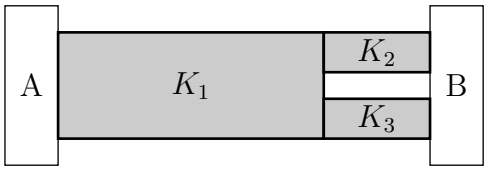
4C-999: Electromagnetism for Sci/Eng NAME: _____

Week 03

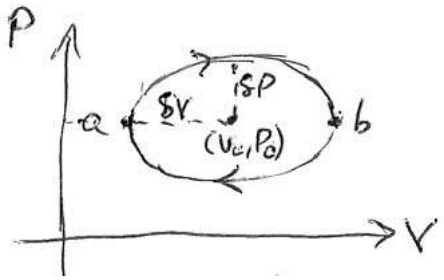
Group: _____

1. (8 points) System A is at 40°C and system B is at 0°C. The two systems are connected by a sequence of rods with conductances $K_1 = 100\,\mathrm{W/K}$, $K_2 = 125\,\mathrm{W/K}$ and $K_3 = 175\,\mathrm{W/K}$, as shown below.

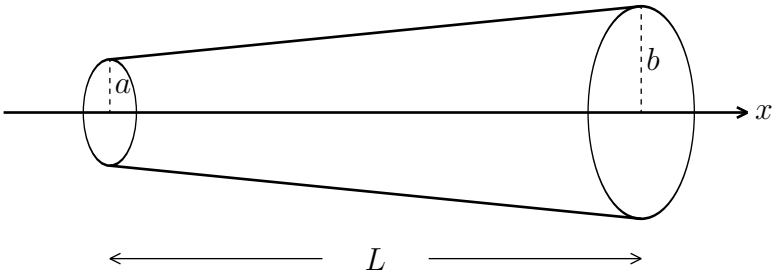


Calculate the rate of heat flow through each rod and the temperature in the middle where K_1 is connected to the parallel combination of K_2 and K_3.

2. (2 points) A particular system executes a cyclical process whose P-V graph is a clockwise-directed ellipse centered at (V_0, P_0) and radii δV and δP, respectively. Calculate the net work done and the net heat flow into / out of this system during one cycle.



3. (10 points) The left face of a rod at $x = 0$ (shown below) is fixed at a temperature of $T(0)$ and the right face at $x = L$ is fixed at a temperature of $T(L)$. The radius varies from a to b uniformly as x varies from 0 to L. The material has a thermal conductivity k which is the same throughout the entire volume.



a. (4 points) Show that the temperature profile is given by

$$T(x) - T(0) = -\frac{x}{k\pi a r}\frac{dQ}{dt}$$

where r is the radius at x. Hint: Recall that $dT/dx = (-1/k\pi r^2)dQ/dt$. This should be integrated over x, although the integral can be most easily done if you substitute $x \to r$.

b. (2 points) Determine the thermal conductance of the entire rod.

c. (4 points) If $T(0) = 80°\text{C}$, $T(L) = 20°\text{C}$, and $b = 2a$, calculate $T(L/2)$.