Classical Mechanics

Do two out the following three problems, each on a separate sheet.

Problem 1

As shown in the Figure, a ball with mass $m = 0.71\,\text{kg}$ is tied with two wires to a very thin massless rod. The mass revolves around the rod with a constant speed of $7.5\,\text{m/s}$. Ignore the mass of the wires and air resistance. State your answer with the correct SI units and an appropriate number of significant figures.

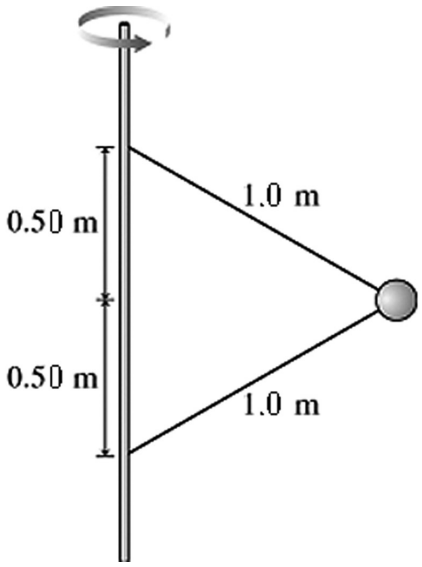
(a) What is the moment of inertia of the object shown in the Figure? (2 points)

(b) How many forces act on the ball? Describe these forces in words and with symbols. (1 point)

(c) Draw a free-body force diagram for the ball. Label the forces in your free-body force diagram using the symbols you chose in part (b). (1 point)

(d) What is the acceleration (magnitude and direction) of the ball? (1 point)

(e) What is the magnitude of the tension in the upper wire? (5 points)



Problem 2

A rigid body of mass m is used as a physical pendulum such that it has the moment of inertia I about the rotation axis and its center of mass is a distance l from the axis. The center of mass passes through its lowest point with a speed $v_0 > \sqrt{4gml3/I}$. How fast is it at its highest point? Give an integral expression for the time it takes to travel between the two points. Do **not** attempt to evaluate the integral.

Problem 3

A ball is thrown upward at great speed. How fast does it need to be thrown to escape the earth's gravity? In other words, what is the escape velocity? (Ignore friction).
Hints: The acceleration due to gravity at the earth's surface is $9.8\,\mathrm{m/s^2}$ and the Earth's radius is 6371 km).