DPP - Daily Practice Problems

Chapter-wise Sheets

Date :   **Start Time :**   **End Time :**

PHYSICS

CP14

SYLLABUS : Waves

Max. Marks : 180   **Marking Scheme :** (+4) for correct & (–1) for incorrect answer   **Time : 60 min.**

INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. Where should the two bridges be set in a 110cm long wire so that it is divided into three parts and the ratio of the frequencies are 3 : 2 : 1 ?
(a) 20cm from one end and 60cm from other end
(b) 30cm from one end and 70cm from other end
(c) 10cm from one end and 50cm from other end
(d) 50cm from one end and 40cm from other end

2. When a wave travel in a medium, the particle displacement is given by the equation $y = a \sin 2\pi (bt - cx)$ where a, b and c are constants. The maximum particle velocity will be twice the wave velocity if
(a) $c = \frac{1}{\pi a}$ (b) $c = \pi a$ (c) $b = ac$ (d) $b = \frac{1}{ac}$

3. The wave described by $y = 0.25 \sin (10\pi x - 2\pi t)$, where x and y are in meters and t in seconds, is a wave travelling along the:
(a) –ve x direction with frequency 1 Hz.
(b) +ve x direction with frequency π Hz and wavelength $\lambda = 0.2$ m.
(c) +ve x direction with frequency 1 Hz and wavelength $\lambda = 0.2$ m
(d) –ve x direction with amplitude 0.25 m and wavelength $\lambda = 0.2$ m

4. The equation of a plane progressive wave is $y = 0.9 \sin 4\pi\left[t - \frac{x}{2}\right]$. When it is reflected at a rigid support, its amplitude becomes $\frac{2}{3}$ of its previous value. The equation of the reflected wave is
(a) $y = 0.6 \sin 4\pi\left[t + \frac{x}{2}\right]$
(b) $y = -0.6 \sin 4\pi\left[t + \frac{x}{2}\right]$
(c) $y = -0.9 \sin 8\pi\left[t - \frac{x}{2}\right]$
(d) $y = -0.6 \sin 4\pi\left[t + \frac{x}{2}\right]$

5. A person carrying a whistle emitting continuously a note of 272 Hz is running towards a reflecting surface with a speed of 18 km h^{-1}. The speed of sound in air is 345 m s^{-1}. The number of beats heard by him is
(a) 4 (b) 6 (c) 8 (d) zero

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

6. A closed organ pipe (closed at one end) is excited to support the third overtone. It is found that air in the pipe has
(a) three nodes and three antinodes
(b) three nodes and four antinodes
(c) four nodes and three antinodes
(d) four nodes and four antinodes

7. A wave disturbance in a medium is described by $y(x,t) = 0.02\cos\left(50\pi t + \frac{\pi}{2}\right)\cos(10\pi x)$ where x and y are in metre and t is in second. Which of the following is correct?
(a) A node occurs at x = 0.15 m
(b) An antinode occurs at x = 0.3 m
(c) The speed wave is 5 ms^{-1}
(d) The wavelength is 0.3 m

8. In a resonance column, first and second resonance are obtained at depths 22.7 cm and 70.2 cm. The third resonance will be obtained at a depth
(a) 117.7 cm (b) 92.9 cm
(c) 115.5 cm (d) 113.5 cm

9. An engine approaches a hill with a constant speed. When it is at a distance of 0.9 km, it blows a whistle whose echo is heard by the driver after 5 seconds. If the speed of sound in air is 330 m/s, then the speed of the engine is :
(a) 32 m/s (b) 27.5 m/s (c) 60 m/s (d) 30 m/s

10. Two identical piano wires kept under the same tension T have a fundamental frequency of 600 Hz. The fractional increase in the tension of one of the wires which will lead to occurrence of 6 beats/s when both the wires oscillate together would be
(a) 0.02 (b) 0.03 (c) 0.04 (d) 0.01

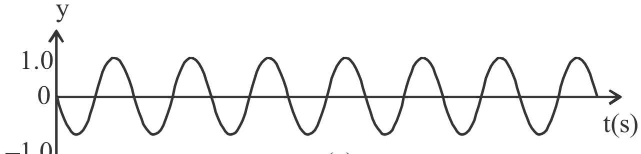
11. Two sound sources emitting sound each of wavelength λ are fixed at a given distance apart. A listener moves with a velocity u along the line joining the two sources. The number of beats heard by him per second is
(a) $\frac{u}{2\lambda}$ (b) $\frac{2u}{\lambda}$ (c) $\frac{u}{\lambda}$ (d) $\frac{u}{3\lambda}$

