DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 30

SYLLABUS : Waves-2 (Standing waves in strings and organ pipes, Fundamental mode and harmonics, Beats, Doppler effect in sound)

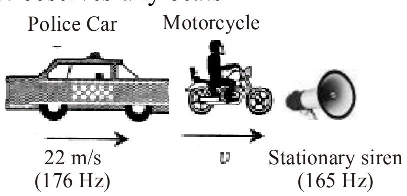
Max. Marks : 120 | **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.22) : There are 22 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A police car moving at 22 m/s, chases a motorcyclist. The police man sounds his horn at 176 Hz, while both of them move towards a stationary siren of frequency 165 Hz. Calculate the speed of the motorcycle, if it is given that he does not observes any beats



(a) 33 m/s (b) 22 m/s (c) Zero (d) 11 m/s

Q.2 A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipes. Both the pipes are vibrating in their first overtone with same frequency. The length of the open organ pipe is

(a) $\frac{L}{3}$ (b) $\frac{4L}{3}$ (c) $\frac{4L}{3}\sqrt{\frac{\rho_1}{\rho_2}}$ (d) $\frac{4L}{3}\sqrt{\frac{\rho_2}{\rho_1}}$

Q.3 Two whistles A and B produces notes of frequencies 660 Hz and 596 Hz respectively. There is a listener at the mid-point of the line joining them. Now the whistle B and the listener start moving with speed 30 m/s away from the whistle A. If speed of sound be 330 m/s, how many beats will be heard by the listener

(a) 2 (b) 4 (c) 6 (d) 8

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ

Space for Rough Work

Q.4 An open organ pipe is in resonance in its 2nd harmonic with tuning fork of frequency f_1. Now, it is closed at one end. If the frequency of the tuning fork is increased slowly from f_1 then again a resonance is obtained with a frequency f_2. If in this case the pipe vibrates nth hamonics then

(a) $n = 3, f_2 = \frac{3}{4} f_1$ (b) $n = 3, f_2 = \frac{5}{4} f_1$

(c) $n = 5, f_2 = \frac{5}{4} f_1$ (d) $n = 5, f_2 = \frac{3}{4} f_1$

Q.5 The source producing sound and an observer both are moving along the direction of propagation of sound waves. If the respective velocities of sound, source and an observer are v, v_s and v_0, then the apparent frequency heard by the observer will be (n = frequency of sound)

(a) $\frac{n(v+v_0)}{v-v_0}$ (b) $\frac{n(v-v_0)}{v-v_s}$

(c) $\frac{n(v-v_0)}{v+v_s}$ (d) $\frac{n(v+v_0)}{v+v_s}$

Q.6 A whistle sends out 256 waves in a second. If the whistle approaches the observer with velocity 1/3 of the velocity of sound in air, the number of waves per second the observer will receive

(a) 384 (b) 192 (c) 300 (d) 200

Q.7 A source of sound emitting a note of frequency 200 Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is

(a) 50 Hz (b) 100 Hz (c) 150 Hz (d) 200 Hz

Q.8 The speed of sound in air at a given temperature is 350 m/s. An engine blows whistle at a frequency of 1200 cps. It is approaching the observer with velocity 50 m/s. The apparent frequency in *cps* heard by the observer will be

(a) 600 (b) 1050 (c) 1400 (d) 2400

Q.9 A source of sound of frequency n is moving towards a stationary observer with a speed S. If the speed of sound in air is V and the frequency heard by the observer is n_1, the value of n_1 / n is

(a) (V + S)/V (b) V/ (V + S)

(c) (V – S)/V (d) V/ (V – S)

Q.10 An observer is moving away from source of sound of frequency 100 Hz. His speed is 33 m/s. If speed of sound is 330 m/s, then the observed frequency is

(a) 90 Hz (b) 100 Hz (c) 91 Hz (d) 110 Hz

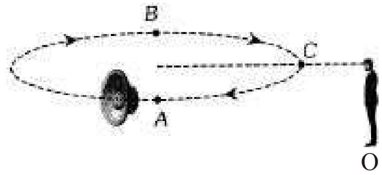
Q.11 A whistle giving out 450 Hz approaches a stationary observer at a speed of 33 m/s. The frequency heard by the observer in Hz is

