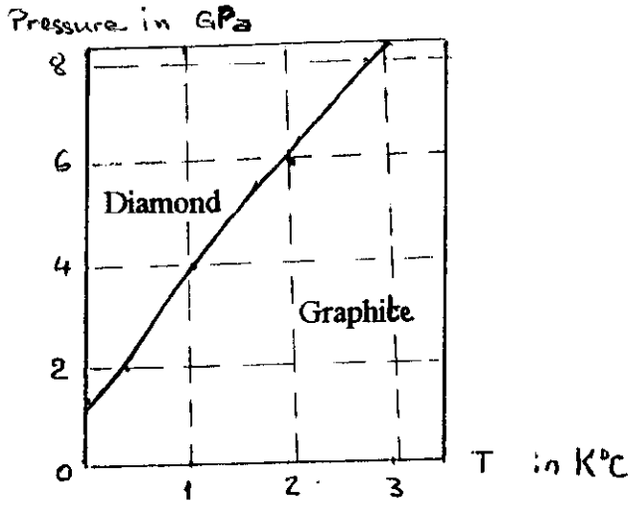
AUB
Physics Department
Name:_____
I.D. #:_____

Physics 204
Final Exam

August 27, 1997
Time: 2:00 n

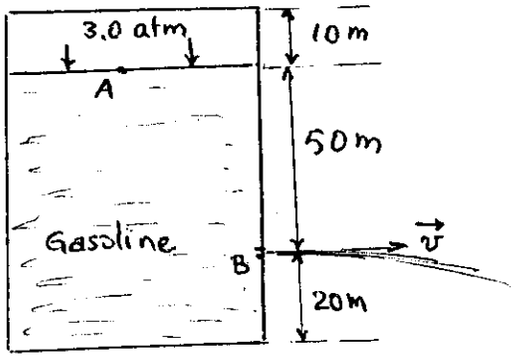
1. ***10 marks***
The figure displays the phase diagram of carbon, showing the ranges of temperature and pressure in which carbon will crystallize either as diamond or graphite. What is the minimum depth at which diamonds can form if the temperature at that depth is 1000°C and the subsurface rocks have density 3.1 g/cm^3 ? Assuming that, as a fluid, the pressure is due to the weight of material lying above.



2. ***15 marks***
A block of wood has a mass of 3.67 kg and a density of 600 kg/m^3. It is to be loaded with lead so that it will float in water with 0.90 of its volume immersed. What mass of lead (of density 1.13×10^4 kg/m^3) is needed a) if the lead is on top of the wood and b) if the lead is attached below the wood?

3. ***15 marks***

A sniper fires a rifle bullet into a gasoline tank, making a small hole 50 m below the surface of the gasoline. The tank was sealed and is under 3.0 atm absolute, as shown in the figure. The stored gasoline has a density of 660 kg/m^3 . At what speed $\vec{v}$ does the gasoline begin to shoot out of the hole?



4. ***15 marks***

A needle of radius 0.30 mm and length 3.0 cm is used to give a patient a blood transfusion. Assume the change in pressure across the needle is achieved by elevating the blood 1.0 m above the patient's arm.

a) What is the rate of flow of blood through the needle?

b) At this rate of flow, how long will it take to inject 500 cm^3 of blood into the patient? The density of blood is 1050 kg/m^3, and its coefficient of viscosity is 4.0×10^{-3} N.s/m^2.

5. ***10 marks***

Sucrose is allowed to diffuse along a 10 cm length of tubing filled with water. The tube is 6.0 cm^2 in cross-sectional area. The diffusion coefficient is 5.0×10^{-10} m^2/s and 8.0×10^{-4} kg is transported along the tube in 15 s. What is the difference in the concentration levels of sucrose at the two ends of the tube?

6. ***10 marks***

When the temperature of a copper penny is raised by 100°C , its diameter increases by 0.18% . To two significant figures, give the percent increase in **a)** the area of a face, **b)** the thickness, **c)** the volume, and **d)** the mass of the penny.

e) Calculate its coefficient of linear expansion.

$Q = \alpha L_0 \Delta T$

$A = A_0 \Delta T$

$A = 2 \times \pi r^2$

$\frac{\pi r^2}{\pi r_0^2} = 2\alpha \times 100$

$0.09^2 = 2\alpha \times 100$

diameter

D

7. ***15 marks***

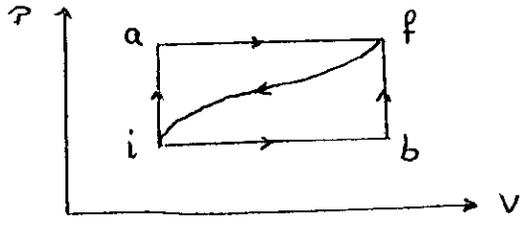
What mass of steam at 100°C must be mixed with 150 g of ice at its melting point, in a thermally insulated container to produce liquid water at 50° C ?
(Latent heat of melting is L_m = 79.7 cal/g , latent heat of vaporization is L_v = 539 cal/g.)

