Physics 10154 - Exam #5d

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 an ideal gas a pressure of 1.5 atm and temperature of 25° C is 750 grams/cm^3. If the pressure rises to 2.2 atm and the temperature rises to 150° C, what is the new density of the gas in mks units? Assume the number of particles in the gas remains constant.

$N_1 = N_2$

$P_1 = 1.5\ atm \quad P_2 = 2.2\ atm$

$T_1 = 298K \quad T_2 = 423K$

$$\frac{V_2}{V_1} = \frac{\left(\frac{N_2}{N_1}\right)\left(\frac{k}{k}\right)\left(\frac{T_2}{T_1}\right)}{\left(P_2/P_1\right)} = \frac{(1)(1)\left(423/298\right)}{\left(2.2/1.5\right)} = 0.968$$

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{M_2}{M_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{1}{.968} = 1.033$$

$\rho_2 = 1.033\,\rho_1 =$ 775 g/cm^3

$=$ 0.775 kg/m^3

2. (30 pts) A gas has three states on a P-V diagram:

A: P = 20,000 Pa, V = 20 Liters
B: P = 70,000 Pa, V = 120 Liters
C: P = 20,000 Pa, V = 120 Liters

The gas cycles through the states in the order ABCA.

If the heat added to the system during the AB step is 1500 Joules, how much heat is added to the system as it moves through the steps BCA?

$$\Delta U(AB) = Q(AB) - W_{by\ gas}(AB)$$

$$W_{by\ gas}(AB) = P_{Avg}\,\Delta V = (45000\ Pa)(100\times10^{-3}\ m^3)$$

$$= 4500\ J$$

$$\Delta U(AB) = 1500 - 4500 = -3000$$

$$\Delta U(AB) + \Delta U(BCA) = 0 \quad (cycle)$$

$$\text{So } \Delta U(BCA) = +3000\ J$$

$$W_{by\ gas}(BCA) = W_{by\ gas}(BC) + W_{by\ gas}(CA)$$

$$= 0 + (20000)(-100\times10^{-3})$$

$$= -2000\ J$$

$$\Delta U(BCA) = Q(BCA) - W_{by\ gas}(BCA)$$

$$3000 = Q(BCA) - (-2000)$$

$$\boxed{Q(BCA) = 1000\ J}$$

3. (40 pts) A 2.5 kg aluminum pot is heated to an initial temperature of 360° C. 280 grams of water is poured into the pot with an initial temperature of 28° C.

Determine the final temperature of the system. If the final temperature is 100° C, then determine how many grams of water are converted into steam.

Q to cool Al to $100°C$: $(2.5)(900)(-260) = -585,000$

Q to heat water to $100°C$: $(.280)(4186)(72) = 84,400\,J$

Q to boil water $= (.280)(2.26\times10^6) = +632,800\,J$

$717,200$

So, not all water boils

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

$$-585000 + 84400 + m_w(2.26\times10^6) = 0$$

$$-500,600 + m_w(2.26\times10^6) = 0$$

$$m_w = \frac{500,600}{2.26\times10^6} = 0.2215$$

222 grams boils