Tutorials --Modern Physics&Quantum Mechanics
(Aug 2019 to Dec 2019)

1. In a Compton experiment, X-ray of initial frequency 2.9×10^{19}Hz is scattered through 84^0. Estimate its new frequency and kinetic energy of the recoiled electron.
2. An X-ray photon of initial frequency 2.6×10^{19}Hz collides with an electron and is Compton scattered through 70^0. Find its new frequency.
3. A beam of X-rays with energy 28keV undergoes Compton scattering. A scattered photon emerges at 55^0 relative to the incoming beam. Find the modified wavelength and kinetic energy of the scattered electron?
4. X-rays of wavelength 13pm are Compton scattered by a target. Calculate the scattered wavelengths and maximum kinetic energy of scattered electrons at $\theta=0^0, 45^0, 90^0$ and 180^0.
5. Calculate the Compton wavelength.
6. Calculate the group velocity and phase velocity for electrons of wavelength 1.2Å.
7. An electron and a photon have the same energy and the wavelength of photon is 20 times that of electron. Calculate the value of energy.
8. Helium nucleus (He_2^4) has de Broglie wavelength 0.75 pm. Find its group velocity and phase velocity. What is the required potential difference to accelerate the He nucleus to this velocity?
9. Compare the de- Broglie wavelength of an electron and a proton if they have (a) the same speed and (b) the same kinetic energy.
10. An electron beam is accelerated from rest through a potential difference of 300V. Calculate the associated wavelength, group velocity and phase velocity.
11. The phase velocity of ripples on liquid surface is $v_p = \sqrt{2\pi s/\lambda\rho}$ where s is surface tension and ρ is density. Find the group velocity in terms of phase velocity.
12. The phase velocity of ocean waves is $v_p = \sqrt{g\lambda/2\pi}$ where 'g' is acceleration due to gravity. Find the group velocity in terms of phase velocity.
13. An electron is confined within 0.1nm. Calculate its energy and de Broglie wavelength if the uncertainty in the measurement of its wavelength is 4.5×10^{-4}Å.
14. The mass of a particle is $0.6MeV/c^2$ and its energy is 160 eV. Calculate the group velocity. If the velocity can be determined to a precision of 3%, what is the uncertainty in determining its position?
15. The position and momentum of a 4keV electron are simultaneously determined. If its position is located to within 0.15nm, what is the percentage uncertainty in its momentum?

16. Compare the uncertainties in the velocities of an electron and proton confined within 15nm.
17. The mass of a particle is $0.5MeV/c^2$ and its energy is 160eV. Calculate the group velocity. If the velocity of an electron was measured to be 6×10^5 m/s with an uncertainty of 1.4%, what is the uncertainty involved in the measurement of its position?
18. The position and momentum of an electron with energy 0.5keV are determined. What is the minimum percentage in its momentum if the uncertainty in the measurement of position is 0.5Å?
19. The lowest energy possible for a particle trapped in one dimensional box is 1.7eV. What are the next two higher energies the particle can have? If the particle is an electron, how wide is the box?
20. A electron is in the ground state in an infinite potential well of $15\AA$. Calculate the excitation energy required to raise the electron to the fourth excited state. Calculate the wavelength of radiation emitted when it undergoes a transition from fourth state to second excited state.
21. The eigen function of an electron in an infinite potential well has 5 antinodes. If the energy of the electron is 260 eV, calculate the width of the potential well.
22. An electron is confined in 1-D potential well of infinite height and width 5 $\AA$ in its 2nd excited state. Estimate its momentum, energy and de Broglie wavelength.
23. Calculate the lowest energy level for a neutron in a nucleus by treating it as if it were in an infinite potential well of width 10^{-14} m. Compare this with the lowest energy level for an electron in the same infinite potential well.
24. A particle is moving in one dimension infinite potential well of width 2.5 nm. Calculate the probability of finding the particle within a small interval of 0.5 nm at the centre of the box in ground state.
25. A particle of mass $1.67\text{x}10^{-27}$kg is confined to the second excited state in a one dimensional potential well of infinite height and width a=0.1nm. Calculate its momentum, energy and probability of finding the particle between 0 and a/3.
26. A particle is confined to an infinite potential well of width L. Calculate the probability of finding the particle for the following cases:

    (i) between x=0 and x=L/2 in the ground state.

    (ii) between x=0 and x=L/4 in the first excited state.

    (iii) between x=0.35L and x=0.75L in the second excited state.