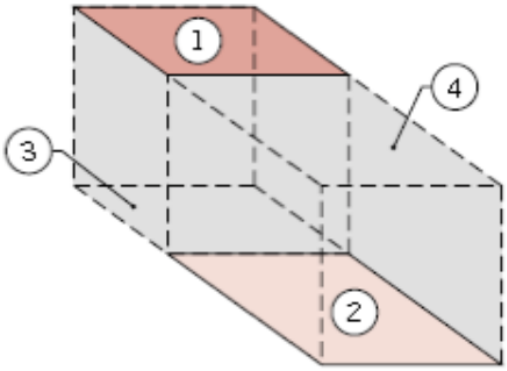
Exercise 13.1

Consider the parallel rectangles shown schematically. Show that the view factor F_{12} can be expressed as

$$F_{12} = \frac{1}{2A_1}\left[A_{1.4}F_{(1.4)(2.3)} - A_1F_{13} - A_4F_{42}\right]$$

Where all view factors on the right-hand side of the equation can be evaluated from the known relations for aligned parallel rectangles.



Exercise 13.2

A thermocouple whose surface is diffuse and gray with an emissivity of 0.6 indicates a temperature of $180°C$ when used to measure the temperature of a gas flowing through a large duct whose walls have an emissivity of 0.85 and a uniform temperature of $450°C$.

If the convection heat transfer coefficient between the thermocouple and the gas stream is $h = 125W/m^2K$ and there are negligible losses from the thermocouple, determine the temperature of the gas.

Hint 1: observe that the thermocouple and the surrounding duct form a two-surface cavity. *Hint 2*: what are the view factors for the thermocouple and the duct walls?

Solution

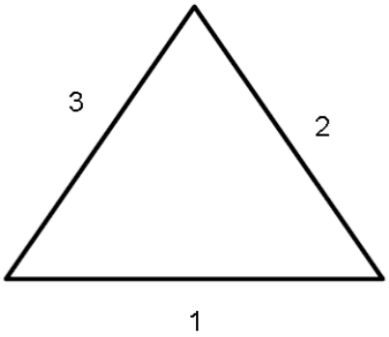
- $T_\infty = 117C$

Exercise 13.3 [DIFFICULT] FOR REVISION

A cavity composed of three, infinitely long, gray and opaque surfaces have the following conditions at the steady state:

$$\text{Surface } 1 : \mathrm{T}_1 = 300°\mathrm{C}, \mathrm{L}_1 = 0.5\mathrm{m}, \varepsilon_1 = 0.7$$
$$\text{Surface } 2 : \mathrm{T}_2 = 200°\mathrm{C}, \mathrm{L}_2 = 0.5\mathrm{m}, \varepsilon_2 = 1$$
$$\text{Surface } 3 : \mathrm{T}_3 = 100°\mathrm{C}, \mathrm{L}_3 = 0.5\mathrm{m}, \varepsilon_3 = 1$$

Determine the net heat rate for each surface and verify that the sum of the heat rates is equal to 0.



Hint 1: what are the view factors for the various surfaces?

Hint 2: write the energy balance for surface 1

Solution

- $q_1 = 1.453e3W/m$
- $q_2 == 72.53W/mW/m$
- $q_3 = -1.379e3W/m$