Experiment 6

Building and using a digital thermometer

Some things happen so fast that one simply cannot monitor them without help from a fast computer in the role of a data taker. One example is a rapid quench which occurs when a hot body is immersed into a cold fluid. Is the rate of cooling still proportional to the temperature difference?

(!) Assemble the thermistor circuit as shown in Fig.6.1.

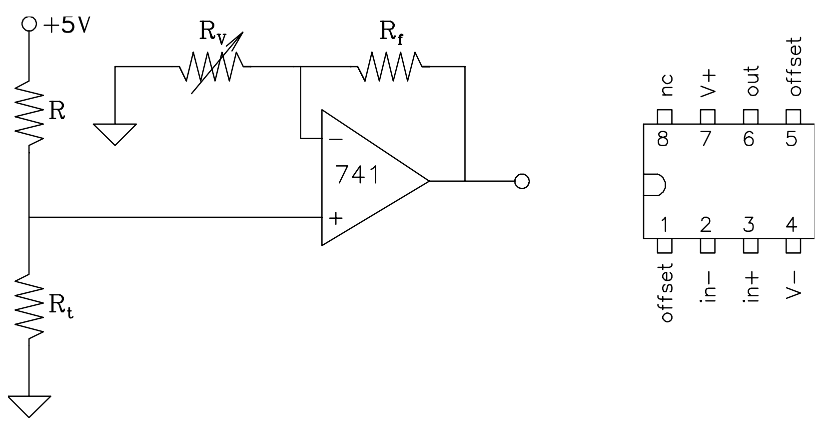

Figure 6.1: **Thermistor circuit.**
R, $R_f \sim 10\mathrm{k}\Omega$; $R_V = 10\mathrm{k}\Omega$ potentiometer; $R_t =$ thermistor, R_t decreases as temperature increases

(!) Immerse thermistor and mercury thermometer into a beaker of ice-water at $t = 0°\mathrm{C}$. Adjust R_V so that $V \approx 9.5\,\mathrm{V}$ at 0°C.

Calibrate V as a function of t. Slowly heat the water — so as to maintain thermal quasi-equilibrium — and measure V and t at $\sim 5\,\mathrm{s}$ intervals. Heat to $\sim 60°\mathrm{C}$. Use little water for speed. Use the program you have written to measure V; record temperature readings from the mercury thermometer by hand.

(!) Plot and analyze your data and create the temperature calibration plot of the thermistor circuit.

- ❗ *Optional:* modify your program to report true temperature in °C.

- ❗ Prepare two beakers, one with ice-water, one at a moderately high temperature. Immerse the thermistor/mercury thermometer assembly into the hot one. Modify your program to perform a frame grab of a large number of points. Start the program and rapidly transfer the assembly into the ice-water beaker. Use your calibration data to plot true temperature as a function of time and analyze your data, attempting to verify Newton's law of cooling (the rate of cooling is proportional to the temperature difference). Note and comment on the deviations from the exponential behaviour.