FINAL EXAM – v2

PHYS 201 (Spring 2004), 05/07/04

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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8	
9	
Sum	

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

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

(a) The acceleration of an object always points in the same direction as the velocity of that object.
TRUE FALSE

(b) The net acceleration of an object always points in the same direction as the net force acting on that object.
TRUE FALSE

(c) The centripetal force required for uniform circular motion at constant speed increases with the radius of the circle.
TRUE FALSE

(d) The net torque on an object is directly proportional to the angular speed of the object.
TRUE FALSE

(e) If a gas expands, it does positive work on its environment.
TRUE FALSE

(f) A perfect heat engine has an efficiency that is smaller than 1.
TRUE FALSE

2.) *1-D Kinematics* *(10 pts.)*

The engine of a sports car provides a uniform acceleration that enables the car to go from 0 to $60mph$ in $6.5s$. At time t=0 a truck, cruising at constant speed of $25mph$, passes the car; at this moment the car starts to accelerate from rest. ($1mph$=$0.444m/s$)

(a) How long (in *seconds*) does it take the car to catch up with the truck?

(b) After how many *meters* has the car caught up with the truck?

3.) *Newton's 2. Law and Friction* *(12 pts.)*

Block A and block B (mass m_B=$2kg$) sit on a horizontal surface and are connected by a horizontal (ideal) rope. The coefficient of kinetic friction between each block and the surface is μ_k=0.5. A force F=$25N$ at an angle of 37° above the horizontal is applied to block B and the blocks accelerate at the same rate to the right. While the blocks are moving, the tension in the horizontal rope is T=$7.5N$.

(a) What is the magnitude of the kinetic friction force on block B?

(b) What is the acceleration of block B?

(c) What is the mass m_A of block A?

4.) *Car Jump* *(16 pts.)*

A toy car is released from rest on a ramp h_1=30cm above the ground, moving onto a launch ramp which reaches to a maximal height of h_2=10cm above the ground (neglect 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 15cm 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?

5.) *Momentum Conservation* *(12 pts.)*

A projectile (mass m=0.015kg) is horizontally shot at a wood block (mass M=3kg) which is originally at rest and attached to a relaxed spring with spring constant k=110N/m. The projectile gets stuck in the block, which subsequently compresses the spring up to a maximum of 8cm.

(a) Is the projectile-block collision elastic or inelastic (no calculation required)?

(b) What was the speed of the block+projectile system immediately after the projectile got stuck (neglecting the spring compression at this moment)?

(c) What was the speed of the projectile before hitting the block?

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

A thin rod (mass M=40$grams$, length 20cm) is originally at rest and free to rotate about one of its ends in a horizontal plane (ignore gravity). A person pushes with a force of F=0.2N for 0.08$seconds$ at the lose end of the rod, perpendicular to the rod, see figure below. A bug (approximated by a pointlike mass of m_{bug}=10$grams$) originally sits at the fixed end of the rod (that is, in the center of the rotation).

(a) What is the moment of inertia of the rotating rod?

(b) How large is the torque exerted by the person on the rod, and what is the rod's resulting angular speed?

(c) Now the bug crawls from the center to the lose end of the rod. With no external torque acting, what is the tangential speed of the bug once it arrives at the end?

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

A spherical balloon of radius $3.41m$ can carry an additional load of up to $200kg$ before starting to sink in air. What is the density of the gas that the balloon is filled with?
(the density of air is $\rho_{air} = 1.29kg/m^3$; volume of a sphere: $4\pi R^3/3$)

8.) *Ideal Gas* *(12 pts.)*

A cylinder with a movable piston contains $3 moles$ of an ideal gas at an initial temperature of $250° K$ and with an initial volume of $0.03 m^3$. $3000 J$ of heat energy is added to the gas while the pressure of the gas is kept constant.

(a) What is the final temperature of the gas?

(b) What is the final volume of the gas?

(c) What is the amount of work done by the gas during the expansion?

9.) *Entropy* *(7 pts.)*

$3kg$ of liquid water at the boiling temperature of $100°C$ evaporate into steam at the same temperature. By how much does the entropy of the H_2O change from the liquid to the gaseous phase (indicate an increase or decrease by a '+' or '−' sign, respectively)?

(latent heat of evaporation for water: L_v=$22.6 \cdot 10^5 J/kg$)