



PHYSICS 204
Final Examination
TIME: 2 hours

February 12, 1998

You may see your exam paper on Monday, February 16, from 10 a.m to 1 p.m.

NAME _____

Section _____ ID Number _____

Useful information

$\rho_{\text{Hg}} = 13.6 \text{ g/cm}^3$ $\rho_{\text{water}} = 1.0 \text{ g/cm}^3$

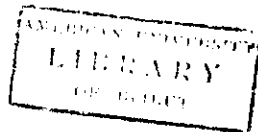
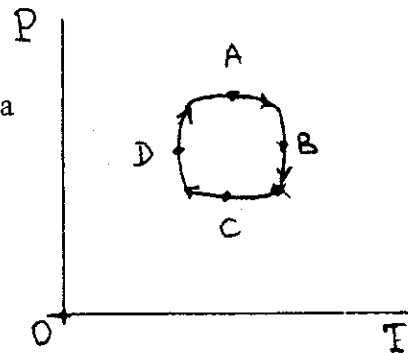
$R = 8.31 \text{ J/(mol K)}$

$1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$

Part A (36%; each question carries 3 %)

1. The dependence of pressure of one mole of an ideal gas on its temperature is shown for a cyclic process. The volume of gas is a maximum for the state represented by point

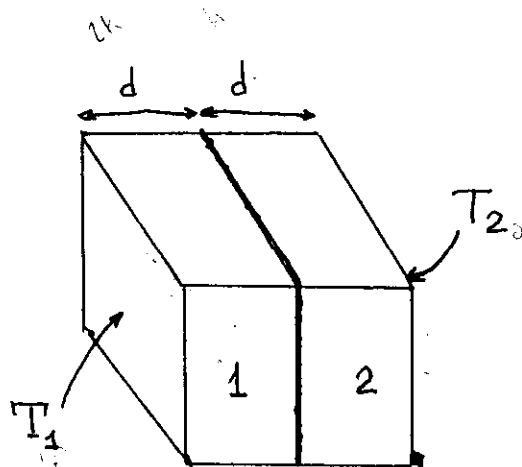
- A) B) C) D)
e) none of the above (show your answer in the diagram)



2. Mark the correct statement:

- a) When wetting agents are added to water, the contact angle it makes with greasy surfaces increases
- b) The surface tension is related to the surface energy of a fluid per unit surface area
- c) If the Reynolds number increases above 3000, the flow of fluid in the pipe changes from turbulent to a streamline
- d) Viscosity of most fluids is independent of temperature
- e) The volumetric thermal expansion coefficient is 1/3 of the linear expansion coefficient

3) Two metal plates of the same surface area and the same thickness are soldered together face-to-face as shown. The thermal conductivity of plate 1 is twice as large as that of the plate 2. If the surface of plate 1 is kept at $T_1 = 60^\circ\text{C}$ and the surface of plate 2 is at $T_2 = 0^\circ\text{C}$, the temperature of the soldered junction will be



- a) 30°C b) 40°C c) 20°C d) 80°C
 e) none of the above, my answer is _____

4. In a two-slit interference experiment, the distance between the two very narrow slits is equal to the wavelength of the incoming light, $a = \lambda = 700\text{ nm}$. How many bright fringes can be seen on a screen at a distance of 1.0 m away from the slits ?

- a) 3 b) 1.3×10^6 c) 1 d) depends on the width of the screen
 e) none of the above, my answer is _____

5. A lens of index of refraction 1.52 is coated with a thin film of magnesium fluoride of index of refraction 1.38. What minimum thickness should the coating have in order to minimize reflection for 550 nm- light.

- a) 99 nm b) 90.5 nm c) 181 nm d) 199 nm
 e) none of the above, my answer is _____

6. There are two copper rods. The first rod has twice the length and three times the cross-sectional area of the other one. The ratio of the Young's modulus of the first rod to that of the second one is

- a) 3.0 b) 0.5 c) 1.5 d) 1.0
e) none of the above, my answer is _____

7) An open U-tube of constant cross-sectional area contains mercury. When water is poured into the right arm to make a 13.6 cm-column, the mercury in the left arm rises above the initial level by:

- a) 1.0 cm b) 0 cm c) 0.5 cm d) 2.0 cm
e) none of the above, my answer is _____

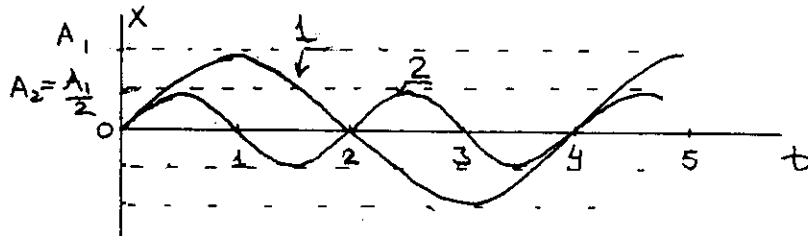
8. When on a cold day you put on warm clothes, you are trying to decrease the heat loss. The heat loss due to which mechanism of the heat transfer is affected most ?

