I cont. ②

(c) g é o "reflexo" de f ao redor do ponto $x = \ell$ (cond. cont.)

$$y(\ell, t) = 0 \qquad y = f(x - vt) + g(x + vt)$$

$$f(\ell - vt) + g(\ell + vt) = 0$$

$$g(\underbrace{\ell + vt}_{x''}) = -f(\underbrace{\ell - vt}_{x'})$$

$$x'' = \ell + vt \Rightarrow -x'' = -\ell - vt$$

$$2\ell - x'' = \ell - vt = x'$$

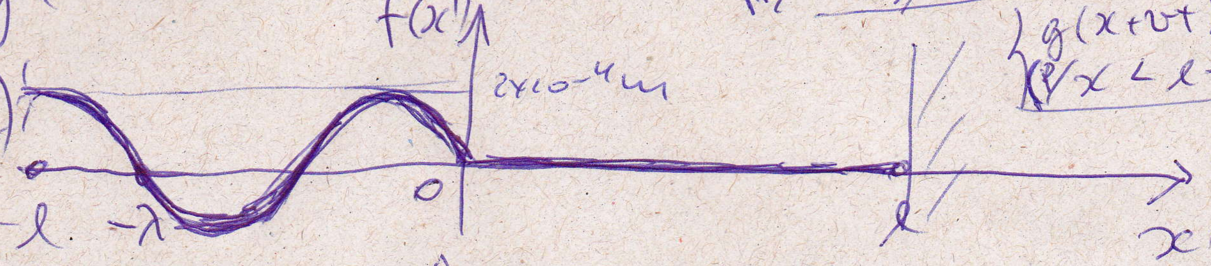
$$\therefore \; g(x'') = -f(2\ell - x'')$$

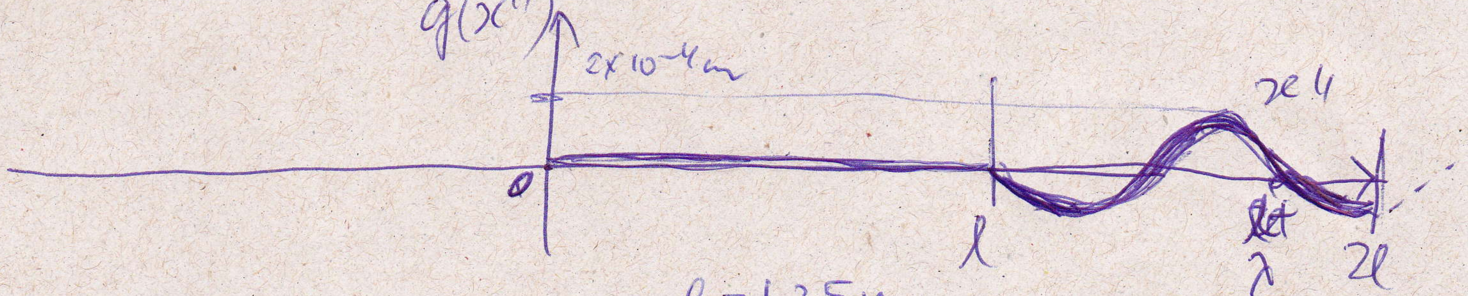
$$g(x + vt) = -f(2\ell - x - vt)$$

$$g(x + vt) = 0{,}2 \operatorname{sen}\left(2\ell - (x + vt)\right) \Big\} \; p/ \; x \geq \ell - vt$$

$$\Big\} \; g(x + vt) = 0 \quad p/ \; x < \ell - vt$$

(d)

