Answer on Question #62022-Physics-Atomic and Nuclear Physics

1. a) Calculate the ionization energy of rubidium per atom, if light of wavelength 5.84 x 10 raised to the power of -8 m produces electrons with a speed of 2.450 x 10 raised to the power of 6 m/sec.

[Hint: Assume that the threshold frequency refers to the frequency corresponding to the ionization energy.]

Solution

$$E_{light} = E_{ionisation} + E_{kinetic}$$

$$E_{ionisation} = E_{light} - E_{kinetic}$$

$$E_{ionisation} = \frac{hc}{\lambda} - \frac{mv^2}{2} = \frac{6.626 \cdot 10^{-34} \cdot\ 3 \cdot 10^{8}}{5.84 \cdot 10^{-8}} - \frac{9.11 \cdot 10^{-31}(2.450 \cdot 10^{6})^2}{2} = 6.67 \cdot 10^{-19} J.$$

b) Assume that the electron in Li raised to the power 2+ ion is in third orbit. Calculate

i) the radius of the orbit and,

ii) the total energy of the electron.

[Hint: Li raised to the power 2+ ion also has atomic spectra similar to hydrogen atom. While applying relevant equations, use Z = 3.]

Solution

(i) the radius of the orbit

$$r\ = \frac{h^2 n^2}{4\pi m k Z e^2} = \frac{(6.6 \cdot 10^{-34})^2 \cdot (3)^2}{4\pi \cdot 9.1 \cdot 10^{-31} \cdot 9 \cdot 10^{9} \cdot 3(1.6 \cdot\ 10^{-19})^2} = 5.0 \cdot\ 10^{-10} m.$$

(ii) the total energy of the electron

$$E = -\frac{1}{2}\frac{kZe^2}{r} = -\frac{1}{2}\frac{9 \cdot 10^{9} \cdot 3(1.6 \cdot\ 10^{-19})^2}{5.0 \cdot\ 10^{-10}} = -6.9 \cdot\ 10^{-19} J$$