EXAM-3 – v1

PHYS 201 (Spring 2007), 04/24/07

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!

1.) *Multiple Choice* *(21 pts.)*

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

(a) When increasing the tension in a string, the wave speed on the string decreases.
TRUE FALSE

(b) When increasing the equilibrium temperature of a black body from $40°F$ to $80°F$, the radiated power of that body increases by a factor 2^4.
TRUE FALSE

(c) The total internal energy of an ideal gas amounts to the sum of the kinetic energies of all molecules in the gas.
TRUE FALSE

(d) At room temperature, the average speed of hydrogen molecules ($m_{H_2} = 2u$) is smaller than the average speed of nitrogen molecules ($m_{N_2} = 28u$).
TRUE FALSE

(e) Spontaneous heat flow increases the entropy of the Universe.
TRUE FALSE

(f) A Carnot engine operates with reversible processes only.
TRUE FALSE

(g) If a gas does adiabatic expansion work, the total entropy of the universe does not increase.
TRUE FALSE

No.	Points
1	
2	
3	
4	
5	
6	
Sum	

2.) *Doppler Effect* *(18 pts.)*

A police car, with its siren on, is approaching a tunnel (which passes through a mountain) with a speed of $105mph$. At rest, the siren emits a pure tone of frequency $1200Hz$. An observer is standing next to the tunnel entrance. (use a sound speed of $343m/s$; $1m/s$=$2.25mph$)

(a) What is the frequency of the siren tone that the observer hears?

(b) If the siren emits sound with a power of $1W$, and the car is $1km$ away from the observer, with what intensity level does the observer hear the siren (assume the sound wave to be a spherical wave)?

(c) The siren tone is reflected from the mountain back to the police officer in the car. With what frequency does the police officer hear the reflected siren sound?

3.) *Calorimetry and Entropy Production* *(18 pts.)*

A thirsty student prepares himself an ice tea by mixing $1.5kg$ of tea with $0.5kg$ of ice in a perfectly insulating Aggie cup. The initial temperature of the tea is $30°C$, while the initial temperature of the ice is -10°C. Neglect the heat capacity of the cup, and assume the heat capacity of the tea to be equal to that of water. (specific heat capacity of water and ice: $c_{\text{water}} = 4186J/(kg{\cdot}C°)$, $c_{\text{ice}} = 2000J/(kg{\cdot}C°)$, latent heat of fusion for water: $L_f = 33400J/kg$).

(a) After equilibration, what is the final temperature of the mixture?

(b) What is the amount of net heat transfered from the ice/water to the tea?

(c) Calculate the entropy changes of the tea and of the ice/water (using their average temperatures in the process), as well as the total change in entropy. Is the total consistent with the second law of thermodynamics?

4.) *Adiabatic Expansion* *(15 pts.)*

In the P-V diagram shown below, $110J$ of work was done by $0.6mol$ of an ideal monatomic gas ($\gamma = 5/3$) during an adiabatic process (i.e., $Q = 0$). $(1L = (10cm)^3)$

(a) By how many joules did the internal energy of the gas change (include the proper plus/minus sign)?

(b) What was the initial volume of the gas?

(c) What are the initial and final temperature of the gas?

5.) *Carnot Engine* *(15 pts.)*

In each cycle, a power plant extracts $7000J$ of energy from a hot reservoir at a temperature of $250°C$ while dumping an unknown amount of heat into the environment which is at a temperature of $25°C$. Assume the heat engine to be a Carnot engine.

(a) What is the thermal efficiency of the engine?

(b) How much mechanical work does the engine perform in each cycle?

(c) How much heat is dumped into the environment in each cycle?

6.) *Ideal Gas Expansion* *(6+7 pts.)*

A fixed amount of Helium gas expands slowly doing $400J$ of work in the process (assume Helium to be an ideal monatomic gas). Find the heat added to the gas and the change in internal energy if the expansion proceeds

(a) isothermal,

(b) isobaric.