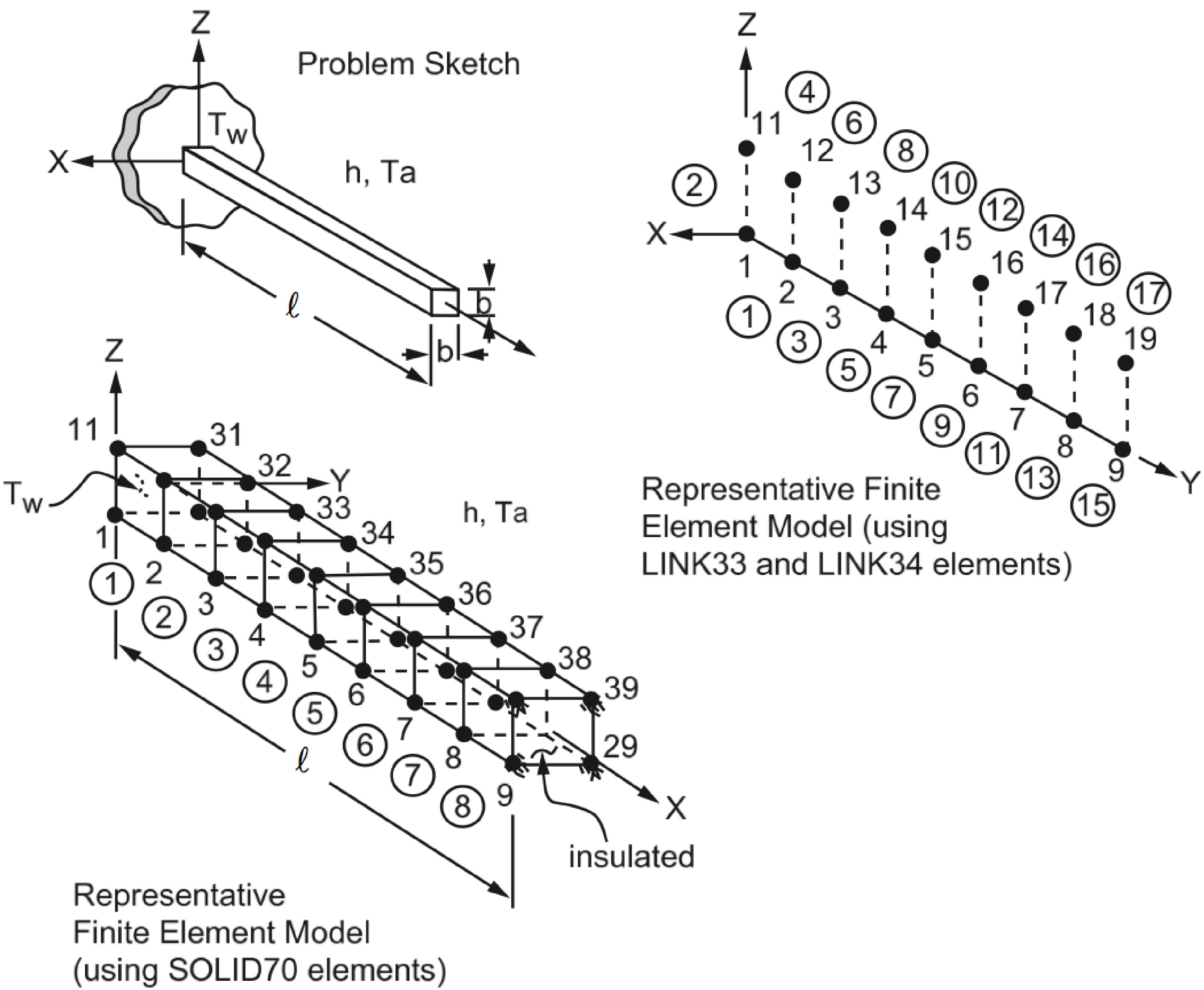
A cooling spine of square cross-sectional area A, length ℓ, and conductivity k extends from a wall maintained at temperature T_w. The surface convection coefficient between the spine and the surrounding air is h, the air temperature is T_a, and the tip of the spine is insulated. Determine the heat conducted by the spine q and the temperature of the tip T_ℓ.

