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) Helium gas has a density of 0.181 kg/m^3 at an initial pressure of 1.0 atm and temperature of 38° C. If the number of atoms is kept constant while the pressure increases to 2.5 atm and the temperature increases to 73° C, what is the new density of the gas?

$N_1 = N_2$

$P_1 = 1.0\ atm \qquad P_2 = 2.5\ atm$

$T_1 = 311K \qquad T_2 = 346K$

$$\frac{V_2}{V_1} = \frac{\left(\frac{N_2}{N_1}\right)\left(\frac{k}{k}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{P_2}{P_1}\right)} = \frac{(1)(1)\left(\frac{346}{311}\right)}{2.5} = 0.445$$

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{M_2}{M_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{1}{.445} = 2.25$$

$\rho_2 = 2.25\rho_1 =$ **0.41 kg/m^3**

2. (30 pts) A gas has three states defined with the following pressures and volumes:

A: P = 1.0 atm, V = 4.0 L
B: P = 4.0 atm, V = 4.0 L
C: P = 4.0 atm, V = 9.5 L

As the gas moves state A –> B –> C, 520 Joules of heat are added to the gas. How many Joules of heat are added to the gas (or taken from the gas) as the gas moves from state C –> A?

$W_{by\,gas}(AB) = P_{avg}\,\Delta V = (2.5\,atm)(0) = 0$

$W_{by\,gas}(BC) = (4.0\,atm)(5.5\,L)$

$= (405200\,Pa)(5.5\times10^{-3}\,m^3) = 2230\,J$

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

$= 520 - 2230 = -1710\,J$

$\Delta U(ABC) + \Delta U(CA) = 0$ (cycle)

so $\Delta U(CA) =$ (1710 J)

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

$W_{by\,gas}(CA) = P_{avg}\,\Delta V = (2.5\,atm)(-5.5\,L)$

$= (253250)(-5.5\times10^{-3})$

$=$ (−1390 J)

$+1710 = Q(CA) - (-1390)$

$Q(CA) = 310\ J$

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: $(.280)(4186)(72) = 84,400\text{J}$

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

$-585,000 + 84,400 + 632,800 = 717,200$

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