Chapter 38 Tutorial

Modern Physics - I

Photons: Light Waves Behaving as Particle

Question 1:

A laser pointer with a power output of 5.00 mW emits red light ($\lambda = 650$ nm).

(a) What is the magnitude of the momentum of each photon?

(b) How many photons does the laser pointer emit each second?

Question 2:

(a) What is the minimum potential difference between the filament and the target of an x-ray tube if the tube is to produce x rays with a wavelength of 0.150 nm?

(b) What is the shortest wavelength produced in an x-ray tube operated at 30.0 kV?

Question 3:

X rays are produced in a tube operating at 18.0 kV. After emerging from the tube, x rays with the minimum wavelength produced strike a target and are Compton-scattered through an angle of 45.0°.

(a) What is the original x-ray wavelength?

(b) What is the wavelength of the scattered x rays?

(c) What is the energy of the scattered x rays (in electron volts)?

Question 4:

A laser produces light of wavelength 625 nm in an ultrashort pulse. What is the minimum duration of the pulse if the minimum uncertainty in the energy of the photons is 1.0% ?

Question 5:

An ultrashort pulse has a duration of 9.00 fs and produces light at a wavelength of 556 nm. What are the momentum and momentum uncertainty of a single photon in the pulse?

Question 6:

A horizontal beam of laser light of wavelength 585 nm passes through a narrow slit that has width 0.0620 mm . The intensity of the light is measured on a vertical screen that is 2.00 m from the slit.

(a) What is the minimum uncertainty in the vertical component of the momentum of each photon in the beam after the photon has passed through the slit?

(b) Use the result of part (a) to estimate the width of the central diffraction maximum that is observed on the screen.