4.33 (a) This portion of the problem calls for a determination of the average grain size of the specimen which microstructure is shown in Figure 9.25(a). Seven line segments were drawn across the micrograph, each of which was 60 mm long. The average number of grain boundary intersections for these lines was 6.3. Therefore, the average line length intersected is just

$$\frac{60 \text{ mm}}{6.3} = 9.5 \text{ mm}$$

Hence, the average grain diameter, *d*, is

$$d = \frac{\text{ave. line length intersected}}{\text{magnification}} = \frac{9.5 \text{ mm}}{90} = 0.106 \text{ mm}$$

(b) This portion of the problem calls for us to estimate the ASTM grain size number for this same material. The average grain size number, *n*, is related to the number of grains per square inch, *N*, at a magnification of 100x according to Equation 4.16. However, the magnification of this micrograph is not 100x, but rather 90x. Consequently, it is necessary to use Equation 4.17

$$N_M \left(\frac{M}{100}\right)^2 = 2^{n-1}$$

where N_M = the number of grains per square inch at magnification *M*, and *n* is the ASTM grain size number. Taking logarithms of both sides of this equation leads to the following:

$$\log N_M + 2 \log\left(\frac{M}{100}\right) = (n - 1) \log 2$$

Solving this expression for *n* gives

$$n = \frac{\log N_M + 2 \log\left(\frac{M}{100}\right)}{\log 2} + 1$$

From Figure 9.25(a), N_M is measured to be approximately 4, which leads to

$$n = \frac{\log 4 + 2 \log\left(\frac{90}{100}\right)}{\log 2} + 1$$

$$= 2.7$$