Physics 10154 - Exam #5b

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. (33 pts) Helium gas has a density of 0.181 kg/m3 at an initial pressure of 1.0 atm and a temperature of 35°C. If the number of atoms is kept constant, and the pressure increases to 1.5 atm while the temperature increases to 85°C, what is the new density of the gas?

$V_1 = ?$ $\quad V_2 = ?$

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

$T_1 = 308\ K$ $\quad T_2 = 358\ K$

$N_1 = N_2$

$$\frac{V_2}{V_1} = \frac{\left(\frac{N_2}{N_1}\right)\left(\frac{R}{R}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{P_2}{P_1}\right)} = \frac{(1)(1)\left(\frac{358}{308}\right)}{\left(\frac{1.5}{1.0}\right)} = 0.775$$

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{M_2}{M_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{(1)}{(.775)} = 1.29$$

$$\rho_2 = 1.29\,\rho_1 = \boxed{0.234\ kg/m^3}$$

2. (33 pts) 60 grams of ice at a temperature of -35°C is dropped into a 540 gram aluminum container at an initial temperature of 85°C.

What is the final temperature of the system? If the final temperature of the system is 0°C, how much 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: $Q = (.060)(2090)(35)$

$= 4389$

To melt ice: $Q = (.060)(333000)$

$= 19980$ total $= 24369$

To cool Al: $Q = (.540)(900)(-85)$

$= -41310$ more than this, so all ice melts

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

$$24369 + (.060)(4186)(T_F - 0) + (.540)(900)(T_F - 85) = 0$$

$$24369 + 251.16\,T_F + 486\,T_F - 41310 = 0$$

$$737.16\,T_F = 16941$$

$$T_F = \frac{16941}{737.16} = \boxed{23^\circ C}$$

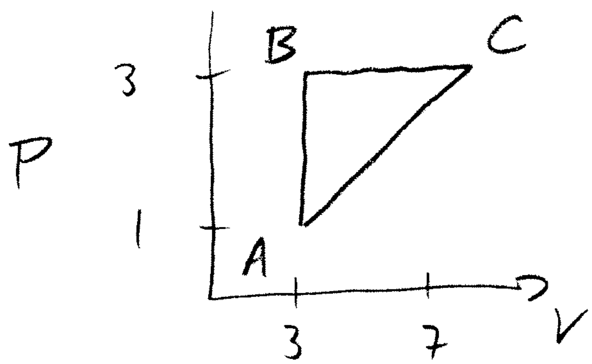
3. (33 pts) A gas has three states defined with the following pressures and volumes:

A: P = 1.0 atm, V = 3.0 L

B: P = 3.0 atm, V = 3.0 L

C: P = 3.0 atm, V = 7.0 L

As the gas moves from state A --> B --> C, and 550 Joules of heat are added to the gas. How many Joules of heat are added to the gas if the gas moves from state C --> A?



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

$W_{by\,gas}(B \to C) = (3\,atm)(4\,L)$

$= (303900\,Pa)(4 \times 10^{-3}\,m^3)$

$= 1215.6$

$\Delta U(A \to B \to C) = 550 - 1215.6 =$

$= -665.6$

Therefore $\Delta U(C \to A) = \underline{665.6}$ so that

$\Delta U(\text{cycle}) = 0$

$W_{by\,gas}(C \to A) = \bar{P}\Delta V = (2\,atm)(-4\,L)$

$= (202600)(-4 \times 10^{-3})$

$= -810.4$

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

$665 = Q - (-810.4)$

$Q = 665 - 810.4$

$= \boxed{-145\,J}$