

# Modern Physics Exercises Chapter 3-4

## Exercises Chapter 3

3.1.1 A photon has the wavelength 350 nm. Calculate the momentum of the photon in kgm/s.

Answer:  $1.89 \times 10^{-27}$  kgm/s

3.2.1 Calculate the energy in eV of an X-ray photon with wavelength 2.0 nm.

Answer: 620 eV

3.2.2 In a TV-apparatus the acceleration voltage is 10.0 kV. Calculate the deBroglie wavelength for the electron.

Answer: 12.3 pm

3.2.3 An X-ray tube has a so-called cut-off at the wavelength  $1.7 \text{ \AA}$  ( $1 \text{ \AA} = 10^{-10} \text{ m}$ ). Calculate the acceleration voltage of the tube.

Answer: 7.3 kV

3.2.4 What is the speed of an electron accelerated across a voltage of 1.2 kV?

Answer:  $6.5 \times 10^5$  m/s

3.2.5 Determine the above electrons deBroglie-wavelength.

Answer: 35 pm

## Exercises Chapter 4

4.1.1 Let the work function of a metal be 2.02 eV. In vacuum, the metal surface is irradiated by light of wavelength 400 nm. Calculate the kinetic energy of the ejected electron

Answer:  $1.7 \times 10^{-19}$  J

4.1.2 The same parameters as above. Calculate the speed of the electron.

Answer:  $6.1 \times 10^6$  m/s

4.1.3 One irradiates a photocell with light of wavelength 369 nm. Across the photocell one puts a back voltage thus making the current of the circuit become zero. One measures to voltage to be 0.68 V. Calculate the work function  $W$  of the cathode material.

Answer: 2.7 eV

4.2.1 Determine the Compton wavelength for protons.

Answer:  $1.32 \times 10^{-15}$  m

4.2.2 A 0.15 MeV photon collides with a free electron in rest. Determine the wavelength of the photon before the collision.

Answer:  $8.27 \times 10^{-3}$  nm

4.2.3 The photon is scattered the angle  $90^\circ$ .  
How large will the wavelength change become?

Answer:  $2.43 \times 10^{-3}$  nm

4.2.4 Determine the kinetic energy of the electron after the collision.

Answer: 34 keV.

4.3.1 A photon with the energy 3.0 MeV comes close to a nucleus and pair production occurs, an electron-positron pair appears. He electron gets the kinetic energy 0.25 MeV.

Determine the kinetic energy of the positron.

Answer: 1.73 MeV