Name: _____ Student ID #: _____

You must show your work to get credit

Examination 3 Fall 2004 Physics 211 Professor: Philip Cole
Date: 19 Nov. 2004

Test Time: 50 minutes
Possible Score: 100 points.

Write your name on each page. Do the easier problems first. If a problem seems too difficult, skip it, and return to it once you have completed all of the other problems first. There are six pages to this test. **Write Neatly**

Good Luck!

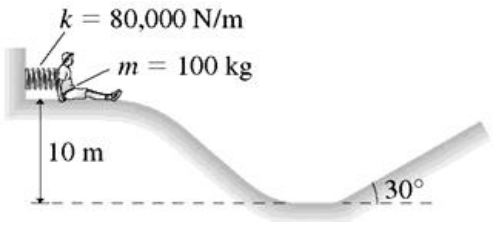
Problem 1 _____ (45 pts)

Problem 2 _____ (55 pts)

Total _____ (100 pts)

Name: _____

Problem 1



The spring shown in the figure is compressed 1.00 m. It is used to launch a 100-kg physics student. The track is frictionless until it starts up the incline. The student's coefficient of friction on the 30° incline is $\mu_k = 0.20$. (N.B. $U_{\text{el}} = \frac{1}{2}k(\Delta s)^2$ and $U_{\text{grav}} = mg\Delta y$).

(a) What is the potential energy stored in the spring just before the student is launched?
(b) What is student's kinetic energy just after losing contact with the spring?
(c) What is student's kinetic energy K_{bottom} at the bottom of the track, i.e. just before the student starts up the incline?
(d) The student travels a distance d up the incline. What is the work done by friction on the student in terms of μ_k, m, g, d, and θ? Hint: You will need to draw a free-body diagram of the forces acting upon the student as the student goes up the incline.
(e) What is the work done by the normal force as the student goes up the incline?
(f) In terms of m, g, d, and θ, what is the mechanical energy of the physics student right after the student comes to a complete halt up the incline?
(g) How far up the incline does the student go in terms of K_{bottom}, μ_k, m, g, d, and θ? You do not need to put in any numbers.

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Useful Expressions

$$\vec{r} = \vec{r}_\circ + \vec{v}_\circ t + \tfrac{1}{2}\vec{a}t^2$$

$$\vec{v} = \vec{v}_\circ + \vec{a}t$$

$$v_y^2 = v_{\circ y}^2 + 2a_y\Delta y$$

$$v_x^2 = v_{\circ x}^2 + 2a_x\Delta x$$

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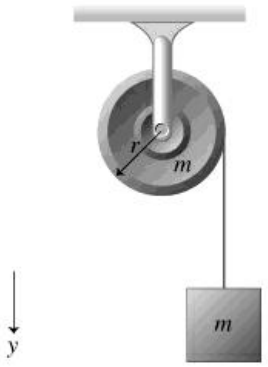
Problem 2



In a lab experiment to test the conservation of energy in rotational motion, we wrap a light, flexible cable around a solid cylinder of mass m and radius r. Here, $I = \frac{1}{2}mr^2$. The cylinder rotates with negligible friction about a stationary horizontal axis as depicted in the figure. We tie the free end of the cable to a mass m and release the the mass with no initial velocity a distance h above floor. As the mass falls, the cable unwinds – without stretching or slipping – thereby causing the cylinder to spin about its axis. (N.B. $K_{\text{rot}} = \frac{1}{2}I\omega^2$)

$m = 2.00$ kg $\quad r = 0.500$ m $\quad h = 1.00$ m

PART I

(a) By means of the conservation of mechanical energy, calculate the speed of the falling mass just before it hits the ground.
(b) By means of the conservation of mechanical energy, calculate the angular velocity of the cylinder just before the falling mass hits the ground.

PART II

(c) Draw free-body diagrams for the hanging mass and the pulley and obtain the equations of motion for $\sum \tau_i = I\alpha$ and $\sum \vec{F}_i = m\vec{a}$.
(d) Does gravity provide a torque on the cylinder? Explain.
(e) Does the normal force from the strut upon the axle of the cylinder provide a torque on the cylinder? Explain.
(f) Does the cable provide a torque on the cylinder? Explain.

PART III Hint: You may find the relationship $v^2 = v_\circ^2 + 2ah$ useful.

(g) Find the acceleration of the falling mass.
(h) Find the tension in the cable.

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