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) A tank of volume 0.240 m^3 contains helium gas at a pressure of 125 atm. How many spherical balloons can the tank fill if each filled balloon is a sphere with a diamter of 21 cm and an absolute pressure of 1.1 atm? You can assume no gas is lost or gained during the process.

$V_1 = 0.240\ m^3$ $\quad V_2 = ?$

$P_1 = 125\ atm$ $\quad P_2 = 1.1\ atm$

$N_1 = N_2$

$T_1 = T_2$

$$\frac{V_2}{V_1} = \frac{\left(\frac{N_2}{N_1}\right)\left(\frac{k}{k}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{P_2}{P_1}\right)} = \frac{(1)(1)(1)}{\left(\frac{1.1}{125}\right)}$$

$$\frac{V_2}{V_1} = 113.64 \qquad V_2 = 27.27\ m^3$$

$$V_{BAL} = \frac{4}{3}\pi r^3 = .00485\ m^3$$

$$N = \frac{V_2}{V_{BAL}} = \boxed{5600}$$

2. (40 pts) 35 grams of ice (c = 2090 J/kg-C) at an initial temperature of -81°C is placed into a 74 gram aluminum container (c = 900 J/kg-C) which is filled with 64 grams of water (c = 4186 J/kg-C). Both container and water are at a temperature of 32°C. The latent heat of fusion for water is 333,000 J/kg.

Calculate the final temperature of the system.

If the final temperature is zero, calculate how much ice melts.

$m_{ice} = 0.035$ kg $m_{Al} = 0.074$ $m_w = .064$

$c_{ice} = 2090$ $c_{Al} = 900$ $c_w = 4186$

$T_i = -81°C$ $T_i = 32°C$ $T_w = 32°C$

Warming: heat ice: $Q = (.035)(2090)(81) = 5925$ J

melt ice: $Q = (.035)(333{,}000) = 11655$ J

17580 J

Cooling cool Al: $Q = (.074)(900)(-32) = -2131$ J

cool water: $Q = (.064)(4186)(-32) = -8573$ J

-10704 J

$|Q|$ to warm up & melt ice $> |Q|$ to cool Al + water, so not all ice melts.

$T_F = 0$

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

$5925 + m(333000) - 2131 - 8573 = 0$

$m(333000) = 4779$

$m = .01435$

14g melts

3. (30 pts) A substance undergoes the cyclic process as follows, and it moves from one state to another along a straight line on the P-V diagram: ABCA

State A has P = 2.00 atm, V = 40.0 L, U = 45600 J.

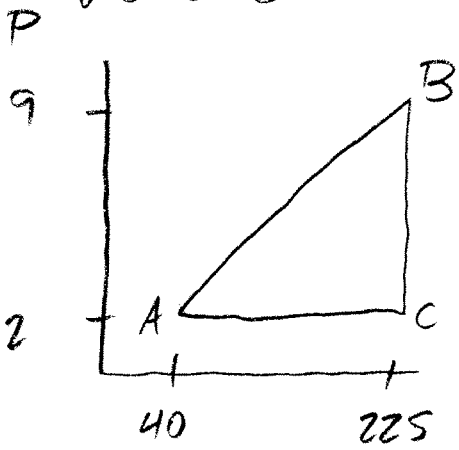
State B has P = 9.00 atm, V = 225 L, U = 123000 J.

State C has P = 2.00 atm, V = 225 L.

a) Determine the work done by the gas during each step.

b) Find the heat added to the gas during this entire cycle.

c) ~~Find the internal energy of state C.~~



$W(A \to B) = \bar{P}\,\Delta V$

$= (5.5\ \text{atm})(185\ \text{L})$

$= (557150\ \text{Pa})(185 \times 10^{-3}\ \text{m}^3)$

$W(A \to B) = 103000\ \text{J}$

$W(B \to C) = 0 \quad \Delta V = 0$

$W(C \to A) = (2.0\ \text{atm})(-185\ \text{L})$

$= (202600)(-185 \times 10^{-3}) = -37500\ \text{J}$

6) $\Delta U_{TOT} = Q_{TOT} - W_{TOT} = 0$

$W_{TOT} = 103000 + 0 - 37500 = 65500 = Q_{TOT}$