CH301H – Principles of Chemistry I: Honors
Fall 2013, Unique 52195

Quiz 3, October 3, 2013

B^{4+} is a one-electron atom and therefore certain properties can be explained by the Bohr Model:

$$r_n = \frac{\varepsilon_0 n^2 h^2}{\pi Z e^2 m_e} \qquad E_n = -\frac{Z^2 e^4 m_e}{8\varepsilon_0^2 n^2 h^2}$$

a) Estimate the ionization energy of the remaining electron in B^{4+}.

b) An electron with $n = 7$ moves to $n = 6$. Is light emitted from or absorbed by the atom?

c) What is the wavelength of the photon that is either emitted or absorbed in part b)?

d) What color would you observe if you were watching this transition?

The following information may be helpful.

$q = 1.602 \times 10^{-19}$ C
$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 J^{-1} m^{-1}
$h = 6.626 \times 10^{-34}$ J s
$c = 3.0 \times 10^{8}$ m s^{-1}
$m_e = 9.11 \times 10^{-31}$ kg

$E_n = \frac{-Z^2 e^4 m_e}{8\varepsilon_0^2 n^2 h^2}$

a) $IE = E(n=\infty) - E(n=1) = -\frac{(5)^2 e^4 m_e}{8\varepsilon_0^2 (1)^2 h^2}$

$= 0 - \left(-2.18\times10^{-18}\right) \times \frac{25}{1} = 5.45\times10^{-17}$ J (for 1 atom)

$IE(1\,mol) = 5.45\times10^{-17}\ \frac{J}{atom} \left| \frac{6.023\times10^{23}\ atom}{1\ mol} \right. = \boxed{3.28\times10^{7}\ J/mol}$

b) Emission

c) Transition $n=7 \rightarrow n=6$

$\Delta E = E(n=6) - E(n=7)$

$= -\frac{(2.18\times10^{-18}\ J)(25)}{36} - \left(-\frac{2.18\times10^{-18}\ J \cdot 5^2}{49}\right)$

$\Delta E = -4.01644\times10^{-19}\ J$

$\Delta E = h\nu = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{\Delta E}$

$\lambda = \frac{6.626\times10^{-34}\ J/s \times 3\times10^{8}\ m/s}{4.01644\times10^{-19}\ J}$

$\lambda = 4.949\times10^{-7}$ m

$\boxed{\lambda = 495\ nm}$

d) blue/green