Problem 1.54

An acre, a unit of land measurement still in wide use, has a length of one furlong $\left(\frac{1}{8}\text{ mi}\right)$ and a width one-tenth of its length. (a) How many acres are in a square mile? (b) How many square feet are in an acre? See Appendix E. (c) An acre-foot is the volume of water that would cover 1 acre of flat land to a depth of 1 foot. How many gallons are in 1 acre-foot?

Solution

Multiply the length by the width to get the area of one acre A.

$$A = \left(\frac{1}{8}\text{ mi}\right)\left(\frac{1}{80}\text{ mi}\right) = \frac{1}{640}\text{ mi}^2$$

Part (a)

Invert this area to get the number of acres in one square mile.

$$\frac{1}{640}\;\frac{\text{square miles}}{\text{acre}}\quad\rightarrow\quad 640\;\frac{\text{acres}}{\text{square mile}}$$

Part (b)

Use the fact that there are 5280 feet in one mile.

$$A = \frac{1}{640}\;\text{mi}^2 \times \left(\frac{5280\text{ ft}}{1\text{ mi}}\right)^2 = 43\,560\text{ ft}^2$$

Part (c)

Multiply the result of part (b) by 1 ft to get the volume of an acre-foot and then convert it to gallons using the conversion factor in Appendix E.

$$V = A(1\text{ ft}) = 43\,560\text{ ft}^3 \times \frac{7.477\text{ gal}}{1\text{ ft}^3} = 325\,698\text{ gal}$$