Problems on x-rays

Q1. An electron is accelerated in an x-ray tube by a voltage of 40 kV. What is its energy (a) in electron volts (b) in joules ?
[Given e = 1.6 x 10^{-19} C]

Q2. The shortest wavelength produced in an x-ray tube is 3.3 x 10^{-11} m. What is the potential difference across the tube?
[h = 6.6 x 10^{-34} Js , c = 3 x 10^{8} ms^{-1}, e = 1.6 x 10^{-19} C]

Q3. An x-ray tube operates at a potential difference of 30 kV. Calculate the wavelength of x-rays produced.
[h = 6.6 x 10^{-34} Js , c = 3 x 10^{8} ms^{-1} , e = 1.6 x 10^{-19} C]

Q4. Electrons strike an anode with a total energy of 2.4 J per sec. 99.5% of this energy is turned into heat. The remaining energy is released as x-rays of wavelength 3.3 pm. How many photons of x-radiation are emitted per sec?
[h = 6.6 x 10^{-34} , c = 3 x 10^{8} ms^{-1} e = 1.6 x 10^{-19} C]

Q5. An x-ray tube operates at 50 kV and draws a current of 4 mA.
Calculate (a) the number of electrons travelling through the tube per second and (b) the minimum wavelength of the x-rays.
[h = 6.6 x 10^{-34} Js , c = 3 x 10^{8} ms^{-1} , e = 1.6 x 10^{-19} C]

Answers to exercises

1. (a) 40 keV
   (b) 6.4 x 10^{-15} J

2. 37.5 kV

3. 41.25 pm (pico meters)

4. 2 x 10^{11} electrons

5. (a) 2.5 x 10^{16} electrons

   (b) 25 pm (pico metres)