Physics 10154 - Exam #10B

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (34 pts) The density of an ideal gas at a pressure of 1.0 atm and a temperature of 25° C is 550 grams/cm^3. If the pressure is increased to 1.5 atmospheres and the temperature rises to 75° C, what is the new density of the gas in mks units? Assume the number of molecules in the gas remains constant.

$P_1 = 1.0\ atm \qquad P_2 = 1.5\ atm$

$T_1 = 298K \qquad T_2 = 348K$

$$\frac{V_2}{V_1} = \frac{\frac{N_2}{N_1}\frac{k}{k}\frac{T_2}{T_1}}{P_2/P_1} = \frac{1 \cdot 1 \cdot 1.17}{1.5} = 0.7785$$

$$\frac{\rho_2}{\rho_1} = \frac{m_2/m_1}{V_2/V_1} = \frac{1}{.7785} = 1.28$$

$$\rho_2 = 1.28\,\rho_1 = 706\ g/cm^3$$

$= 0.706$ ~~or~~ $0.71\ kg/m^3$

$710{,}000\ kg/m^3$

2. (33 pts) A styrofoam cooler has a surface area of 1.2 square meters and a wall thickness of 2.5 cm. The temperature on the inside is 42° F. The temperature outside is 85° F. If it takes 6.0 hours for 4.0 kg of ice to melt from an initial temperature of 32° F and the resulting water to warm to 42° F, what is the thermal conductivity of the styrofoam in mks units (J / s m °C)?

The specific heat of water is 4186 J/kg °C.
The specific heat of ice is 2090 J/kg °C.
The latent heat of fusion for ice is 333,000 J/kg.

$\Delta T = 85F - 42F$

$= 29.4C - 5.56C$

$= 23.8C$

$$P = \frac{kA\Delta T}{L} = \frac{k(1.2)(23.8)}{.025}$$

$$= 1145k$$

$$P = \frac{\Delta Q}{t} = \frac{mL_f + mc\Delta T}{t}$$

$\Delta T = 42F - 32F$

$= 5.56 - 0$

$$= \frac{(4.0)(333{,}000) + (4.0)(4186)(5.56)}{21600s}$$

$$= 65.98$$

$$1145k = 65.98$$

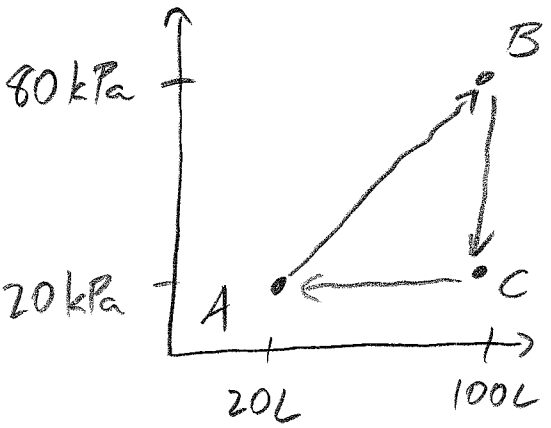
$$\boxed{k = .058 \ J/s \cdot m \cdot °C}$$

3. (33 pts) A gas has three states on a P-V diagram.

State A is a pressure of 20,000 Pa, volume of 20 L.
State B is a pressure of 80,000 Pa, volume of 100 L.
State C is a pressure of 20,000 Pa, volume of 100 L.

The gas cycles through the states in the order A --> B --> C --> A

If the heat added to the system during the A --> B step is 1500 Joules, how much heat is added to the system during the steps leading from B --> C --> A?



$W_{by\ gas}(A \to B) = (50{,}000)(.080) = 4000\,J$

$W_{by\ gas}(B \to C) = 0$

$W_{by\ gas}(C \to A) = (20{,}000)(-.080) = -1600\,J$

$2400\,J$

$\Delta U_{TOT} = -W_{by\ gas}(ABCA) + Q(ABCA)$

$0 = -2400 + Q_{TOT} \qquad Q_{TOT} = +2400$

$Q_{AB} + Q_{BCA} = +2400$

$1500 + Q_{BCA} = +2400$

$Q_{BCA} = 900\,J$