(a) 409 (b) 429 (c) 517 (d) 500

Q.12 Two sirens situated one kilometre apart are producing sound of frequency 330 Hz. An observer starts moving from one siren to the other with a speed of 2 m/s. If the speed of sound be 330 m/s, what will be the beat frequency heard by the observer

(a) 8 (b) 4 (c) 6 (d) 1

Q.13 A small source of sound moves on a circle as shown in the figure and an observer is standing on O. Let n_1, n_2 and n_3 be the frequencies heard when the source is at A, B and C respectively. Then



(a) $n_1 > n_2 > n_3$

(b) $n_2 > n_3 < n_1$

(c) $n_1 = n_2 > n_3$

(d) $n_2 > n_1 > n_3$

Q.14 A person carrying a whistle emitting continuously a note of 272 Hz is running towards a reflecting surface with a speed of 18 km/hour. The speed of sound in air is $345 ms^{-1}$. The number of beats heard by him is

(a) 4 (b) 6 (c) 8 (d) 3

Q.15 A source of sound of frequency 256 Hz is moving rapidly towards a wall with a velocity of 5m/s. The speed of sound is 330 m/s. If the observer is between the wall and the source, then the beats heard per second will be

(a) 7.8 Hz (b) 7.7 Hz

(c) 3.9 Hz (d) Zero

Q.16 The harmonics which are present in a pipe open at one end are

(a) odd harmonics

(b) even harmonics

(c) even as well as odd harmonics

(d) None of these

RESPONSE GRID					
	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ
	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ
	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ		

Space for Rough Work

Q.17 A source of sound placed at the open end of a resonance column sends an acoustic wave of pressure amplitude P_0 inside the tube. If the atmospheric pressure is P_A, then the ratio of maximum and minimum pressure at the closed end of the tube will be

(a) $\frac{(P_A+P_0)}{(P_A-P_0)}$ (b) $\frac{(P_A+2P_0)}{(P_A-2P_0)}$

(c) $\frac{P_A}{P_A}$ (d) $\frac{\left(P_A+\frac{1}{2}P_0\right)}{\left(P_A-\frac{1}{2}P_0\right)}$

Q.18 The frequency of fundamental tone in an open organ pipe of length 0.48 m is 320 Hz. Speed of sound is 320 m/sec. Frequency of fundamental tone in closed organ pipe will be

(a) 153.8 Hz (b) 160.0 Hz
(c) 320.0 Hz (d) 143.2 Hz

Q.19 A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21Å between them. The wavelength of the standing wave is

(a) 1.21 Å (b) 2.42 Å (c) 6.05 Å (d) 3.63 Å

Q.20 A string on a musical instrument is 50 cm long and its fundamental frequency is 270 Hz. If the desired frequency of 1000 Hz, is to be produced, the required length of the string is

(a) 13.5 cm (b) 2.7 cm (c) 5.4 cm (d) 10.3 cm

Q.21 The loudness and the pitch of a sound depends on

(a) intensity and velocity
(b) frequency and velocity
(c) intensity and frequency
(d) frequency and number of harmonics

Q.22 If in an experiment for determination of velocity of sound by resonance tube method using a tuning fork of 512 Hz, first resonance was observed at 30.7 cm and second was obtainded at 63.2 cm, then maximum possible error in velocity of sound is (consider actual speed of sound in air is 332 m/s)

(a) 204 cm/sec (b) 110 cm/sec
(c) 58 cm/sec (d) 80 cm/sec

DIRECTIONS (Q.23-Q.25) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.23 You are given four tuning forks, the lowest frequency of the fork is 300Hz. By striking two tuning forks at a time any of 1, 2, 3, 5, 7 & 8 Hz beat frequencies are heard. The possible frequencies of the other three forks –

(1) 301, 302 & 307 (2) 301, 303 & 308
(3) 300, 304 & 307 (4) 305, 307 & 308

Q.24 Doppler shift in frequency depends upon

(1) the frequency of the wave produced
(2) the velocity of the source
(3) the velocity of the observer
(4) distance from the source to the listener

Q.25 The (x, y) coordinates of the corners of a square plate are (0, 0), (L, 0), (L, L) and (0, L). The edges of the plate are clamped and transverse standing waves are set up in it. If $u(x, y)$ denotes the displacement of the plate at the point (x, y) at some instant of time, the possible expression(s) for u is (are) (a = positive constant)

