1. A particle of mass \( m \) moves on a circle of radius \( r \) with a constant speed \( v \). By differentiating the position vector of the particle, find its acceleration. Then use Newton’s laws to find the force that acts on the particle. If this force is not zero, explain why this is not in contradiction to the fact that the speed of the particle is constant.

2. An electron of mass \( m \) traveling with speed \( v_i \) collides head-on with an atom of mass \( M \), initially in ground state, and excites the atom to an energy level lying \( \Delta E \) above the ground state. After the collision, the electron bounces back with speed \( v_f \) and the atom, which was initially at rest, travels with speed \( V_f \). Find the minimum value of \( v_i \) making the excitation possible (note that it is not just the speed corresponding to the kinetic energy of electron equal to \( \Delta E \)).

3. A thin rod of length \( L \) and mass \( m \) is suspended at its midpoint from a long wire, see the figure. The rod performs simple angular harmonic motion with the period \( T_a \). The moment of inertia of a thin rod about its perpendicular axis can be shown to be \( I = mL^2/12 \). Then, an irregular object is hung from the same wire and its period of oscillations is measured to be \( T_b \). What is the moment of inertia of this object about its suspension axis?