Massachusetts Institute of Technology
Physics Department

8.01X **Fall 2001**

PROBLEM FOR EXPERIMENT ET: Energy Transformation

Handed out: October 26. Due: November 2 at 5 pm in 4-339B. The Experiment must be checked off in the lab.

Lab hours: Monday Oct 29 3-5 pm, Tuesday Oct 30 7:30-9:30 pm, Wednesday Oct 31 7:30-9:30 pm, Thursday November 1 3-5 pm, Friday November 2 11am-noon

Problem: Experiment ET

Part I: FITTING THE CALIBRATION DATA

a) Make a data table for your thermistor resistance R and temperature T measurements. Plot the thermistor resistance versus temperature with temperature along the horizontal axis.

b) Plot $\ln R$ versus and fit a straight line to the data points (by eye and ruler). Determine the constants $\ln R_0$ (the intercept at T = 0) and α (negative of the slope). The temperature T can then be obtained from

$$T = (\ln R_0 - \ln R)/\alpha$$

for any measured value of R. Check it for a couple of the values of R you measured to see if you get the proper temperatures.

c) What temperature do you obtain for resistance readings of 10Ω, 50Ω, *100*Ω, 150Ω, and 200Ω?

PART II: DETERMINING THE SPECIFIC HEAT OF WATER

d) What length of 800-resistance wire did you use when the 1157 lamp was connected? What voltage did you measure across the 800 wire? What was the power $P = I\Delta V_L$ delivered to the lamp?

e) Make a data table for your time and resistance measurements when the 8W filament was placed in the water. Add a third column for the conversion of your resistance measurements to temperature measurements using your calibration results from part b).

f) What values did you measure for the measured depth d (in cm) of water in the cup, the bottom radius, r_1, and the top radius, r_2, of the cup and its height h? What was your water volume V in cm^3 and the mass in kilograms?

g) Plot the temperature versus time, using an expanded ordinate scale that includes only the range of temperatures encountered, i.e., do not start the ordinate at 0° C; start it at ~20° C.

h) Fit a straight line by eye, which goes through the data points, and determine the slope dT/dt in units of deg/s for both the heating phase and the cooling phase.

i) The equivalence between electrical power and the rate of heat flow is

$$I\Delta V_L \cong m_w c_w \frac{dT}{dt}.$$

Use this result to obtain a value for the specific heat, c_w, of water in $[J/kg\cdot K]$. How does your result compare to the accepted experimental value for water.

j) Discuss the errors that occurred in your experiment. Which ones do you think are the most significant? Can you estimate their effect on your result?

k) If the room temperature is exactly between your initial and final temperatures of your water, how would this effect the power loss and gain due to conductive heating?

l) What is the approximate effect of the heat capacity of the light lamp, which has a mass of about 9 g (note that $c_{glass} \approx 1000\,J/kg\cdot K$ and $c_{brass} \approx 300\,J/kg\cdot K$)?