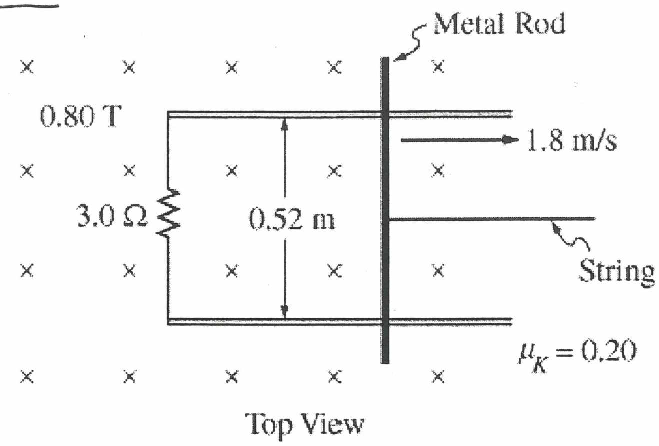
Name Key   AP Review #84



3. (15 points)

A metal rod of mass 0.22 kg lies across two parallel conducting rails that are a distance of 0.52 m apart on a tabletop, as shown in the top view above. A 3.0 Ω resistor is connected across the left ends of the rails. The rod and rails have negligible resistance but significant friction with a coefficient of kinetic friction of 0.20. There is a magnetic field of 0.80 T perpendicular to the plane of the tabletop. A string pulls the metal rod to the right with a constant speed of 1.8 m/s.

(m, d, R, μ, B, v)

(a) Calculate the magnitude of the current induced in the loop formed by the rod, the rails, and the resistor. (I; none, ∥)

(b) Calculate the magnitude of the force required to pull the rod to the right with constant speed.

(c) Calculate the energy dissipated in the resistor in 2.0 s.

(d) Calculate the work done by the string pulling the rod in 2.0 s.

(e) Compare your answers to parts (c) and (d). Provide a physical explanation for why they are equal or unequal.

a) $I = \frac{\varepsilon}{R} = \frac{(B\ell v)}{R} = \frac{(.80\,T)(.52\,m)(1.8\,m/s)}{3.0\,\Omega} = .25\,A$

(1) ohm's (1) Faraday (1) answer "symbolic or numeric"

b) $F_A = F_B + F_f = BI\ell + \mu F_N = BI\ell + \mu mg$

(1) multiple forces eqn, FBD (1) F_B (1) friction

$= (.80\,T)(.25\,A)(.52\,m) + (.20)(.22\,kg)(9.81\,m/s^2)$

$= .54\,N$

(1) answer

c) $W = Pt = ~~IVt~~ = I^2Rt = ~~\frac{V^2t}{R}~~$

(1) energy eqn

(1) power eqn $= (.25\,A)^2(3.0\,\Omega)(2.0\,s)$

(1) sub consistent $= .38\,J$

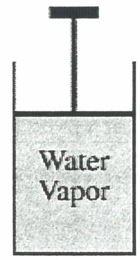
d) $W = Fd = Fvt = (.54\,N)(1.8\,m/s)(2.0\,s)$

(1) correct distance eqn (1) sub

$= 1.9\,J$

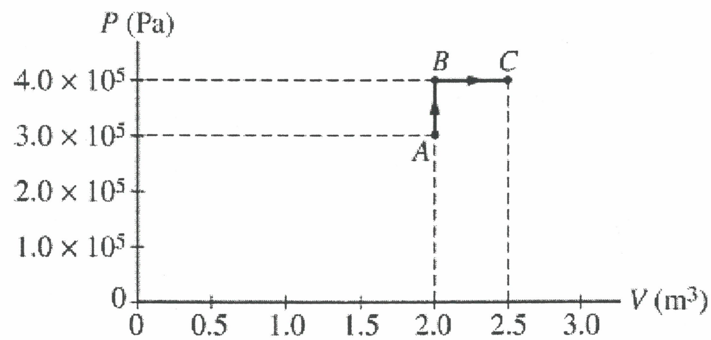
e) The work done by the string is also used to overcome friction, so more work needs to be done by the string due to this force. (2)

(1) Correct units on ALL answers



4. (10 points)

The cylinder represented above contains 2.2 kg of water vapor initially at a volume of 2.0 m^3 and an absolute pressure of 3.0×10^5 Pa. This state is represented by point A in the PV diagram below. The molar mass of water is 18 g, and the water vapor can be treated as an ideal gas.



a) (1) calc n: ① $n = \frac{m}{M} = \frac{2.2\text{ kg}}{18 \times 10^{-3}\text{ kg}} = 120\text{ mol}$

② $PV = nRT$, $T = \frac{PV}{nR}$ (1) eqn + sub (not just eqn)

$= \frac{(3.0 \times 10^5\text{ Pa})(2.0\text{ m}^3)}{(120\text{ mol})(8.31\text{ J/mol K})}$ (1) sub

$= 602\text{ K}$

(a) Calculate the temperature of the water vapor at point A.

The absolute pressure of the water vapor is increased at constant volume to 4.0×10^5 Pa at point B, and then the volume of the water vapor is increased at constant pressure to 2.5 m^3 at point C, as shown in the PV diagram.

(b) Calculate the temperature of the water vapor at point C.

(c) Does the internal energy of the water vapor for the process $A \to B \to C$ increase, decrease, or remain the same?

(1) _X_ Increase ____ Decrease ____ Remain the same

Justify your answer.

(d) Calculate the work done on the water vapor for the process $A \to B \to C$.

b) $T_C = \frac{P_C V_C}{nR} = \frac{(4.0 \times 10^5\text{ Pa})(2.5\text{ m}^3)}{(120\text{ mol})(8.31\text{ J/mol K})} = 1000\text{ K}$ (1) answer w/unit

d) (1) eqn $W = -P\Delta V$

$= -(4.0 \times 10^5\text{ Pa})(.5\text{ m}^3)$

$= -2.0 \times 10^5\text{ J}$ (1) negative (1) answer w/unit

c) The internal energy is proportional (2) to temperature, since the temperature increased the internal energy increased.