Figure 95.1: Cooling Spine Problem Sketch



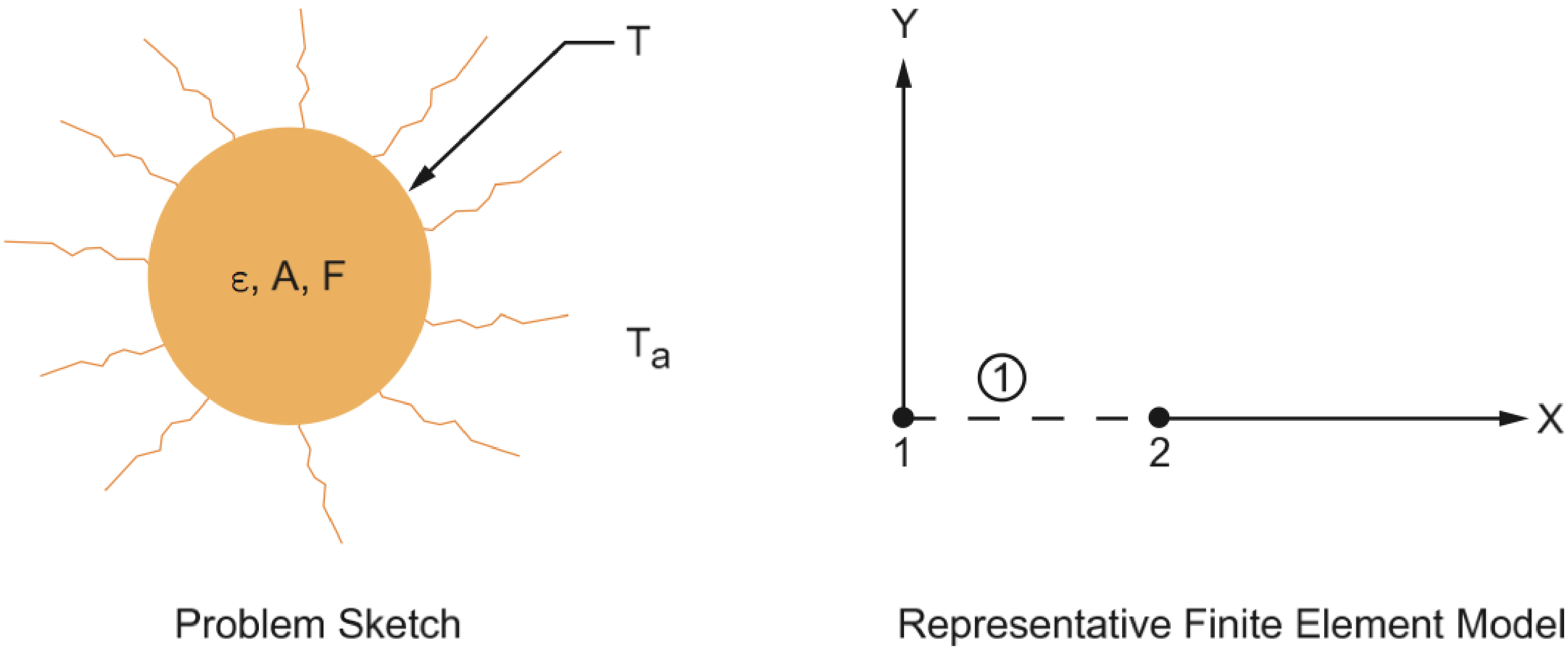
Material Properties
k = 25 Btu/hr-ft-°F
h = 1 Btu/hr-ft^2-°F

Geometric Properties
A = 1 in^2 = (1/144) ft^2
ℓ = 8 in = (2/3) ft
b = 1 in = (1/12) ft

Loading
T_a = 0°F
T_w = 100°F

Determine the rate of radiant heat emission q in Btu/hr from a black body of unit area A at a temperature T, when ambient temperature is T_a.