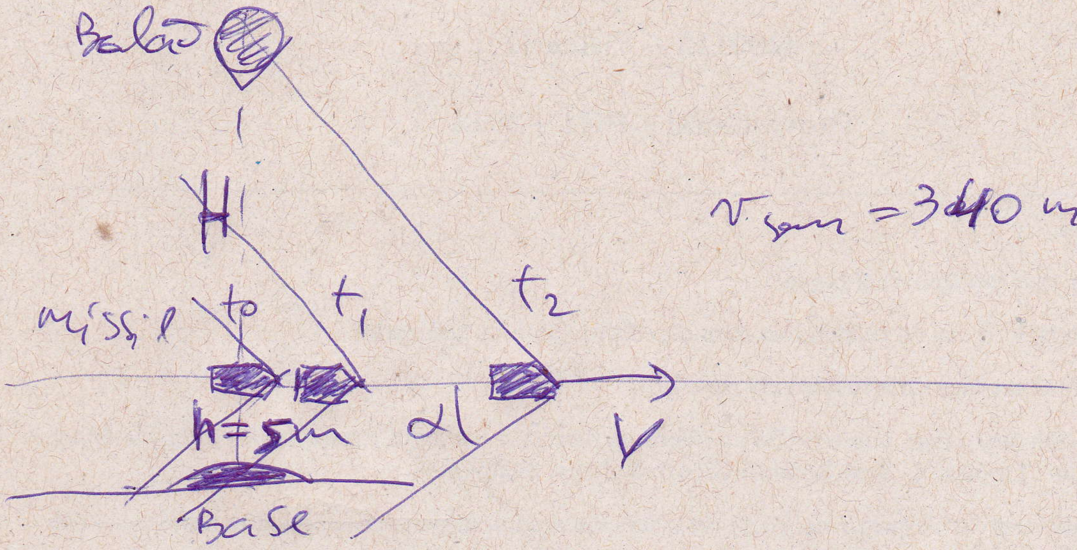




$\ell = 1{,}25\,m$

QUESTÃO 2

(a)



$v_{som} = 340 \ m/s$

(b) $t_1 = \frac{5}{680} s$ $\frac{h}{V t_1} = tg\,\alpha = \frac{sen\,\alpha}{cos\,\alpha}$

$sen\,\alpha = \frac{v_{som}}{V}$ (Mach)

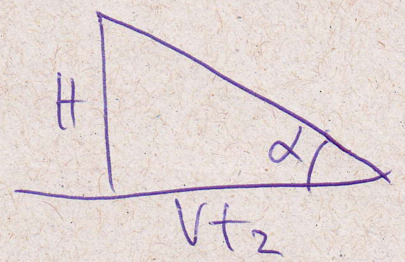
$$\frac{h}{\cancel{V} t_1} \cdot \frac{\cancel{V}}{v_{som}} = \frac{sen\,\alpha}{cos\,\alpha} \frac{1}{sen\,\alpha} = \frac{1}{cos\,\alpha}$$

$$\frac{1}{cos\,\alpha} = \frac{5}{\frac{5}{680} \cdot 340} = 2 \qquad cos\,\alpha = \frac{1}{2}$$

$\boxed{\alpha = 60^\circ}$ $\boxed{sen\,\alpha = \frac{\sqrt{3}}{2}}$

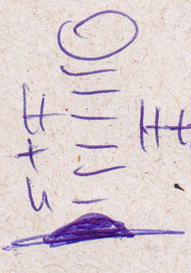
$$V = \frac{v_{som}}{sen\,\alpha} = \frac{340 \times 2}{\sqrt{3}} = \frac{680\sqrt{3}}{3}$$

(c)



$$\operatorname{tg}\alpha = \frac{H}{Vt_2} \qquad \boxed{t_2 = \frac{H}{V\operatorname{tg}\alpha}}$$

(d)



$H+h = v_{son}\,\Delta t \qquad \Delta t = t_3 - t_2$

$$H+h = v_{son}(t_3 - t_2) = v_{son}\left(t_3 - \frac{H}{V\operatorname{tg}\alpha}\right)$$

$$H\left(1 + \frac{v_{son}}{V\operatorname{tg}\alpha}\right) = v_{son}\,t_3 - h$$

$$H\left(1 + \frac{340}{\frac{680}{\cancel{\sqrt{3}}}\cancel{\sqrt{3}}}\right) = 340 \times 0{,}5 - 5$$

$$H \times 1{,}5 = 165 \qquad H = \frac{165}{5} = 33\,\text{m}$$

(e)

$$f = f_0\,\frac{1}{1 + \frac{V}{v_s}} = 440(2+\sqrt{3})\,\frac{1}{1 + \frac{680}{340\sqrt{3}}}$$

$$f = 440(2+\sqrt{3})\,\frac{\sqrt{3}}{2+\sqrt{3}} = 440\sqrt{3}\ \text{Hz}$$

QUESTÃO 3

(a)

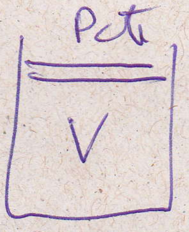
$$V = V_0(1 + 3\alpha\Delta T)$$

$$P = \frac{nRT}{V}$$

$$P_0 = \frac{nRT_0}{V_0} \qquad \frac{P}{P_0} = \frac{T}{V}\frac{V_0}{T_0}$$

$$P = \frac{P_0 T \cancel{V_0}}{T_0 \cancel{V_0}(1+3\alpha\Delta T)} = \frac{P_0 T}{T_0(1+3\alpha(T-T_0))}$$

(b)



$$PV = nRT \qquad dV = \underbrace{(V_0\beta)}_{(def)} dT$$

$$dV = \left(\frac{nR}{P}\right) dT$$

$$\frac{nR}{P} = V_0\beta \qquad \beta = \frac{nR}{PV_0} = \frac{\cancel{nR}}{\cancel{nR}T_0} = \frac{1}{T_0}$$

QUESTÃO 4

(a) 2-3 Isocórica ($V = cte$)

