Physics 10154 - Exam #10D

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 35° C is 650 grams/cm^3. If the pressure is increased to 1.6 atmospheres and the temperature rises to 120° C, what is the new density of the gas in mks units? Assume the number of molecules in the gas remains constant.

$P_1 = 1.0\ atm \qquad P_2 = 1.6\ atm$

$T_1 = 308K \qquad T_2 = 393K$

$$\frac{V_2}{V_1} = \frac{\frac{N_2}{N_1}\frac{k}{k}\frac{T_2}{T_1}}{\frac{P_2}{P_1}} = \frac{1 \cdot 1 \cdot 1.276}{1.6} = 0.7975$$

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{M_2}{M_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{1}{.7975} = 1.254$$

$$\rho_2 = (1.254)(.650\ kg/m^3) \times 10^6$$

$$= \boxed{820{,}000\ g/m^3}$$

820,000

2. (33 pts) A styrofoam cooler has a surface area of 1.4 square meters and a wall thickness of 3.5 cm. The temperature on the inside is 41° F. The temperature outside is 75° F. If it takes 5.0 hours for 3.0 kg of ice to melt from an initial temperature of 32° F and the resulting water to warm to 41° 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.

$$P = \frac{kA\Delta T}{L} \qquad T_{in} = 41F = 5C \qquad T_{out} = 75F = 23.9C$$

$$= \frac{k(1.4)(18.9)}{.035} = 756k$$

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

$$= \frac{(3.0)(333{,}000) + (3.0)(4186)(5)}{18000\ s}$$

$$= 58.99$$

$$756k = 58.99$$

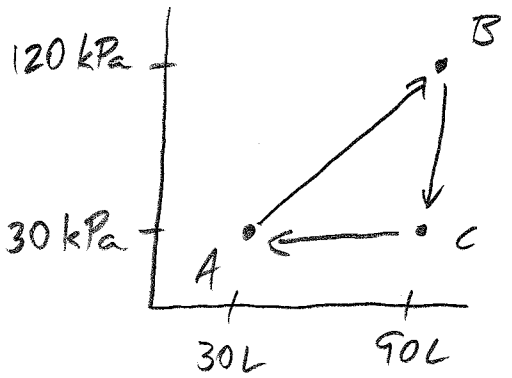
$$\boxed{k = 0.078\ J/s \cdot m \cdot °C}$$

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

State A is a pressure of 30,000 Pa, volume of 30 L.
State B is a pressure of 120,000 Pa, volume of 90 L.
State C is a pressure of 30,000 Pa, volume of 90 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 2100 Joules, how much heat is added to the system during the steps leading from B --> C --> A?



$W_{by\,gas}(A \to B) = (75000)(.060) = 4500\,J$

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

$W_{by\,gas}(C \to A) = (30000)(-.060) = -1800\,J$

$2700\,J$

$\Delta U_{TOT} = 0 = -W_{by\,gas} + Q_{TOT}$

$Q_{TOT} = +2700\,J$

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

$2100 + Q_{BCA} = +2700$ $\boxed{600\,J}$

$\boxed{Q_{BCA} = \text{[illegible]}}$