

WEEKLY TEST OYM TEST - 28 Balliwala
SOLUTION Date 17-11-2019

[PHYSICS]

1. (a) It is given that energy remains the same.

$$\text{Hence, } E_A = E_B$$

$$\text{Energy} \propto a^2 n^2 \Rightarrow \frac{a_B}{a_A} = \frac{n_A}{n_B} \quad (\because \text{energy is same})$$

$$\therefore \left(\frac{a_A}{a_B} \right)^2 = \left(\frac{n_B}{n_A} \right)^2$$

$$\text{Given, } n_A = n, n_B = \frac{n}{8}$$

$$\therefore \frac{a_A}{a_B} = \frac{n/8}{n} = \frac{1}{8} \Rightarrow a_B = 8a_A = 8a$$

2. (a) Time required for a point to move from maximum displacement to zero displacement is

$$t = \frac{T}{4} = \frac{1}{4n}$$

$$\Rightarrow n = \frac{1}{4t} = \frac{1}{4 \times 0.170} = 1.47 \text{ Hz}$$

3. (a) The apparent change in the frequency of the source due to relative motion between source and observer is known as Doppler's effect. The perceived frequency (n') when listener is static and source is moving away is given by

$$n' = n \left(\frac{v}{v + v_s} \right)$$

where n is frequency of source, v is velocity of sound and v_s is velocity of source.

Putting $v = 330$ m/s, $v_s = 30$ m/s, $n = 800$ Hz.

$$n' = 800 \times \left(\frac{330}{330 + 30} \right)$$

$$n' = 733.3 \text{ Hz}$$

In the limit when speed of source and observer is much lesser than that of sound v_1 , the change in frequency becomes independent of the fact whether the source is moved or the detector.

4. (b) Since the point $x = 0$ is a node and reflection is taking place from point $x = 0$. This means that reflection must be taking place from the fixed end and hence the reflected ray must suffer an additional phase change of π or a path change of $\lambda/2$

So, if $y_{\text{incident}} = a \cos(kx - \omega t)$

$$\begin{aligned} \Rightarrow y_{\text{reflected}} &= a \cos(-kx - \omega t + \pi) \\ &= -a \cos(\omega t + kx) \end{aligned}$$

5. (d) Points B and F are in same phase as they are λ distance apart.
6. (c) Critical hearing frequency for a person is 20,000 Hz.

If a closed pipe vibration in N^{th} mode then frequency of vibration

$$n = \frac{(2N-1)v}{4l} = (2N-1)n_1$$

(where n_1 = fundamental frequency of vibration)

$$\text{Hence } 20,000 = (2N-1) \times 1500 \Rightarrow N = 7.1 \approx 7$$

Maximum possible harmonics obtained are

$$1, 3, 5, 7, 9, 11, 13$$

Hence, man can hear up to 13th harmonic

$$= 7 - 1 = 6$$

So, number of overtones heard = 6

7. (a) In first overtone mode, $l = \frac{3\lambda}{4}$

$$\therefore \frac{\lambda}{4} = \frac{l}{3} = \frac{1.2}{3} = 0.4 \text{ m}$$

Pressure variation will be maximum at displacement nodes, i.e., at 0.4 m from the open end.

8. (c) The frequency of A, $n_A = n + \frac{2}{100}n$

and the frequency of B, $n_B = n - \frac{3}{100}n$

According to question, $n_A - n_B = 6$

$$\therefore \left(n + \frac{2}{100}n \right) - \left(n - \frac{3}{100}n \right) = 6$$

or $\frac{5}{100}n = 6 \Rightarrow n = \frac{600}{5} = 120 \text{ Hz}$

The frequency of A

$$\begin{aligned} n_A &= \left(n + \frac{2}{100}n \right) = 120 + \frac{2}{100} \times 120 \\ &= 122.4 \text{ Hz} \end{aligned}$$

9. (c) Fundamental frequency of closed pipe

$$n = \frac{v}{4l} = 220 \text{ Hz} \Rightarrow v = 220 \times 4l$$

If 1/4 of the pipe is filled with water then remaining

length of air column is $\frac{3l}{4}$

Now fundamental frequency = $\frac{v}{4\left(\frac{3l}{4}\right)} = \frac{v}{3l}$ and