Figure 106.1: Radiant Energy Emission Problem Sketch



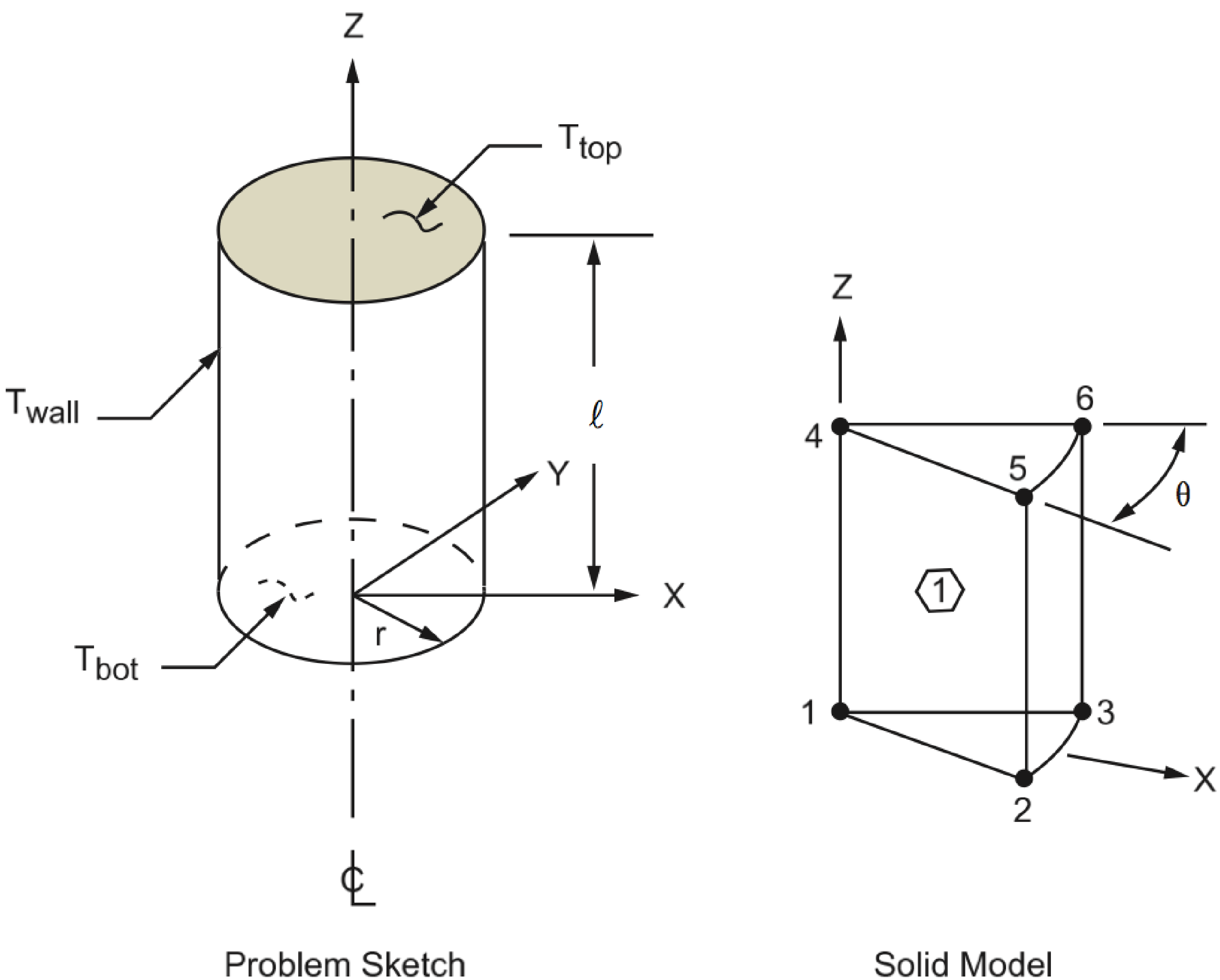
Material Properties	Geometric Properties	Loading
ε = emissivity = 1.0	$A = 1\ ft^2$ F = form factor = 1.0	T = 3000°F T_a = 0°F

Analysis Assumptions and Modeling Notes

A conversion factor of 144 in^2/ft^2 is included in the area input to convert the default Stefan-Boltzmann constant to feet units. The temperature offset of 460°F is required to convert the input Fahrenheit temperature to an absolute (Rankine) temperature. The node locations are arbitrarily selected as coincident.

