Quantum Mechanics

1. Find the de Broglie wavelength of (a) 46 g golf ball with velocity 30 m/s and (b) an electron with velocity 10^7 m/s. [(a) 4.8×10^{-34} m, (b) 73Å]

2. If the kinetic energy of an electron is 54 eV, what is the wavelength associated with it? [1.66Å]

3. A measurement establishes the position of a proton with an accuracy of ±10Å. Find the uncertainty in the proton's position 1 sec later. Assume the velocity of proton is much smaller compared to *c*. [$\Delta x \geq 3.15\ km$]

4. The radius of a hydrogen atom is $5.3\times10^{-11}m$. Use the uncertainty principle to estimate the minimum energy an electron can have in this atom. Compare your result with lowest energy level of the hydrogen atom. [$KE_{min} = 3.375\ eV$, $E_0 = 13.6\ eV$]

5. Calculate the de Broglie wavelength of an electron accelerated by the potential difference of 150 V. [1 Å]

6. The position of an electron is located within a distance of 0.1 Å. What is the uncertainty in measuring the momentum of the electron? [$0.527 \times 10^{-23}\ kg\ m/s$]

7. An electron is in a one-dimensional box of 0.1 nm, which is of the order of magnitude of atomic dimensions. Find the permitted energies. [37.5 n^2 eV]

8. A 10 g of marble is in a box 10cm across. Find its permitted energies. [$5.5 \times 10^{-64} n^2$]

9. A proton in a 1D box has the energy of 400 keV in its first excited state. How wide the box is? [45.32×10^{-15} m]

10. The position and momentum of a 1 keV electron are simultaneously determined. If its position is located within 0.1nm, what is the percentage of minimum uncertainty in its momentum? [3.1%]

11. The de Broglie wavelength of a particle moving with 10 % of the velocity of light and that of proton moving with 20 % of the velocity of light are equal. Calculate the wavelength and mass of the particle. [6.6×10^{-15} m, 3.34×10^{-27} Kg]

12. An electron is confined to move between two rigid walls separated by $10^{-9}m$. Find the de Broglie wavelengths representing first three allowed energy states and the corresponding energies. [2,1,2/3 nm ; 0.4,1.5,3.4 eV]

13. If a 15 g of marble moving with a speed of 1/3 ms^{-1} is confined over a distance of 12 cm, find the total number of energy levels. What do you infer from the result? [1.81×10^{30}]

14. If $\psi = A\exp(-kx)$ for $0 < x < \infty$ and $\psi = 0$ for $-\infty < x < 0$, find A in terms of k and evaluate the probability of the particle lying in the region $\frac{2}{k} < x < \frac{3}{k}$. [$\sqrt{2k}$, 0.016]

15. Find the average momentum of a particle, confined to a one dimensional box of length L, in ground state. [0]

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