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. (35 pts) 3.5 moles of an ideal gas are held in a container at a pressure of 2.0 atmospheres and a temperature of 25° C.

a) What is the volume of the container, in Liters?

b) Keeping the number of moles constant, the volume of the container is doubled, and the temperature is increased to 75°C. How much work is done by the gas during this expanasion, in Joules?

$n_1 = 3.5$ moles

$P_1 = 2.0$ atm

$T_1 = 25°C = 298K$

$$V_1 = \frac{n_1 R T_1}{P_1} = \frac{(3.5)(.0821)(298)}{2.0} = 43\ L$$

b) $n_1 = n_2$

$V_1 = \frac{1}{2} V_2$

$T_2 = 348K$

$$\frac{P_2}{P_1} = \frac{\left(\frac{n_2}{n_1}\right)\left(\frac{R}{R}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{(1)(1)\left(\frac{348}{298}\right)}{(2)}$$

$= 0.584$

$P_2 = 0.584 P_1 = 1.17$ atm

$P_{Avg} = \frac{2.0 + 1.17}{2} = 1.58$ atm

$W_{by\ gas} = P_{Avg} \Delta V$

$= (1.58\ atm)(43\ L)$

$= (1.60 \times 10^5\ Pa)(43 \times 10^{-3}\ m^3) = 6900\ J$

2. (35 pts) 35 grams of ice (c = 2090 J/kg-°C) at an initial temperature of -81°C is placed into a 640 gram aluminum container (c = 900 J/kg-°C) at an initial temperature of 45°C. The latent heat of fusion for water is 333,000 J/kg. Also, the specific heat of water is 4186 J/kg-°C.

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

To heat ice to 0°C : $(.035)(2090)(81) = 5925\ J$

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

$17580\ J$

To cool Al to 0°C : $(.640)(900)(-45) = -25920\ J$

So all ice melts, $T_F > 0$

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

$$17580 + (.035)(4186)(T_F - 0) + (.640)(900)(T_F - 45) = 0$$

$$17580 + 146.51 T_F + 576 T_F - 25920 = 0$$

$$722.51 T_F = 8340$$

$$T_F = 12°C$$

3. (30 pts) A spring (k = 320 N/m) has a 2.5 kg mass attached. The spring is stretched by 15 cm and released from rest, free to oscillate back and forth on a frictionless, horizontal surface.

a) What maximum velocity does the mass reach while oscillating on the spring?

b) What is the mechanical energy of the system?

c) If the coefficient of kinetic friction between the mass and the surface is 0.33, what is the velocity of the mass when it passes through equilibrium for the first time after being released?

$k = 320$ N/m

$m = 2.5$ kg

$A = 0.15$

a) V_{max} occurs at $x = 0$

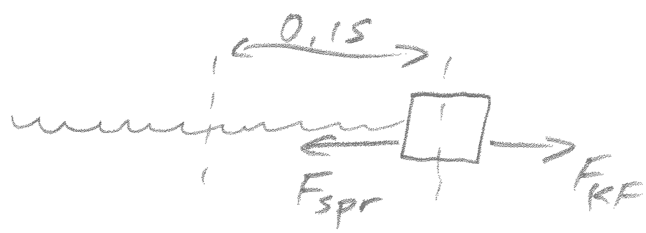
$$v = \sqrt{\frac{k}{m}(A^2 - x^2)}$$

$$= \sqrt{\frac{320}{2.5}(.15)^2}$$

$$= 1.7 \text{ m/s}$$

b) $E = \frac{1}{2}kA^2 = \frac{1}{2}(320)(.15)^2 = 3.6 \text{ J}$

c)



$$W_{KF} = (F_{KF})(\Delta s)\cos\theta$$

$$= (\mu_K F_N)(\Delta s)(-1)$$

$$= \mu_K mg\Delta s(-1)$$

$$= -\mu_K mg\Delta s$$

$$\Sigma W_F = W_{spr} + W_{KF} = \Delta K$$

$$\frac{1}{2}kx^2 - \mu_K mg\Delta s = \frac{1}{2}mv^2 - 0$$

$$3.6 - 1.2 = \frac{1}{2}(2.5)v^2$$

$$2.4 = 1.25v^2$$

$$v = 1.4 \text{ m/s}$$