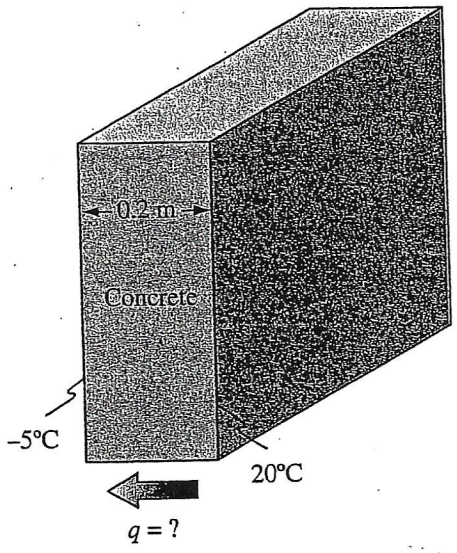
# ASSIGNMENT #1

## Problem Identification / Formulation

**1–1** The outer surface of a 0.2-m-thick concrete wall is kept at a temperature of −5°C, while the inner surface is kept at 20°C. The thermal conductivity of the concrete is 1.2 W/m K.



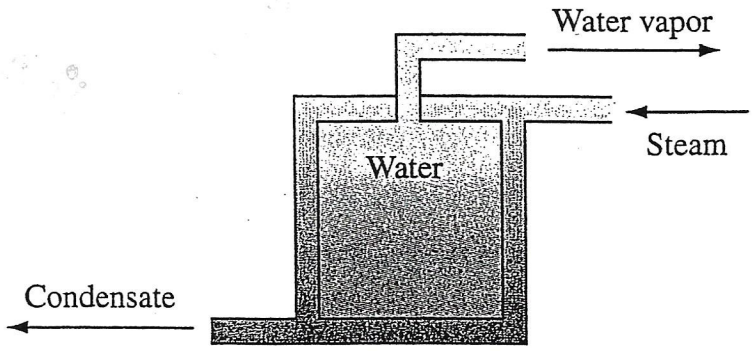

Determine the heat loss through a wall 10 m long and 3 m high.

**1–2** To determine the thermal conductivity of a structural material, a large 6-in.-thick slab of the material was subjected to a uniform heat flux of 800 Btu/h ft$^2$, while thermocouples embedded in the wall at 2-in. intervals were read over a period of time. After the system had reached equilibrium, an operator recorded the thermocouple readings shown below for two different environmental conditions:

| Distance from the Surface (in.) | Temperature (°F) |
|---|---|
| **Test 1** | |
| 0 | 100 |
| 2 | 150 |
| 4 | 206 |
| 6 | 270 |
| **Test 2** | |
| 0 | 200 |
| 2 | 265 |
| 4 | 335 |
| 6 | 406 |

Analyze the data and plot the thermal conductivity as a function of temperature between 100°F and 400°F.

1–3 Water at a temperature of 77°C is to be evaporated slowly in a vessel. The water is in a low-pressure container surrounded by steam as shown in the sketch below. The steam is condensing at 107°C. The overall heat transfer coefficient between the water and the steam is 1100 W/m$^2$ K. Calculate the surface area of the container that would be required to evaporate water at a rate of 0.01 kg/s.




1–4 A steam pipe 200 mm in diameter passes through a large basement room. The temperature of the pipe wall is 500°C, while that of the ambient air in the room is 20°C. Determine the heat transfer rate by convection and radiation per unit length of steam pipe if the emissivity of the pipe surface is 0.8 and the natural convection heat transfer coefficient has been determined to be 10 W/m$^2$ K.

1–5 A flat roof of a house absorbs a solar radiation flux of 600 W/m$^2$. The backside of the roof is well insulated, while the outside loses heat by radiation and convection to ambient air at 20°C. If the emittance of the roof is 0.80 and the convection heat transfer coefficient between the roof and the air is 12 W/m$^2$ K, calculate (a) the equilibrium surface temperature of the roof and (b) the ratio of convection to radiation heat loss. Can one or the other of these be neglected? Explain your answer.