Cap. 8, vol 2 : Moysés Nussenzveig — Março, 2025

Francisco Jardinson Moreno de Matos
UFC - Física/Bacharelado

01 Suponha que toda energia potencial de uma massa m seja usada para aquecê-la:

$$mgh = m \cdot c_A \cdot \Delta T \Rightarrow \Delta T = \frac{gh}{c_A} = \frac{9,81.50}{4,184.10^3} = 0,117°C$$

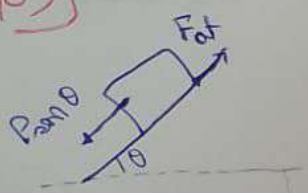
02 a) $$\bar{C_V} = \frac{1}{20-10}\int_{10}^{20} \frac{464}{T_0^3} \cdot T^3 dT$$

$$= \frac{464}{10.281^3} \cdot \frac{T^4}{10}\Big|_{10}^{20} = 0,0784 \text{ cal/K.mol}$$

b) $$Q = n.\bar{C_V}\Delta T = \frac{m}{M}\bar{C_V}\Delta T$$

$$= \frac{10^3}{58,44} \cdot 0,0784.10 \cong 13,4 \text{ cal}$$

03



Para velocidade constante : $F_{at} = P\,sen\theta = mg\,sen\theta$

A energia, por segundo, gasto por esse torço é:

$$P = \frac{W}{\Delta t} = mgsen\theta \cdot \frac{d}{\Delta t} = vmgsen\theta$$

Em 1min = 60s : $E = vmgsen\theta.60 = 0,1.10^3.9,81.sen10°.60 = 10221\,J$
$= 2443,86 cal$

$$\Rightarrow m = \frac{Q}{L} = \frac{2443}{80} = 30,53g \text{ por minuto}$$

04 a) $E = P.A.\Delta t = (1,36.10^3).(\pi.[6,4.10^6]^2).24.60.60 = 1,51.10^{22}\,J$

b) Energia para evaporar: $E_{EV} = 0,23.E = 3,477.10^{21}\,J = 8,312.10^{20}$ cal

Que produz : $m = \frac{8,312.10^{20}}{590} = 1,4088.10^{18}g = 1,4088.10^{15}kg$

Volume : $V = 1,413.10^{12}\,m^3$

Área da Terra: $A = 4\pi R^2 = 5,11.10^{14}\,m^2$ $\Rightarrow h = \frac{V}{A} = 2,389\,cm$

Coberta por água: $0,71.A = 3,629.10^{14}\,m^2$

05 $m_a 1,250 (T-20) + 500.1.(T-20) + 100.80 + 100.1.(T-0) = 0$

$250T - 5000 + 500T - 10000 + 8000 + 100T = 0$

$52,5T - 1050^2$

$\Rightarrow 652,5T = 3050$

$\Rightarrow T = 4,67°C$

06 $200.0,09.(26,3-30) + 250.1.(26,3-30) + 150.c.(26,3-15) = 0$

$\Rightarrow -66,6 - 925 + 1695c = 0$

$\Rightarrow c = 0,585\ cal/g°C$

07 $Q = 50.(39,7-0) + 100.1.39,7 + 100.80 + 100.1.39,7 = 17900\ cal$

$= 74892,6$

$\rightarrow P = \frac{Q}{\Delta t} = \frac{74892,6}{5.60} = 249,64\ W$

08 $V_m = \frac{m}{t} \rightarrow m = V_m.t \rightarrow Q = mc\Delta T$

$P = \frac{Q}{t} \rightarrow Q = P.t$

$\rightarrow m.c.\Delta T = P.t$

$\rightarrow V_m.t.c.\Delta T = P.t$

$\rightarrow c = \frac{200}{5.10^{-3}.(38,3-15)} = 1716,74\ J/kg°C$

$= 241\ cal/g°C$

09 $E = 20\ mcal = 20.26,3.9,8.1,6 = 8248\ J$

$Q = m.c.\Delta T = 632.10^3.1.0,313 = 1978\ cal$

$\rightarrow 8247,685 = 1978,16\ cal$

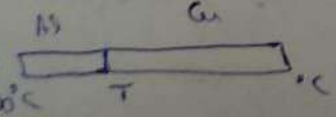
$\rightarrow 1\ cal = 4,169\ J$

10 $m_1 V_1 = (m_1+m_2)V_2 \rightarrow 108.300 = 210g.V_2 \rightarrow V_2 = 14,28\ m/s$

$\Delta E = \frac{m_1 V_1^2}{2} - \frac{(m_1+m_2)V_2^2}{2} = \frac{900-42,86}{2} = 428,5\ J = 102,43\ cal$

De $27°C \rightarrow 327°C$: $Q_1 = 10.0,031.300 = 93\ cal$

$\rightarrow 102,43 - 93 = m.5,85 \rightarrow m = 1,61g$

11 

$\Phi = K_{Al}.A.\frac{(100-T)}{5cm} = K_{Cu}.\frac{A(T-0)}{10cm}$

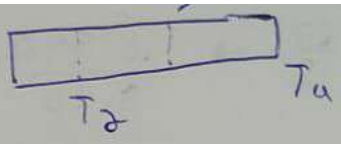
$\rightarrow 2.0,48(100-T) = 0,92.T$

$\rightarrow 96 - 0,96T = 0,92T$

$\rightarrow 96 = 1,88T$

$\rightarrow T = 51°C$

12 $\Phi = K.A.\frac{\Delta T}{l} \rightarrow \Delta T = \frac{l}{K}.\frac{\Phi}{A}$