A short, solid cylinder is subjected to the surface temperatures shown. Determine the temperature distribution within the cylinder

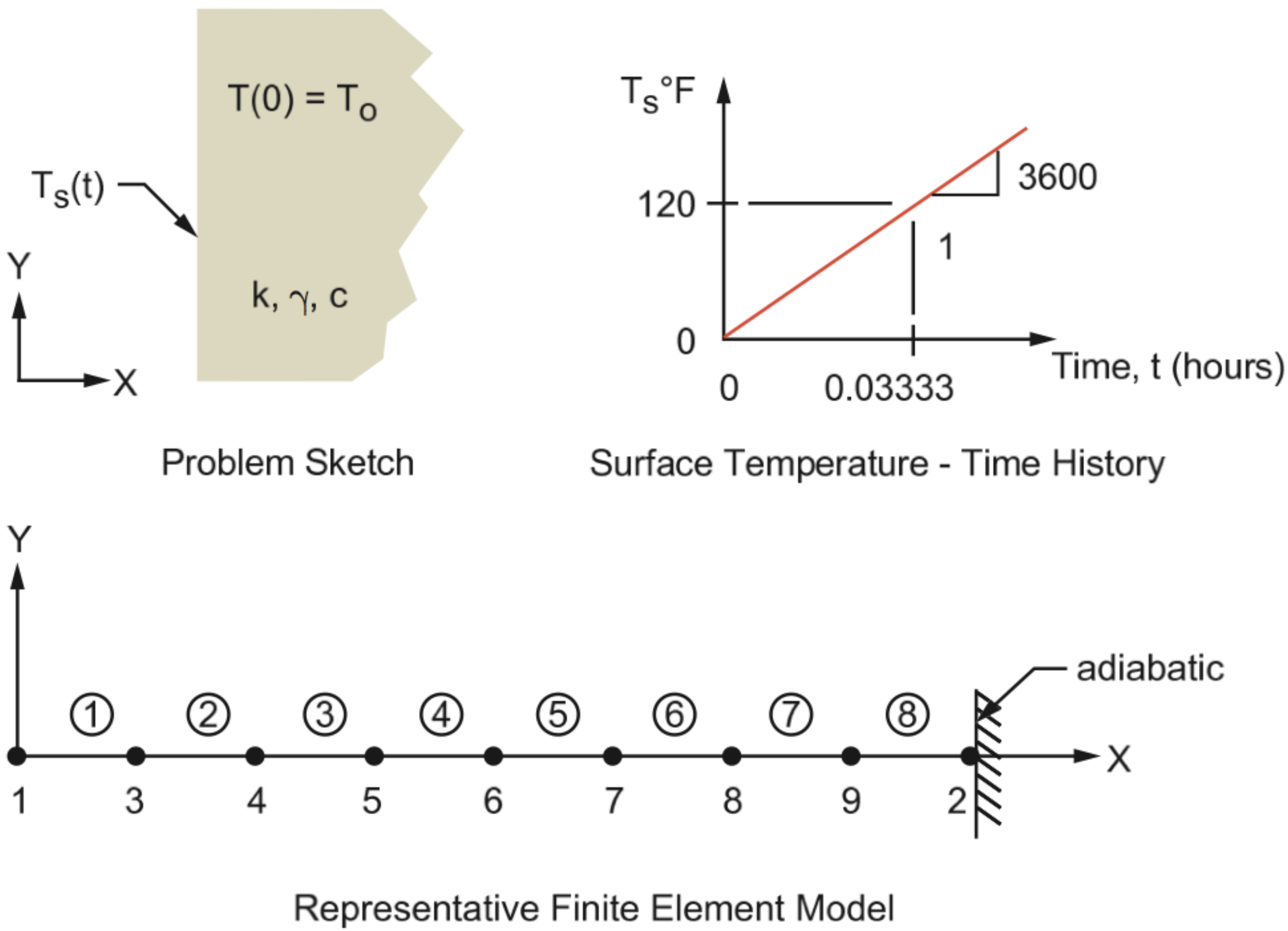
Figure 96.1: Short, Solid Cylinder Problem Sketch



