PHYSICS 218 Final Exam

Fall, 2011

Name:_____
Signature:_____
E-mail:_____
Section Number: _____

- No calculators are allowed in the test.
- Be sure to put a box around your final answers and clearly indicate your work to your grader.
- **All work must be shown to get credit for the answer marked. If the answer marked does not obviously follow from the shown work, even if the answer is correct, you will not get credit for the answer.**
- Clearly erase any unwanted marks. No credit will be given if we can't figure out which answer you are choosing, or which answer you want us to consider.
- Partial credit can be given only if your work is clearly explained and labeled. **Partial credit will be given if you explain which law you use for solving the problem.**

Put your initials here after reading the above instructions:

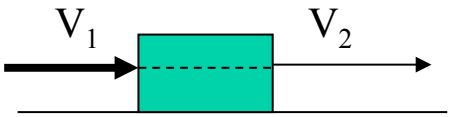
For grader use only:

Problem 1 (20) _____
Problem 2 (20) _____
Problem 3 (20) _____
Problem 4 (15)_____
Problem 5 (15) _____
Problem 6 (15)_____

Total (105) _____

Problem 1: (20 points)

A bullet of mass m moving with a velocity V_1 hits a wooden block of mass M through its center and continues with velocity V_2 in the same direction.



a) Find the velocity of the box after the collision.

b) Find the kinetic energy that was lost in the collision.

c) After the collision the block continues moving for some time and then stops due to friction. Find the distance traveled by the block if the coefficient of friction is μ.

Problem 2: (20 points)

This is a one-dimensional problem. A particle with mass *m* is acted on by a single force equal to

$$F_x(x) = -ax + b$$

where *a* and *b* are known positive constants. The particle is initially placed at $x = x_0$ and is given an initial velocity $V_x = V_0$, where x_0 and V_0 are known positive constants.

a) Verify that the force is conservative by calculating the potential energy function.

b) Find the coordinates of the turning points where the direction of motion of a particle reverses. **Write down the equation but do not solve it!**

c) Find the point where the kinetic energy of the particle will have its maximum value.

d) Find the work done by this force as the particle moves from x_0 to $2x_0$.

Problem 3: (20 points)

A cylinder and a block are placed on the top of an inclined plane of height *H* and inclination angle θ. They start moving down simultaneously from rest. The coefficient of friction between the block and the incline is μ. A cylinder rolls without slipping. (Reminder: a cylinder of mass M and radius R has a moment of inertia $I = (1/2)\,MR^2$ around the central axis.)

a) Draw the free body diagram for the block.

b) Find the acceleration of the block.

c) Draw the free body diagram for the cylinder.

d) Find the force of friction between the cylinder and the incline.

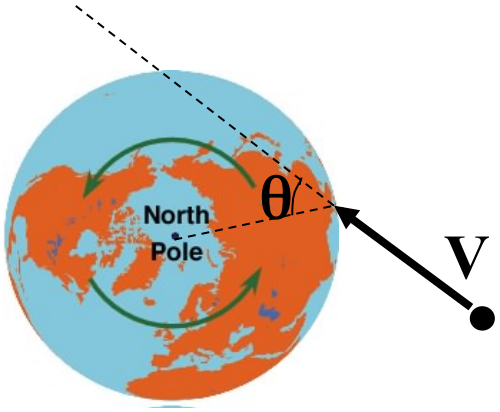
e) Find the acceleration of the cylinder.

f) Find the value of an inclination angle θ for which the two bodies reach the bottom of the incline at the same time.

Problem 4: (15 points)

An asteroid of mass *m* strikes the Earth at the equator with a velocity V, as shown below (θ is a given constant). Assume that the asteroid remains stuck where it hit the ground. Assume that the Earth is a sphere of radius R, mass M, and moment of inertia I. It was rotating with angular velocity ω_0 before the collision. Find the angular velocity of the Earth after the collision.

View from the North pole. Note that the Earth rotates counter-clockwise as viewed from the North pole.



Problem 5: (15 points)

An object of mass *m* circles the Earth and is attracted to it with a force of magnitude given by

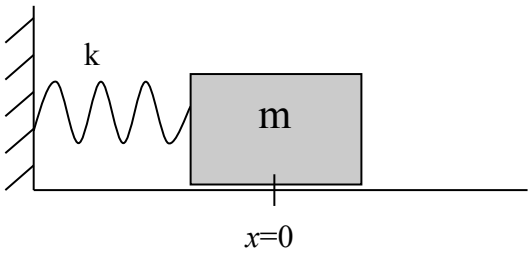
$$\left|\vec{F}\right| = G\frac{M_E m}{r^2}$$

where G and M_E are known constants.

a) If the object is given a velocity of magnitude V_0, find the radius of the orbit.

b) Denote the radius you found in part a) as R_1. Find the work done by force F if you move the object from the orbit of radius R_1 to the orbit of radius $3R_1$.

Problem 6 (15 points).
A spring with constant k is attached to a block of mass m on a frictionless table. The block is pushed a distance x_0 to the right and released from rest.



a) Find the position of the block at any time.

b) How long will it take for the block to return from distance x_0 to its equilibrium position?

c) How fast will the block be moving at x=0?

d) What is the period of oscillations?