12. An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency ?
(a) 0.5% (b) zero (c) 20% (d) 5%

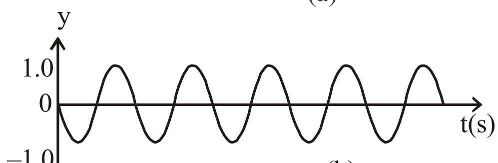
13. Velocity of sound in air is 320 m s^{-1}. A pipe closed at one end has a length of 1 m. Neglecting end correction, the air column in the pipe cannot resonate with sound of frequency
(a) 80 Hz (b) 240 Hz (c) 320 Hz (d) 400 Hz

14. The driver of a car travelling with speed 30 m/sec towards a hill sounds a horn of frequency 600 Hz. If the velocity of sound in air is 330 m/s, the frequency of reflected sound as heard by driver is
(a) 555.5 Hz (b) 720 Hz (c) 500 Hz (d) 550 Hz

15. What will be the frequency of beats formed from the superposition of two harmonic waves shown below?



(a)



(b)

(a) 20 Hz (b) 11 Hz (c) 9 Hz (d) 2 Hz

16. What is the effect of increase in temperature on the frequency of sound produced by an organ pipe?
(a) increases (b) decreases
(c) no effect (d) erratic change

17. A cylinderical tube open at both ends, has a fundamental frequency f in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of air column is now
(a) f / 2 (b) f (c) 3f / 4 (d) 2 f

18. The transverse displacement y (x, t) of a wave on a string is given by $y(x,t) = e^{-\left(ax^2 + bt^2 + 2\sqrt{ab}xt\right)}$.
This represents a:
(a) wave moving in –x direction with speed $\sqrt{\frac{b}{a}}$
(b) standing wave of frequency $\sqrt{b}$
(c) standing wave of frequency $\frac{1}{\sqrt{b}}$
(d) wave moving in + x direction with speed $\sqrt{\frac{a}{b}}$

19. A longitudinal wave is represented by
$$x = x_0 \sin 2\pi\left(nt - \frac{x}{\lambda}\right)$$
The maximum particle velocity will be four times the wave velocity if
(a) $\lambda = \frac{\pi x_0}{4}$ (b) $\lambda = 2\pi x_0$
(c) $\lambda = \frac{\pi x_0}{2}$ (d) $\lambda = 4\pi x_0$

20. Two tones of frequencies n_1 and n_2 are sounded together. The beats can be heard distinctly when
(a) $10 < (n_1 - n_2) < 20$ (b) $5 < (n_1 - n_2) > 20$
(c) $5 < (n_1 - n_2) < 20$ (d) $0 < (n_1 - n_2) < 10$

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ

Space for Rough Work

21. A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250 Hz. The velocity of sound in air is 340 m/s.
(a) 12 (b) 8 (c) 6 (d) 4

22. A vehicle, with a horn of frequency n is moving with a velocity of 30 m/s in a direction perpendicular to the straight line joining the observer and the vehicle. The observer perceives the sound to have a frequency $n + n_1$. Then (if the sound velocity in air is 300 m/s)
(a) $n_1 = 10n$ (b) $n_1 = 0$
(c) $n_1 = 0.1n$ (d) $n_1 = -0.1n$

23. A source of sound gives 5 beats per second, when sounded with another source of frequency 100/sec. The second harmonic of the source, together with a source of frequency 205/sec gives 5 beats per second. What is the frequency of the source?
(a) $95\ sec^{-1}$ (b) $100\ sec^{-1}$
(c) $105\ sec^{-1}$ (d) $205\ sec^{-1}$

24. If we study the vibration of a pipe open at both ends, then which of the following statements is not true ?
(a) Odd harmonics of the fundamental frequency will be generated
(b) All harmonics of the fundamental frequency will be generated
(c) Pressure change will be maximum at both ends
(d) Antinode will be at open end

