Assignment I

Instructions:

- *Deadline for submitting the assignment 1 is on or before 21.02.2021 (Sunday Mid-night).*
- *Assignments should be hand-written in your notebook. The Name and Roll No should be mentioned in every single page.*
- *Questions should be written first, followed by answers.*

Compton Effect: $\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta)$

1. Monochromatic X-rays of wavelength 0.7078Å are scattered by carbon. The X-rays scattered at an angle of 90° with the direction of incident beam are observed. What is the wavelength of the scattered X-rays?
2. Calculate the wavelength of X-rays scattered at 180° from a carbon block if the frequency of the incident rays is 1.8×10^{18} s^{-1}.
3. X-radiation of wavelength of 1.12 Å is scattered from a carbon target. Calculate (i) the wavelength of X-rays scattered at an angle of 90° with respect to the original direction and (ii) the energy of scattering electron after collision.
4. An incident photon of wavelength 0.03 Å recoils at an angle of 60° after collision with a free electron. Find the energy of the recoiling electron.
5. If an X-ray photon of wavelength 0.5 Å makes a Compton collision with a free electron in carbon and is scattered at 90°, find the energy of the recoiling electron.
6. In a Compton experiment the wavelength of X-ray radiation scattered at an angle of 45° is 0.022 Å. Calculate the wavelength of incident X-rays.
7. X-ray of wavelength 0.240 nm are Compton scattered and the scattered beam is observed at an angle 60° relative to the incident beam. Find the wavelength of the scattered X-rays.
8. In an experiment of Compton scattering, the incident radiation has wavelength, 2 Å. Calculate the energy of recoil electron which scatters radiation through 60°.

Uncertainty Principle: $\Delta x \Delta p_x \geq \frac{h}{4\pi}$ $\Delta E \Delta t \geq \frac{h}{4\pi}$

9. The life time of an energy state is 10^{-8} s. Calculate the uncertainty in the frequency of the photon emitted during the transition (de-excitation of the atom).
10. A nucleon is confined in a nucleus of radius 5×10^{-15}m. Calculate the minimum uncertainty in the momentum of the nucleon.

11. The position and momentum of 1 keV electron are determined simultaneously. If its position is located within 1 Å, what is the percentage of uncertainty in its momentum?
12. The time period of a radar vibration is 0.25μs. what is the uncertainty in the energy of the photon?

$$E_n = n^2 \frac{\pi^2 \hbar^2}{2mL^2}$$

Particle in a box:

13. Determine the energy values of an electron confined in a box of width 1 Å.
14. Find the lowest energy level and the momentum of an electron in one-dimensional potential well of width 1 Å.
15. A particle is moving in one-dimensional potential box (of infinite height) of width 50 Å. Calculate the probability of finding the particle within an interval of 10 Å at the centre of the box when it is in its state of least energy.
16. Find the lowest energy of an electron confined to move in a cubical box of length 0.5 Å.

Assignment – I – Descriptive Type

17. Whether electrons are present in atomic nuclei or not? Prove using Heisenberg uncertainity principle. (1 page)
18. Explain the working parts of scanning tunnelling microscope in detail. (2 pages+ 2 figures)
19. Write briefly the underlying principle used in Davison - Germer experiment to verify wave nature of electron experimentally. (2 pages)