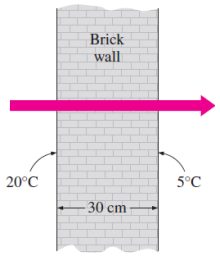
In-Class Exercise n°01

| General Introduction to Heat Transfer |

Exercise 1.1

The inner and outer surfaces of a **4-m x 7-m** brick wall of thickness **30 cm** and thermal conductivity **0.69 W/m·K** are maintained at temperatures of **20°C** and **5°C**, respectively.

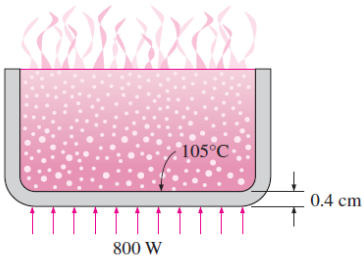
Determine the rate of heat transfer through the wall, in **W**.



(Figure 1.1)

Exercise 1.2

An aluminium pan whose thermal conductivity is **237 W/m·°C** has a flat bottom with diameter **15 cm** and thickness **0.4 cm**. Heat is transferred steadily to boiling water in the pan through its bottom at a rate of **800 W**. If the inner surface of the bottom of the pan is at **105°C**, determine the temperature of the outer surface of the bottom of the pan.



(Figure 1.2)

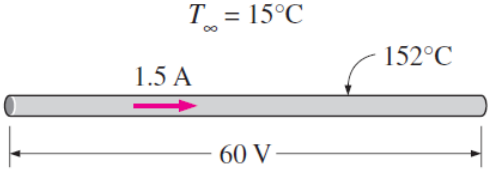
Exercise 1.3

A **5-cm-external-diameter**, **10-m-long** hot-water pipe at **80°C** is losing heat to the surrounding air at **5°C** by natural convection with a heat transfer coefficient of **25 W/m^2·°C**. Determine the rate of heat loss from the pipe by natural convection.

Exercise 1.4

A **2-m-long**, **0.3-cm-diameter** electrical wire extends across a room at **15°C**, as shown in **Fig. 1–3**. Heat is generated in the wire as a result of resistance heating, and the surface temperature of the wire is measured to be **152°C** in steady operation. Also, the voltage drop and electric current through the wire are measured to be **60 V** and **1.5 A**, respectively.

Disregarding any heat transfer by radiation, determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room.



(Figure 1.3)

Exercise 1.5

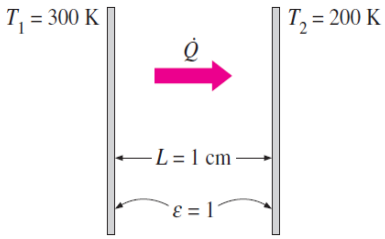
The heat flux through a wood slab **50 mm** thick, whose inner and outer surface temperatures are **40** and **20°C**, respectively, has been determined to be **40 W/m²**. What is the thermal conductivity of the wood?

Exercise 1.6

The inner and outer surfaces of a **0.5-cm thick 2-m x 2-m** window glass in winter are **10°C** and **3°C**, respectively. If the thermal conductivity of the glass is **0.78 W/m·K**, determine the amount of heat loss through the glass over a period of **5 h**. What would your answer be if the glass were **1 cm** thick?

Exercise 1.7

Consider steady heat transfer between two large parallel plates at constant temperatures of $\mathbf{T_1 = 300\ K}$ and $\mathbf{T_2 = 200\ K}$ that are **L = 1 cm** apart, as shown in **Fig. 1–7**. Assuming the surfaces to be black (**emissivity ε = 1**), determine the rate of heat transfer between the plates per unit surface area assuming the gap between the plates is



(Figure 1.7)

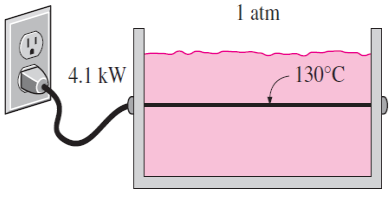
a) filled with atmospheric air (**k = 0.0219 W/m·K**),
b) evacuated,
c) filled with urethane insulation (**k = 0.026 W/m·K**), and
d) filled with superinsulation that has an apparent thermal conductivity of **0.00002 W/m·K**.

Exercise 1.8

A **5-cm-diameter** spherical ball whose surface is maintained at a temperature of **70°C** is suspended in the middle of a room at **20°C**. If the convection heat transfer coefficient is **15 W/m²·°C** and the emissivity of the surface is **0.8**, determine the total rate of heat transfer from the ball.

Exercise 1.9

A **50-cm-long**, **2-mm-diameter** electric resistance wire submerged in water is used to determine the boiling heat transfer coefficient in water at **1 atm** experimentally. The wire temperature is measured to be **130°C** when a wattmeter the electric power consumed to be **4.1 kW**. Using Newton's law of cooling, determine the boiling heat transfer coefficient.



(Figure 1.8)