25. 41 forks are so arranged that each produces 5 beats per sec when sounded with its near fork. If the frequency of last fork is double the frequency of first fork, then the frequencies (in Hz) of the first and the last fork are respectively.
(a) 200, 400 (b) 205, 410
(c) 195, 390 (d) 100, 200

26. Two points are located at a distance of 10 m and 15 m from the source of oscillation. The period of oscillation is 0.05 sec and the velocity of the wave is 300 m/sec. What is the phase difference between the oscillations of two points?
(a) $\frac{\pi}{3}$ (b) $\frac{2\pi}{3}$ (c) π (d) $\frac{\pi}{6}$

27. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of
(a) 100 (b) 1000 (c) 10000 (d) 10

28. A wave travelling along the x-axis is described by the equation $y(x, t) = 0.005 \cos(\alpha x - \beta t)$. If the wavelength and the time period of the wave are 0.08 m and 2.0s, respectively, then α and β in appropriate units are
(a) $\alpha = 25.00\pi, \beta = \pi$ (b) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$
(c) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$ (d) $\alpha = 12.50\pi, \beta = \frac{\pi}{2.0}$

29. The equation $Y = 0.02 \sin(500\pi t) \cos(4.5x)$ represents
(a) progressive wave of frequency 250 Hz along x-axis
(b) a stationary wave of wavelength 1.4 m
(c) a transverse progressive wave of amplitude 0.02 m
(d) progressive wave of speed of about 350 m s^{-1}

30. Which of the following statements is/are incorrect about waves ?
(a) Waves are patterns of disturbance which move without the actual physical transfer of flow of matter as a whole.
(b) Waves cannot transport energy.
(c) The pattern of disturbance in the form of waves carry information that propagate from one point to another.
(d) All our communications essentially depend on transmission of signals through waves.

31. An organ pipe P_1, closed at one end vibrating in its first harmonic and another pipe P_2, open at both ends vibrating in its third harmonic, are in resonance with a given tuning fork. The ratio of the lengths of P_1 and P_2 is :
(a) $\frac{8}{3}$ (b) $\frac{1}{6}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

32. Two vibrating tuning forks producing waves given by $y_1 = 27 \sin 600\pi t$ and $y_2 = 27 \sin 604\pi t$ are held near the ear of a person, how many beats will be heard in three seconds by him ?
(a) 4 (b) 2 (c) 6 (d) 12

33. A source of sound A emitting waves of frequency 1800 Hz is falling towards ground with a terminal speed v. The observer B on the ground directly beneath the source receives waves of frequency 2150 Hz. The source A receives waves, reflected from ground of frequency nearly: (Speed of sound = 343 m/s)
(a) 2150 Hz (b) 2500 Hz (c) 1800 Hz (d) 2400 Hz

34. Consider the three waves z_1, z_2 and z_3 as
$z_1 = A \sin(kx - \omega t)$
$z_2 = A \sin(kx + \omega t)$
$z_3 = A \sin(ky - \omega t)$
Which of the following represents a standing wave?
(a) $z_1 + z_2$ (b) $z_2 + z_3$
(c) $z_3 + z_1$ (d) $z_1 + z_2 + z_3$

35. A sonometer wire supports a 4 kg load and vibrates in fundamental mode with a tuning fork of frequency 416 Hz. The length of the wire between the bridges is now doubled. In order to maintain fundamental mode, the load should be changed to
(a) 1 kg (b) 2 kg (c) 4 kg (d) 16 kg

RESPONSE GRID					
	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ
	31. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ	34. ⓐⓑⓒⓓ	35. ⓐⓑⓒⓓ

Space for Rough Work

36. The vibrations of a string of length 60 cm fixed at both the ends are represented by the equation $y = 2\sin\left(\frac{4\pi x}{15}\right)\cos(96\pi t)$ where x and y are in cm. The maximum number of loops that can be formed in it is
(a) 4 (b) 16 (c) 5 (d) 15

37. If n_1, n_2 and n_3 are the fundamental frequencies of three segments into which a string is divided, then the original fundamental frequency n of the string is given by
(a) $n = n_1 + n_2 + n_3$
(b) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$
(c) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}}$
(d) $\sqrt{n} = \sqrt{n_1} + \sqrt{n_2} + \sqrt{n_3}$

