19a) $c = \lambda \cdot \nu$ inverse

$E = h\nu$ direct

$E = \frac{hc}{\lambda}$ inverse

$J = \frac{kg\,m^2}{s^2}$

37) $\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\,\frac{m}{s}}{7.80 \times 10^{-7}\,m} = 3.84 \times 10^{14}\,s^{-1}$

39a) $\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\,\frac{m}{s}}{1.0 \times 10^{-2}\,m} = 3.0 \times 10^{10}\,s^{-1}$

$E = h\nu$

$= (6.626 \times 10^{-34}\,J \cdot s)(3.0 \times 10^{10}\,s^{-1})$

$2.0 \times 10^{-23}\,\frac{J}{photon} \cdot \frac{6.02 \times 10^{23}\,photon}{1\,mole} = 12\,\frac{J}{mol}$

41) wave a: $\lambda = \frac{1.6 \times 10^{-3} m}{4} = 4.0 \times 10^{-4} m$

wave b: $\lambda = \frac{1.6 \times 10^{-3} m}{8} = 2.0 \times 10^{-4} m$

since wave b has the shorter wavelength, so higher frequency + energy per photon

$$\nu = \frac{c}{\lambda} = \frac{3.0 \times 10^{8} \frac{m}{s}}{2.0 \times 10^{-4} m} = 1.5 \times 10^{12} s^{-1}$$

$$E = h\nu$$
$$(6.626 \times 10^{-34} J \cdot s)(1.5 \times 10^{12} s^{-1}) = 9.9 \times 10^{-22} J$$

* both waves travel at the speed of light in a vaccuum

* From table - both represent infrared

53 $\Delta E = -2.178 \times 10^{-18} J \left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$

a) $\Delta E = -2.178 \times 10^{-18} J \left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$\Delta E = -3.025 \times 10^{-19} J$

$c = \lambda \cdot \nu$ $\quad E = h\nu$ $\quad E = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34} J \cdot s)(3.0 \times 10^{8} \frac{m}{s})}{3.025 \times 10^{-19} J}$

$\lambda = 6.567 \times 10^{-7} m = 656.7\ nm$

red

b) $\Delta E = -2.178 \times 10^{-18} J \left[\frac{1}{2^2} - \frac{1}{4^2} \right]$

$= -4.084 \times 10^{-19} J$

$\lambda = \frac{hc}{\Delta E} = \frac{(6.626 \times 10^{-34} J \cdot s)(3.00 \times 10^{8} \frac{m}{s})}{4.084 \times 10^{-19} J}$

$\lambda = 4.864 \times 10^{-7} m = 486.4 nm$

green blue

c) $\Delta E = -2.178 \times 10^{-18} J \left[\frac{1}{1^2} - \frac{1}{2^2} \right]$

$= -1.634 \times 10^{-18} J$

$\lambda = \frac{hc}{2} = \frac{(6.626 \times 10^{-34} J)(3.00 \times 10^{8} \frac{m}{s})}{1.634 \times 10^{-18} J}$

$\lambda = 1.216 \times 10^{-7} m = 121.6 nm$

Ultraviolet

59a) $\Delta E = -2.178 \times 10^{-18}\,J\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$

$\Delta E = -2.178 \times 10^{-18}\,J\left(\frac{1}{5^2} - \frac{1}{1^2}\right)$

$= 2.091 \times 10^{-18}\,J$

$\lambda = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\,J \cdot s)(3.00 \times 10^{8}\,\frac{m}{s})}{2.091 \times 10^{-18}\,J}$

$\lambda = 9.50 \times 10^{-8}\,m = 95.0\,nm$

wavelength + energy are inverse

higher λ means lower energy

$$\Delta E = -2.178 \times 10^{-18} J \left[\frac{1}{6^2} - \frac{1}{2^2} \right]$$

$$= 4.840 \times 10^{-19} J$$

$$\lambda = \frac{hc}{\sim} = \frac{(6.626 \times 10^{-34} J \cdot s)(3.00 \times 10^{8} \frac{m}{s})}{4.840 \times 10^{-19} J}$$

$$\lambda = 4.104 \times 10^{-7} m = 410.4 nm$$

visible light contains 410.4 nm

so there is enough energy

to excite an electron from

$n=2$ to $n=6$