1) $m = 2\,g$ a) ? cost. termometriche

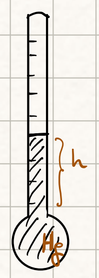
$h_1 = 5\,cm$ b) $?T_3 \mid h_3 = 8\,cm$

$T_1 = 0\,°C$ c) $?Q \mid h_1 \rightarrow h_4 = 6{,}9\,cm$

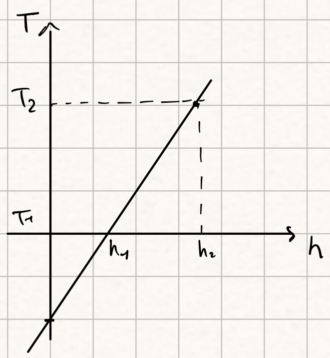
$h_2 = 10\,cm$

$T_2 = 100\,°C$

a)



$T = ah + b$



$C^*_{Hg} = 3{,}3 \cdot 10^{-2}\ cal/g\,°C$

$$\begin{cases} T_1 = ah_1 + b \\ T_2 = ah_2 + b \end{cases} \Rightarrow \begin{cases} T_1 = ah_1 + T_2 - ah_2 \\ b = T_2 - ah_2 \end{cases}$$

$$\begin{cases} a = \dfrac{T_1 - T_2}{h_1 - h_2} \\ b = T_2 - h_2 \dfrac{T_1 - T_2}{h_1 - h_2} \end{cases} \Rightarrow \begin{cases} a = 20\ °C/cm \\ b = -100\ °C \end{cases}$$

$$\Rightarrow T = 20 \frac{°C}{cm} h - 100\ °C$$

b) $T_3 = 20 \frac{°C}{cm} h_3 - 100\,°C = 60\ °C$

c) $h_1 = 5\,cm$ $h_4 = 6{,}9\,cm$

$T_1 = 0\,°C$ $T_4 = ah_4 + b = 38\ °C$

$$\Rightarrow \Delta T = T_4 - T_1 = 38\ °C$$

$1\ cal = 4{,}1868\ J$

$$Q = C\,\Delta T = m\,C^*_{Hg}\,\Delta T \Rightarrow Q_{1\to4} = m\,C^*_{Hg}\,\Delta T = 2{,}5\ cal = \ldots$$

MISURARE TEMPERATURA:

$\Delta T = 38\,°C \quad (0\,°C \rightarrow 38°)$

$\underset{\text{termometro}}{Q_T} = -\underset{\text{corpo}}{Q_c} \Rightarrow C_T (T_{eq} - T_T) = -C_c (T_{eq} - T_c)$

$$T_{eq} = \frac{T_c + \frac{C_T}{C_c} T_T}{1 + \frac{C_T}{C_c}} \xrightarrow{\text{deve tendere a}} T_c \quad \text{per} \quad \frac{C_T}{C_c} \rightarrow 0 \Rightarrow C_T \ll C_c$$

capacità termica del termom. molto minore

$$\Delta T_{eq} = |T_{eq} - T_c| = \frac{|T_T - T_c|}{1 + \frac{C_c}{C_T}} \xrightarrow[\frac{C_c}{C_T} \to \infty]{} 0$$

errore di misura

$$Q_c = m_c C^*_c \Delta T_c \qquad (m_c = 70\,kg\ ;\ C^*_c = 0{,}83\ kcal/kg\,°C)$$

$$\Rightarrow \Delta T_c = \frac{Q_c}{m_c C^*_c} = -4{,}3 \cdot 10^{-5}\ °C$$

Errore di misura trascurabile

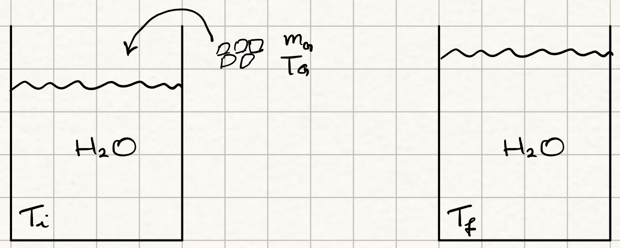
2) $V_{H_2O} = 500 \text{ cm}^3$ $\qquad\qquad$ $C^*_{H_2O} = 1 \text{ cal}/g\,°C$

$T_i = 20\,°C$

? $m_{G\,min}$ | $T_G = -5\,°C$; $T_f = 0\,°C$

$\lambda_F = 80 \text{ cal}/g$ calore latente di fusione

$C^*_G = 0{,}49 \text{ cal}/g\,°C$



$\rho_{H_2O} = 1000 \text{ kg}/m^3 = 1 g/cm^3$

$m_{H_2O} = \rho_{H_2O} V_{H_2O} = 500 g$

SISTEMA ISOLATO $\Rightarrow$ scambio Temp. tra ghiaccio e acqua

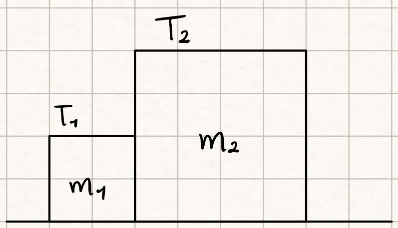
$\Delta Q_{sist} = 0$

$$m_{H_2O} C^*_{H_2O} (T_f - T_i) + m_G C^*_G (T_f - T_i) + m_G \lambda_F = 0$$

durante passaggio di stato temp. = costante

$$m_G \left[C^*_G (T_f - T_i) + \lambda_F \right] = m_{H_2O} C^*_{H_2O} (T_i - T_f) \rightarrow m_G = \frac{m_{H_2O} C^*_{H_2O} (T_i - T_f)}{C^*_G (T_f - T_i) + \lambda_F} = 121{,}3 g$$

