1-6E From the Newton's second law, the force required is

\[ F = ma = (60 \text{ lbf})(45 \text{ ft}/s^2) \left( \frac{1 \text{ lbf}}{32.174 \text{ lbf} \cdot \text{ft}/s^2} \right) = 8392 \text{ lbf} \]

1-10 (a) A spring scale measures weight, which is the local gravitational force applied on a body:

\[ W = mg = (75 \text{ kg})(1.67 \text{ m}/s^2) = 125 \text{ N} \]

(b) A beam scale compares masses and thus is not affected by the variations in gravitational acceleration. The beam scale will read what it reads on earth,

\[ W = 735 \text{ N} \text{ (or 75 kg)} \]

1-10E (a) A spring scale measures weight, which is the local gravitational force applied on a body:

\[ W = mg = (150 \text{ lbf})(5.48 \text{ ft}/s^2) \left( \frac{1 \text{ lbf}}{1 \text{ lbf} \cdot \text{ft}/s^2} \right) = 255 \text{ lbf} \]

(b) A beam scale compares masses and thus is not affected by the variations in gravitational acceleration. The beam scale will read what it reads on earth,

\[ W = 145 \text{ lbf} \]

1-31E The atmospheric (or barometric) pressure can be expressed as

\[ P_{\text{atm}} = \rho gh \]

\[ = (848.4 \text{ lbf}/\text{ft}^3)(32.174 \text{ ft}/s^2)(29.112 \text{ ft}) \left( \frac{1 \text{ lbf}}{32.174 \text{ lbf} \cdot \text{ft}/s^2} \right) \left( \frac{1 \text{ ft}^2}{144 \text{ in}^2} \right) \]

\[ = 14.29 \text{ psia} \]

Then the absolute pressure in the tank is

\[ P_{\text{abs}} = P_{\text{gage}} + P_{\text{atm}} = 50 + 14.29 = 64.29 \text{ psia} \]

1-36E The density of the sea water is obtained by multiplying its specific gravity by the density of water which is taken to be 1000 kg/m³:

\[ \rho = (\rho_S)(\rho_{H_2O}) = (1.03)(62.4 \text{ lbf}/\text{ft}^3) = 64.27 \text{ lbf}/\text{ft}^3 \]

The pressure exerted on the surface of the submarine cruising 300 ft below the free surface of the sea is the absolute pressure at that location:

\[ P = P_{\text{atm}} + \rho gh \]

\[ = (14.7 \text{ psia}) + (64.27 \text{ lbf}/\text{ft}^3)(32.174 \text{ ft}/s^2)(300 \text{ ft}) \left( \frac{1 \text{ lbf}}{32.174 \text{ lbf} \cdot \text{ft}/s^2} \right) \left( \frac{1 \text{ ft}^2}{144 \text{ in}^2} \right) \]

\[ = 148.6 \text{ psia} \]

1-40 (a) The pressure in the duct is above atmospheric pressure since the fluid column on the duct side is at a lower level.

(b) The absolute pressure in the duct is determined from

\[ P = P_{\text{atm}} + \rho gh \]

\[ = (100 \text{ kPa}) + (13,600 \text{ kg/m}^3)(9.807 \text{ m}/s^2)(0.015 \text{ m}) \left( \frac{1 \text{ N}}{1 \text{ kg} \cdot \text{m}/s^2} \right) \left( \frac{1 \text{ kPa}}{1000 \text{ N}/\text{m}^2} \right) \]

\[ = 102.0 \text{ kPa} \]
1-45E Using the conversion relations between the various temperature scales,

\[ T(K) = T(\degree C) + 273 = 18\,\degree C + 273 = 291\, K \]
\[ T(\degree F) = 1.8(\degree C) + 32 = (1.8)(18) + 32 = 64.4\, \degree F \]
\[ T(R) = T(\degree F) + 460 = 64.4 + 460 = 524.4\, R \]

1-47E This problem deals with temperature changes, which are identical in Rankine and Fahrenheit scales. Thus,

\[ \Delta T(R) = \Delta T(\degree F) = 27\, R \]

The temperature changes in Celsius and Kelvin scales are also identical, and are related to the changes in Fahrenheit and Rankine scales by

\[ \Delta T(K) = \Delta T(R)/1.8 = 27/1.8 = 15\, K \]

and

\[ \Delta T(\degree C) = \Delta T(K) = 15\, \degree C \]
2-25 The boiling temperature of water in Denver is the saturation temperature corresponding to the atmospheric pressure in Denver which is 83.4 kPa:

\[ T = T_{sat @ 83.4 \text{ kPa}} = 94.4^\circ \text{C} \]

2-29E This is a constant volume process \((v = V/m = \text{constant})\), and the specific volume is determined to be

\[ v = \frac{V}{m} = \frac{30 \text{ ft}^3}{1.5 \text{ lbm}} = 20 \text{ ft}^3/\text{lbm} \]

When the liquid is completely vaporized the tank will contain saturated vapor only. Thus,

\[ v_s = v_g = 20 \text{ ft}^3/\text{lbm} \]

The temperature at this point is the temperature which corresponds to this \(v_g\) value,

\[ T = T_{sat @ v_g = 20 \text{ ft}^3/\text{lbm}} = 228.4^\circ \text{F} \]

2-31 Initially the cylinder contains compressed liquid (since \(P > P_{sat @ 25^\circ \text{C}}\)) which can be approximated as a saturated liquid at the specified temperature,

\[ v_1 = v_{f @ 25^\circ \text{C}} = 0.001003 \text{ m}^3/\text{kg} \]

\[ h_1 = h_{f @ 25^\circ \text{C}} = 104.89 \text{ kJ/kg} \]

(a) The mass is determined from

\[ m = \frac{V_1}{v_1} = \frac{0.050 \text{ m}^3}{0.001003 \text{ m}^3/\text{kg}} = 49.85 \text{ kg} \]

(b) At the final state the cylinder contains saturated vapor, and thus the final temperature must be the saturation temperature at the final pressure,

\[ T = T_{sat @ 300 \text{ kPa}} = 133.55^\circ \text{C} \]

(c) The final enthalpy is \(h_2 = h_{g @ 300 \text{ kPa}} = 2725.3 \text{ kJ/kg}\). Thus,

\[ \Delta H = m(h_2 - h_1) = (49.85 \text{ kg})(2725.3 - 104.89) \text{ kJ/kg} = 130,627 \text{ kJ} \]

2-33E At 30 psia, \(v_f = 0.01209 \text{ ft}^3/\text{lbm}\) and \(v_g = 1.5408 \text{ ft}^3/\text{lbm}\). The volume occupied by the liquid and the vapor phases are

\[ V_f = 1.5 \text{ ft}^3 \quad \text{and} \quad V_g = 13.5 \text{ ft}^3 \]

Thus the mass of each phase is

\[ m_f = \frac{V_f}{v_f} = \frac{1.5 \text{ ft}^3}{0.01209 \text{ ft}^3/\text{lbm}} = 124.1 \text{ lbm} \]

\[ m_g = \frac{V_g}{v_g} = \frac{13.5 \text{ ft}^3}{1.5408 \text{ ft}^3/\text{lbm}} = 8.76 \text{ lbm} \]

Then the total mass and the quality of the refrigerant are

\[ m = m_f + m_g = 124.1 + 8.76 = 132.86 \text{ lbm} \]

\[ x = \frac{m_g}{m} = \frac{8.76}{132.86} = 0.0659 \]