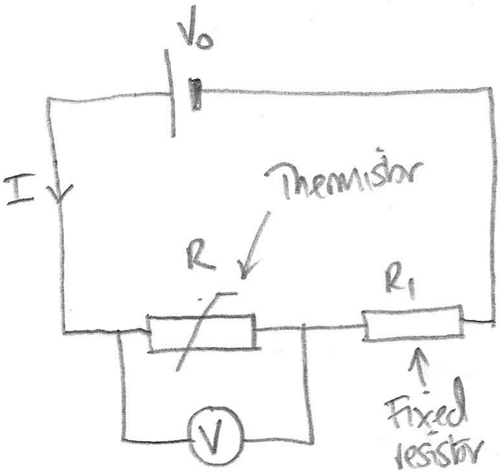
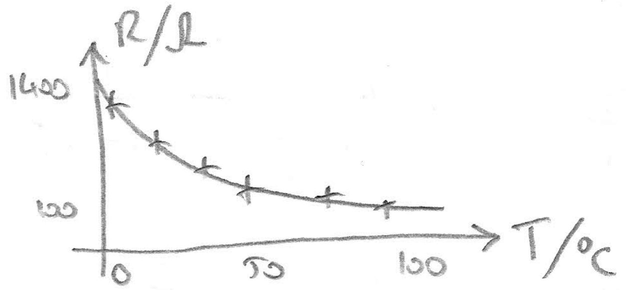
Thermistor & Potential divider

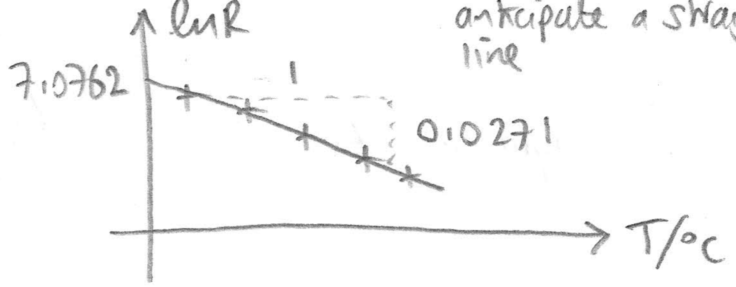




Resistance of thermistor decays $\propto$ exponentially with temperature

Model: $\boxed{R = R_0 e^{-kT}}$ (*)

From a line of best fit to $\ln R$ vs T ↖ From (*) we anticipate a straight line



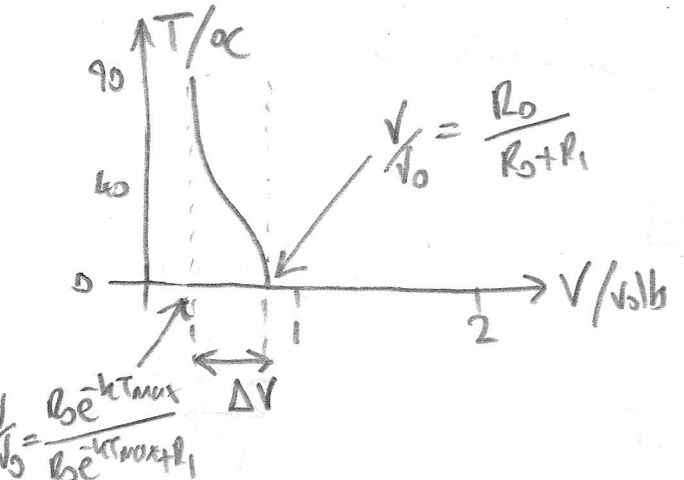
ie $R_0 \simeq e^{7.0762} \simeq \boxed{1183\,\Omega}$

$k \simeq \boxed{0.0271}$

Potential divider circuit

$$\frac{V}{V_0} = \frac{R}{R+R_1}$$

For our circuit $V_0 \simeq 2$ volts



For greater $\boxed{\text{precision}}$ want ΔV to be as large as possible. So what should R_1 be?

$$\frac{\Delta V}{V_0} = -\frac{R_0 e^{-kT_{max}}}{R_0 e^{-kT_{max}}+R_1} + \frac{R_0}{R_0+R_1}$$

$$\frac{\Delta V}{V_0} = -\frac{1}{1+\frac{R_1}{R_0}e^{kT_{max}}} + \frac{1}{1+R_1/R_0}$$

let $y = \Delta V / V_0$; $x = \frac{R_1}{R_0}$; $a = e^{kT_{max}}$

$T_{max} = 80°C$

$$\therefore y = \frac{-1}{1+ax} + \frac{1}{1+x}$$

To maximize y, find x s.t. $\frac{dy}{dx} = 0$

$$y = -\frac{1}{1+ax} + \frac{1}{1+x}$$

$$\frac{dy}{dx} = +\frac{a}{(1+ax)^2} - \frac{1}{(1+x)^2}$$

$$\frac{dy}{dx} = 0 \quad \text{when} \quad \frac{a}{(1+ax)^2} = \frac{1}{(1+x)^2}$$

$$a(1+2x+x^2) = 1 + 2ax + a^2x^2$$

$$a + ax^2 = 1 + a^2x^2$$

$$a-1 = a(a-1)x^2$$

$$\boxed{\frac{1}{\sqrt{a}} = x}$$

$\therefore$ optimum R_1 is $\boxed{R_1 = R_0 e^{-\frac{1}{2}kT_{max}}}$

ie $R_1 = 1183 \times e^{-\frac{1}{2}0.0271 \times 90}$

$\approx \boxed{349.4\ \Omega}$

$[e^{\frac{1}{2}kT_{max}} \approx 3.385]$

So $\Delta V_{max} = -\frac{1}{1+\sqrt{a}} + \frac{1}{1+\frac{1}{\sqrt{a}}}$

$$= -\frac{1}{1+\sqrt{a}} + \frac{\sqrt{a}}{\sqrt{a}+1}$$

$$= \frac{-1+\sqrt{a}}{1+\sqrt{a}} = \frac{e^{\frac{1}{2}kT_{max}}-1}{e^{\frac{1}{2}kT_{max}}+1}$$

$$= \boxed{0.544} \text{ Volts}$$