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. (33 pts) An unknown quantity of gas is in a piston chamber at an initial pressure of 2.5 atm, initial volume of 1.2 Liters and initial temperature of 150°C. The gas expands to a new state with a final pressure of 1.5 atm and final temperature of 50°C.

a) What is the new volume of gas, in liters?

b) How much work is done by the gas during the expansion?

$P_1 = 2.5\,atm \qquad P_2 = 1.5\,atm$

$V_1 = 1.2\,L \qquad V_2 = ?$

$T_1 = 423\,K \qquad T_2 = 323\,K$

$$\frac{V_2}{V_1} = \frac{\left(\frac{n_2}{n_1}\right)\left(\frac{R}{R}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{P_2}{P_1}\right)} = \frac{(1)(1)\left(\frac{323}{423}\right)}{\left(\frac{1.5}{2.5}\right)} = 1.27$$

$$\boxed{V_2 = 1.53\,L}$$

$$W = \bar{P}\Delta V = (2.0\,atm) * (0.33\,L)$$

$$= (202600)(0.33 \times 10^{-3}) = \boxed{67\,J}$$

2. (33 pts) 60 grams of ice at a temperature of -20°C is dropped into a 240 gram aluminum container at an initial temperature of 65°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 to 0°: $Q = (.060)(2090)(20)$

$= 2508$

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

$= 19980$

To cool Al to 0°: $Q = (.240)(900)(-65)$

$= -14040$

Takes more heat than Al can give to heat up + melt ice, so not all ice melts: $T_F = 0°$

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

$2508 + m(333000) - 14040 = 0$

$m = \frac{11532}{333000} = .0346$

so 34.6 g of ice melts

3. (33 pts) A 1.5 kg mass is attached to a horizontal spring with spring constant k = 120 N/m. The mass initially stretches the spring to a length of 48 cm and released from rest.

a) Assuming the surface is frictionless, how fast is the mass moving after it has moved [redacted] to the spring's equilibrium point?

b) If the coefficient of kinetic friction between the mass and the surface is 0.55, how fast is the mass moving at the same place as in part a?

a) $\Sigma W_F = W_{spr} = \frac{1}{2}mv^2 - 0$

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$$

$$\frac{1}{2}(120)(.48)^2 = \frac{1}{2}(1.5)v^2$$

$$v^2 = 18.4$$

$$\boxed{v = 4.3\ m/s}$$

b) $\Sigma W_F = W_{spr} + W_{KF} = \frac{1}{2}mv^2 - 0$

$$\frac{1}{2}kx^2 - \mu_k mgx = \frac{1}{2}mv^2$$

$$\frac{1}{2}(120)(.48)^2 - (.55)(1.5)(9.8)(.48) = \frac{1}{2}(1.5)v^2$$

$$13.824 - 3.881 = 0.75v^2$$

$$v^2 = 13.26$$

$$\boxed{v = 3.6\ m/s}$$