(1) $a\sin\frac{\pi x}{L}\sin\frac{\pi y}{L}$ (2) $a\sin\frac{\pi x}{L}\sin\frac{2\pi y}{L}$

(3) $a\cos\frac{\pi x}{2L}\cos\frac{\pi y}{2L}$ (4) $a\cos\frac{2\pi x}{L}\cos\frac{\pi y}{L}$

DIRECTIONS (Q.26-Q.27) : Read the passage given below and answer the questions that follows :

A plate was cut from a quartz crystal and is used to control the frequency of an oscillating electrical circuit. Longitudinal standing waves are set up in the plate with displacement antinodes at opposite faces. The fundamental frequency of vibration is given by the equation $f_0 = \frac{2.87\times10^4}{s}$. Here s is thickness of the plate and density of quartz is 2658.76 kg/m^3.

RESPONSE GRID					
	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ
	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	

Space for Rough Work

Q.26 Young's modulus of elasticity for quartz is –

(a) 7×10^{11} N/m^2 (b) 8.76×10^{12} N/m^2
(c) 2×10^{12} N/m^2 (d) Information insufficient

Q.27 If the quartz plate is vibrating in 3rd harmonic while measuring the frequency of 1.2×10^6 Hz, then the thickness of the plateis

(a) 71.75cm (b) 7.175 cm
(c) 6.02 cm (d) 0.07 cm

DIRECTIONS (Q.28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

Q.28 **Statement-1 :** Beats cannot be produced by light sources.

Statement-2: Light sources have constant phase difference.

Q.29 **Statement-1 :** In the case of a stationary wave, a person hear a loud sound at the nodes as compared to the antinodes.

Statement-2 : In a stationary wave all the particles of the medium vibrate in phase.

Q.30 **Statement-1 :** Velocity of particles, while crossing mean position (in stationary waves) varies from maximum at antinodes to zero at nodes.

Statement-2: Amplitude of vibration at antinodes is maximum and at nodes, the amplitude is zero, and all particles between two successive nodes cross the mean position together.

RESPONSE GRID					
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 30 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	48
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS 30

1. **(b)** n_1 = Frequency of the police car horn observer heard by motorcyclist
   n_1 = Frequency of the siren heard by motorcyclist.
   v_2 = Speed of motor cyclist
   $$n_1 = \frac{330 - v}{330 - 22} \times 176; n_2 = \frac{330 + v}{330} \times 165$$
   $\therefore n_1 - n_2 = 0 \Rightarrow v = 22\ m/s$

2. **(c)** Frequency of first over tone of closed pipe = Frequency of first over tone of open pipe
   $$\Rightarrow \frac{3v}{4L_1} = \frac{v}{L_2} \Rightarrow \frac{3}{4L_1}\sqrt{\frac{\gamma P}{\rho_1}} = \frac{1}{L_2}\sqrt{\frac{\gamma P}{\rho_2}} \left[\therefore v = \sqrt{\frac{\gamma P}{\rho}}\right]$$
   $$\Rightarrow L_2 = \frac{4L_1}{3}\sqrt{\frac{\rho_1}{\rho_2}} = \frac{4L}{3}\sqrt{\frac{\rho_1}{\rho_2}}$$

3. **(b)** For observer note of B will not change due to zero relative motion.
   Observed frequency of sound produced by A
   $$= 660\frac{(330 - 30)}{330} = 600 Hz$$
   $\therefore$ No of beats = 600 - 596 = 4

4. **(c)** Open pipe resonanace frequency $f_1 = \frac{2v}{2L}$
   Closed pipe resonance frequency $f_2 = \frac{nv}{4L}$
   $f_2 = \frac{n}{4} f_1$ (where n is odd and $f_2 > f_1$) $\therefore n = 5$

5. **(b)** $\frac{n(v - v_0)}{v - v_s}$

6. **(a)** Wave number $= \frac{1}{\lambda}$ but $= \frac{1}{\lambda'} = = \frac{1}{\lambda}\left(\frac{v}{v - v_s}\right)$ and
   $v_s = \frac{v}{3}$
   $$\therefore (W.N.)' = (W.N.)\left(\frac{v}{v - v/3}\right) = 256 \times \frac{v}{2\upsilon/3}$$
   $$= \frac{3}{2} \times 256 = 384$$

7. **(d)** Since there is no relative motion between observer and source, *therefore* there is no apparent change in frequency.

