Physics 120
Some Sample Term Test #2 questions

I could not find a copy of the second term test from the last time I taught this class. Below are some appropriate problems I have created over the years which cover the relevant material, most of these questions have appeared on past exams. (Sorry for the lack of figures. From the description you can make up an appropriate system and attempt to solve it.)

1. A block of wood of mass m_W is placed on a horizontal table and is attached by a "massless" rope of length l_0 to a vertical axis that passes through the table. The rope is initially swung around the axis, causing the wood to have a tangential speed of v_{t_1} m/s. After one revolution the wood is observed to have a tangential speed of only v_{t_2} m/s.
   - How much "work" has friction done on the block of wood during the first revolution?
   - Calculate the coefficient of kinetic friction between the block of wood and the table.
   - What is the potential energy of the block of wood at the beginning, after one revolution, and when the block of wood comes to rest?
   - How many revolutions does the block of wood make before stopping?
   - How much work has gravity done on the block of wood after one revolution?
2. A proton of mass m_p and kinetic energy K scatters elastically from an alpha particle (with mass four times that of the proton). The proton is deflected at an angle θ from its original direction.
   - At what angle does the alpha particle recoil?
   - Calculate the final velocities of the two particles.
3. Consider the system shown below. The system is released from rest when the spring (with spring constant κ) is compressed by and amount δ. The system slides and eventually comes to a halt. The coefficient of kinetic friction between the blocks and the surfaces is μ_k. The pulley has moment if inertia I_p and radius R_p. The angles and the masses are known quantities.
   - Calculate the distance, Δs, that the block m_1 slides before coming to a stop.

Short answer questions

4. A bullet strikes a ballistic pendulum whose target block has a mass of m_{block} and gets embedded in it. The block is observed to rise a distance of h cm, and the bullet is weighed and found to have a mass of m_{bullet} grams. Calculate the speed of the bullet when it strikes the block.

5. A person pulls a heavy load of mass m_L up the side of a building by using a frictionless pulley. The load travels up a distance of h meters. Take the load to move with constant velocity and ignore any acceleration at the beginning or end of the move.
   - How much work is done on the load by gravity?
   - by the tension in the rope?
   - by the person?
   - Calculate the net work done on the mass.
6.
   - Calculate the rotational kinetic energy of a dumbbell consisting of two equal (compact) masses of mass m each, connected by a "massless" rod of length l, when the dumbbell rotates about an axis through the center of, and perpendicular to, the rod at Ω revolutions per minute?
   - What is the rotational kinetic energy if the dumbbell rotates with the same angular velocity about a parallel axis through one of the masses.
7. Consider a spinning plate driven by a motor so that it has constant angular velocity. The plate is spinning clockwise as viewed from above. At some point, the motor is switched off and the plate slows down due to friction.
   - Draw the plate on your answer sheet as viewed from above (yes, you will get marks for doing this correctly).
   - Beside your drawing indicate the direction of the angular velocity vector and angular acceleration vector.