38. An echo repeats two syllables. If the velocity of sound is 330 m/s, then the distance of the reflecting surface is
(a) 66.0 m (b) 33.0 m (c) 99.0 m (d) 16.5 m

39. What is the effect of humidity on sound waves when humidity increases?
(a) Speed of sound waves is more
(b) Speed of sound waves is less
(c) Speed of sound waves remains same
(d) Speed of sound waves becomes zero

40. If the ratio of maximum to minimum intensity in beats is 49, then the ratio of amplitudes of two progressive wave trains is
(a) 7 : 1 (b) 4 : 3 (c) 49 : 1 (d) 16 : 9

41. A whistle of frequency 1000 Hz is sounded on a car travelling towards a cliff with velocity of 18 m s^{-1} normal to the cliff. If velocity of sound (v) = 330 m s^{-1}, then the apparent frequency of the echo as heard by the car driver is nearly
(a) 1115 Hz (b) 115 Hz (c) 67 Hz (d) 47.2 Hz

42. The transverse wave represented by the equation $y = 4\sin\left(\frac{\pi}{6}\right)\sin(3x - 15t)$ has
(a) amplitude = 4
(b) wavelength $= 4\frac{\pi}{3}$
(c) speed of propagation = 5
(d) period $= \frac{\pi}{15}$

43. If the intensities of two interfering waves be I_1 and I_2, the contrast between maximum and minimum intensity is maximum, when
(a) $I_1 >> I_2$ (b) $I_1 << I_2$
(c) $I_1 = I_2$ (d) either I_1 or I_2 is zero

44. The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is
(a) 100 cm (b) 120 cm (c) 140 cm (d) 80 cm

45. The equation of a travelling wave is $y = 60\cos(180t - 6x)$ where y is in μm, *t* in second and x in metres. The ratio of maximum particle velocity to velocity of wave propagation is
(a) 3.6×10^{-2} (b) 3.6×10^{-4}
(c) 3.6×10^{-6} (d) 3.6×10^{-11}

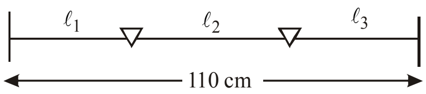
RESPONSE GRID					
	36. ⓐⓑⓒⓓ	37. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ	39. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ
	41. ⓐⓑⓒⓓ	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP14 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS — PHYSICS SOLUTIONS — DPP/CP14

1. **(a)**



$n_1 : n_2 : n_3 = 3 : 2 : 1$

$n \propto \frac{1}{\ell}$

$\ell_1 : \ell_2 : \ell_3 = \frac{1}{3} : \frac{1}{2} : \frac{1}{1} = 2 : 3 : 6$

$\ell_1 + \ell_2 + \ell_3 = 110$

$\Rightarrow 2x + 3x + 6x = 110 \Rightarrow x = 10$

$\therefore$ The two bridges should be set at 2x i.e, 20 cm from one end and 6x i.e, 60 cm from the other end.

2. **(a)** Equation of the harmonic progressive wave given by : $y = a \sin 2\pi (bt - cx)$.
Here $\upsilon = b$

$k = \frac{2\pi}{\lambda} = 2\pi c$ take, $\frac{1}{\lambda} = c$

$\therefore$ Velocity of the wave $= \upsilon\lambda = b\frac{1}{c} = \frac{b}{c}$

$\frac{dy}{dt} = a\, 2\pi b \cos 2\pi (bt - cx) = a\omega \cos(\omega t - kx)$

Maximum particle velocity $= a\omega = a 2\pi b = 2\pi ab$

given this is $2 \times \frac{b}{c}$ i.e. $2\pi a = \frac{2}{c}$ or $c = \frac{1}{\pi a}$

3. **(c)** $y = 0.25 \sin (10\pi x - 2\pi t)$
Comparing this equation with the standard wave equation
$y = a \sin (kx - \omega t)$
We get, $k = 10\pi$

$\Rightarrow \frac{2\pi}{\lambda} = 10\pi \Rightarrow \lambda = 0.2$ m

And $\omega = 2\pi$ or, $2\pi v = 2\pi \Rightarrow v = 1$ Hz.
The sign inside the bracket is negative, hence the wave travels in + ve x- direction.