Material Properties	Geometric Properties	Loading
k = 1.0 Btu/hr-ft-°F	$r = \ell = 0.5$ ft	$T_{top} = 40°F$ $T_{bot} = T_{wall} = 0°F$

A semi-infinite solid, initially at a temperature T_o, is subjected to a linearly rising surface temperature $T_s = 3600\ t$, where T_s is in °F and t is time in hours. Determine the temperature distribution in the solid at t = 2 min.

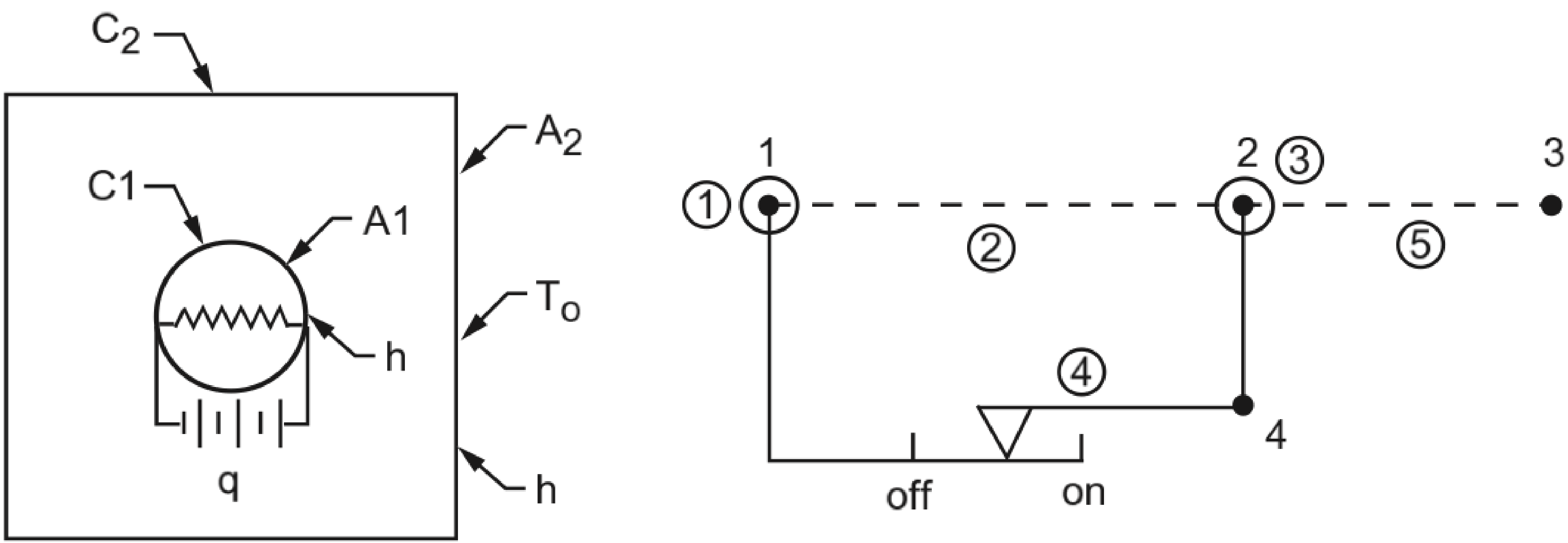
Figure 114.1: Linearly-rising Surface Temperature Problem Sketch



Material Properties	Loading
k = 10 Btu/hr-ft-°F γ = 500 lb/ft^3 c = 0.2 Btu/lb-°F	T_o = 0°F @ t = 0 T_s = 120°F @ t = 2 (ramped) (see Figure 114.2: Temperature vs. Time Plot (p. 306))

An assembly consisting of a heater with capacitance C_1 and surface area A_1 is surrounded by a box having capacitance C_2 and surface area A_2. The box is initially at a uniform temperature T_o. The heater, which supplies heat at a rate q, is turned on and remains on until the surrounding box temperature reaches a value T_{off}. The heater then switches off until the box temperature lowers to T_{on} and then switches on again. Determine the temperature response of the box and the heater status vs. time.

