EXAM-2  − v1

PHYS 201 (Spring 2004), 03/25/04

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!

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Sum
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) To change the angular momentum of an object, a net torque on that object is required.
   TRUE   FALSE

(c) The tangential speed of an extended object which is rotating at constant angular speed,
   increases proportional to the distance from the axis of rotation.
   TRUE   FALSE

(d) If a solid sphere and a solid cylinder of equal mass and radius roll down the same inclined
   plane, the cylinder will reach the bottom first.
   TRUE   FALSE

(e) The restoring force of an ideal spring is always directed opposite to the displacement from
   the spring’s equilibrium position.
   TRUE   FALSE

(f) If a kinetic friction force is acting on a moving object, it always does negative work on that object.
   TRUE   FALSE
2.) *Power and Tangential Motion* (16 pts.)
A car is cruising on a farm road at 40 *mph*. The driver shifts into 2. gear so that the engine can provide its maximal power of 160 *hp*, and he then accelerates uniformly to 60 *mph*.

(a) What is the net force acting on the car during the acceleration?

(b) The car tires have a radius of 35 *cm*. What are the initial and final angular speed, and corresponding revolutions per second, of the tires?

(1 *mph* = 0.444 *m/s*, 1 *hp* = 745.7 *W*)
3.) *Linear Momentum Conservation* (10 pts.)

A coal cart (total mass of 180 kg) is moving at constant horizontal speed of 1.2 m/s. An additional 90 kg load of coal is dropped vertically into the moving cart. What is the new (horizontal) speed of the cart?
4.) *Simple Harmonic Motion* (21 pts.)
A block (mass 0.5 kg) is attached to a horizontal spring, on a horizontal frictionless surface. A person pulls on the block stretching the spring by 6 cm with a force of 8 N, and releases it.

(a) What is the spring constant?

(b) What is the maximal velocity that the block reaches during its vibration?

(c) How long does it take the block to complete 3 cycles of vibration?
5.) *Angular Momentum Conservation and Dynamics* (14 pts.)

A merry-go-round (uniform disk of mass 80 kg and diameter 3 m) is rotating about its center with a constant angular velocity of 2 rad/s.

(a) A child of mass 30 kg steps on the outer edge of the disk (approximate the child as a point mass). If no external forces are acting, what is the new angular speed of the child+disk system?

(b) The child’s mother then exerts a tangential force on the child+disk system, by pushing the child with 60 N for 2 s. What is the corresponding torque, and how large is the final angular speed of child and disk?
Mechanical Energy and Nonconservative Work

A solid sphere (mass \( m_S = 1.5 \text{ kg} \)) is rolling without slipping on a horizontal plane with linear speed \( v_S = 1.8 \text{ m/s} \). In parallel, a block of the same mass (\( m_B = 1.5 \text{ kg} \)) is sliding at the same speed (\( v_B = 1.8 \text{ m/s} \)) without friction.

(a) What are the total (linear plus rotational) kinetic energies of the sphere and the block?

(b) Both objects are now approaching an upward incline. Neglecting any friction, at what vertical heights above the horizontal do the block and the sphere come to a stop?

(c) Suppose the inclined plane surface is a little rough, resulting in a kinetic friction force of 3 \text{ N} on the block. What is the work done by the friction force once the block has reached a vertical height of 10 \text{ cm}, and what is its speed at this point?

(\text{the inclination angle of the plane is 35°})