9. Hot plate (12 points) — *Jaan Kalda.*

Tools: a resistor with resistance $R = 220\,\Omega$ mounted in one corner of a foam plastic plate (resistor's upper surface is painted black), a power supply (on the power supply, readings other than voltage are not reliable!), two identical $40\,\text{mm} \times 40\,\text{mm}$ aluminium plates that differ only in their coating: one is polished, the other is anodized black and can be assumed to be a black body, 4 silicone rubber pads of thickness $t = 0.8\,\text{mm}$, a foam cup with hot water, tweezers, a stopwatch, an infrared thermometer (press the knob twice and take a reading) , sheets of graph paper and paper tissues for cleaning. Note that for thermal radiation, water can be also assumed to be a black body.

Do not apply voltages higher than $U = 15\,\text{V}$ to the resistor as this will lead to a melting of the foam plastic! Please handle foam cups with care and do not break them (you will not get a spare one)!

i) *(3 points)* Determine the emissivity (thermal radiation power relative to a black body) of the polished aluminium plate. *Hint:* infrared thermometers measure temperature via thermal radiation power (assume it is calibrated for objects of 100% emissivity); within relevant temperature ranges, this relationship can be approximated as linear,

ii) *(3 points)* Determine the heat transfer coefficient between the top surface of the black aluminium plate and air (i. e. the coefficient of proportionality between heat dissipation power and the temperature difference) that includes both conductive and radiative heat transfer.

iii) *(2 points)* Determine the heat capacity of a metal plate.

iv) *(4 points)* Determine the heat conductance of silicon rubber pads (neglect their heat capacitance).