EXAM-4

PHYS 201 (Fall 2011), 12/02/11

Name:

Lab-Sect. no.:

Signature:

Duration: 50 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) When a spaceship approaches a space-traffic light at high speed, a red light could appear as green to the pilot of the ship.
TRUE FALSE

(b) An object at a constant temperature absorbs more thermal radiation than it emits.
TRUE FALSE

(c) When you mix $1kg$ of liquid water at the boiling point (T=100°C) with $1kg$ of ice at the freezing point (T=0°C) into an insulated container, the final equilibrium temperature will be smaller than 50°C.
TRUE FALSE

(d) When oxygen (molar mass of $32g$) and hydrogen (molar mass of $2g$) are held at the same temperature, the average speed of the oxygen molecules is higher than that of the hydrogen molecules.
TRUE FALSE

(e) Spontaneous heat flow from a cold to a hot substance violates the *first* law of thermodynamics.
TRUE FALSE

(f) Spontaneous heat flow from a cold to a hot substance violates the *second* law of thermodynamics.
TRUE FALSE

No.	Points
1	
2	
3	
4	
5	
Sum	

2.) *Doppler Effect and Beat Frequency* *(20 pts.)*

You and your friend both own cars whose horn frequency is $450Hz$. You are driving toward your friend with a speed of $40mph$, while your friend is sitting in his car which is at rest. Both you and your friend blow the horn of their car.

(a) With what frequency will your friend hear the horn of your car?

(b) What is the frequency of the beat that your friend will hear as a result of the interference of tone from the horn of his car and your car?

3.) *Heat Loss due to Radiation* *(20 pts.)*

A spherical pot (radius $8cm$, emissivity 0.8) is filled with water at a temperature of $80°C$, and is sitting in a room of ambient temperature $15°C$.

(a) Calculate the radiative rate of heat loss of the water pot.

(b) With the rate from part (a), how long does it take to cool the water in the pot by $2C°$? Neglect the pot material and use the density of water, $\rho_W = m/V = 1000kg/m^3$, to calculate its mass, m, from its volume, V.

4.) *Calorimetry and Entropy* *(10+11 pts.)*

A construction worker mixes 1.5 liters (or $1.5kg$) of lukewarm water (temperature $30°C$) with three ices cubes into an insulating styrofoam cup. Each ice cube has a mass of $80g$ and is at a temperature of $-7°C$.

(a) Calculate the equilibrium temperature of the mixture.

(b) Calculate the total change of entropy after the mixture has equilibrated. To do so, assume an average temperature during the equilibration process of $20°C$ for the lukewarm water and of $0°C$ for the ice cubes.

5.) *Adiabatic and Isobaric Processes of Ideal Gas* *(21 pts.)*

The cycle of a heat engine using $2.8 moles$ of an ideal gas (with γ=1.67) is shown below. The curved part from a to b is an adiabatic process, bc is isobaric and ca is isochoric.

(a) Calculate the pressure of the gas at point a.
(*hint: use the adiabatic path of the process*).

(b) How much work does the engine do from a to b?

(c) How much heat is added to the gas from c to a?

Useful constants and conversions:
$1m/s$=$2.25mph$, speed of sound in air: $v = 343m/s$
specific heat capacities: $c_{water} = 4.19 \cdot 10^3 J/(kg\ K)$, $c_{ice} = 2.01 \cdot 10^3 J/(kg\ K)$
latent heats of water: fusion: $L_f = 3.34 \cdot 10^5 J/kg$, vaporization: $L_v = 2.26 \cdot 10^6 J/kg$
surface area of sphere: $A = 4\pi R^2$, volume of sphere: $V = 4\pi R^3/3$