19.22 This problem asks that we treat a porous material as a composite wherein one of the phases is a pore phase, and that we estimate upper and lower limits for the room-temperature thermal conductivity of an aluminum oxide material having a 0.25 volume fraction of pores. The upper limit of k (k_{upper}) may be determined using Equation 16.1 with thermal conductivity substituted for the elastic modulus, *E*. From Table 19.1, the value of *k* for Al₂O₃ is 39 W/m-K, while for still air in the pore phase, k = 0.02 W/m-K (Section 19.4). Thus

$$k_{\text{upper}} = V_{\text{p}}k_{\text{air}} + V_{\text{Al}_2\text{O}_3}k_{\text{Al}_2\text{O}_3}$$

= (0.25)(0.02 W/m-K) + (0.75)(39 W/m-K) = 29.3 W/m-K

For the lower limit we employ a modification of Equation 16.2 as

$$k_{\text{lower}} = \frac{k_{\text{air}}k_{\text{Al}_2\text{O}_3}}{V_{\text{p}}k_{\text{Al}_2\text{O}_3} + V_{\text{Al}_2\text{O}_3}k_{\text{air}}}$$

 $= \frac{(0.02 \text{ W/m-K})(39 \text{ W/m-K})}{(0.25)(39 \text{ W/m-K}) + (0.75)(0.02 \text{ W/m-K})} = 0.080 \text{ W/m-K}$

Excerpts from this work may be reproduced by instructors for distribution on a not-for-profit basis for testing or instructional purposes only to students enrolled in courses for which the textbook has been adopted. Any other reproduction or translation of this work beyond that permitted by Sections 107 or 108 of the 1976 United States Copyright Act without the permission of the copyright owner is unlawful.