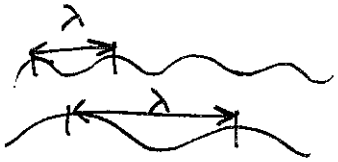
A Review of Atomic Structure – KEY

1) $\nu = 3.20 \times 10^{11}\ s^{-1}$
$E = ?$

$E = h\nu$
$= (6.626 \times 10^{-34}\ J\cancel{s})(3.20 \times 10^{11}\ \cancel{s^{-1}})$
$= 2.12 \times 10^{-44}\ J$
↳ energy of one photon

2) 

As λ increases:
- ν decreases
- E decreases
- speed is constant

3) $\lambda = 530\ nm = 530 \times 10^{-9}\ m$
$E = ?$

$E = h\nu$
$= (6.626 \times 10^{-34}\ J\cancel{s})(5.66 \times 10^{14}\ \cancel{s^{-1}})$
$= 3.75 \times 10^{-19}\ J$
↳ a quantum of energy

$c = \lambda\nu$
$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^{8}\ \cancel{m}/s}{530 \times 10^{-9}\ \cancel{m}}$
$= 5.66 \times 10^{14}\ s^{-1}$

4) $\frac{208.4\ kJ}{1\ mol\ e^-}$
$\lambda = ?$

$\frac{1\ \cancel{photon}}{1} \times \frac{1\ \cancel{e^-}}{1\ \cancel{photon}} \times \frac{1\ mol\ e^-}{6.02 \times 10^{23}\ \cancel{e^-}} \times \frac{208.4\ \cancel{kJ}}{1\ mol\ e^-} \times \frac{1000\ J}{1\ \cancel{kJ}}$
$= 3.46 \times 10^{-19}\ J/photon$

$E = h\nu$
$\nu = \frac{E}{h} = \frac{3.46 \times 10^{-19}\ \cancel{J}}{6.626 \times 10^{-34}\ \cancel{J}s} = 5.22 \times 10^{14}\ s^{-1}$

$c = \lambda\nu$
$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^{8}\ m/s}{5.22 \times 10^{14}\ s^{-1}} = 5.74 \times 10^{-7}\ m$
574 nm

5) $v = 2.998 \times 10^8 (.90) = 2.698 \times 10^8 \text{ m/s}$

$\lambda = 1.5 \times 10^{15} \text{ m}$

$$\lambda = \frac{h}{mv}$$

$$m = \frac{h}{\lambda v} = \frac{6.626 \times 10^{-34} \text{ kg } \cancel{\text{J s}}}{(1.5 \times 10^{15} \cancel{\text{m}})(2.698 \times 10^8 \cancel{\text{m/s}})}$$

$$= 1.6 \times 10^{-57} \text{ kg}$$

$\text{kg} \frac{\text{m}^2}{\text{s}^2} \cdot \text{s}$ / m $\frac{}{\text{m/s}}$

6.) $\Delta E = -2.178 \times 10^{-18} \text{ J} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$

n_f → infinity

$$= -2.178 \times 10^{-18} \text{ J} \left(0 - \frac{1}{4} \right)$$

$$= 5.445 \times 10^{-19} \text{ J}$$

$E = h\nu$

$$\nu = \frac{E}{h} = \frac{5.445 \times 10^{-19} \text{ J}}{6.626 \times 10^{-34} \text{ J s}} = 8.218 \times 10^{14} \text{ s}^{-1}$$

$c = \lambda\nu$

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8 \text{ m/s}}{8.218 \times 10^{14} \text{ s}^{-1}} = 3.648 \times 10^{-7} \text{ m}$$

364.8 nm

7) $\nu = 6.90 \times 10^{14} s^{-1}$

$E = h\nu = (6.626 \times 10^{-34} Js)(6.90 \times 10^{14} s^{-1})$

$= 4.57 \times 10^{-19} J$

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

$-4.57 \times 10^{-19} = -2.178 \times 10^{-18} J \left(\frac{1}{n_f^2} - \frac{1}{25}\right)$

$-4.57 \times 10^{-19} = -2.178 \times 10^{-18} \left(\frac{1}{n_f^2}\right) + 8.712 \times 10^{-20}$

$-5.44 \times 10^{-19} = -2.178 \times 10^{-18} \left(\frac{1}{n_f^2}\right)$

$.2498 = \frac{1}{n^2}$

$n^2 = \frac{1}{.2498} = 4.00$

$n = 2$

8) $\lambda = 397.2 nm = 397.2 \times 10^{-9} m$

$C = \lambda\nu$

$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^{8} m/s}{397.2 \times 10^{-9} m} = 7.548 \times 10^{14} s^{-1}$

$E = h\nu = (6.626 \times 10^{-34} Js)(7.548 \times 10^{14} s^{-1})$

$= 5.001 \times 10^{-19} J$

$-5.001 \times 10^{-19} J = -2.178 \times 10^{-18} J \left(\frac{1}{4} - \frac{1}{n_i^2}\right)$

$-5.001 \times 10^{-19} J = -5.445 \times 10^{-19} J + 2.178 \times 10^{-18} \left(\frac{1}{n_i^2}\right)$

$4.44 \times 10^{-20} = 2.178 \times 10^{-18} \left(\frac{1}{n_i^2}\right)$

$.0204 = \frac{1}{n_i^2}$

$n_i^2 = 49$

$n_i = 7$