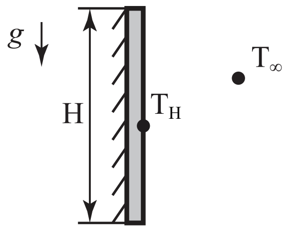
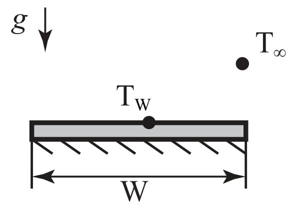
Exercise III.13: (Horizontal and vertical wall ⋆⋆)

Two heat-emitting surfaces (case 1: H height, case 2: W width) with the respective wall temperatures T_H and T_W are given. The quiescent environment has a temperature T_∞.



(a) Case 1



(b) Case 2

Given parameters:

- Prandtl Number: $\mathrm{Pr} = 1$
- Value range for laminar boundary layer: $1 \cdot 10^5 < \mathrm{Gr}_L \mathrm{Pr} < 1 \cdot 10^6$
- Geometrical ratio: $W = 2 \cdot H$
- Length of both plates: L
- Temperatures: $T_H = 2 \cdot T_W = 4 \cdot T_\infty$

Hint:

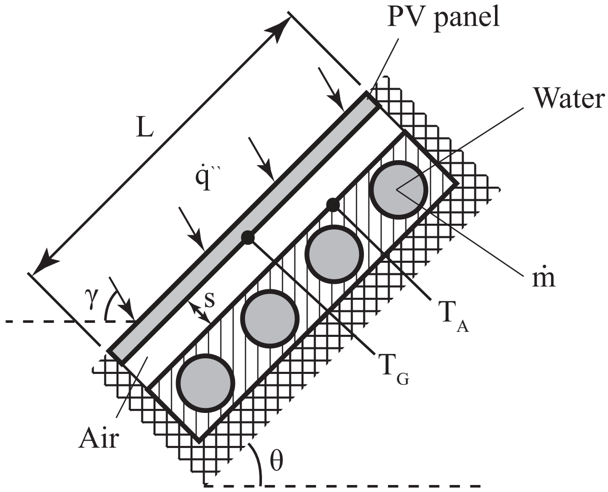
- The difference in average fluid properties between both cases is negligible.
- $W \ll L$

Tasks:

a) Determine the ratio of the convective losses from the surfaces.

Exercise III.14: (PV-T Panel ⋆⋆)

PV-T panels, generating thermal and electrical power, are frequently inclined towards the sun to enhance their efficiency. The tilt angle, denoted as θ, plays a crucial role in determining the effectiveness of the solar panel. Radiation is incident upon a PV-T collector at an angle γ, and it possesses a constant heat density represented by $\dot{q}''$. Within the tube collectors, water flows in, entering at a temperature T_{in}, and exits at a temperature T_{out}.



Given parameters:

- Collector height: $L = 0.8$ m
- Collector width: $W = 3$ m
- Space between absorber plate and glass cover: $s = 2$ cm
- Heat flux density: $\dot{q}'' = 1000$ W/m^2
- Heat flux angle: $\gamma = 60^\circ$
- Glass cover temperature: $T_{\text{G}} = 40$ °C
- Absorber plate temperature: $T_{\text{A}} = 100$ °C
- Air average density: $\rho = 1.05$ kg/m^3
- Air average thermal conductivity: $\lambda = 0.029$ W/mK
- Air average kinematic viscosity: $\nu = 1.9 \cdot 10^{-5}$ m^2/s
- Air average Prandtl number: Pr = 0.71
- Water inlet temperature: $T_{\text{in}} = 10$ °C
- Water mass flow rate: $\dot{m} = 0.01$ kg/s
- Water average specific heat capacity: $c_{\text{p}} = 4.2$ kJ/kgK
- Water outlet temperature:

$$T_{\text{out}} = T_{\text{in}}\left(2 + 2 \cdot \sin\left(2\gamma - \theta\right)\right)$$

Hints:

- All incident radiation is absorbed by the collector.
- The back side of the absorber is heavily insulated.
- The process can be assumed to be steady-state.

Tasks:

a) Determine the overall efficiency of the PV-T panel for $\theta = 0^o$.

b) Reason what you expect to be the optimal tilt angle for the PV-T panel to have the highest generation of useful energy.

c) Draw the temperature profile for the domain $0 \le x \le \infty$.