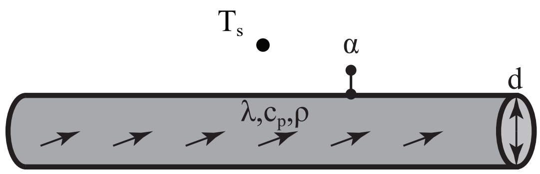
Exercise II.13 (Cooling of a copper rod ⋆⋆):

A long copper rod is initially at a uniform temperature T_0. It is now exposed to an air stream at T_∞ with a heat transfer coefficient α.



Given parameters:

- Diameter of the copper rod: $d = 2$ cm
- Initial temperature: $T_0 = 100$ °C
- Air stream temperature: $T_\infty = 20$ °C
- Heat transfer coefficient: $\alpha = 200$ W/m^{2}K
- Thermal conductivity of copper: $\lambda = 399$ W/mK
- Specific heat capacity of copper: $c_p = 382$ J/kgK
- Density of copper: $\rho = 8930$ kg/m^3

Hints:

- Heat radiation can be neglected.
- Setup an energy balance.

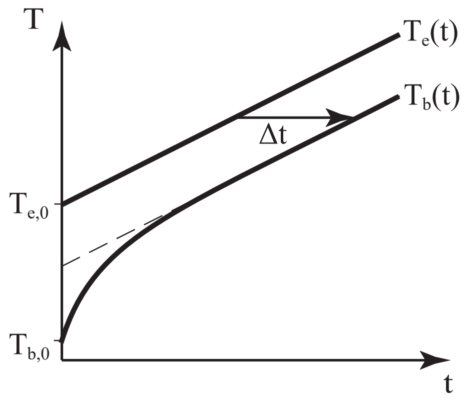
Tasks:

a) Determine how long will it take for the copper rod to cool to a temperature of $T_1 = 25$ °C.

b) Sketch the temperature profile over the course of time.

Exercise II.14 (The temperature delay ⋆⋆)**:**

A body with a temperature of T_b is located within an environment with the linearly rising temperature T_e and heats up accordingly to the diagram below. As $t \to \infty$, the temperature of the body follows that of the environment with a constant time delay Δt.



Given parameters:

- Heat transfer coefficient of the body: α
- Surface of the body: A
- Mass of the body: m
- Heat capacity of the body: c_p
- Temperature of the environment: $T_\mathrm{e}\,(t)$

Hints:

- The temperature is uniform within the body
- The environment, and its temperature, are not affected by the body.
- Heat radiation can be neglected.
- Setup an energy balance.

Tasks:

a) Determine this delay Δt.