16.3 Given the elastic moduli and specific gravities for copper and tungsten we are asked to estimate the upper limit for specific stiffness when the volume fractions of tungsten and copper are 0.70 and 0.30, respectively. There are two approaches that may be applied to solve this problem. The first is to estimate both the upper limits of elastic modulus [$E_c(u)$] and specific gravity (ρ_c) for the composite, using expressions of the form of Equation 16.1, and then take their ratio. Using this approach

$$E_c(u) = E_{\mathrm{Cu}}V_{\mathrm{Cu}} + E_{\mathrm{W}}V_{\mathrm{W}}$$

$$= (110 \text{ GPa})(0.30) + (407 \text{ GPa})(0.70)$$

$$= 318 \text{ GPa}$$

And

$$\rho_c = \rho_{\mathrm{Cu}}V_{\mathrm{Cu}} + \rho_{\mathrm{W}}V_{\mathrm{W}}$$

$$= (8.9)(0.30) + (19.3)(0.70) = 16.18$$

Therefore

$$\text{Specific Stiffness} = \frac{E_c(u)}{\rho_c} = \frac{318 \text{ GPa}}{16.18} = 19.65 \text{ GPa}$$

With the alternate approach, the specific stiffness is calculated, again employing a modification of Equation 16.1, but using the specific stiffness-volume fraction product for both metals, as follows:

$$\text{Specific Stiffness} = \frac{E_{\mathrm{Cu}}}{\rho_{\mathrm{Cu}}}V_{\mathrm{Cu}} + \frac{E_{\mathrm{W}}}{\rho_{\mathrm{W}}}V_{\mathrm{W}}$$

$$= \frac{110 \text{ GPa}}{8.9}(0.30) + \frac{407 \text{ GPa}}{19.3}(0.70) = 18.47 \text{ GPa}$$