = 1087.6\,nm$

b) $\lambda = \frac{1240\,eV\cdot nm}{0.72\,eV} = 1722\,nm$

c) $\lambda = \frac{1240\,eV\cdot nm}{7.0\,eV} = 177\,nm$

ch11 #27. $^{232}Th \rightarrow {}^{4}\alpha + {}^{228}Ra + \text{energy}$

$232.038051 = 4.0026 + 228.031064 + E$

$E = 0.004387\,u = 4.086\,MeV/c^2$

$P_\alpha = P_{Ra} \equiv P \quad E_\alpha = \frac{p^2}{2m_\alpha} \quad E_{Ra} = \frac{p^2}{2m_{Ra}}$

$E = \frac{p^2}{2m_\alpha} + \frac{p^2}{2m_{Ra}} = 4.086\,MeV$

$E_{Ra}/E_\alpha = \frac{1/m_{Ra}}{1/m_\alpha} = \frac{m_\alpha}{m_{Ra}} = \frac{4}{232} = 0.01724$

thus $E_{Ra} = \frac{0.01724}{1+0.01724} E = 0.06926\,MeV$

$E_\alpha = \frac{1}{1+0.017} E = 4.0172\,MeV$

#34 $^{80}Br \rightarrow {}^{80}Kr + e^- + \bar{\nu} \quad Q/c^2 = 79.91853 - 79.916378 = 2.152\times10^{-3}u = 2.00\,MeV/c^2$

$^{80}Br \rightarrow {}^{80}Se + e^+ + \nu \quad Q/c^2 = 79.91853 - 79.9165218 - 2(5.4858\times10^{-4}) = 848.6\,keV/c^2$

$^{80}Br + e^- \rightarrow {}^{80}Se + \nu \quad Q/c^2 = (79.91853 - 79.9165218)u = 1.87\,MeV/c^2$

#51 a) (p,n) $^{1}_{1}p_{0} + ^{23}_{10}Ne_{13} \rightarrow ^{1}_{0}n_{1} + ^{23}_{11}Na_{12}$

(γ,n) $\gamma + ^{24}_{11}Na_{13} \rightarrow ^{1}_{0}n_{1} + ^{23}_{11}Na_{12}$

(α,n) $^{4}_{2}\alpha_{2} + ^{20}_{9}F_{11} \rightarrow ^{1}_{0}n_{1} + ^{23}_{11}Na_{12}$

b) (n,p) $^{1}_{0}n_{1} + ^{14}_{7}N_{7} \rightarrow ^{1}_{1}p_{0} + ^{14}_{6}C_{8}$

(γ,p) $\gamma + ^{15}_{7}N_{8} \rightarrow$ 〃 〃

(α,p) $^{4}_{2}\alpha_{2} + ^{11}_{5}B_{6} \rightarrow$ 〃 〃

c) (n,d) $^{1}_{0}n_{1} + ^{32}_{16}S_{16} \rightarrow ^{2}_{1}d_{1} + ^{31}_{15}P_{16}$

(p,d) $^{1}_{1}p_{0} + ^{32}_{15}P_{17} \rightarrow$ 〃 〃

(γ,d) $\gamma + ^{33}_{16}S_{17} \rightarrow$ 〃 〃