Figure 159.1: Temperature-controlled Heater Problem Sketch



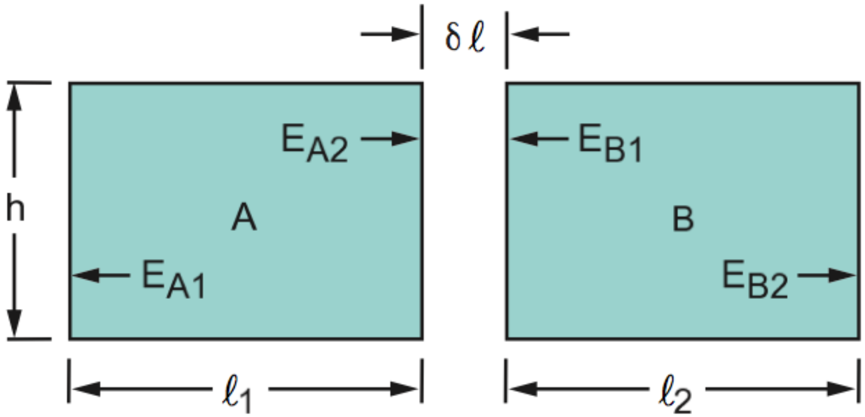
Problem Sketch

Representative Finite Element Model

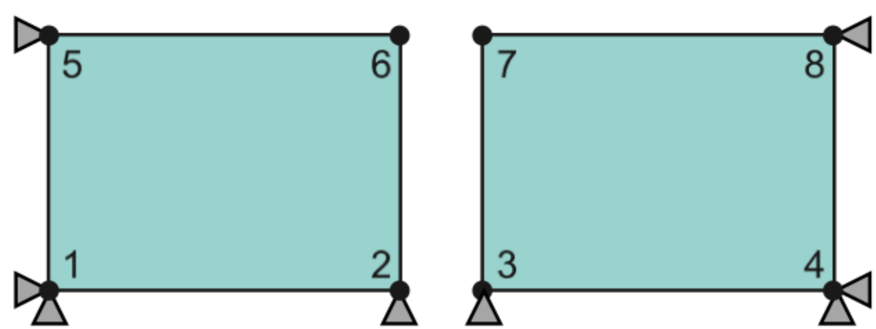
Material Properties	Geometric Properties	Loading
$C_1 = 2.7046 \times 10^{-4}$ Btu/°F $C_2 = 2.7046 \times 10^{-3}$ Btu/°F $h = 4$ Btu/hr-ft^2-°F	$A_1 = 8.1812 \times 10^{-3}$ ft $A_2 = 4.1666 \times 10^{-2}$ ft	$q = 10$ Btu/hr $T_{on} = 100$°F $T_{off} = 125$°F $T_o = 70$°F

Two bodies, A and B, are initially at a temperature of 100°C. A temperature of 500°C is then imposed at the left edge, E_{A1}, of A. Further, the right edge, E_{B2}, of B is heated to attain a temperature of 850°C and is subsequently cooled back to 100°C. Compute the interface temperature (right edge) of A, E_{A2}, and the amount of heat flow through the interface when the right edge of E_{B2} is at 600°C and 850°C, respectively. Also, compute the heat flow through the interface when B is subsequently cooled to 100°C.

Figure 23.1: Contact Problem Sketch



Problem Sketch (not to scale)



Representative Finite Element Model

Material Properties	**Geometric Properties**	**Loading**
$E = 10 \times 10^6$ N/m^2	$h = 0.1$ m	$T_{ref} = 100$°C

Material Properties	**Geometric Properties**	**Loading**
K = 250 W/m°C $\alpha = 12 \times 10^{-6}$ m/m°C Contact Conductance = 100 W/°C (per contact element)	$\ell_1 = 0.4$ m $\ell_2 = 0.5$ m $\delta\ell = 0.0035$ m	Load Step 1 T@E_1 = 500°C Load Step 2 T@E_2 = 850°C Load Step 3 T@E_2 = 100°C