Onde e suono

AS 2020-21 prof. A. Pisani

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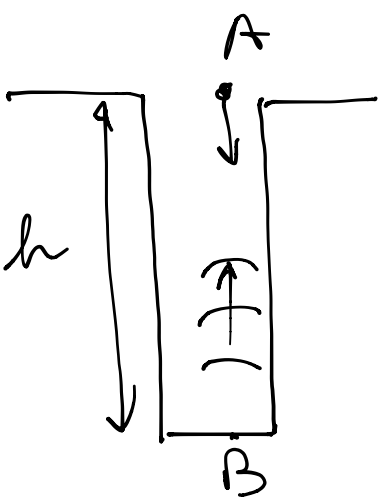

$h = 7.35\ m$

$\underbrace{\Delta t} = ?$

$\Delta t = \Delta t_s + \Delta t_c$

CADUTA: $h = \frac{1}{2} g \cdot \Delta t_c^2$

$\Delta t_c = \sqrt{\frac{2h}{g}}$

$\Delta t_s = h / v_s$ $\qquad v_s = 343\ m/s$

$$\Delta t_c = \sqrt{\frac{2 \cdot 7.35\,m}{9,81\,m/s^2}} \approx 1.22\,s$$

$$\Delta t_s = \frac{7.35\,m}{343\,m/s} \approx 0,02\,s$$

$$\Delta t = 1.24\,s$$

$$\Delta t = 1.47\,s \qquad h = ?$$

$$\Delta t = \sqrt{\frac{2h}{g}} + \frac{h}{v} \qquad \cdot v$$

$$v\,\Delta t = v\sqrt{\frac{2h}{g}} + h$$

$$h + v\sqrt{\frac{2h}{g}} - v\Delta t = 0$$

$$x = \sqrt{h}$$

$$x^2 + v\sqrt{\frac{2}{g}}\,x - v\Delta t = 0$$

$$a x^2 + b x + c = 0$$

$$a = 1 \quad b = v\sqrt{\frac{2}{g}} \quad c = -v\Delta t$$

$$x = \frac{-v\sqrt{\frac{2}{g}} \pm \sqrt{v^2\frac{2}{g} + 4v\Delta t}}{2}$$

NO

$$\sqrt{h} = x = \frac{-v\sqrt{\frac{2}{g}} + \sqrt{\frac{2v^2}{g} + 4v\Delta t}}{2}$$

$$h = \left(\frac{-v\sqrt{\frac{2}{g}} + \sqrt{\frac{2v^2}{g} + 4v\Delta t}}{2} \right)^2$$

$$= \left(\frac{-343\,\frac{m}{s}\sqrt{\frac{2}{9.81\,m/s^2}} + \sqrt{\frac{2\cdot\left(343\,\frac{m}{s}\right)^2}{9.81\,m/s} + 4\cdot 343\,\frac{m}{s}\cdot 1{,}47\,s}}{2} \right)^2$$

$$= \left(3.2\sqrt{m} \right)^2 \simeq 10.2\,m$$

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Q1) $f = 400\,Hz$

$\lambda = 2.5\,m$ $\quad v = ?$

$v = f \cdot \lambda$

$$v = 400\,\underset{\downarrow\, s^{-1}}{Hz} \cdot \underbrace{2.5}_{5/2}\,m = 1000\,\frac{m}{s}$$

B

Q2) $f = 500\,Hz$

$\lambda = 0{,}4\,m$ $\quad D = 600\,m$

$\Delta t = ?$

$$\Delta t = \frac{D}{v} \qquad v = \lambda \cdot f$$

$$= \frac{D}{\lambda f}$$

$$= \frac{600\,m}{500\,Hz \cdot 0.4\,m} = 3\,s$$

A

Q 3) $y = 8 \cos\left[\pi\left(\frac{x}{4} - \frac{t}{10}\right)\right]$

$\lambda = ?$

$$y(x;t) = A \cdot \cos\left[2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)\right]$$

$$y = 8 \cos\left[2\pi\left(\frac{x}{8} - \frac{t}{20}\right)\right]$$

$\lambda = 8\ m \qquad T = 20\ s$

(C)

Q 4) $r_1 = 4\ m$

$I(r_1) = 140\ W/m^2$

$r_2 = 10\,m \qquad I(r_2) = ?$

$$I(r) = \frac{P}{4\pi r^2}$$

$$I(r_1) = \frac{P}{4\pi r_1^2}$$

$$I(r_2) = \frac{P}{4\pi r_2^2}$$

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} \qquad I \propto r^{-2}$$

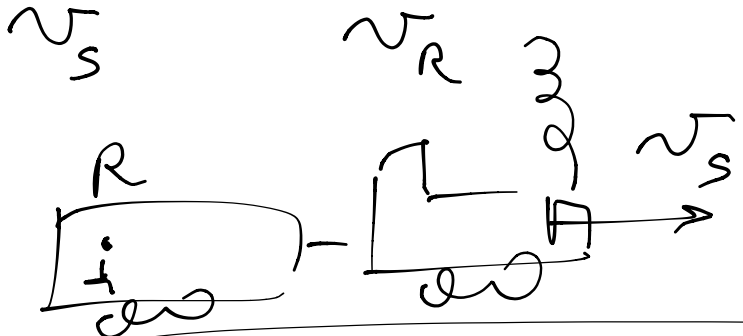
$$I_2 = I(10\,m) = I_1 \cdot \frac{r_1^2}{r_2^2}$$