- a) heat conduction b) convection c) radiation d) reflection

9. A ring of material A is to fit tightly on a hollow rod of material B. This is done by heating both substances to the same temperature, slipping the ring over the rod, and allowing both to cool. For a tight fit to be achieved, the thermal expansion coefficients of the materials should be related by

- a) $\alpha_A < \alpha_B$ b) $\alpha_A = \alpha_B$ c) $\alpha_A > \alpha_B$ d) it is necessary that the coefficient α_A itself increase with temperature, while α_B be nearly constant
e) none of the above

10. Oscillations of two mass-spring systems are shown in the diagram. The two masses are equal ($m_1 = m_2$). The ratio of the energy of oscillation of the first system to that of the second one is



- a) 1.0 b) 4.0 c) 0.25 d) 2.0
 e) none of the above, my answer is _____

11. The intensity ^{level} of sound produced by a small source at a 10-m distance source is 60 dB. The intensity _{level} produced by two such sources at a 20-m distance will be

- a) 57 dB b) 30 dB c) 60 dB d) 63 dB
 e) none of the above, my answer is _____

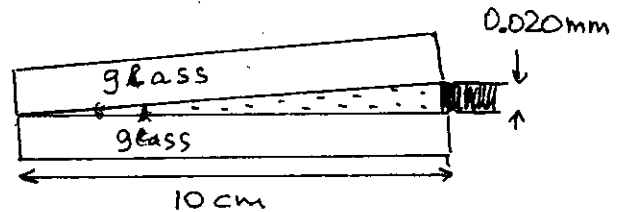
12. A pipe resonates at 100 Hz at 10 °C and atmospheric pressure. If the temperature of air in the room is raised by 20 °C, the resonant frequency of the pipe will

- a) increase b) decrease c) remain the same
 d) may decrease or increase depending on the type of the pipe.

V.V.O.P.P.C

Part B (64%) Show the way you arrive at your solutions

1. (10%) Two microscope glass plates, 10 cm long and of index of refraction 1.52, have one end in contact while at the other they are separated by a piece of paper 0.020 mm thick. The space between the plates contains water of refraction index 1.33. The light used is monochromatic, its wavelength in air being $\lambda = 500 \text{ nm}$.



1) Find the spacing of the interference fringes seen by reflection.

b) Is the fringe of the line of contact bright or dark ?

c) If water were substituted by carbon disulfide with $n = 1.63$, would the line of contact be bright or dark ?

2. (10%) A real object is imaged by the lens on a screen which is 15.0 cm from the lens. When the lens is moved 2.00 cm closer to the object, the screen must also be moved by a distance of 2.00 cm towards the lens in order to refocus the image.

a) Is the lens converging or diverging? Give your reasoning briefly.

b) Find the focal length of the lens.

3. (10%) Water flows into an office building through a pipe 5.50 cm in diameter at a speed of 0.50 m/s. At street level, the gauge pressure of the water in the pipe is 4.3 atm. In the building, the pipe tapers down to 2.50 cm in diameter.

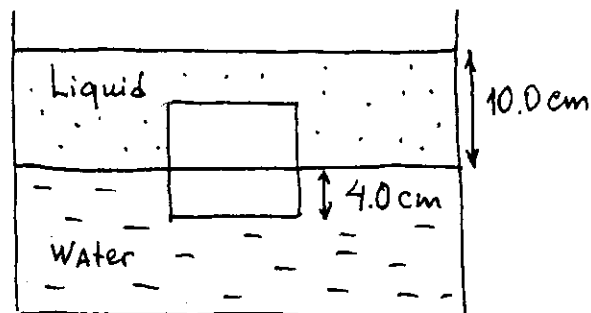
a) Find the flow velocity of water on the top floor, 25 m above the street level

$$\frac{A_1}{A_2} v_1 = v_2$$

b) Find the gauge pressure in the pipe on the top floor

$$P_2 = P_1 + \frac{1}{2} \rho v_1^2 - \frac{1}{2} \rho v_2^2 - \rho g y_2$$

4. (8%) A block of wood of cubic shape (10cm x10cm x10cm) and of density 0.8 g/cm³ floats at the interface between a liquid of unknown density and water. Its lower end is 4.0 cm below the interface



a) Find the density of the liquid



b) Find the pressure at the bottom surface of the block

5. (8%) An ideal gas is confined to a cylinder by a piston. The piston is pushed in slowly so that the gas temperature remains at 20°C . During the compression, 730 J of work is done on the gas.

a) Find the entropy change of the gas

b) Does this mean an increase or decrease in entropy? Justify your answer briefly in terms of entropy as a measure of disorder.

6. (8%) Three kilomoles of helium gas, initially at $T = 273 \text{ K}$, $P = 1.0 \text{ atm}$, expand isobarically to twice its initial volume.

- a) What is the final temperature of the gas?
- b) What is the work done by the gas?
- c) How much does the internal energy of the gas change?
- d) How much heat is supplied to the gas during the expansion?

7. (10%) A string of length $L = 1.0$ m and of mass $M = 20.0$ g, with both ends fixed, is under tension. The string vibrates, generating a pure harmonic sound of its fundamental frequency. A pipe of 3.0 m long, open at both ends, resonates to this sound. It is found that this is the smallest length of the pipe allowing resonance.

a) Find the wavelength and the frequency of the sound wave in the pipe. Take 345 m/s as the speed of sound in air.

b) Find the wavelength of the wave in the string.

c) Find the tension in the string.