17.84. For aluminum, $\beta = 7.2\times10^{-5}\ \text{K}^{-1}$. $1\ \text{L} = 10^{-3}\ \text{m}^3$.

(a) The lost volume, 2.6 L, is the difference between the expanded volume of the fuel and the tanks, and the maximum temperature difference is

$$\Delta T = \frac{\Delta V}{(\beta_{\text{fuel}} - \beta_{\text{A1}})V_0} = \frac{(2.6\times10^{-3}\ \text{m}^3)}{(9.5\times10^{-4}\ (\text{C}°)^{-1} - 7.2\times10^{-5}\ (\text{C}°)^{-1})(106.0\times10^{-3}\ \text{m}^3)} = 28\ \text{C}°.$$

The maximum temperature was 32° C.

(b) No fuel can spill if the tanks are filled just before takeoff.

17.92. For water, $c = 4190\ \text{J/kg}\cdot\text{K}$ and $L_\text{v} = 2256\times10^3\ \text{J/kg}$. For solid iron, $c = 470\ \text{J/kg}\cdot\text{K}$.

The heat released when the iron slug cools to 100° C is $Q = mc\Delta T = (0.1000\ \text{kg})(470\ \text{J/kg}\cdot\text{K})(645\ \text{K}) = 3.03\times10^4\ \text{J}$. The heat absorbed when the temperature of the water is raised to 100° C is $Q = mc\Delta T = (0.0850\ \text{kg})(4190\ \text{J/kg}\cdot\text{K})(80.0\ \text{K}) = 2.85\times10^4\ \text{J}$. This is less than the heat released from the iron and $3.03\times10^4\ \text{J} - 2.85\times10^4\ \text{J} = 1.81\times10^3\ \text{J}$ of heat is available for converting some of the liquid water at 100° C to vapor. The mass m of water that boils is $m = \dfrac{1.81\times10^3\ \text{J}}{2256\times10^3\ \text{J/kg}} = 8.01\times10^{-4}\ \text{kg} = 0.801\ \text{g}.$

(a) The final temperature is 100° C.

(b) There is $85.0\ \text{g} - 0.801\ \text{g} = 84.2\ \text{g}$ of liquid water remaining, so the final mass of the iron and remaining water is 184.2 g.

17.98. $\int dT = T$ and $\int T dT = \frac{1}{2}T^2$. Express T_1 and T_2 in kelvins: $T_1 = 300\ \text{K}$, $T_2 = 500\ \text{K}$.

Denoting C by $C = a + bT$, a and b independent of temperature, integration gives

$$Q = n(a(T_2 - T_1) + \frac{b}{2}(T_2^2 - T_1^2)).$$

$$Q = (3.00\ \text{mol})[(29.5\ \text{J/mol}\cdot\text{K})(500\ \text{K} - 300\ \text{K}) + (4.10\times10^{-3}\ \text{J/mol}\cdot\text{K}^2)((500\ \text{K})^2 - (300\ \text{K})^2)].$$

$$Q = 1.97\times10^4\ \text{J}.$$

17.106. H equals the power input required to maintain a constant interior temperature.

$$k = H\frac{L}{A\Delta T} = (180\ \text{W})\frac{(3.9\times10^{-2}\ \text{m})}{(2.18\ \text{m}^2)(65.0\ \text{K})} = 5.0\times10^{-2}\ \text{W/m}\cdot\text{K}.$$