4. **(b)** Amplitude of reflected wave $= \frac{2}{3} \times 0.9 = 0.6$

It would travel along negative direction of x-axis, and on reflection at a rigid support, there occurs a phase change of π.

5. **(c)** Velocity of source = 18 km h^{-1} = 5 m s^{-1}
(i) S moves towards listener (v_S)
(ii) listener moves towards source (v_L)

$v' = \frac{v + v_L}{v - v_S} v = 280$ Hz , Beats $= v' - v = 8$.

6. **(d)** Third overtone has a frequency 7 n, which means $L = \frac{7\lambda}{4}$ = three full loops + one half loop, which would make four nodes and four antinodes.

7. **(c)** Comparing it with $y(x, t) = A \cos(\omega t + \pi/2) \cos kx$.
If $kx = \pi/2$, a node occurs ; $\therefore 10\pi x = \pi/2 \Rightarrow x = 0.05$ m
If $kx = \pi$, an antinode occurs $\Rightarrow 10\pi x = \pi$
$\Rightarrow x = 0.1$ m

Also speed of wave $\omega / k = \frac{50\pi}{10\pi} = 5$ m/s and

$\lambda = 2\pi / k = 2\pi / 10\pi = 0.2$ m

8. **(a)** $\ell_1 + x = \frac{\lambda}{4} = 22.7$ equation (1)

$\ell_2 + x = \frac{3\lambda}{4} = 70.2$ equation (2)

$l_3 + x = \frac{5\lambda}{4}$ equation (3)

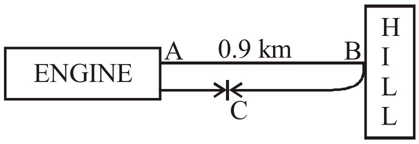
From equation (1) and (2)

$x = \frac{\ell_2 - 3\ell_1}{2} = \frac{70.2 - 68.1}{2} = \frac{2.1}{2} = 1.05$ cm

From equation (2) and (3) $\frac{\ell_3 + x}{\ell_1 + x} = 5$

$\ell_3 = 5\ell_1 + 4x = 5 \times 22.7 + 4 \times 1.05 = 117.7$ cm

9. **(d)**



Let after 5 sec engine at point C

$t = \frac{AB}{330} + \frac{BC}{330}$

$5 = \frac{0.9 \times 1000}{330} + \frac{BC}{330}$

$\therefore$ BC = 750 m
Distance travelled by engine in 5 sec
= 900 m – 750 m = 150 m
Therefore velocity of engine

$= \frac{150\text{ m}}{5\text{ sec}} = 30$ m/s

10. **(a)** For fundamental mode,

$f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

Taking logarithm on both sides, we get

$$\log f = \log\left(\frac{1}{2\ell}\right) + \log\left(\sqrt{\frac{T}{\mu}}\right)$$

$$= \log\left(\frac{1}{2\ell}\right) + \frac{1}{2}\log\left(\frac{T}{\mu}\right)$$

or $\log f = \log\left(\frac{1}{2\ell}\right) + \frac{1}{2}[\log T - \log\mu]$

Differentiating both sides, we get

$$\frac{df}{f} = \frac{1}{2}\frac{dT}{T} \quad (\text{as } \ell \text{ and } \mu \text{ are constants})$$

$$\Rightarrow \frac{dT}{T} = 2 \times \frac{df}{f}$$

Here $df = 6$

$f = 600$ Hz

$$\therefore \frac{dT}{T} = \frac{2\times 6}{600} = 0.02$$

11. (b) Frequency received by listener from the rear source,

$$n' = \frac{v-u}{v}\times n = \frac{v-u}{v}\times\frac{v}{\lambda} = \frac{v-u}{\lambda}$$

Frequency received by listener from the front source,

$$n'' = \frac{v+u}{v}\times\frac{v}{\lambda} = \frac{v+u}{\lambda}$$

No. of beats $= n'' - n'$

$$= \frac{v+u}{\lambda} - \frac{v-u}{\lambda} = \frac{v+u-v+u}{\lambda} = \frac{2u}{\lambda}$$