First overtone = $3 \times$ fundamental frequency

$$= \frac{3v}{3l} = \frac{v}{l} = \frac{220 \times 4l}{l} = 880 \text{ Hz}$$

10. (c) $f \propto \sqrt{T}$

$$f = \frac{1}{2l} \sqrt{\frac{T}{\mu}} \Rightarrow \frac{\Delta f}{f} = \frac{1}{2} \frac{\Delta T}{T}$$

$$\Rightarrow \Delta f = \frac{202}{2} \times \frac{1}{101} = 1$$

11. (d) $\frac{v_1}{v_2} = \frac{28}{27}$

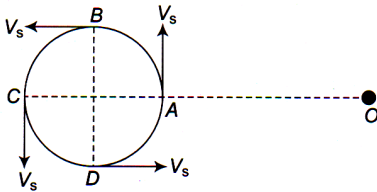
$$v_1 - v_2 = 3 \text{ or } \frac{28}{27}v_2 - v_2 = 3$$

$$v_2 = 27 \times 3 \text{ Hz} = 81 \text{ Hz}$$

or $v_1 = v_2 + 3 = (81 + 3) \text{ Hz}$

or $v_1 = 84 \text{ Hz}$

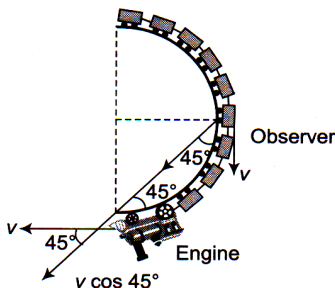
12. (d) Frequency heard by the observed will be maximum when the source is in the position D . In this case, source will be approaching towards the stationary observer, almost along the line of sight (as observer is stationed at a larger distance).



Similarly, frequency heard by the observer will be minimum when the source reaches at the position B . Now, the source will be moving away from the observer.

$$\begin{aligned} n_{\min.} &= \frac{v}{v + v_s} \times n = \frac{330}{330 + 1.5 \times 20} \times 440 \\ &= \frac{330 \times 440}{360} = 403.3 \text{ Hz} \end{aligned}$$

13. (c) The situation is shown in the fig. Both the source (engine) and the observer (Person in the middle of the train) have the same speed, but their direction of motion is right angles to each other. The component of velocity of observer towards source is $v \cos 45^\circ$ and that of source along the time joining the observer and source is also $v \cos 45^\circ$. There is no relative motion between them, so there is no change in frequency heard. So frequency heard is 200 Hz.



14. (b) Equation of A, B, C and D are

$$y_A = A \sin \omega t, \quad y_B = A \sin(\omega t + \pi/2)$$

$$y_C = A \sin(\omega t - \pi/2), \quad y_D = A \sin(\omega t - \pi)$$

It is clear that wave C lags behind by a phase angle of $\pi/2$ and the wave B is ahead by a phase angle of $\pi/2$.

15. (c) The particle velocity is maximum at B and is given by

$$\frac{dy}{dt} = (v_p)_{\max} = \omega A$$

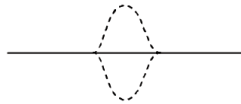
$$\text{Also wave velocity is } \frac{dx}{dt} = v = \frac{\omega}{k}$$

$$\text{So slope } \frac{dy}{dx} = \frac{(v_p)_{\max}}{v} = kA$$

16. (c) We know frequency $n = \frac{p}{2l} \sqrt{\frac{T}{\pi r^2 \rho}} \Rightarrow n \propto \frac{1}{\sqrt{\rho}}$

i.e., graph between n and $\sqrt{\rho}$ will be hyperbola.

17. (c) After two seconds each wave travel a distance of $2.5 \times 2 = 5 \text{ cm}$ i.e. the two pulses will meet in mutually opposite phase and hence the amplitude of resultant will be zero.



18. (c) $n_Q = 341 \pm 3 = 344 \text{ Hz}$ or 338 Hz

on waxing Q, the number of beats decreases hence $n_Q = 344 \text{ Hz}$

19.

20. (d) Intensity $\propto a^2 \omega^2$

$$\text{here } \frac{a_A}{a_B} = \frac{2}{1} \text{ and } \frac{\omega_A}{\omega_B} = \frac{1}{2} \Rightarrow \frac{I_A}{I_B} = \left(\frac{2}{1}\right)^2 \times \left(\frac{1}{2}\right)^2 = \frac{1}{1}$$