Physics 10154 - Exam #5a

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. (30 pts) The density of a gas at room temperature (20° C) is 0.213 kg/m^3 at atmospheric pressure. If the temperature is raised to 150° C and the pressure increases to 3.5 atmospheres, while keeping the number of atoms constant, what is the new density of the gas?

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{M_2}{M_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{V_1}{V_2} \qquad T_1 = 293K \quad T_2 = 423K$$

$$\frac{V_1}{V_2} = \frac{\left(\frac{N_1}{N_2}\right)\left(\frac{k}{k}\right)\left(\frac{T_1}{T_2}\right)}{\left(\frac{P_1}{P_2}\right)} = \frac{(1)(1)\left(\frac{293}{423}\right)}{\left(\frac{1.0}{3.5}\right)}$$

$$= 2.42$$

$$\rho_2 = (0.213)(2.42) = 0.516 \text{ kg/m}^3$$

or $\boxed{0.52 \text{ kg/m}^3}$

2. (30 pts) A 35 gram cube of ice at an initial temperature of -35°C is placed inside a 550 gram aluminum container with an initial temperature of 22° C.

What is the final temperature of this system when it reaches thermal equilibrium? If the final temperature is zero, determine how much of the ice melts.

The specific heat of ice is 2090 J/kg-C
The specific heat of water is 4186 J/kg-C
The specific heat of aluminum is 900 J/kg-C

The latent heat of fusion for water is 333,000 J/kg.

To heat ice to 0°C

$$\Delta Q = (.035)(2090)(35) = 2560\ J$$

To melt ice:

$$\Delta Q = (.035)(333{,}000) = 11655\ J$$

To cool Al to 0°C

$$\Delta Q = (.55)(900)(-22) = -10890$$

Enough heat in Al to warm ice to 0°C but not enough to melt all ice, so $T_F = 0$

$$\Delta Q_{ice} + \Delta Q_{Al} = 0$$

$$2560 + m_{ice}(333000) - 10890 = 0$$

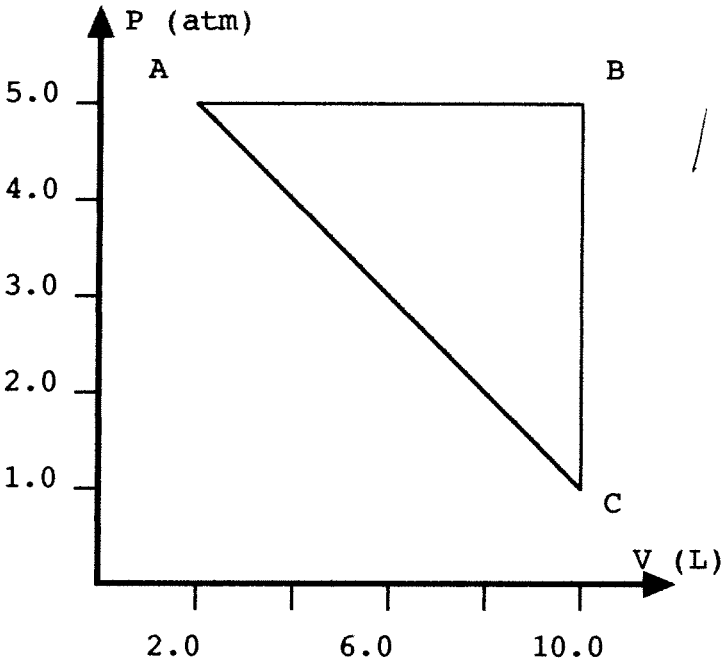
$$m_{ice} = \frac{8330}{333000} = .025\ kg$$

25 grams of ice melts

3. (40 pts) When a gas moves from state A directly to state C, the internal energy of the gas drops from 2400 J to 1100 Joules.

a) How much heat is added to the gas when it travels along the path ABC?

a) How much heat is added to the gas when it travels along the path ABCA?



$1\ L\cdot atm \cdot \frac{10^{-3}\ m^3}{L} \cdot \frac{10^5\ Pa}{atm}$

$= 100\ J$

$W(AB) = (5.0)(8.0) = 40\ L\cdot atm = 4000\ J$

a) $W(BC) = 0$

$\Delta U(ABC) = Q - W(ABC)$

$-1300 = Q - 4000$

$\boxed{Q_{ABC} = 2700\ J}$

b) $W(CA) = (3.0)(-8.0) = -24\ L\cdot atm = -2400\ J$

$\Delta U(ABCA) = Q(ABCA) - W(ABCA)$

$0 = Q(ABCA) - 1600\ J$

$\boxed{Q(ABCA) = 1600\ J}$