Thermal Stresses

19.D2 This is a materials selection problem wherein we must decide for which of the five metals listed, the stress in the rod will not exceed 138 MPa (20,000 psi), when it is heated while its ends are mounted between rigid supports. Upon examination of Equation 19.8, it may be noted that all we need do is to compute the $E\alpha_l \Delta T$ product for each of the candidate materials, and then note for which of them the stress is less than the stipulated maximum. [The value of ΔT is $T_0 - T_f = 20°C - (-60°C) = 80°C$.] These parameters and their product for each of the alloys are tabulated below. (Modulus of elasticity values were taken from Table 6.1, while the α_l values came from Table 19.1.)

Alloy	α_l (°C)$^{-1}$	E (MPa)	$\alpha_l E \Delta T$ (MPa)
Aluminum	23.6 x 10^{-6}	69 x 10^3	130
Copper	17.0 x 10^{-6}	110 x 10^3	150
Brass	20.0 x 10^{-6}	97 x 10^3	155
1025 Steel	12.0 x 10^{-6}	207 x 10^3	200
Tungsten	4.5 x 10^{-6}	407 x 10^3	145

Thus, aluminum is the only suitable candidate.