37.39 An $8ft$ long, $1in$ diameter solid aluminum alloy rod with coefficient of linear thermal expansion of $12.8 \times 10^{-6} \frac{1}{^\circ F}$ is heated from $70^\circ F$ to $230^\circ F$. What is the change in cross-sectional area?

A. $-3.2 \times 10^{-3} in^2$

B. $-2.1 \times 10^{-3} in^2$

C. $+2.1 \times 10^{-3} in^2$

D. $+3.2 \times 10^{-3} in^2$

The change in cross-sectional area of the rod is dependent upon the change in diameter, which is linear with the change in temperature. To obtain the change in the diameter, multiple the original diameter by the linear coefficient of thermal expansion and the ΔT.

$$\Delta D = D_0 \alpha \Delta T$$

$$\Delta D = (1in)\left(12.8 \times 10^{-6} \frac{1}{^\circ F}\right)(230^\circ F - 70^\circ F) = 0.00205in$$

Calculate the new diameter.

$$D_1 = D_0 + \Delta D = 1in + 0.00205in = 1.00205in$$

Calculate the new difference between the new and old cross-sectional areas.

$$A_1 - A_0 = \frac{\pi}{4}\left[D_1^2 - D_0^2\right]$$

$$A_1 - A_0 = \frac{\pi}{4}\left[(1.00205in)^2 - (1in)^2\right] = 3.2 \times 10^{-3} in^2$$

Answer D