Approach

The approach below gives a guideline in how to solve the problems presented during this course. Correctly applying this approach will lead to a good understanding of the concepts presented in this course.

Analysis

1. Explain the problem: which physical phenomena are important in this problem?
2. Make a sketch of the problem
3. Give the known variables (with the appropriate units!)

Approach

1. Explain the assumptions you make to solve the problem
2. Show the solution method for solving the problem

Elaboration

1. Show the calculation steps and explain the equations you use
2. Give references if values are found online or in tables

Evaluation

1. Check the units of your solution
2. Is the answer realistic/expected?
3. Did you answer all the questions asked?
4. Iterate if this is required

Lecture 5

5.1 Heat loss of a person by radiation

A person has an exposed surface of 1.7 m^2, an emissivity of 0.70 and a surface temperature of 32 °C. Determine the rate of heat loss from that person by radiation in a large room whose walls are at a temperature of 27 °C.

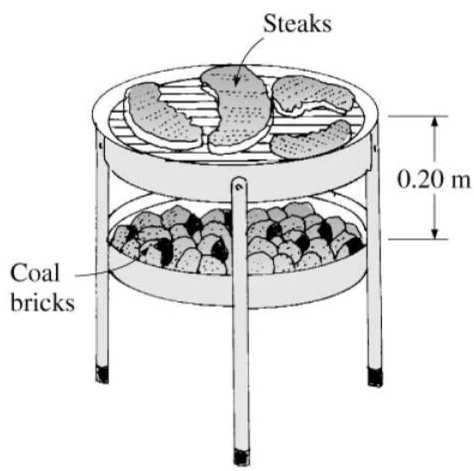
5.2 The BBQ

Consider a circular grill with a diameter of 0.30 m. The bottom of the grill is covered with hot coal bricks at 827 °C, while the mesh on top of the grill is covered with steaks initially at 5 °C. The distance between the coal bricks and the steaks is 0.20 m. Treat both the steaks and the coal bricks as blackbodies.

a) Make a simple diagram of the described situation, with all relevant parameters.

b) Determine the initial rate of radiation heat transfer from the coal bricks to the steaks. Hint: not all the heat radiated by the coal bricks will reach the steaks.

c) Also determine the initial rate of radiation heat transfer to the steaks if the side opening of the grill is covered by aluminium foil, which can be approximated as a re-radiating surface (reflecting all incoming radiation).



5.3 Radiation of heat from a coffee machine

In problem 4.2, the equilibrium temperature of the heater plate surface of a coffee machine has been determined.

a) Find the emissivity ϵ of the heater plate surface.

b) Find the total thermal resistance between the heater surface and the surrounding as well as the total heat transfer coefficient, including convection and radiation.

5.4 Heating a meal in an oven - Hand in

The inside of an oven is 0.45 m wide, 0.30 m high and 0.30 m deep. All surfaces can be approximated as blackbodies.

a) Determine the view factors from the top surface to all other surfaces. Therefore, indicate the surfaces clearly by numbers in a sketch.

b) What is the sum of all view factors? Explain why this could be expected.

A meal ($\epsilon = 0.95$, A = 0.085 m^2) is taken out of the oven at a uniform temperature of 180 °C and is immediately wrapped tightly in aluminium foil ($\epsilon = 0.070$, k = 237 W/mK). The ambient temperature of the room is 25 °C. Heat is transferred from the meal to the environment by natural convection and radiation. The convection heat transfer coefficient (directly after taking the meal out of the oven) is determined to be 10 W/m^2K^1.

c) Show that it is reasonable to assume that the surface temperature of the meal is the same for the wrapped and unwrapped case by estimating/calculating and comparing the heat resistances involved in this problem. Explain your answer.

d) Determine the total rate of heat loss from the wrapped meal for this situation. What is the percentual reduction with respect to the unwrapped case?

e) At which wavelength the power emitted from the meal by radiation is maximum? What type of radiation is this? Use the chart of the electromagnetic spectrum.

f) Can thermal radiation of the meal be seen by human eyes? Support your answer with a calculation.