FINAL EXAM – v2

PHYS 201 (Spring 2005), 05/07/05

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!

No.	Points
1	
2	
3	
4	
5	
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7	
8	
9	
Sum	

1.) *Multiple Choice* *(12 pts.)*

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

(a) In projectile motion, the motion in x- and y-direction superimposes each other without mutual distortion.
TRUE FALSE

(b) The torque generated by a constant force can be increased by reducing the lever arm.
TRUE FALSE

(c) If a kinetic friction force is acting on a moving object, it always does positive work on that object.
TRUE FALSE

(d) The frequency of a simple harmonic motion does not depend on the amplitude of the motion.
TRUE FALSE

(e) If net heat is transferred to a substance, its temperature must always increase. (*Hint: Phase Transition*)
TRUE FALSE

(f) If a transverse wave is traveling on a rope, the rope particles move in the same direction as the propagating signal.
TRUE FALSE

2.) *Newton's 2. Law* *(10 pts.)*

Two blocks (m_2=5.0 kg, m_1 unknown) are connected via a massless wire running over a pulley as shown below. The net acceleration of both masses if found to be 3.2 m/s^2, with block 1 accelerating down and block 2 accelerating up (neglect any friction force).

(a) What is the tension force in the wire? (*hint: consider block 2*)

(b) What is the mass of the first block?

3.) *Car Launch and Projectile Motion* *(12 pts.)*

A toy car is released from rest on a ramp at a height of h_1=35 *cm* above the ground, moving onto a launch ramp which reaches to a maximal height of h_2=11 *cm* above the ground (neglect any friction and the rotational energy of the wheels).

(a) What is the speed of the car once it becomes airborne?

(b) If the car reaches a maximal height of 14 *cm* above the ground during its flight, what is the inclination angle Θ of the launch ramp with respect to the horizontal?

(c) How long is the car in the air?

(d) What is the horizontal flight distance?

4.) *Ballistic Pendulum* *(10 pts.)*

A bullet (mass 3.5 g), traveling horizontally at unknown speed, strikes a ballistic pendulum (that is, a wood block of mass 420 g suspended vertically and originally at rest), see figure below. The bullet quickly comes to rest in the block, and the block+bullet swing to a height of 12 cm above the original position of the block.

(a) What is the speed of block+bullet immediately after the collision?

(b) What was the original speed of the bullet?

5.) *Simple Harmonic Motion* *(10 pts.)*

A block of mass 0.35 kg is attached to a horizontal spring on a horizontal frictionless surface. The spring constant is 20 N/m. The block is then pushed parallel to the spring and given an initial speed of 1.2 m/s while the spring is initially unstrained.

(a) What is the amplitude of the resulting vibration?

(b) What is the period of the motion?

6.) *Torque and Angular Momentum* *(12 pts.)*

A uniform solid disk (total mass 35 kg, radius 0.3 m) is free to rotate about an axis through its center (see figure below). Two forces of magnitude 40 N and 52 N are applied tangentially to the disk for a duration of 5 s (as shown below).

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

(b) What is the angular acceleration of the disk?

(c) Starting from rest, what is the final angular momentum of the disk?

7.) *Buoyant Force* *(6 pts.)*

A large plastic sphere is attached by a vertical rope to the bottom of a lake. The sphere has a mass of 45 kg and the tension in the rope is 460 N. The water in the lake has a density of 1000 kg/m^3. What is the density of the sphere?

8.) *Carnot Engine* *(12 pts.)*

A Carnot heat engine has a thermal efficiency of 45%. The cold (low-temperature) reservoir has a temperature of -80°C, and the engine exhausts 380 J of heat into the cold reservoir each cycle. Calculate

(a) the temperature of the hot (high-temperature) reservoir (in °K).

(b) the amount of heat that flows from the hot reservoir into the engine in each cycle.

(c) the work done by the engine during each cycle.

9.) *Sound Propagation and Doppler Effect* *(16 pts.)*

A train sounds its whistle as it approaches a tunnel into a (vertical) cliff (see figure below). The whistle produces a tone of 1600 Hz and the train travels at a speed of v_{train}=45 m/s.

(a) If the air temperature is -30°C and the train is still 900 m away from the observer, how long does the whistle-sound travel from the train to the observer (assume γ_{air}=1.4 and the average mass of air molecules to be $30u$, where $1u$=$1.66\times10^{-27}kg$)?

(b) Find the tone frequency that is heard by an observer standing near the entrance of the tunnel.

(c) If the whistle sound arrives at the observer with an intensity of 8×10^{-5} W/m^2, what is the corresponding intensity level?

(d) The sound of the whistle is now reflected from the cliff back to the engineer sitting in the train. With what frequency does the engineer hear the reflected whistle sound?