$T_1 - T_2 = \frac{l_1}{K_1}\frac{\Phi}{A}$

$T_2 - T_3 = \frac{l_2}{K_2}.\frac{\Phi}{A}$

$T_3 - T_a = \frac{l_3}{K_3}.\frac{\Phi}{A}$

$$\frac{(T_1 - T_a)A}{\frac{l_1}{K_1} + \frac{l_2}{K_2} + \frac{l_3}{K_3}} = \Phi \rightarrow \frac{l_T}{K_T} = \frac{l_1 + l_2 + l_3}{K_T} = \frac{l_1}{K_1} + \frac{l_2}{K_2} + \frac{l_3}{K_3}$$

$$\rightarrow K_T = \frac{l_1 + l_2 + l_3}{\frac{l_1}{K_1} + \frac{l_2}{K_2} + \frac{l_3}{K_3}}$$

13 Em dr: $\Phi = K.A.\frac{dT}{dr} = K.(4\pi r^2)\frac{dT}{dr}$

$$\rightarrow \frac{\Phi}{4\pi K}.\frac{dr}{r^2} = dT \rightarrow \frac{\Phi}{4\pi K}\int_{r_1}^{r_2} r^{-2}dr = \int dT$$

$$\rightarrow \frac{\Phi}{4\pi K}\left[\frac{1}{r_2} - \frac{1}{r_1}\right] = \Delta T \rightarrow \Phi = \frac{d\theta}{dt} = 4\pi K\Delta T\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

14 a) $\Phi = K.A.\frac{dT}{d\rho} = K.2\pi\rho l.\frac{dT}{d\rho} \rightarrow \frac{\Phi}{2\pi K l}.\frac{d\rho}{\rho} = dT$

$$\rightarrow \frac{\Phi}{2\pi K l}.\ln\frac{\rho_2}{\rho_1} = \Delta T \rightarrow \frac{d\theta}{dt} = \frac{2\pi K l\,\Delta T}{\ln\frac{\rho_2}{\rho_1}}$$

b) $\frac{d\theta}{dt} = \frac{2\pi.5,7.10^{-5}.(100-25).20}{\ln\frac{95}{5}} = 5,64\ cal/s$

$m = \rho.V = 1.1\pi\rho_1^2 = 1571\ g$

$Q = mc\Delta T = 1571.1.(100-25) = 117825 = 5,64.t$

$\Rightarrow t = 20890\ s$

$= 5h\ 48\ min$

15) $\frac{Q}{t} = KA\frac{\Delta T}{l} \rightarrow \frac{10^3 \cdot 540}{5 \cdot 60} = 0{,}49 \cdot \pi \cdot 7{,}5^2 \frac{(T-100)}{0{,}2} \rightarrow T = 104{,}2°C$

16) Calor dQ perdido para formar uma camada de área A e
a) espessura dx

$dQ = dm \cdot L = \rho A L \cdot dx$

Mas: $\Phi = \frac{dQ}{dt} = KA\frac{\Delta T}{x} \rightarrow \rho A L \frac{dx}{dt} = KA\frac{\Delta T}{x}$

$\rightarrow \rho A L \cdot (x\,dx) = KA(\Delta T\, dt)$ (ΔT → to)

$\rho L \frac{x^2}{2} = KA \cdot \Delta T \cdot t \rightarrow l = \sqrt{\frac{2Kt\Delta T}{\rho L}}$

b) $l^2 = \frac{2 \cdot 4 \cdot 10^{-3} \cdot 60 \cdot 60 \cdot (100)}{0{,}92 \cdot 80} \rightarrow l = 1{,}98cm$

17) a) $V_0 = 1l = 0{,}01m^3$
$V_F = 1{,}671m^3$
$\rightarrow \Delta V = 1{,}670m^3 \rightarrow W = 101325 \cdot 1{,}67 = 1{,}69 \cdot 10^5 J$

b) $Q = mL = \frac{10^3 \cdot 536{,}9}{cal} \cdot 4{,}184 = 2{,}25 \cdot 10^6 J$

$\Delta U = Q - W = (22{,}5 - 1{,}69)\,10^5 = 2{,}10 \cdot 10^6 J$

18) a) $W_{ibf} = 100J$
$W_{iafbi} = 200J$
$\Delta U = 50J$
$\rightarrow Q_{ibf} = \Delta U + W_{ibf} = 150J$

b) $W \triangleq 200J \Rightarrow W_{iaf} = W_{iafbi} + W_{ibf} = 200 + 100 \rightarrow 300J$

c) $Q_{iaf} = \Delta U + W_{iaf} = 50 + 300 = 350J$

d) $W_{fi} = (P_i - P_a)(V_i - V_b) = -(P_a - P_i)(V_i - V_b) = -W_{iafbi} = -200J$

$\rightarrow Q_{fi} = \Delta U + W = -50 - 200 = -250J$

19

$W_{ab} = P_a \cdot (V_b - V_a) = 10^5 \cdot (10-5) \cdot 10^{-3} = 500\,J$

$W_{bc} = \frac{(P_b - P_a)(V_b - V_b)}{2} + P_a (V_a - V_b) = -750\,J$

$W_{ca} = 0 \quad (V = cte)$

$W_T = 500 - 750 = -250\,J$

$\Delta U_{ab} = Q - W_{ab} = 800 - 500 = 300\,J$

$Q_{ca} = W_{ca} + \Delta U_{ca} = 0 - 100 = -100\,J$

$\Delta U_{ab} = 300 \rightarrow \Delta U_{bc} = -200\,J$

$\Delta U_{ca} = -100$

$Q_{bc} = W_{bc} + \Delta U_{bc} = -750 - 200 = -950\,J$

$Q_T = 800 - 950 - 100 = -250\,J$