FINAL EXAM (v1)

PHYS 201 (Spring 2006), 05/05/06

Name:

Lab-Sect. no.:

Signature:

Duration: 120 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* *(12 pts.)*

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

(a) In projectile motion, the acceleration of an object at its highest point is zero.
TRUE FALSE

(b) Every force has an equal-opposite reaction force to it.
TRUE FALSE

(c) The work-energy theorem only applies to conservative forces.
TRUE FALSE

(d) The buoyant force on an object that is submerged in liquid mercury is larger than the buoyant force on the same object submerged in water (ρ_{Hg}=13600 kg/m^3, ρ_{H_2O}=1000 kg/m^3).
TRUE FALSE

(e) Sound waves are transverse pressure waves.
TRUE FALSE

(f) Electromagnetic waves can propagate (send signals) even in vacuum.
TRUE FALSE

No.	Points
1	
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Sum	

2.) *Conceptual Questions* *(16 pts.)*

(1) Briefly explain the "Superposition Principle" and give three different examples for it (as discussed in this course).

(2) Give at least two different criteria of how to decide whether a force is conservative or nonconservative, and quote potential energies for two different conservative forces.

(3) For linear motion the kinematic variables are the displacement x, velocity v and acceleration a, and dynamic quantities include the force F and mass m. Quote the 5 corresponding quantities for angular motion.

(4) Draw the diagrams for a heat engine and a refrigerator indicating the flow of work and heat into/out of the hot/cold reservoirs.

3.) *Projectile Motion* *(12 pts.)*

A person shoots a gun toward a wall which is $45m$ away in horizontal direction. The release point of the bullet is $1.55m$ above the ground, and the initial velocity of the bullet encloses an angle of 4° with the horizontal. The bullet hits the wall after $0.4s$.

(a) What are x and y component of the initial velocity of the bullet?

(b) How high above the ground does the bullet hit the wall?

(c) What is the angle of the velocity vector relative to the horizontal just before hitting the wall?

4.) *Newton's 2. Law and Circular Motion* *(6 pts.)*

A truck, traveling on a horizontal road, is transporting a box on its loading deck. The static friction coefficient between box and deck is 0.45. The road makes a circular turn of radius $145m$. What is the maximal speed (in mph) with which the truck can take the turn before the box starts sliding? $(1m/s{=}2.25mph)$

5.) *Dynamics vs. Energetics on Inclined Plane* *(12 pts.)*

A toy car is released from rest on an inclined plane at a (vertical) height of $45cm$ above the ground. The inclination angle of the plane with respect to the horizontal is $15°$. Neglect effects of friction.

(a) Determine the net acceleration of the car and calculate the time it takes to reach the bottom of the plane (neglect effects of rolling motion for the car wheels).

(b) Use mechanical energy conservation to calculate the speed of the car at the bottom of the plane (neglect effects of rolling motion for the car wheels).

(c) Use mechanical energy conservation to calculate the speed of the car at the bottom of the plane *including the effects of rolling motion* for the wheels of the car. Assume that the 4 wheels together make up half of the car's mass.

6.) *Inelastic Collision* *(10 pts.)*

On a frictionless, horizontal, one-dimensional air track, two carts are approaching each other. The first cart (m_1=$0.3kg$) has a velocity of $0.5m/s$ due east, while the second cart (m_2=$0.55kg$) has a velocity of $0.45m/s$ due west. After the collision, the two carts are stuck together.

(a) Calculate the velocity of the center of mass of the two carts before the collision.

(b) How much nonconservative work has been done in the collision process?

7.) *Torques* *(10 pts.)*

Two persons are applying forces of magnitude F_1=25N and F_2=35N to a revolving door as shown below (top view). The door is 1.8m broad ams weighs 260N.

(a) What is the net torque on the door?

(b) If the door is initially at rest, how long does it take for the door to turn through an angle of 60° (assuming the net torque to be constant)?

8.) *Hydraulic Lift* *(10 pts.)*

A water system is closed by two cylindrical pistons (see the drawing below). The first (small) piston has a radius of $35cm$, while the second (large) piston has a radius of $2m$. On the large piston a car of mass M=$1.65tons$ is positioned. (In the following, ignore the weight of the pistons and assume water to be an incompressible fluid; $1ton$=$1000kg$).

(a) What force needs to be applied to the small piston to balance the weight of the car?

(b) How much work is required to lift the car by $10cm$, and by what displacement has the small piston to be pushed down?

9.) *Standing Waves* *(12 pts.)*

A guitar string of length $0.8m$ and mass m=$8g$ is suspended at two fixed ends under a tension force of $130N$. A person plucks the string which generates a standing wave of the lowest harmonic on the string.

(a) What is the wavelength of the standing wave?

(b) What is the frequency of the generated tone (do not use the speed of sound for this calculation!)?

(c) If the generated sound wave carries a total power of $3 \cdot 10^{-9}\ W$, and if it propagates spherically, what is the intensity level (in dB) at a distance of $7m$ from the source?