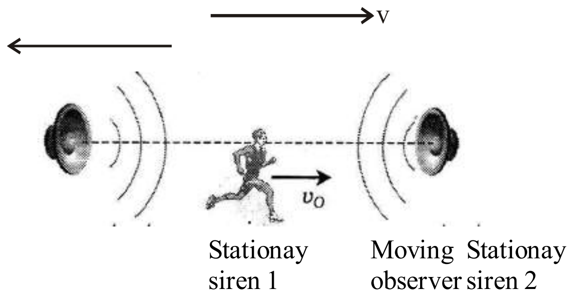
8. **(c)** $n' = n\left(\frac{v}{v - v_s}\right) = 1200 \times \left(\frac{350}{350 - 50}\right) = 1400\ cps$

9. **(d)** By using $n' = n\frac{v}{v - v_s} \Rightarrow \frac{n_1}{n} = \left(\frac{V}{V - S}\right)$

10. **(a)** $n' = n\frac{v - v_0}{v} = \left(\frac{330 - 33}{330}\right) \times 100 = 90\ Hz$

11. **(d)** The apparent frequency heard by the observer is given by
    $$n' = \frac{v}{v - v_s} x = \frac{330}{330 - 33} \times 450 = \frac{330}{297} \times 450 = 500\ Hz$$

12. **(b)** Observer is moving ayay form siren 1 and towards the siren 2.

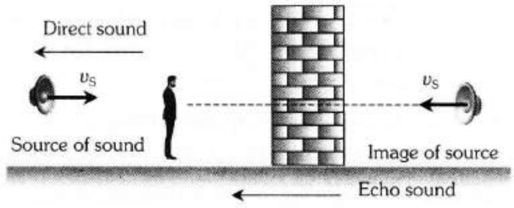


Hearing frequency of sound emitted by siren 1
$$n_1 = n\left(\frac{v - v_0}{v}\right) = 330\left(\frac{330 - 2}{330}\right) = 328 Hz$$
Hearing frequency of sound emitted by siren 2
$$n_2 = n\left(\frac{v - v_0}{v}\right) = 330\left(\frac{330 + 2}{330}\right) = 332 Hz$$
Hence, beat frequency $= n_2 - n_1 = 332 - 328 = 4$

13. **(b)** At point A, source is moving away from observer so apparent frequency $n_1 < n$ (actual frequency). At point B source is coming towards observer so apparent frequency $n_2 > n$ and point C source is moving perpendicular to observer so $n_3 = n$
    Hence $n_2 > n_3 > n_1$

14. **(c)** According the concept of sound image
    $$n' = \frac{v + v_{person}}{v - v_{person}}.272 = \frac{345 + 5}{345 - 5} \times 272 = 280 Hz$$
    Δn = Number of beats = 280 – 272 = 8 Hz

15. **(a)** The observer will hear two sound, one directly from source and other from reflected image of sound



Hence number of beats heard per second

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

$$=\frac{2n\upsilon\upsilon_s}{\upsilon^2-\upsilon_s^2}=\frac{2\times256\times330\times5}{335\times325}=7.8Hz$$

16. **(a)** In closed pipe only odd harmonics are present.

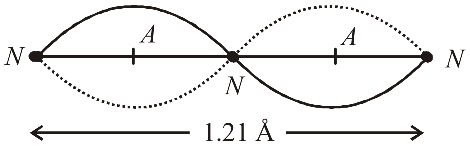
17. **(a)** Maximum pressure at closed end will be atmospheric pressure adding with acoustic wave pressure

So $P_{\max}=P_A+P_0$ and $P_{\min}=P_A-P_0$

Thus $\frac{P_{\max}}{P_{\min}}=\frac{P_A+P_0}{P_A-P_0}$

18. **(b)** $n_{closed}=\frac{1}{2}(n_{open})=\frac{1}{2}\times320=160Hz$

19. **(a)** $\lambda=1.21Å$



20. **(a)** $n\propto\frac{1}{l}\Rightarrow\frac{l_2}{l_1}=\frac{n_1}{n_2}\Rightarrow l_2=l_1\left(\frac{n_1}{n_2}\right)=50\times\frac{270}{1000}=13.5cm$

21. **(c)** Loudness depends upon intensity while pitch depends upon frequency.