12. (c) $n' = n\left[\frac{v+v_0}{v}\right] = n\left[\frac{v+\frac{v}{5}}{v}\right] = n\left[\frac{6}{5}\right]$

$$\frac{n'}{n} = \frac{6}{5};\ \frac{n'-n}{n} = \frac{6-5}{5}\times 100 = 20\%$$

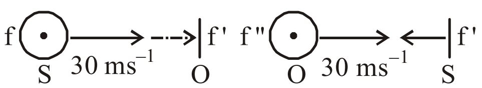
13. (c) In a closed organ pipe the fundamental frequency is

$$\upsilon = \frac{\upsilon}{4L}$$

$$\upsilon = \frac{320\ ms^{-1}}{4\times 1\ m} = 80\ Hz$$

In a closed organ pipe only odd harmonics are present. So, it can resonate with 80 Hz, 240 Hz, 400 Hz, 560 Hz.

14. (b)



f ′ is the apparent frequency received by an observer at the hill. f ″ is the frequency of the reflected sound as heard by driver.

$$f' = \frac{v}{v-30}f,$$

$$f'' = \frac{v+30}{v}f' = \frac{v+30}{v-30}f = \frac{360}{300}\times 600$$

$= 720$ Hz

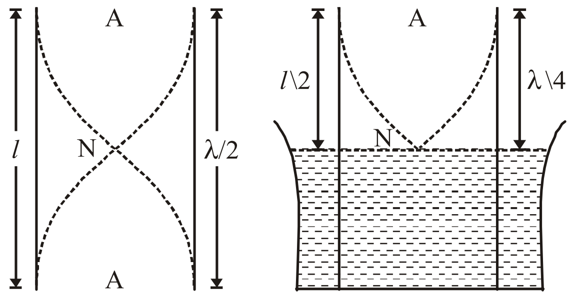
15. (d) Figure(a) represents a harmonic wave of frequency 7.0 Hz, figure (b) represents a harmonic wave of frequency 5.0 Hz. Therefore beat frequency $v_s = 7 - 5 = 2.0$ Hz.

16. (a) $\upsilon \propto \sqrt{T}$

17. (b) In fundamental mode,

$$\frac{\lambda}{2} = l \Rightarrow \lambda = 2l$$

$$\therefore f = \frac{v}{\lambda} = \frac{v}{2l} \qquad \text{....... (1)}$$



Fundamental mode   Half length dipped in water

In half length dipped in water mode,

$$\frac{l}{2} = \frac{\lambda}{4} \Rightarrow \lambda = 2l$$

$$\therefore f' = \frac{v}{\lambda} = \frac{v}{2l} = f$$

18. (a) Given wave equation is $y(x,t)$

$$= e^{\left(-ax^2+bt^2+2\sqrt{ab}\,xt\right)}$$

$$= e^{-[(\sqrt{a}x)^2+(\sqrt{b}t)^2+2\sqrt{a}x.\sqrt{b}t]}$$

$$= e^{-(\sqrt{a}x+\sqrt{b}t)^2}$$

$$= e^{-\left(x+\sqrt{\frac{b}{a}}t\right)^2}$$

It is a function of type $y = f(x+vt)$

$\Rightarrow$ Speed of wave $= \sqrt{\frac{b}{a}}$

19. (c) Particle velocity

$$v = \frac{d}{dt}\left[x_0\sin 2\pi\left(nt - \frac{x}{\lambda}\right)\right]$$

$$= 2\pi n x_0\cos 2\pi\left(nt - \frac{x}{\lambda}\right)$$

$\therefore$ Maximum particle velocity $= 2\pi n x_0$

Wave velocity $= \frac{\lambda}{T} = n\lambda$

Given, $2\pi n x_0 = 4n\lambda \Rightarrow \lambda = \frac{2\pi n x_0}{4n} = \frac{\pi x_0}{2}$

20. (d) As number of beats/sec = diff. in frequencies has to be less than 10, therefore $0 < (n_1 - n_2) < 10$

21. (c) Length of pipe = 85 cm = 0.85m
Frequency of oscillations of air column in closed organ pipe is given by,

$$f=\frac{(2n-1)v}{4L}$$

$$f=\frac{(2n-1)v}{4L}\le 1250$$

$$\Rightarrow \frac{(2n-1)\times 340}{0.85\times 4}\le 1250$$

$$\Rightarrow 2n-1\le 12.5\approx 6$$

22. (b) As the source is not moving towards or away from the observer in a straight line, so the Doppler's effect will not be observed by the observer.