8. ***20 marks***

When a system is taken from state i to state f along path iaf , Q = 50 cal and W = 20 cal. Along path ibf , Q = 36 cal. **a)** What is W along path ibf? **b)** if W = -13 cal for the curved return path fi, what is Q for this path?

c) Take $E_{int,i}$ = 10 cal. What is $E_{int,f}$?

d) If $E_{int,b}$ = 22 cal, what are the values of Q for path ib and path bf?



iaf Q = 50 cal ibf Q = 36

W = 20 cal

$\Delta U = Q - W$

$\Delta U = 30$

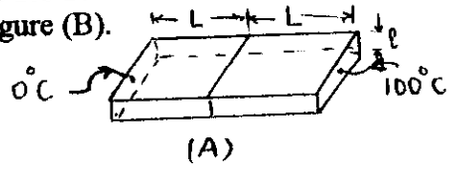
$\Delta U = Q - W$

$30 = 36 - W$ $W = 6$

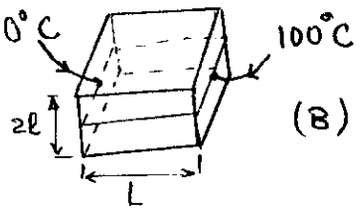
c)

9. ***15 marks***

Two identical rectangular rods of metal are welded end to end as shown in the figure (A), and 10 J of heat is conducted (in a steady-state process) through the rods in 2.0 min. How long would it take for 10 J to be conducted through the rods if they are welded together as shown in figure (B).



(A)



(B)

10. ***15 marks***

The equation of a transverse wave traveling along a string is given by

$$y = 2.0\text{mm}\ \sin\left[\left(20\text{m}^{-1}\right)x - \left(600\text{s}^{-1}\right)t\right]$$

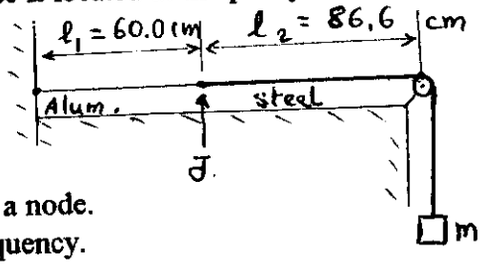
a) Find the amplitude, frequency, velocity, and wavelength of the wave.

b) Find the maximum transverse speed of a particle in the string.

c) If the tension in the string is 15 N, find the linear density of this string in grams per meter?

11. ***15 marks***

An Aluminum wire, of length $\ell_1 = 60.0$ cm, cross-sectional area 1.00×10^{-2} cm^2, and density $\rho_1 = 2.60$ g/cm^3, is joined to a steel wire, of density $\rho_2 = 7.80$ g/cm^3 and the same cross-sectional area. The compound wire, loaded with a block of mass m = 10.0 kg, is arranged as in the figure. Transverse waves are set up in the wire by using an external source of variable frequency; a node is located at the pulley.



a) If the joined end J of the wire is a node, show that $\frac{n_1}{n_2} = \frac{l_2}{l_1}\sqrt{\frac{\rho_2}{\rho_1}}$ where n_1 and n_2 are the number of loops in each wire.

b) Find the lowest frequency of excitation such that J is a node.

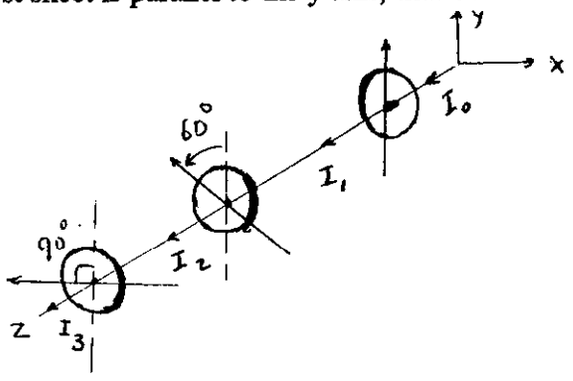
c) How many nodes and loops are observed at this frequency.

12. ***10 marks***

In a discussion of Doppler shifts of Ultrasonic waves used in medical diagnosis, the authors remark: "For every millimeter per second that a structure in the body moves, the frequency of the incident ultrasonic waves is shifted approximately 1.30 Hz per MHz." What speed of the ultrasonic waves in tissue do you deduce from this statement?

13. ***10 marks***

The figure shows a system of three polarizing sheets in the path of initially unpolarized light. The polarizing direction of the first sheet is parallel to the y axis, that of the second sheet is 60° counterclockwise from the y axis, and that of the third sheet is parallel to the x-axis. What fraction of the initial intensity of the light emerges from the system, and how is that light polarized?



14. ***10 marks***

A 20 mm - thick layer of water (n = 1.33) floats on a 40 mm-thick layer of carbon Tetrachloride (n = 1.46) in a tank. A penny lies at the bottom of the tank.
At what depth below the top water surface do you perceive the penny? (use the small angle approximation) : $\sin\theta \cong \tan\theta \cong \theta$).