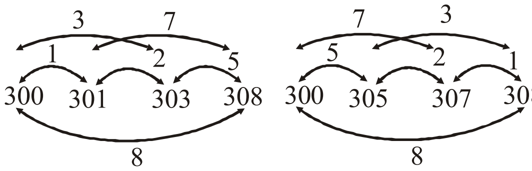
22. **(d)** Using $\lambda=2(l_2-l_1)\Rightarrow v=2n(l_2-l_1)$

$\Rightarrow 2\times215(63.2-30.7)=33280cm/s$

Actual speed of sound $v_0=332m/s=33200cm/s$

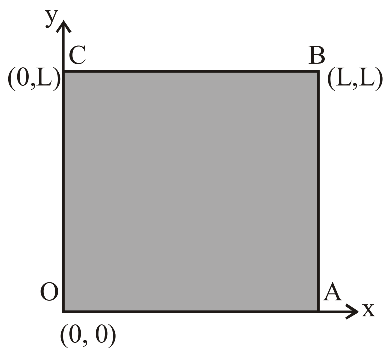
Hence error = 33280 – 33200 = 80cm / s

23. **(c)**



24. **(a)** Doppler shift doesn't depend upon the distance of listner from the source.

25. **(b)** Since the edges are clamped, displacement of the edges $u(x,y)=0$ for line -



OA i.e $y=0,\ 0\le x\le L$

AB i.e. $y=L, 0\le y\le L$

BC i.e. $y=L, 0\le x\le L$

OC i.e. $x=0, 0\le y\le L$

The above conditions are satisfied only in alternatives (*b*) and (*c*).

Note that $u(x,y)=0$ for all four values *e.g.* in alternative (*d*), $u(x,y)=0$ for $y=0, y=L$ But it is not zero for $x=0$ or $x=L$. Similarly in option (a) $u(x,y)=0$ at $x=L, y=L$ but it is not zero for $x=0$ or $y=0$, while in options (b) and (c), $u(x,y)=0$ for $x=0, y=0, x=L$ and $y=L$

26. (b), **27. (d).**

For fundamental force, $\frac{\lambda}{2}=s\Rightarrow\lambda=2s$

Velocity of waves is, $v=\sqrt{\frac{Y}{\rho}}$ where Y is Young's modulus of quartz and ρ is its density.

From $f_0=\frac{v}{\lambda}=\frac{2.87\times10^4}{s}\ \Rightarrow\sqrt{\frac{Y}{\rho}}\times\frac{1}{2s}=\frac{2.87\times10^4}{s}$

$\Rightarrow Y=8.76\times10^{12}\ N/m^2$

For 3rd harmonic, $f=3f_0=1.2\times10^6\ Hz\Rightarrow\frac{3\times2.87\times10^4}{s}$

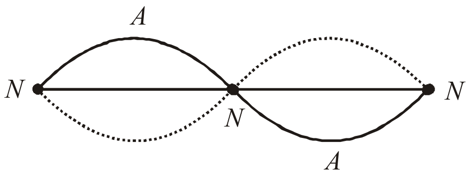
$=1.2\times10^6\Rightarrow s=0.07175$ cm.

28. **(d)** As emission of light from atom is a random and rapid phenomenon. The phase at a point due to two independent light source will change rapidly and randomly. Therefore, instead of beats, we shall get uniform intensity. However, if light sources are LASER beams of nearly equal frequencies, it may possible to observe the phenomenon of beats in light.

29. **(d)** The person will hear the loud sound at nodes than at antinodes. We know that at anti-nodes the displacement is maximum and pressure change is minimum while at nodes the displacement is zero and pressure change is maximum. The sound is heared due to variation of pressure.

Also in stationary waves particles in two different segment vibrates in opposite phase.

30. **(a)** Stationary wave



A node is a place of zero amplitude and an antinode is a place of maximum amplitude.