

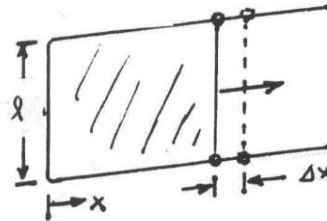
PROBLEM 2.44

KNOWN: A soap film on a wire frame is stretched.

FIND: Determine the work done.

SCHEMATIC & GIVEN DATA:

ENGR. MODEL: (1) The film is a closed system. (2) The moving boundary is the only work mode. (3) The surface tension is constant, acting on both sides of the film.



ANALYSIS: (a) The work is determined using Eq. 2.19

$$W = - \int_{A_1}^{A_2} \tau dA = - \int_{x_1}^{x_2} \tau 2l dx$$

For constant surface tension τ

$$W = - \tau 2l \Delta x$$

(b) If $l = 5\text{ cm}$, $\Delta x = 0.5\text{ cm}$, $\tau = 25 \times 10^{-5} \text{ N/cm}$,

$$W = - (25 \times 10^{-5} \text{ N/cm}) (2) (5\text{ cm}) (0.5\text{ cm}) \left| \frac{1\text{ m}}{10^2\text{ cm}} \right| \left| \frac{1\text{ J}}{1\text{ N}\cdot\text{m}} \right| = -1.25 \times 10^{-5} \text{ J}$$

The negative sign denotes work done on the film. Note the small magnitude of the work required to stretch the film.