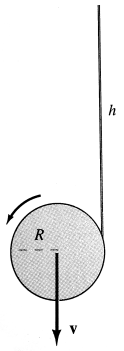
Name: _____

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page. *Please make an effort on all problems, partial credit is awarded for effort-based solutions which demonstrate familiarity with the physics concepts.*

1. Calculate the potential kinetic energy of a solid ball of mass 2 kg and radius 0.20 m that rolls without slipping on a flat surface at a speed of 0.8 m/s. *Hint: Account for both translational and rotational kinetic energy. For a solid sphere,* $I = \frac{2}{5}mr^2$.

2. Two equal heavy masses are positioned at either end of a rod with negligible mass. The rod is mounted in the center in such a way that it can spin freely, the masses are each a distance r_1 away from the center of spinning, and it is set to spin at a speed of ω_1. What will be the rotational speed (ω_2) of the setup if the masses are moved half-way inward (so that $r_2 = r_1/2$)? *Hint: Assume we can treat the masses as point particles such the inertia is* $I = mr^2 + mr^2 = 2mr^2$, *and recall that angular momentum is equal to* $L = I\omega$.

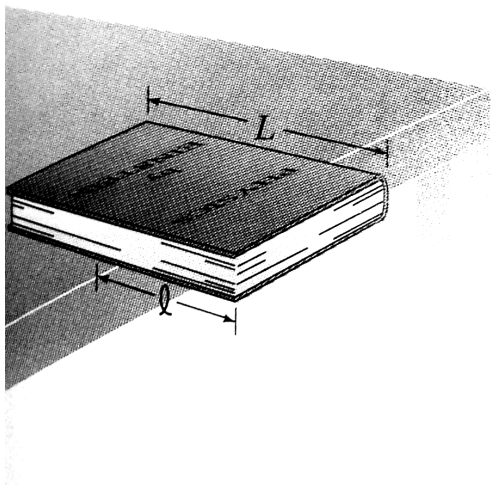
3. Show that the velocity of an unwinding spool of mass m, angular inertia I and radius r is equal to $v = r\sqrt{\frac{2mgh}{mr^2+I}}$ after it has fallen a height h.



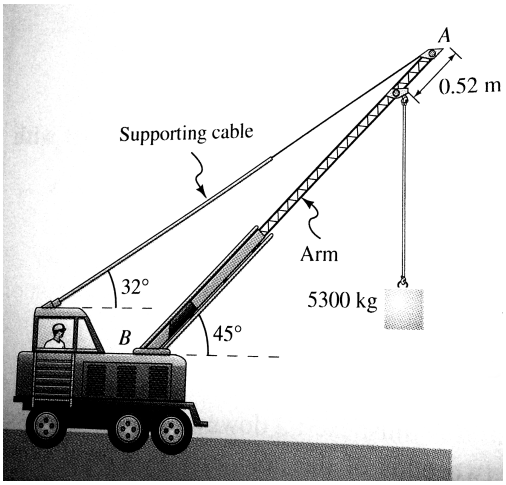
Hint: This isn't as tedious to solve as it might seem at first!

- *Step 1: Find the Kinetic Energy of the unwinding spool and remember that you need to account for both linear and angular kinetic energy;*
- *Step 2: Use conservation of mechanical energy to relate the height that the spool has fallen to the change in its total kinetic energy. Since the spool is unwinding at the rightmost tip, then we can relate $v = r\omega$.*
- *Step 3: Solve for v.*

4. Treating a book as a rectangular box with uniform density and length L, lying with an edge parallel to a table and also hanging off the table's edge by an amount l, what is the largest possible value of l for which the book does *not* rotate off the edge? *Hint: You can treat gravity as acting from the center of mass.*



5. A massive crane (assume it is fixed to the Earth) is lifting a mass of 5300 kg. The arm of the crane is supported at its base at point B by a strong pivot and at its top at point A by a cable. The arm makes an angle with the horizontal of 45° and the cable makes an angle 32°. The arm is 10.0 m long. The mass is lifted from a point on the arm 0.52 m from the end point A. Assume that the mass of the arm is small enough to ignore, find the tension in the cable. *Hint: the angle the tension cable makes with the arm of the crane is* 13°



6. A ladder of length 3.0 m with eight rungs spaced 0.33 m apart is leaning against a wall at an angle of 58°. Ignore the ladder's mass. A window washer of mass $m = 85kg$ is climbing the ladder. The coefficient of static friction between the rubber feet of the ladder and the floor is $\mu_s = 0.51$, but assume that the wall is smooth and frictionless. Is the ladder safe for climbing for the washer as he ascends to the seventh rung of the ladder?