Answer Key for Homework # 1: Chapter 1: P1.4, P1.7, P1.15, P1.20
Assigned: August 25; Due: September 3

P1.4
Solve the de Broglie relation for υ, after using $p = m\,\upsilon$:

$$\upsilon = \frac{h}{m\lambda} = \frac{6.626\times10^{-34}\,\text{J s}}{(9.109\times10^{-31}\ \text{kg})(1.50\times10^{-10}\ \text{m})} = 4.85\times10^{6}\ \text{m/s}$$

P1.7
From calorimetry we first determine the amount of heat energy needed to heat the water, $q = mC\Delta T$ = (1.00 g)(1 mol/18.02 g)(75.3 J/mol K)(1 K) = 4.18 J. Each photon contains energy given by $E = h\nu = hc/\lambda$. Thus, the number of photons N needed to provide 4.183 J is given by:

$$N = \frac{q}{hc/\lambda} = \frac{(4.18\ \text{J})(3.00\times10^{-6}\ \text{m})}{(6.626\times10^{-34}\ \text{J s})(2.998\times10^{8}\ \text{m/s})} = 6.31\times10^{19}\ \text{photons}$$

P.15
The total energy radiated by the sun depends on its surface area, $4\pi r^2$, assuming a sphere. Thus, the total energy radiated is $E = PA$. Thus,

$$E = PA = \sigma T^4 \times 4\pi r^2$$
$$= (5.67\times10^{-8}\ \text{W/m}^2\ \text{K}^4)\ (6000\ \text{K})^4(4\pi)(7.00\ 10^{8}\ \text{m})^2 = 4.52\times10^{26}\ \text{W}$$

P.20
Once ejected, the electrons are free. Thus, all of the energy is kinetic, and we can write $K = E = \frac{1}{2}m\upsilon^2$. The kinetic energy is given by

$$E = \frac{hc}{\lambda} - \phi = \frac{(6.626\times10^{-34}\ \text{J s})(2.998\times10^{8}\ \text{m/s})}{3.00\times10^{-7}\ \text{m}} - 2.40\ \text{eV}\left(\frac{1.602\times10^{-19}\ \text{J}}{1\ \text{eV}}\right)$$
$$= 2.77\times10^{-19}\ \text{J}$$

Solving the above equation for υ gives:

$$\upsilon = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2(2.77\times10^{-19}\ \text{J})}{9.109\times10^{-31}\ \text{kg}}} = 7.80\times10^{5}\ \text{m/s}$$

The number of electrons n is given by:

$$n = \frac{E_{total}}{E_{photon}} = \frac{E_{total}}{hc/\lambda} = \frac{3.25\times10^{-3}\ \text{J}}{(6.626\times10^{-34}\ \text{J s})(2.998\times10^{8}\ \text{m/s})/300\times10^{-9}\ \text{m}}$$
$$= 4.91\times10^{15}\ \text{electrons}$$