1. (a) A sphere rolls down an incline without slipping as shown in the figure. Calculate the speed of its center of mass \( v_{CM} \) at the bottom. Momentum of inertia of a sphere rotating through the center is \( I = \frac{2}{5}MR^2 \). (10%) (b) What is the minimum static friction coefficient \( \mu \) of the slope to sustain the pure rolling? (10%)

2. (a) A damped oscillator of mass \( m \) and the force constant \( k \) is driven by a force \( F = F_0 \cos \omega t \). The damping force is \( -b \vec{v} \), where \( b \) is the damping constant. Find the \( \omega \) dependence of the oscillation amplitude \( A \). Plot \( A \) vs. \( \omega \) for small and large \( b \), respectively. When \( \omega = \omega_0 = (k/m)^{1/2} \), \( A \) has its maximum. This is called resonance. (10%) (b) Give two examples of resonance. (10%)

3. By the first law of thermodynamics, explain why air at the top of a mountain is cold. (10%)

4. In a hot day, if you open the door of a refrigerator to try to cool your room, will it work? Why or Why not? (10%)

5. Why is the high voltage used in transmission of the electric power from the power plant to the city? (10%)

6. (a) Give an example to show that the magnetic moment \( \vec{\mu} \) feels a torque in a magnetic field \( \vec{B} \) by \( \vec{\tau} = \vec{\mu} \times \vec{B} \). (10%) (b) From the result in (a), show that the potential energy of a magnetic moment is \( -\vec{\mu} \cdot \vec{B} \). (10%)

7. (a) How do you generate an electromagnetic (EM) wave? (5%) (b) The propagating intensity of an EM wave is described by the Poynting vector \( \vec{S} \). What is the expression of \( \vec{S} \) in \( \vec{E} \) and \( \vec{B} \) for an EM wave? (5%)