PHYS 172 – Fall 2010 Exam 3 **Hand-written Portion (30 points total)**

Name (Print):

_____

Signature:

_____

PUID:

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You will lose points if your explanations are incomplete, if we can't read your handwriting, or if your work is sloppy.

Write down your recitation time:

Day (either Wed, Th, Fri):

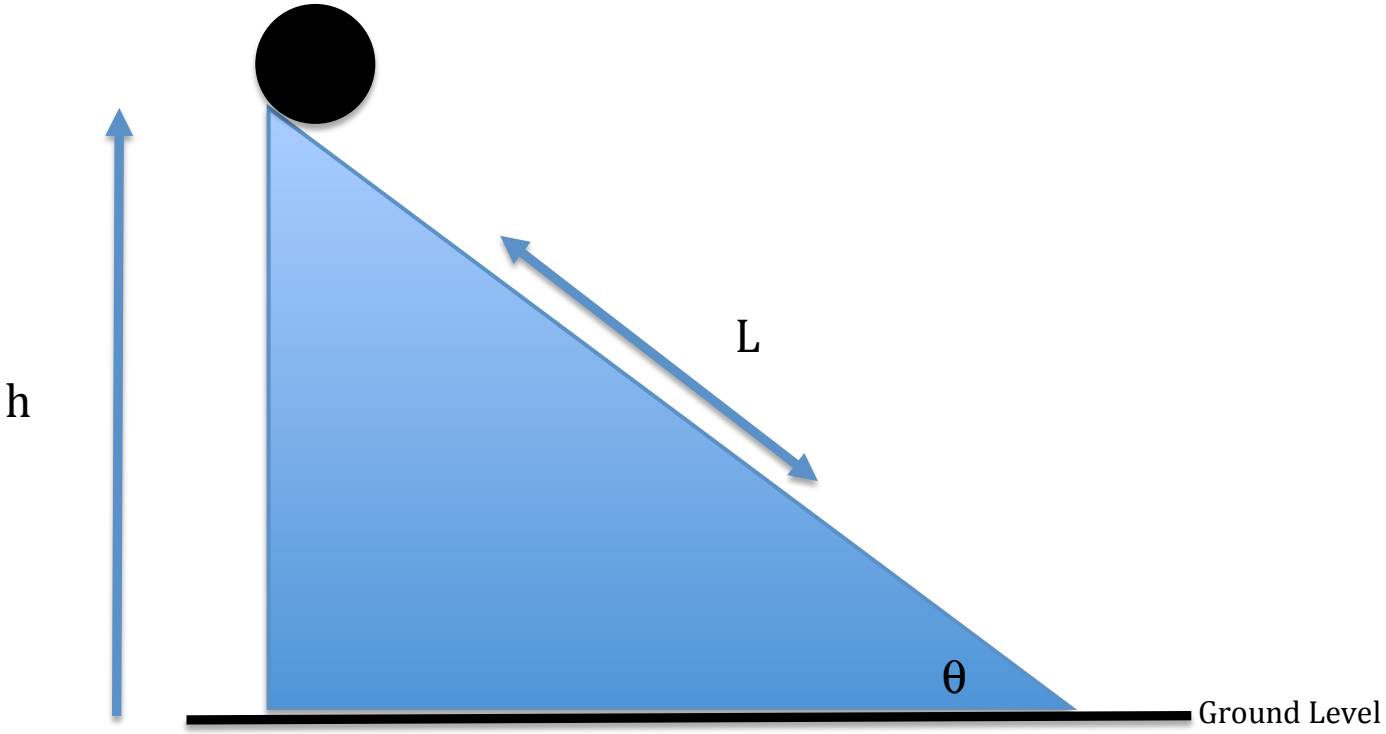
_____

Time:

_____

Hand-Written Problem: Object rolling down an inclined plane

An object of mass *M*, radius *R* and moment of inertia *I* rolls without slipping (due to a frictional force of magnitude *f*, down an inclined plane of length *L* that is fixed to the ground as shown in the figure below. The object starts from rest a height *h* above ground level. When the object reaches the bottom of the inclined plane, its center of mass has fallen through a vertical distance h. Take the object as the system in the following analysis.



A. (6 points) Treat the object as a point particle. In the space below, draw a force diagram on which all forces acting on the object are shown and labeled. Be certain to define a set of coordinate axes, X and Y.

B. (6 points) What is the object's translational kinetic energy when it reaches ground level? [Hint: Use the Energy Principle to answer this question to express your answer in terms of M, g, θ, L, and f.]

C. **(6 points)** What is the object's total kinetic energy (translational plus rotational) when it reaches ground level?

D. **(6 points)** Use your answer to part **C** to find that the speed of the object when it reaches ground level is $V = \sqrt{\frac{2gh}{(1+\frac{I}{MR^2})}}$.

E. **(6 points)** The object's moment of inertial can be represented as $I = b \cdot M \cdot R^2$ where *b* is a dimensionless number associated with the objects geometry. For example, *b* = 1 for a hoop, 2/5 for a sphere, ½ for a disk, etc. Express your answer in part **D** in terms of this expression for *I,* thereby showing that the final speed does not depend on either the object's mass nor its radius.