SOLUTIONS TO PROBLEMS

P19.15 (a) $L_{\text{Al}}(1+\alpha_{\text{Al}}\Delta T)=L_{\text{Brass}}(1+\alpha_{\text{Brass}}\Delta T)$

$$\Delta T=\frac{L_{\text{Al}}-L_{\text{Brass}}}{L_{\text{Brass}}\alpha_{\text{Brass}}-L_{\text{Al}}\alpha_{\text{Al}}}$$

$$\Delta T=\frac{(10.01-10.00)}{(10.00)(19.0\times10^{-6})-(10.01)(24.0\times10^{-6})}$$

$\Delta T=-199°\text{C}$ so $T=$ $\boxed{-179°\text{C. This is attainable.}}$

(b) $$\Delta T=\frac{(10.02-10.00)}{(10.00)(19.0\times10^{-6})-(10.02)(24.0\times10^{-6})}$$

$\Delta T=-396°\text{C}$ **so** $T=$ $\boxed{-376°\text{C which is below 0 K so it cannot be reached.}}$

P19.18 (a) $L=L_i(1+\alpha\Delta T)$: $5.050\text{ cm}=5.000\text{ cm}\left[1+24.0\times10^{-6}\,°\text{C}^{-1}(T-20.0°\text{C})\right]$

$T=\boxed{437°\text{C}}$

(b) We must get $L_{\text{Al}}=L_{\text{Brass}}$ for some ΔT, or

$L_{i,\text{ Al}}(1+\alpha_{\text{Al}}\Delta T)=L_{i,\text{ Brass}}(1+\alpha_{\text{Brass}}\Delta T)$

$5.000\text{ cm}\left[1+(24.0\times10^{-6}\,°\text{C}^{-1})\Delta T\right]=5.050\text{ cm}\left[1+(19.0\times10^{-6}\,°\text{C}^{-1})\Delta T\right]$

Solving for ΔT, $\Delta T=2\ 080°\text{C}$,

so $\boxed{T=3\ 000°\text{C}}$

This will not work because $\boxed{\text{aluminum melts at 660°C}}$.

P19.19 (a) $V_f=V_i(1+\beta\Delta T)=100\left[1+1.50\times10^{-4}(-15.0)\right]=\boxed{99.8\text{ mL}}$

(b) $\Delta V_{\text{acetone}}=(\beta V_i\Delta T)_{\text{acetone}}$

$\Delta V_{\text{flask}}=(\beta V_i\Delta T)_{\text{Pyrex}}=(3\alpha V_i\Delta T)_{\text{Pyrex}}$

for same V_i, ΔT,

$$\frac{\Delta V_{\text{acetone}}}{\Delta V_{\text{flask}}}=\frac{\beta_{\text{acetone}}}{\beta_{\text{flask}}}=\frac{1.50\times10^{-4}}{3(3.20\times10^{-6})}=\frac{1}{6.40\times10^{-2}}$$

The volume change of flask is

$\boxed{\text{about 6\% of the change in the acetone's volume}}$.

P19.20 (a),(b) The material would expand by $\Delta L = \alpha L_i \Delta T$,

$$\frac{\Delta L}{L_i} = \alpha \Delta T, \text{ but instead feels stress}$$

$$\frac{F}{A} = \frac{Y\Delta L}{L_i} = Y\alpha\Delta T = \left(7.00\times 10^{9}\ \text{N/m}^2\right)12.0\times 10^{-6}\left(\text{C}°\right)^{-1}\left(30.0°\text{C}\right)$$

$$= \boxed{2.52\times 10^{6}\ \text{N/m}^2}. \text{ This will } \boxed{\text{not break}} \text{ concrete}.$$

P19.28 $PV = NP'V' = \frac{4}{3}\pi r^3 NP'$: $\quad N = \frac{3PV}{4\pi r^3 P'} = \frac{3(150)(0.100)}{4\pi(0.150)^3(1.20)} = \boxed{884 \text{ balloons}}$

If we have no special means for squeezing the last 100 L of helium out of the tank, the tank will be full of helium at 1.20 atm when the last balloon is inflated. The number of balloons is then reduced to to $884 - \frac{\left(0.100\ \text{m}^3\right)3}{4\pi(0.15\ \text{m})^3} = 877$.