25 pts total. May 15, 2012 Physics 132 midterm 2 Schwartz Name_____
If you get really stuck with something, make your best conceptual explanation

1) (5 pts) Delrin ® (polyoxymethelene plastic) is a lovely material to machine. It has a density of 1.41 g/cm^3 and a linear thermal coefficient expansion of about
1.3 x 10^{-4}/^{0}C, and costs about $1000 / cubic foot. I need a cubic meter.

a) (1 pt) About how much will this cubic meter cost?

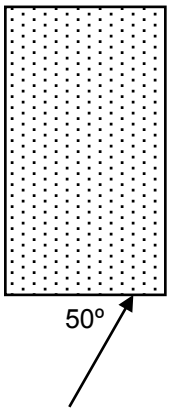
b) (2 pt) If I were weighing it with a spring scale and I put the whole thing under water, what force (in Newtons) would the spring scale read?

c) (2 pt) I increase the temperature from zero Celsius to 100 Celsius, will its density increase or decrease? By how much?

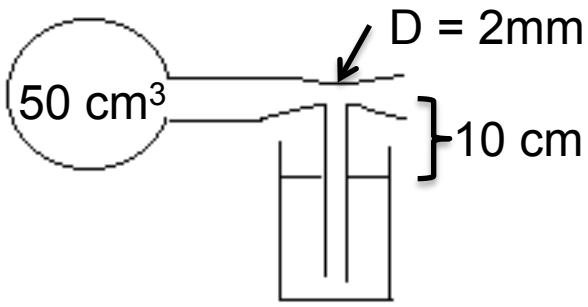
2) (4 pts) Below, you see a rectangular piece of Arsenic Trisulfide glass, (n=2.0).

a) (3 pts) ***Carefully*** finish the drawing of the ray through the rectangle. If possible, show all reflected and refracted rays.

b) (1 pt) Estimate the critical angle in this medium.



3)** (4 pts) I have a perfume bottle full of perfume (density the same as water). A 50 cm^3 bulb is connected to a tube that that narrows to a hole 2 mm in diameter. When I squeeze the bulb, the perfume gets pulled 10 cm up into a tube and mixes with the air to deposit some smell on you.



a) (2 pts) If I completely compress the bulb in one second, find the velocity of air in the thin part of the tube.

b) (2 pts) How fast does the air need to travel in the thin part of the tube in order to pull the perfume up the 10 cm distance?

****Density of air at sea level, 0 Celsius is 1.29 kg/m^3, or about 1/1000 that of water.**

4) (4 pts) I'm making bubbles and I notice some nice colors reflect off the bubbles. Say that I am almost perfectly between the sun and a bubble, so that sunlight still falls on the bubble's surface perpendicular to the surface and reflects back to my eye. The thickness of the bubble is ¼ micron (0.25 micrometer),

a) (1 pts) Explain why only certain wavelengths are reflected back at me… a nice drawing would be a good idea

b) (3 pts) What are the two longest wavelengths that are reflected?

5) (8 pts) I have a convex lens with a focal length of 5 cm, and I hold it 15 cm from a 2 mm ant, and look through it from afar.

a) (2 pts) Make a ray diagram of this situation.

b) (2 pts) Identify the location and size of the image.

Size = ____mm; Location = _____

c) (1 pt) Describe the image I see through the lens. Use words like : real virtual inverted erect enlarged diminished.

d) (3 pts) I slowly move the lens closer to the ant until it is touching the ant. Describe how the image changes during this process. You may make a graph or ray diagram if you like.

132 Schwartz Fall 2001 Formula sheet

k_B = 1.38 x 10^{-23} J/K = 8.6 x 10^{-5} eV/K
e = 1.60 x 10^{-19} C
m_p = 1.67x 10^{-27} kg
m_e = 9.11 x 10^{-31} kg
a_o = 0.0529 = 0.053 nm
R=8.31J/(mole*K)
N_A = 6.02x10^{23}

memorize: the speed of light
the speed of sound (in air at room temp.)
air pressure at sea level

L_{ice} = 80 cal/g
$L_{water\ vapor}$ = 540 cal/g
1 cal = 4.2 J

$$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt} = -kx = -\nabla U$$

$$|F| = \frac{\tau}{r}; \qquad K = \frac{1}{2}mv^2$$

$$U = \frac{1}{2}kx^2 = \frac{\#}{2}NkT = \frac{\#}{2}nRT = mgh$$

$$P = \frac{dE}{dt} = \vec{F}\cdot\vec{v} = \vec{\tau}\cdot\vec{\omega}$$

$$P = \frac{1}{2}\mu(\varpi y_o)^2 v = \frac{1}{2}\rho A(\varpi s)^2 v = IA$$

$$v = \frac{dx}{dt} = f\lambda = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{B}{\rho}} = \frac{c}{n}$$

$$y = A\cos(\varpi t + \phi) = A\cos(kx \pm \varpi t + \phi)$$

$$\varpi = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{l}} = \sqrt{\frac{mgd}{I}} = \sqrt{\frac{\kappa}{I}}$$

$$\sin a + \sin b = 2\sin\left(\frac{a+b}{2}\right)\cos\left(\frac{a-b}{2}\right)$$

$$W = \int \vec{F}\cdot d\vec{x} = \int pdV$$

$$W = p\Delta V = NKT\ln\left(\frac{V_f}{V_i}\right)$$

$$W = \frac{1}{\gamma - 1}(p_1V_1 - p_2V_2)$$

$$PV = NKT = nRT$$

$$dp = \rho g dh$$

$$p = p_O e^{\left(\frac{-h}{8600m}\right)}$$

$$p = \frac{1}{3}\frac{N}{V}mv_{rms}^2$$

$$T_F = \frac{9}{5}T_C + 32$$

$$P = \frac{F}{A} = -B\frac{\Delta V}{V}$$

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

$$\lambda = \frac{1}{A\rho} = \left[4\sqrt{2}\pi\left(\frac{N}{V}\right)r^2\right]^{-1}$$

$$P + \tfrac{1}{2}\rho v^2 + \rho gh = const$$

$$\Delta L = L_O\alpha\Delta T$$

$$\Delta Q = mc\Delta T = nC\Delta T = mL$$

$$\frac{dQ}{dT} = -\kappa A\frac{dT}{dx} = A(e\sigma T^4)$$

$$\sigma = 5.67x10^{-8}\frac{W}{m^2K^4}$$

$$\Delta E_{th} = Q + W$$

$$\Delta E_{th} = nc_V\Delta T$$

$$C_P = C_V + R$$

$$pV^\gamma = const.$$

$$\gamma = \frac{C_p}{C_v}$$

$$\eta = \frac{W}{Q_H} = \frac{Q_H - Q_C}{Q_H} \xrightarrow[reversible]{} \frac{T_H - T_C}{T_H} \qquad COP = \frac{Q_C}{W}, or\ \frac{Q_H}{W}$$

$$n_1\sin\theta_1 = n_2\sin\theta_2 \qquad \frac{1}{s_o} + \frac{1}{s'} = \frac{1}{f} \qquad \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$d\sin\vartheta = m\lambda \qquad \sin\vartheta_c = \frac{1.22\lambda}{a} \qquad M = -\frac{h'}{h_o} = -\frac{s'}{s_o}$$