2.20

2.20 Pikes Peak near Denver, Colorado has an elevation of 14,110 ft. **(a)** Determine the pressure at this elevation, based on Eq. 2.12. **(b)** If the air is assumed to have a constant specific weight of 0.07647 lb/ft^3, what would the pressure be at this altitude? **(c)** If the air is assumed to have a constant temperature of 59 °F what would the pressure be at this elevation? For all three cases assume standard atmospheric conditions at sea level (see Table 2.1).

(a) $$p = p_a \left(1 - \frac{\beta z}{T_a}\right)^{\frac{g}{R\beta}} \qquad \text{(Eq. 2.12)}$$

For $p_a = 2116.2 \frac{lb}{ft^2}$, $\beta = 0.00357 \frac{^\circ R}{ft}$, $g = 32.174 \frac{ft}{s^2}$, $T_a = 518.67^\circ R$, $R = 1716 \frac{ft \cdot lb}{slug \cdot ^\circ R}$, and

$$\frac{g}{R\beta} = \frac{32.174 \frac{ft}{s^2}}{\left(1716 \frac{ft \cdot lb}{slug \cdot ^\circ R}\right)\left(0.00357 \frac{^\circ R}{ft}\right)} = 5.252$$

then

$$p = \left(2116.2 \frac{lb}{ft^2}\right)\left[1 - \frac{\left(0.00357 \frac{^\circ R}{ft}\right)(14{,}110\ ft)}{518.67^\circ R}\right]^{5.252}$$

$$= \underline{1240 \frac{lb}{ft^2} \ (abs)}$$

(b) $$p = p_a - \gamma h$$

$$= 2116.2 \frac{lb}{ft^2} - \left(0.07647 \frac{lb}{ft^3}\right)(14{,}110\ ft)$$

$$= \underline{1040 \frac{lb}{ft^2} \ (abs)}$$

(c) $$p = p_a e^{-\frac{gh}{RT_a}} \qquad \text{(Eq. 2.10)}$$

$$= \left(2116.2 \frac{lb}{ft^2}\right) e^{-\left[\frac{\left(32.174 \frac{ft}{s^2}\right)(14{,}110\ ft)}{\left(1716 \frac{ft \cdot lb}{slug \cdot ^\circ R}\right)(518.67^\circ R)}\right]}$$

$$= \underline{1270 \frac{lb}{ft^2} \ (abs)}$$