

Tutorial 1: Modern Physics

1. If an electron and photon have the same kinetic energy, which has the shorter de Broglie wavelength?
2. If an electron and a photon have the same de Broglie wavelength, which has the greater kinetic energy?
3. The neutral nuclear particle, called the neutron, has a mass of 1.67×10^{-27} kg. Neutrons emitted in nuclear reactions can be slowed down via collisions with matter. They are referred to as thermal neutrons once they come into thermal equilibrium with their surroundings. The average kinetic energy $3k_B T/2$ of a thermal neutron is approximately 0.04 eV. Calculate the de Broglie wavelength of a neutron with a kinetic energy of 0.04 eV. How does it compare with the characteristic atomic spacing in a crystal? Would you expect thermal neutrons to exhibit diffraction effects when scattered by a crystal?
4. A visual inspection of an ant (mass: 0.5 mg) verifies that it is within an uncertainty of $0.7 \mu\text{m}$ of a given point, apparently stationary. How fast might the ant actually be moving?