a)What is the power generated in an X-ray tube operated at 70 kV and 15 mA?

b)What is the energy of a photon of the Ka radiation from tungsten, which has a wavelength of 21.4 pm? Express your answer in both J and eV.

c)What is the momentum of this photon?

Solution

a. Power $N = U * I = (70 * 1000\ V) * (15 * 10^{-3}\ A) = 1050\ W$

b. Energy is calculated by : $E = \frac{h*c}{\lambda} = \frac{1.98*10^{-25}\ Jm}{21.4*10^{-12}\ m} = 9.25 * 10^{-15}$J

$$E = \frac{h*c}{\lambda} = \frac{1.239 * 10^{-6}\ eV \cdot m}{21.4 * 10^{-12}\ m} = 5.79 * 10^{4}\ eV = 57.9\ keV$$

c. The momentum is calculated by : $P = \frac{h}{\lambda}$ where P is the momentum

(h is Planck's constant, c is the speed of light in vacuum, λ is wavelength)

$$P = \frac{6.6 * 10^{-34}\ Js}{21.4 * 10^{-12}\ m} = 3 * 10^{-23}\ \frac{kg \cdot m}{s}$$

Answer: a. $1050\ W$; b. $9.25 * 10^{-15}$J $= 57.9\ keV$; c. $3 * 10^{-23}\ \frac{kg \cdot m}{s}$.