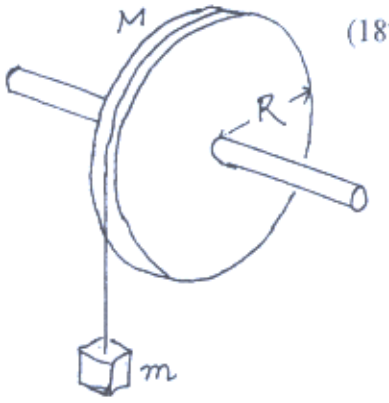
(1) A small sphere of mass m is released from rest in a large vessel filled with oil, where it experiences a resistive force R proportional to its speed v with proportional constant b. (a) Determine the terminal speed of the sphere v_0.

(b) Prove that the speed of the sphere at time t is given by $v = v_0(1 - e^{-bt/m})$ (18%)

(2) A wheel of radius R, mass M, and moment of inertia I is mounted on a frictionless, horizontal axle, as shown in the figure. A light cord wrapped around the wheel supports an object of mass m. Calculate the linear acceleration of the object and the tension in the cord.



(18%)

(3) A solid sphere of radius 40.0 cm has a total positive charge of 26.0 μC uniformly distributed throughout its volume. Calculate the magnitude of the electric field (a) 10.0 cm, and (b) 60.0 cm from the center of the sphere.

(the permittivity of the free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / N \cdot m^2$) (18%)

(4) A loop of wire enclosing an area A is placed in a region where the magnetic field is perpendicular to the plane of the loop. The magnitude of $\vec{B}$ varies in time according to the expression $B = B_0 e^{-at}$, where a is some positive constant.

Find the induced emf in the loop. (18%)

(5) A 1.0-mol sample of an ideal gas is kept at 0.0^0C during an expansion from 3.0 L to 10.0 L. (a) How much work is done by the gas during the expansion? (b) how much is the change of internal energy of the gas? (c) How much energy transfer by heat occurs in the process? (Gas constant R=8.31J/mol.K) (18%)

(6) Explain the Heisenberg uncertainty principle. (10%)