Chapter 39 Tutorial
Modern Physics - II
Particles Behaving as Waves

Question 1:

Find the speed and kinetic energy of a neutron $m = 1.675 \times 10^{-27}$ kg with de Broglie wavelength $\lambda = 0.200$ nm, a typical interatomic spacing in crystals. Compare this energy with the average translational kinetic energy of an ideal-gas molecule at room temperature $T = 20°C = 293K$.

Question 2:

(a) An atom initially in an energy level with $E = -6.52$ eV absorbs a photon that has wavelength 860 nm. What is the internal energy of the atom after it absorbs the photon?

(b) An atom initially in an energy level with $E = -2.68$ eV emits a photon that has wavelength 420 nm. What is the internal energy of the atom after it emits the photon?

Question 3:

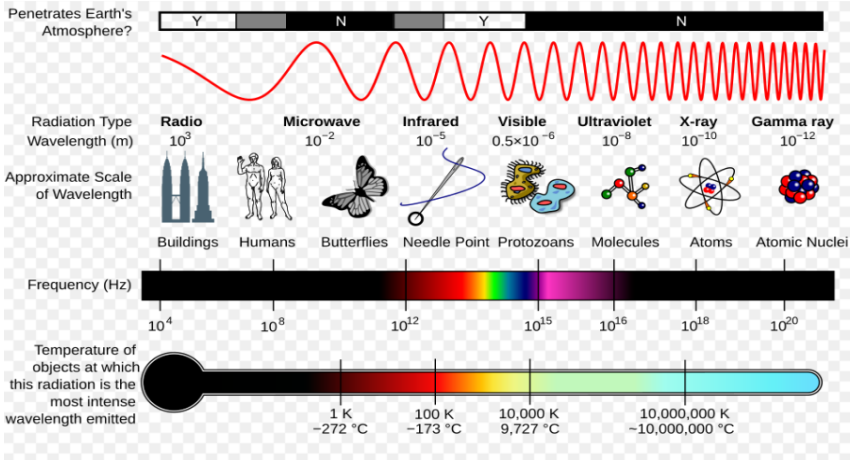
A hydrogen atom initially in the ground level absorbs a photon, which excites it to the level n = 4. Determine the wavelength and frequency of the photon.

Question 4:

Photorefractive keratectomy (PRK) is a laser-based surgical procedure that corrects near- and farsightedness by removing part of the lens of the eye to change its curvature and hence focal length. This procedure can remove layers 0.25μ m thick using pulses lasting 12.0 ns from a laser beam of wavelength 193 nm . Low-intensity beams can be used because each individual photon has enough energy to break the covalent bonds of the tissue.

(a) In what part of the electromagnetic spectrum does this light lie?
(b) What is the energy of a single photon?
(c) If a 1.50 mW beam is used, how many photons are delivered to the lens in each pulse?

Electromagnetic spectrum figure is given below;



Question 5:
A large number of neon atoms are in thermal equilibrium. What is the ratio of the number of atoms in a $5s$ state to the number in a $3p$ state at;

(a) 300 K
(b) 600 K
(c) 1200 K?

The energies of these states, relative to the ground state, are $E_{5s} = 20.66\text{eV}$ and $E_{3p} = 18.70\text{eV}$.

(d) At any of these temperatures, the rate at which a neon gas will spontaneously emit $632.8\ \text{nm}$ radiation is quite low. Explain why.

Question 6:
A 100-W incandescent light bulb has a cylindrical tungsten filament 30.0 cm long, 0.40 mm in diameter, and with an emissivity of 0.26.

(a) What is the temperature of the filament?
(b) For what wavelength does the spectral emittance of the bulb peak?
(c) Incandescent light bulbs are not very efficient sources of visible light. Explain why this is so.