EXAM-3 – v1

PHYS 201 (Spring 2006), 04/18/06

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) In a glass filled with water, the pressure at the water surface is the same as on the bottom of the glass.
TRUE FALSE

(b) If a black body is in equilibrium (that is, at constant temperature), it does not emit any radiation.
TRUE FALSE

(c) The energy (heat) needed to convert 1 kg ice into 1 kg water is much larger than the potential energy gain when lifting 1 kg of ice by 25 $meters$.
TRUE FALSE

(d) At room temperature, the average speed of oxygen molecules ($m_{O_2} = 32u$) is smaller than the average speed of nitrogen molecules ($m_{N_2} = 28u$).
TRUE FALSE

(e) In adiabatic expansion (Q=0) the pressure drops faster than in isothermal expansion (T = const).
TRUE FALSE

(f) At room temperature, water is in the liquid phase and therefore cannot evaporate.
TRUE FALSE

(g) If heat is extracted from a gas, and there is no work done on or by the gas, the entropy of that gas decreases.
TRUE FALSE

No.	Points
1	
2	
3	
4	
5	
6	
Sum	

2.) *Conceptual Questions* *(20 pts.)*

The questions below are essentially unrelated. Please be brief in your answers but state clearly what you mean. No credit will be given for contradictory statements.

(1) State the Archimedes Principle (buoyant force).

(2) Quote the 3 thermodynamic state variables (for a fixed amount of substance) and the equation of state of the ideal gas.

(3) State two different versions of the 2. Law of Thermodynamics.

(4) Explain why the heat capacity of an ideal gas is larger when heat is added at constant pressure as opposed to at constant volume. (*Hint: 1. Law of Thermodynamics*)

3.) *Buoyant Force* *(12 pts.)*

A solid raft (length $3m$, width $2.5m$ and height $20cm$) is floating in water (density $\rho_{water} = 10^3 kg/m^3$), with $10.5cm$ of its height submerged.

(a) What is the density of the raft's material?

(b) How many persons of weight $800N$ can get on the raft before it sinks?

4.) *Radiation Power of Sun* *(12 pts.)*

Assume the Sun to be an ideal spherical black body of radius $R_{sun} = 700000km$, which radiates uniformly in all directions. On Earth (at a distance of $1.5 \cdot 10^8 km$ away from the Sun's center), the radiation power (per unit area) of the Sun is $1600 W/m^2$ (assuming no losses in the atmosphere).

(a) To what temperature does an ideal black body on the Earth heat up to?

(b) What is the temperature at the surface of the Sun? (*hint: the surface area of a sphere is* $A{=}4\pi r^2$)

5.) *Refrigerator* *(18 pts.)*

$1.5kg$ of water are sitting on the kitchen counter at room temperature ($T = 25°C$). The freezing compartment of a nearby Carnot refrigerator is held at -10$°C$ in the same room ($T = 25°C$). A child puts the water into the freezer.
(specific heat capacity of water: $c_w = 4186J/(kg \cdot C°)$, specific heat capacity of ice: $c_i = 2000J/(kg \cdot C°)$, latent heat of fusion for water: $L_f = 33500J/kg$).

(a) How much heat needs to be extracted from the freezer to convert the water into ice at -10$°C$ (neglect the container)?

(b) How much work is needed to extract the amount of heat from part (a)?

(c) What is the coefficient of performance of the refrigerator?

6.) *Spontaneous Heat Flow and Entropy for Ideal Gases* *(18 pts.)*

Two equal containers of fixed volume ($V = 0.6m^3$), each filled with an ideal gas at initial pressure of $1.5atm$, are in thermal contact. The first container is held at an initial temperature of -123.15°C, while the second container is held at a temperature of 363.85°C.
($1atm = 1.013 \cdot 10^5 Pa$)

(a) How many moles of gas are in each container?

(b) If $25000J$ of net heat flows spontaneously between the two containers, by how much does each of the gas temperatures change?

(c) Using the average gas temperatures of part (b), how much is the change in total entropy?