

19.D3 (a) This portion of the problem asks that we cite the units for the thermal shock resistance parameter (TSR). From Equation 19.9

$$TSR = \frac{\sigma_f (\text{N/m}^2) k (\text{W/m-K})}{E (\text{N/m}^2) \alpha_l (\text{°C})^{-1}} = \text{W/m}$$

(Note: in reducing units in the above expression, we have assumed that units of temperature in K and °C are equivalent)

(b) Now we are asked to rank soda-lime glass, fused silica, and silicon as to their thermal shock resistance. Thus, all we need do is calculate, for each, the value of TSR using Equation 19.9. Values of E , σ_f , α_l , and k are found, respectively, in Tables B.2, B.4, B.6, and B.7, Appendix B. (Note: whenever a range for a property value in these tables is cited, the average of the extremes is used.)

For soda-lime glass

$$TSR = \frac{\sigma_f k}{E \alpha_l}$$

$$= \frac{(69 \text{ MPa})(1.7 \text{ W/m-K})}{(69 \times 10^3 \text{ MPa}) [9.0 \times 10^{-6} (\text{°C})^{-1}]} = 189 \text{ W/m}$$

For fused silica

$$TSR = \frac{(104 \text{ MPa})(1.4 \text{ W/m-K})}{(73 \times 10^3 \text{ MPa}) [0.4 \times 10^{-6} (\text{°C})^{-1}]} = 4986 \text{ W/m}$$

And, for silicon

$$TSR = \frac{(130 \text{ MPa})(141 \text{ W/m-K})}{(129 \times 10^3 \text{ MPa}) [2.5 \times 10^{-6} (\text{°C})^{-1}]} = 56,800 \text{ W/m}$$

Thus, these materials may be ranked according to their thermal shock resistance from the greatest to the least as follows: silicon, fused silica, and soda-lime glass.