$$I(10\,m) = 160\,\frac{W}{m^2} \cdot \frac{(4\,m)^2}{(10\,m)^2}$$

(A) $= 22{,}4\,W/m^2$

Q 5) $f_0 = 600\ Hz$

$v = 343\ m/s$



$$v_s = v_R = v_T$$

$$f' = \frac{v \pm v_s}{v \mp v_R} f_0$$

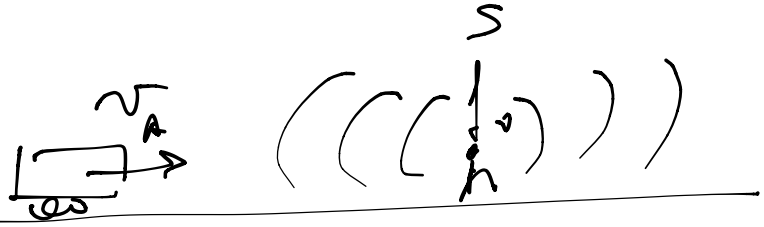
$$= \frac{v + v_s}{v + v_R} f_0$$

$$= \frac{v + v_T}{v + v_T} f_0 = f_0$$

(B) $f' = f_0 = 600\,Hz$

Q6) $v_A = 15\,m/s$

$f_0 = 220\,Hz \quad f' = ?$



$$f' = \frac{v + v_A}{v} f_0$$

$$\overset{!}{=} \left(1 + \frac{v_A}{v}\right) f_0$$

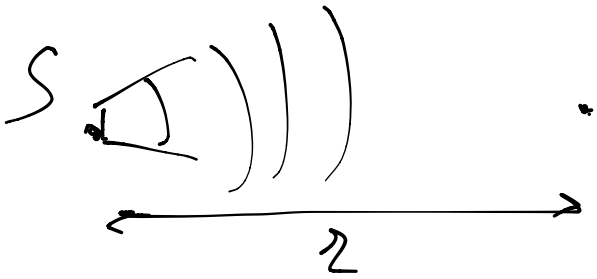
$$\overset{!}{=} \left(1 + \frac{15\,m/s}{343\,m/s}\right) 220\,Hz$$

(D) $\overset{!}{=} 229{,}62\,Hz \simeq 230\,Hz$

Q7) $P_1 = 20\ W$

$P_2 = 400\ W$

$\Delta\beta = ? = \beta_2 - \beta_1$



$$I(r) = \frac{P}{4\pi r^2}$$

$$I_1 = \frac{P_1}{4\pi r^2}$$

$$I_2 = \frac{P_2}{4\pi r^2}$$

$$\frac{I_2}{I_1} = \frac{P_2}{P_1}$$

$$= \frac{400\ W}{20\ W}$$

$$= 20$$

$$\beta = 10\ dB \cdot \log_{10}\left(\frac{I}{I_0}\right)$$

$$I_0 = 10^{-12}\ W/m^2$$

$$\beta_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right)$$

$$\beta_2 = 10 \log_{10}\left(\frac{I_2}{I_0}\right)$$

$$\Delta\beta = \beta_2 - \beta_1 =$$

$$10 \log\left(\frac{I_2}{I_0}\right) - 10 \log\left(\frac{I_1}{I_0}\right) =$$

$$= 10\left[\log\left(\frac{I_2}{I_0}\right) - \log\left(\frac{I_1}{I_0}\right)\right]$$

N.B. $\log A - \log B = \log\left(\frac{A}{B}\right)$

$$\Delta\beta = 10 \log\left[\frac{I_2}{I_0} \cdot \frac{I_0}{I_1}\right]$$

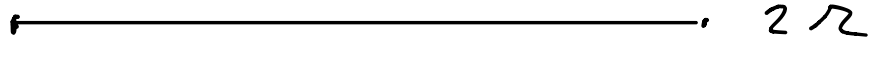
$$= 10 \log\left(\frac{I_2}{I_1}\right)$$

$$= 13.010 \simeq 13\,dB$$

(B)

Q 8)

a)

b) 

$f_{a,1} \qquad f_{b,1}$

$$f = \frac{v}{\lambda}$$

$$f_{a,1} = \frac{v}{\lambda_1}$$

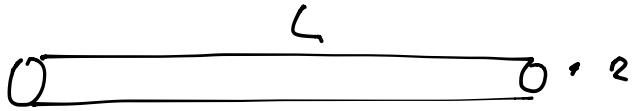
$$\lambda_1 = 2L \qquad L = \frac{\lambda_1}{2}$$

$$f_{a,1} = \frac{v}{2L}$$

$$v = \sqrt{\frac{F}{\mu}} \qquad \mu = \frac{\pi}{L}$$

STESSO MATERIALE

$$c_a = c_b = \frac{m}{V_{ol}}$$



$$V_{ol} = \pi r^2 \cdot L$$

$$\mu = \frac{m}{L} = \frac{c \cdot \pi r^2 L}{L}$$

$$= c \pi r^2$$

$$v_a = \sqrt{\frac{F}{c \pi r^2}} = \frac{\sqrt{F/c\pi}}{r}$$

$$f_{a,1} = \frac{\sqrt{\frac{F}{c\pi}} / r}{2L}$$

$$= \frac{\sqrt{F/\rho\pi}}{2Lr}$$

corda b: $L \to 2L$ $r \to 2r$

$$f_{b,1} = \frac{\sqrt{F/\rho\pi}}{2 \cdot 2L \cdot 2 \cdot r}$$

$$= \frac{\sqrt{F/\rho\pi}}{8Lr}$$

$$\frac{f_{a1}}{f_{b,1}} = \frac{\cancel{\sqrt{F/\rho\pi}}/2Lr}{\cancel{\sqrt{F/\rho\pi}}/8Lr}$$

$$= \frac{1/2Lr}{1/8Lr} = \frac{8Lr}{2Lr} = 4$$

e