3)



$m_1 = 1 \text{ kg}$

$m_2 = 2 \text{ kg}$

$T_1 = 10\,°C$

$T_2 = 50\,°C$

? T_{eq}

$C^*(T) = a T^2$ (a cost)

$Q = m c^* \Delta T$

! solo se c^* cost

$$C^* = \frac{1}{m} \frac{\partial Q}{\partial T} \Rightarrow Q = \int_{T_i}^{T_f} C^*(T)\, m\, dT$$

$$Q = \int_{T_i}^{T_f} a T^2 m\, dT = a m \int_{T_i}^{T_f} T^2 dT = a m \left[\frac{T^3}{3} \right]_{T_i}^{T_f} = a m \frac{T_f^3 - T_i^3}{3}$$

SISTEMA ISOLATO : $Q_1 + Q_2 = 0$

$$\cancel{a} m_1 \frac{T_{eq}^3 - T_1^3}{\cancel{3}} + \cancel{a} m_2 \frac{T_{eq}^3 - T_2^3}{\cancel{3}} = 0 \Rightarrow T_{eq}^3 (m_1 + m_2) - T_1^3 m_1 - T_2^3 m_2 = 0$$

$$\Rightarrow T_{eq} = \sqrt[3]{\frac{T_1^3 m_1 + T_2^3 m_1}{m_1 + m_2}} = 310{,}34 \text{ K} = 37{,}8\,°C$$

SI.

$T(K) = T(°C) + 273{,}15$

va bene per differenze di temperature

4) $m = 50\ kg$

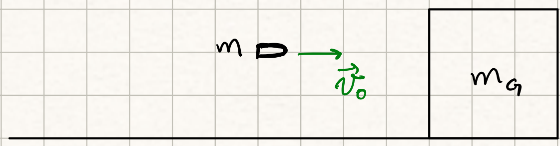
$T_{Pb} = 20°C$

$v_0 = 100\ m/s$

$m_G = 500\ g$

$c^*_{Pb} = 130\ J/kg\ °C$

$\lambda_F = 3,3 \cdot 10^5\ J/kg$



? m_G

URTO ANAELASTICO

- $m v_0 = (m + m_G)\, v_1 \qquad \Rightarrow v_1 = \dfrac{m}{m_1 + m_2}\, v_0$

- $E_{K,0} = \dfrac{1}{2} m v_0^2 \quad ; \quad E_{K,1} = \dfrac{1}{2}(m + m_G)\, v_1^2 = \dfrac{1}{2}\cancel{(m+m_G)}\dfrac{m^2}{(m+m_G)^{\cancel{2}}}\, v_0^2$

$E_{K,1} < E_{K,0} \quad \Rightarrow$ DISSIPATA IN CALORE

$$\Rightarrow Q_{ATT} = \Delta E_K = E_{K,1} - E_{K,0} = \frac{1}{2}\frac{m^2}{m + m_G} v_0^2 - \frac{1}{2} m v_0^2 =$$

$$= \frac{1}{2} m v_0^2 \left(\frac{m}{m + m_G} - 1\right) = \frac{1}{2} m v_0^2 \left(-\frac{m_G}{m + m_G}\right)$$

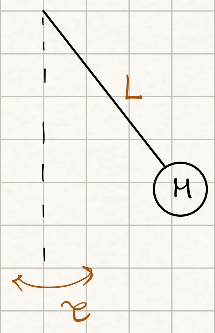
$$= -\frac{m\, m_G}{(m + m_G)2}\, v_0^2$$

SIST. ISOLATO:

$$Q_{SIST} = 0 \quad \Rightarrow \quad \overset{\text{dall'urto}}{Q_{ATT}} + \overset{\text{del proiettile}}{m c^*_{Pb} (\overset{0°C}{T_f} - T_{Pb})} + \Delta m_G \lambda_F = 0$$

$$\Delta m_G = \frac{m c^*_{Pb}(T_{Pb} - T_f) - Q}{\lambda_F} = \frac{1}{\lambda_F}\left[m c^*_{Pb}(T_{Pb} - T_f) + \frac{1}{2}\frac{m\, m_G}{m + m_G} v_0^2\right] = 1,1\ g$$

6)



coeff. di dilataz. lineare

$\alpha_{Acciaio} = 11 \cdot 10^{-6}\ 1/°C$

periodo $\tau = 1s$

$T = 20°C$

$\Delta T = +5°C$

? $\Delta\tau$

? tempo perso in 1 settimana

$$\Delta L = L\alpha_{Acc}\,\Delta T$$

$$\tau = 2\pi\sqrt{\frac{L}{g}} \quad \rightarrow \quad \tau' = 2\pi\sqrt{\frac{L+\Delta L}{g}} = 2\pi\sqrt{\frac{L(1+\alpha\Delta T)}{g}} = 2\pi\sqrt{\frac{L}{g}}\sqrt{1+\alpha\Delta T}$$

$$= \tau\sqrt{1+\alpha\Delta T} \quad > \tau \quad \Rightarrow \quad \Delta\tau > 0$$

$$\Rightarrow \Delta\tau = \tau' - \tau = \tau\left(\sqrt{1+\alpha\Delta T} - 1\right) = 2{,}75 \cdot 10^{-5}\,s \simeq 27{,}5\,\mu s$$

$$N = \frac{t_{giorno}}{\tau} = 86400$$ n. di oscillazioni che compie un pendolo funzionante in 1 giorno

$$\Delta t = 7N\Delta\tau = 16{,}6\,s$$ tempo che il pendolo in considerazione impiega in più rispetto uno normale per compiere n. oscill. in una settimana.