Temperature, Thermal Energy, Heat

No flow (both are 250K or -23°C)

(2.) $\Delta U = 0 = (mc\Delta T)_{iron} + (mc\Delta T)_{water}$

$0 = 0.260\,kg\left(452\frac{J}{kg\cdot°C}\right)(T - 9.0°C) + 0.750\,kg\left(4186\frac{J}{kg\cdot°C}\right)(T - 45°)$

$T = 43.70104574°C$

$\boxed{T = 44°C}$

(3.) $\Delta U = (mc\Delta T)_{lead\ solid} + mH_f + (mc\Delta T)_{lead\ liquid}$

$\Delta U = 6.5\,kg\left(128\frac{J}{kg\cdot°C}\right)(327°C - 22°C) + 6.5\,kg\left(2.32\times10^4\,J/kg\right) + 6.5\,kg\left(108\frac{J}{kg\cdot K}\right)(350°C - 327°C)$

$\boxed{\Delta U = 4.2\times10^5\,J}$

(4.) $\Delta U = \Delta U_c + \Delta K + Q_b + Q_g = -106\,000\,J + \frac{1}{2}(0.025\,kg)(2900\,m/s)^2 + (mc\Delta T)_b + (mc\Delta T)_g$

$0 = -106\,000\,J + 105\,125 + 0.025\,kg\left(825\frac{J}{kg\cdot°C}\right)(26°C) + 0.975\left(452\,J/kg\cdot°C\right)\Delta T_g$

$\Delta T_g = 0.768663490°C$

$\boxed{\Delta T_g = 0.77°C}$

5. $0 = \Delta K + \Delta U_g + Q$

$0 = \frac{1}{2}(0.250\,kg)(6.2\,m/s)^2 - 0.250\,kg(9.80\,N/kg)(3.0\,m) + 0.250\,kg(130\,\frac{J}{kg\,°C})\Delta T$

$\boxed{\Delta T = 0.078\,°C}$

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6. $\Delta U = 0 = Q_x + Q_w$

$-(mc\Delta T)_x = (mc\Delta T)_w$

$-(2c(26.83 - 370)) = 10(4186)(26.83 - 12.00)$

$686.34c = 620783.8$

$\boxed{c = 904.5\,\frac{J}{kg\,°C} \longrightarrow \text{Aluminum}}$

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8. $\Delta U = Q_i + Q_w = (mc\Delta T)_i + MH_f + (mc\Delta T)_w$

$0 = 0.512\,kg(2000\,\frac{J}{kg\,°C})(12\,°C) + M(335\,000\,J/kg) + 0.795\,kg(4186\,\frac{J}{kg\,°C})(-48\,°C)$

$M = 0.9368\ldots\,kg$

$M >$ mass of ice $\Rightarrow$ ALL of the ice will melt!

$\boxed{512\,g}$

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9. $\Delta U = 0 = Q_i + Q_w = (mc\Delta T)_{is} + mH_{f_i} + (mc\Delta T)_{il} + (mc\Delta T)_w$

$0 = 0.058\,kg(2000\,\frac{J}{kg\,°C})(19\,°C) + 0.058\,kg(335000\,\frac{J}{kg}) + 0.058\,kg(4186\,\frac{J}{kg\,°C})(T) + 0.555\,kg(4186\,\frac{J}{kg\,°C})(T - 34\,°C)$

$T = 22.352\ldots$

$\boxed{T = 22\,°C}$

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10. $\Delta L_1 = \alpha_1 L_{01} \Delta T_1 = 0.5\alpha_2(0.80 L_{02})(1.5\Delta T_2) = 0.6\alpha_2 L_{02}\Delta T_2 = 0.60\Delta L_2$

$\Rightarrow$ rod 1 grows less than rod 2 $\boxed{\text{so } x \text{ increases.}}$

11. $\Delta L_1 = \alpha_1 L_{01} \Delta T_1 = 2.0\times10^{-5} K^{-1} (0.42m)(60.0K) = 0.000504m$

$\Delta L_2 = \alpha_2 L_{02} \Delta T_2 = 4.0\times10^{-5} K^{-1} \left(\frac{0.42m}{0.80}\right)(40.0K) = 0.00084m$

$L_1 = L_{01} + \Delta L_1 = 0.42m + 0.000504m = 0.420504m$

$L_2 = L_{02} + \Delta L_2 = 0.525m + 0.00084m = 0.52584m$

$x = L_2 - L_1 = \boxed{0.11m}$

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12. $Q = \frac{kAt\Delta T}{L} = \frac{0.84 \frac{J}{m s °C} (1.5m^2)(3600s)(18°C)}{3.2\times10^{-3} m} = \boxed{2.5\times10^7 J}$

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13. $\Delta U = 0 = Q_{ice} + Q_{water} = \left(\underbrace{(mc\Delta T)_{solid\,ice}}_{(-14°\to 0°C)} + \underbrace{mH_f}_{(melting)} + \underbrace{(mc\Delta T)_{melted\,ice}}_{(0°C\to T)} \right) + \underbrace{(mc\Delta T)_{water}}_{(25°C\to T)}$

$0 = 0.6000kg\left(2000\frac{J}{kg°C}\right)(14°C) + 0.6000kg\left(335000\frac{J}{kg}\right) + 0.6000\left(4186\frac{J}{kg°C}\right)(T-0°) + 16kg\left(4186\frac{J}{kg°C}\right)(T-25°C)$

$T = 20.9620\ldots$

$\boxed{T = 21°C}$

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