EXAM-2 – v1

PHYS 201 (Spring 2006), 03/21/06

Name:

Lab-Sect. no.:

Signature:

Duration: 75 minutes
Show all your work for full/partial credit!
Include the correct units in your final answers for full credit!
Unless otherwise stated, quote your results in SI units!

1.) *Multiple Choice* *(18 pts.)*

For each statement below, circle the correct answer (TRUE or FALSE, no reasoning required).

(a) The kinetic energy of an object can be both positive and negative.
TRUE FALSE

(b) If a nonzero net torque is acting on an object, the angular momentum of that object will change.
TRUE FALSE

(c) The frequency of a simple harmonic motion depends on the amplitude of the motion.
TRUE FALSE

(d) The work-energy theorem implies that a positive net work done on an object leads to an increase of the object's speed.
TRUE FALSE

(e) If a rolling cylinder and a sliding box (frictionless) move at the same speed, their total kinetic energy is equal.
TRUE FALSE

(f) If two objects with different mass have the same (linear) momentum, their kinetic energy is different.
TRUE FALSE

No.	Points
1	
2	
3	
4	
5	
6	
Sum	

2.) *Kinetic Energy and Power* *(18 pts.)*

A car (mass $1800kg$) is cruising on a farm road at $45mph$. The driver shifts into 3. gear so that the engine can provide a power of $140hp$, and he then accelerates uniformly to $70mph$ (assume the power to be constant).

(a) How much work is done on the car during the acceleration?

(b) How long (in *seconds*) does the acceleration process take?

(c) Assuming the wheels of the car to be uniform cylinders of mass $3kg$, what is the total kinetic energy (linear plus rotational) of each wheel after the acceleration?

($1mph$=$0.444m/s$, $1hp$=$745.7W$)

3.) *Angular Momentum Conservation* *(6+10 pts.)*

A thin rod (mass M=35$grams$, length l=20cm) is rotating about one of its ends at 0.5 revolutions per second in a horizontal plane (ignore gravity), implying a moment of inertia I=$M\,l^2/3$. A bug (approximated by a point-like mass of m_{bug}=10$grams$) originally sits at the fixed end of the rod (that is, in the center of the rotation). Then the bug crawls from the fixed end to the loose end of the rod, with no external torque acting. When the bug reaches the loose end,

(a) what is the total moment of inertia of rod+bug?

(b) what are the angular and tangential speed of the bug?

4.) *Momentum, Nonconservative Work, and Impulse* *(21 pts.)*

Two train wagons are approaching each other on a horizontal railway track. Just before the collision, wagon 1 (mass $18t$) is moving at $3m/s$ due east and wagon 2 (mass $21t$) is moving at $4.5m/s$ due west. After they collide, the 2 wagons are stuck together. ($1t$=10^3kg)

(a) What is the final velocity (magnitude and direction) of the 2 wagons?

(b) How much nonconservative work has been done in the collision process? (*Hint: change in kinetic energy*)

(c) If the collision process took $0.5s$, what were the average net forces (magnitude and direction) acting on wagon 1 and 2?

5.) *Torque Equilibrium* *(9 pts.)*

A rigid board (length $1.8m$, mass $15kg$) is set up in a way that the pivot point is $0.6m$ away from the near end of the board. A mass of m_1=$25kg$ is placed on the near end. Where on the longer side of the board needs a mass of m_2=$20kg$ to be placed to have the board and two masses in equilibrium?

(*Hint: choose the pivot point as axis of rotation; include the weight of the board.*)

6.) *Simple Harmonic Motion* *(18 pts.)*

A steel ball of mass m=200g is attached to a vertically suspended spring, which, as a result, stretches by 6cm from its unstrained length.

(a) What is the spring constant of the spring?

(b) The same spring is now attached to a wall in horizontal position; a block (mass 400g) is attached to the free end, displaced by 5cm from the spring's unstrained position, and released to vibrate on a frictionless surface. What are the frequency and period of the motion?

(c) What is the maximal speed of the block in (b)?