Physics 10154 - Exam #5~~b~~d

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) 54 grams of water (c = 4186 J/kg-°C) is at an initial temperature of 25°C. The water is poured onto a hot 4.0 kg iron skillet (c = 448 J/kg-°C) at a temperature of 160°C. The specific heat of steam is 2010 J/kg-°C, and the latent heat of vaporization for water is 2.26×10^6 J/kg.

What is the final temperature of the system? If the final temperature is 100°C, determine how much water vaporizes.

To heat water to 100°C : $(.054)(4186)(75) = 16953$

To vaporize water : $(.054)(2.26 \times 10^6) = 122040$

138993 J

To cool iron to 100°C : $(4.0)(448)(-60) = -107520$ J

Enough Q to heat water to 100°C but not to vaporize all water, so $T_F = 100°C$

$\Delta Q_w + \Delta Q_{iron} = 0$

$16953 + m_w(2.26 \times 10^6) - 107520 = 0$

$m_w(2.26 \times 10^6) = 90567$

$m_w = .040$ kg or 40 g

23. (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 $x = 0$

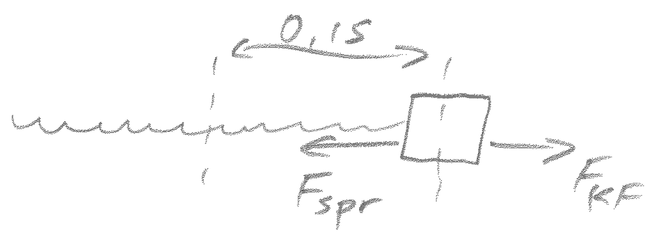
$$V = \sqrt{\frac{k}{m}(A^2 - x^2)}$$

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

$$= 1.7\ m/s$$

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

c)



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

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

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

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

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

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

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

$$2.4 = 1.25v^2$$

$$v = 1.4\ m/s$$

3. (35 pts) A gas initially has a pressure of 2.0 atm at a volume of 5.0 L (state A). It expands at constant pressure to a volume of 22 L (state B). The pressure then drops to 0.75 atm while remaining at a constant volume of 22 L (state C). If 1300 J of heat is added to the gas as it moves from state A to B, how much heat must be added to the gas in order for it to complete the cycle by moving from B -> C -> A?

$$W_{by\ gas}(AB) = (2.0\ atm)(17\ L)$$
$$= (2.0 \times 10^5\ Pa)(17 \times 10^{-3}\ m^3) = 3400\ J$$

$$W_{by\ gas}(BC) = 0 \quad (\Delta V = 0)$$

$$W_{by\ gas}(CA) = (1.375\ atm)(-17\ L)$$
$$= (1.375 \times 10^5\ Pa)(-17 \times 10^{-3}\ m^3) = -2340\ J$$

$$W_{by\ gas}(ABCA) = 1060\ J$$

$$\Delta U(ABCA) = 0 \quad (cycle)$$

$$Q(ABCA) = W_{by\ gas}(ABCA) = 1060\ J$$

$$Q(AB) + Q(BCA) = Q(ABCA)$$

$$1300 + Q(BCA) = 1060$$

$$\boxed{Q(BCA) = -240\ J}$$