EXAM-3 – v1

PHYS 201 (Spring 2005), 04/19/05

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!

No.	Points
1	
2	
3	
4	
5	
6	
Sum	

1.) *Multiple Choice* *(18 pts.)*

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

(a) If the temperature of a fixed amount of an ideal gas increases at constant pressure, the volume of the gas must decrease.
TRUE FALSE

(b) If an ideal black body is at constant temperature, it does not emit any radiation.
TRUE FALSE

(c) If an object is completely submerged into a fluid, the buoyant force on that object depends on the mass of that object.
TRUE FALSE

(d) If two different ideal gases have the same temperature, the average kinetic energy of the atoms in each gas is the same.
TRUE FALSE

(e) If you heat an originally straight bimetallic strip (brass on the right side, steel on the left side), it will bend to the left. (The thermal expansion coefficients for brass and steel are, respectively, $\alpha_{brass}=19\times10^{-6}/C^{\circ}$ and $\alpha_{steel}=12\times10^{-6}/C^{\circ}$).
TRUE FALSE

(f) The change in internal energy of a system only depends on the work done by or on the system.
TRUE FALSE

2.) *Pascal's Principle* *(16 pts.)*

Two identical containers (one open at the top with air pressure $P_{air} = 101\ kPa = 1.01 \times 10^5\ Pa$, the other closed at the top with a constant gas pressure of $P_{gas} = 115\ kPa$) are connected via a tube of negligible volume and a valve that is closed. Both containers are filled with water, initially to the same height level of 2 m, see the drawing below (density of water: ρ_{water}=1000 kg/m^3).

(a) With the valve still closed, calculate the total pressure at the bottom of the container (i) to the left of the valve, and (ii) to the right of the valve.

(b) The valve is now opened so that the pressure at the bottom equilibrates (the gas pressure at the top of the right container is held constant). To what height level does the water rise in the container on the left?

3.) *Heat Flow and 2. Law of Thermodynamics* *(18 pts.)*

Two heat reservoirs, held in containers at constant temperatures of $-80°C$ and $+25°C$, respectively, are separated by an Aluminum plate of thickness 6 cm and cross sectional area 0.3 m^2 (the thermal conductivity of Aluminum is κ=240 $J/(s \cdot m \cdot C°)$).

(a) After 2 *minutes*, how much heat has been transferred between the two reservoirs?

(b) After the same 2 *minutes*, what is the change in entropy in each of the two reservoirs, and what is the total change in entropy?

(c) Now a Carnot heat engine is coupled in between the two reservoirs. If a net heat of Q=11×10^4 J is extracted from the hot reservoir, what is the work that the heat engine performs, and how much heat is transferred into the cold reservoir?

4.) *Ideal Gas and Kinetic Theory* *(24 pts.)*

0.245 kg of Krypton (a monatomic ideal gas with atomic mass number 83.8, $1u$=$1.66\times10^{-27}kg$) are kept in an isolated glass flask (cross sectional area A=140 cm^2, filled up to a height level of $h = 130$ cm) at constant pressure. The gas temperature is found to be $265°K$.

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

(b) What is the pressure of the gas?

(c) What is an atom's average (root-mean-square) speed in the gas?

(d) Now a net heat amount Q is slowly added to the gas so that it expands at constant pressure to a height level of $h = 160$ cm (A remains constant). What is the final gas temperature, how much work has been done by the gas, and how much heat (Q) has been added?

5.) *Heat Pump and Entropy* *(8+6 pts.)*

An air conditioner is used to keep the interior of a house at a temperature of $70°F$ while the outside temperature is $95°F$. Heat leaks into the house at a rate of 13 kW, while the air conditioner has the efficiency of a Carnot engine.

(a) What is the mechanical power required to keep the house cool?
(*recall*: power=work/time, 1 W=1 J/s)

(b) By how much does the entropy of the universe increase during 6 hours of cooling the house?

6.) *Calorimetry* *(10 pts.)*

Ice at -20° is brought together with liquid mercury at $+270^\circ C$ in a perfectly isolated container. The mix equilibrates at a temperature of $45^\circ C$. What is the ratio of the masses of water and mercury?

(specific heat capacities for ice, water and mercury are c_{ice}=2000 $J/(kg \cdot C^\circ)$, c_{water}=4186 $J/(kg \cdot C^\circ)$ and $c_{mercury}$=139 $J/(kg \cdot C^\circ)$; latent heat of fusion into ice is L_{fusion}=3.35 $\times 10^5 J/kg$)