3-4 Isobárica ($P = cte$)

4-1 Adiabática

1-2 Isotérmica

$\frac{dP}{dV}(\text{adiab}) > \frac{dP}{dV}_{isoT}$ no Ponto 1

i.e. adiab. cai mais rapidamente que a isotérmica

(b) A área representa o trabalho realizado pelo gás no ciclo. horário → trabalho positivo

como o ciclo volta ao estado inicial, $\Delta U = 0$

$Q = W$ pois $\Delta U = Q - W$ (1ª lei)

(c) $P_3 V_3 = nRT_3 = 10\,T_3$ $\left(nR = \frac{8.3}{0.83} = 10\right)$

$T_3 = \frac{1280}{10 \times 2} = 64{,}0\,K$

2-3 $P_3 = 2P_2$ $P_2 = \frac{P_3}{2} = 640\,Pa$

3-4 $V_4 = 2V_3 = 1\,m^3$

$V_2 = V_3 = \frac{1}{2}\,m^3$ $P_3 = P_4 = 1280\,Pa$

$P_4 V_4 = 10\,T_4 = 1280$ $T_4 = 128\,K$

$T_2 = T_3/2 = 32{,}0\,K$

TABELA:

Ponto	P (J)	V (m³)	T (K)
1	10	32	32
2	640	0,5	32
3	1280	0,5	64
4	1280	1	128

(d) $i = 1 \quad j = 2 \qquad PV = 10T_1 = 320$

$$W_{12} = \int_{V_1}^{V_2} P\,dV = 320 \ln \frac{\cancel{V}_2}{V_1} = -320 \times 6 \times \ln 2$$

$$V_1 = \frac{1}{2}$$

$$\ln \frac{V_2}{V_1} = \ln(2V_2) = 6 \ln 2 = \ln 2^6$$

$$2V_2 = 2^6 \qquad V_2 = 2^5 = 32\ m^3$$

$$P_1 = \frac{10 T_1}{V_1} = 10\ Pa$$

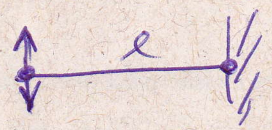
(e) $$\Delta U = n\, c_v \Delta T = \frac{5}{2} \overbrace{nR}^{10} (T_1 - T_4)$$

$$\Delta U = 25(32 - 128) = -2400\ J$$

Em trabalho $W = 2400\ J$
realizado na expansão

FÍSICA II PG 1-2012

QUESTÃO 1



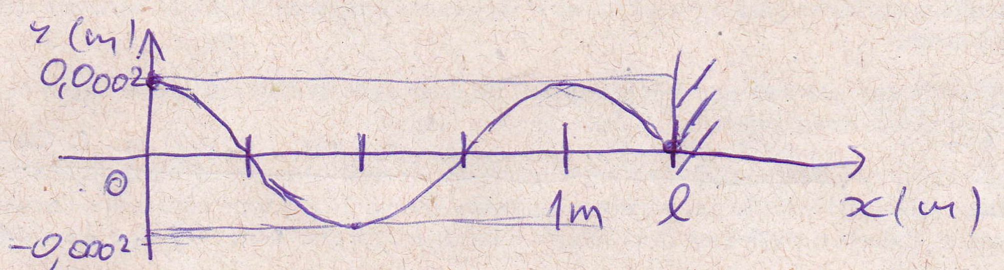
(a) $v = \sqrt{\dfrac{T}{\mu}}$ $\quad \mu = \dfrac{m}{\ell} = \dfrac{0{,}125}{1{,}25} = 0{,}1 \text{ kg/m}$

$$v = \sqrt{\frac{10}{0{,}1}} = \sqrt{100} = 10 \text{ m/s}$$

$$t_c = \frac{\ell}{v} = \frac{1{,}25}{10} = 0{,}125 \text{ s}$$

(b) $\tau = \dfrac{1}{f} = \dfrac{1}{10} = 0{,}1 \text{ s} < t_c$

$$\lambda = v\tau = 1 \text{ m}$$



(c) p/ $\begin{cases} t < 2t_c \\ x = 0 \end{cases}$ $\quad f(-vt) = y(0,t)$

$$y(0,t) = A \operatorname{sen}(2\pi f t) = 0{,}2 \operatorname{sen}(20\pi t)$$

$$y(0,t) = -0{,}2 \operatorname{sen}(2\pi(-10t))$$

$$y(0,t) = -0{,}2 \operatorname{sen}(2\pi(-vt)) = f(-vt)$$

$$\therefore \; f(x - vt) = -0{,}2 \operatorname{sen}(2\pi(x - vt))$$

Válido para $x - vt \leq 0$ i.e. $\underline{x \leq vt}$,
para $x > vt$ $\; f(x - vt) = 0$