FINAL EXAM PHYSICS 9B–01

NAME:

(please print)

December 14, 1993 **Social Sec. #:**

General Instructions: This examination is closed book. Only a calculator is allowed. Please show all your work. Credit will only be given for *complete* solutions. It is against the University Academic Code to present work other than your own on this exam.

There are fourteen problems on nine pages, plus this page of "possibly useful information". There are no blank pages. Please check now to make sure you have a complete exam. Note that not all the problems are worth the same number of points. The total number of points is **200**.

Possibly Useful Information:

$N_A = 6.022 \text{ x } 10^{23}$ atoms/mole (Avogadro's number).

$k_{\rm B} = 1.38 \text{ x } 10^{-23}$ Joules/Kelvin (Boltzmann's constant).

$\rho_{water} = 10^3$ kg/m^3 is the density of water.

$\rho_{air} = 1.29$ kg/m^3 is the density of air.

$M(He) = 4 \text{ x } 1.67 \text{ x } 10^{-27}$ kg. is the mass of a ^4He atom.

$R = 8.314$ Joules/(mole Kelvin)=0.0821 lit–atm/(mole Kelvin).

1 atm=$1.013 \text{ x } 10^5$ N/m^2.

c_{water}= 1 cal/gm is the specific heat of water.

c_{glass}= 0.2 cal/gm is the specific heat of glass.

$\alpha_{\rm steel}$= $12 \text{ x } 10^{-6}$ (degrees Celsius)$^{-1}$ is the coefficient of linear expansion of steel.

Cover Sheet

[15 points] 1. Given the information in the figure, compute v_2 and P_2.

[15 points] 2. A 8 m^3 cube of a material of density $\rho = 1.6$ is floating at the boundary of two liquids of $\rho_1 = 0.9$ and $\rho_2 = 1.8$, as shown in the figure. Compute the distance h of the cube's bottom surface below the interface.

[15 points] 3. A transverse wave traveling on a cord is represented by the relation

$$D(x,t) = 0.008 \sin(5x + 72t + 8).$$

D and x are in meters and t is in seconds. What is the wavelength? What is the period? What is the velocity (magnitude and direction) of the wave? What is the amplitude? What is the maximum velocity of a point on the cord?

[10 points] 4. A string 0.2 meters long is stretched between two fixed supports. What are the allowed wavelengths? If the string has tension $T = 100$ Newtons and mass per unit length $\mu = 0.01$ kg/m, what are the allowed frequencies?

[10 points] 5. If a double slit pattern contains exactly 12 fringes in the central diffraction pattern, what can you say about the slit width and separation?

[10 points] 6. A convex lens has a focal length $f = 20.0$ cm. An object is placed a distance $d_o = 10.0$ cm in front of the lens. Use the figure to locate the image by tracing appropriate rays from the tip of the object. Again using your figure, rather than any equations, estimate d_i. Is the image erect or inverted? Estimate the magnification of the lens.

[15 points] 7. Three waves of equal amplitude but different phases: $A\cos(\omega t)$, $A\cos(\omega t + \pi/4)$, and $A\cos(\omega t - \pi/4)$ are added together. What is the amplitude of the total wave?

[5 points] 8. Does a can of coke cool off faster in the refrigerator or the freezer? Prove your answer using a formula we learned.

[20 points] 9. 0.4 moles of an ideal diatomic gas is initially confined to a volume of 2 liters at 300 kelvin. Calculate the work done by the gas and heat added to the gas in expanding to twice its initial volume by:

a. isobaric expansion;

b. isothermal expansion; and

c. adiabatic expansion.

[10 points] 10. To make a secure fit, rivets that are larger than the rivet hole are often used and the rivet is cooled (usually in dry ice) before it is placed in the hole. A steel rivet 2.385 cm in diameter is to be placed in a hole 2.382 cm in diameter. To what temperature must the rivet be cooled if it is to fit in the hole (at 20 degrees Celsius)?

[15 points] 11. 10 moles of a gas are confined to one half of a well insulated box of total volume $V = 0.2$ m^3. The initial temperature is $T = 300$ degrees Kelvin. The partition separating the full and empty halves is suddenly removed. What is the change in the entropy?

[30 points] 12. When a gas is taken from **a** to **c** along the curved path in the figure, the work done by the gas is $W = -37J$ and the heat added to the gas is $Q = -73J$. Along path **abc** the work done is $W = -52J$.

a. What is Q for path **abc**?

b. If $P_c = 1/2\ P_b$, what is W for path **cda**?

c. What is Q for path **cda**?

d. What is $U_a - U_c$?

e. If $U_d - U_c = 9J$, what is Q for path **da**?

[20 points] 13. In the figure is shown the PV diagram for a reversible heat engine in which one mole of argon, a nearly ideal monatomic gas, is initially at STP (point "a"). Points "b" and "c" are on an isotherm at $T = 423$ degrees Kelvin. Process "ab" is at constant volume and process "ac" is constant pressure. Is the process carried out clockwise or counterclockwise? What is the efficiency of this engine?

[10 points] 14. Equal amounts of ice at 0 degrees Celsius and steam at 100 degrees Celsius are mixed together. Describe in detail the final state of the system. Include in your answer the final temperature, for example.