23. (c) Frequency of first source with 5 beats/ sec = 100 Hz and frequency of second source with 5 beats/sec = 205 Hz. The frequency of the first source = 100 ± 5 = 105 or 95 Hz. Therefore, frequency of second harmonic of source = 210 Hz or 190 Hz. As the second harmonic gives 5 beats/ second with the sound of frequency 205 Hz, therefore, frequency of second harmonic source should be 210 Hz or frequency of source = 105 Hz.

24. (c) Pressure change will be minimum at both ends. In fact, pressure variation is maximum at $\ell/2$ because the displacement node is pressure antinode.

25. (a) $n_{Last}=n_{First}+(N-1)x$

$2n=n+(41-1)\times 5$

$\Rightarrow n_{First}=200$ Hz and $n_{Last}=400$ Hz

26. (b) Here, T = 0.05 sec, v = 300 ms^{-1}.

Now $\lambda=\frac{v}{\nu}=vT=(300\times 0.05)$m

or, $\lambda=15$ m

Phase of the point at 10 m from the source

$$=\frac{2\pi}{\lambda}\times x=\frac{2\pi}{15}\times 10=\frac{4\pi}{3}\text{rad}$$

Phase of the point at 15 m from the source

$$\frac{2\pi}{\lambda}\times x=\frac{2\pi}{15}\times 15=2\pi\,\text{rad}$$

$\therefore$ The phase difference between the points

$$=2\pi-\frac{4\pi}{3}=\frac{2\pi}{3}\text{rad}$$

27. (a) We have, $L_1=10\log\left(\frac{I_1}{I_0}\right)$; $L_2=10\log\left(\frac{I_2}{I_0}\right)$

$$\therefore L_1-L_2=10\log\left(\frac{I_1}{I_0}\right)-10\log\left(\frac{I_2}{I_0}\right)$$

or, $\Delta L=10\log\left(\frac{I_1}{I_0}\times\frac{I_0}{I_2}\right)$ or, $\Delta L=10\log\left(\frac{I_1}{I_2}\right)$

or, $20=10\log\left(\frac{I_1}{I_2}\right)$ or, $2=\log\left(\frac{I_1}{I_2}\right)$

or, $\frac{I_1}{I_2}=10^2$ or, $I_2=\frac{I_1}{100}$.

$\Rightarrow$ Intensity decreases by a factor 100.

28. (a) $y(x,t)=0.005\cos(\alpha x-\beta t)$ (Given)

Comparing it with the standard equation of wave

$y(x,t)=a\cos(kx-\omega t)$ we get

$k=\alpha$ and $\omega=\beta$

But $k=\frac{2\pi}{\lambda}$ and $\omega=\frac{2\pi}{T}$

$\Rightarrow \frac{2\pi}{\lambda}=\alpha$ and $\frac{2\pi}{T}=\beta$

Given that $\lambda=0.08$ m and $T=2.0$s

$\therefore \alpha=\frac{2\pi}{0.08}=25\pi$ and $\beta=\frac{2\pi}{2}=\pi$

29. (b) Equation is of stationary wave. Comparing with the standard equation

$$y=2A\sin\left(\frac{2\pi}{T}\right)t\cos\left(\frac{2\pi}{\lambda}\right)x$$

$$\frac{2\pi}{\lambda}=4.5 \text{ or } \lambda=\frac{2\pi}{4.5}=1.4\text{m}$$

30. (b) Waves are kind of disturbances which moves from one place to another without the actual physical transfer of matter of the medium as a whole. The particles of the medium only oscillate but do not travel from one place to another.
Waves transport energy and the pattern of disturbance has information that propagate from one point to another. Here, wave pattern propagates.
All our communication essentially depend on transmission of signals through the waves.

31. (b) $\frac{v}{4\ell_1}=\frac{3v}{2\ell_2}$, $\therefore \frac{\ell_1}{\ell_2}=\frac{1}{6}$

32. (c) $\omega_1=600\pi$, $\omega_2=604\pi$,

$f_1=300$ Hz, $f_2=302$ Hz

Beat frequency, $f_2-f_1=2$ Hz

$\Rightarrow$ number of beats in three seconds = 6

33. (b) Given $f_A=1800$Hz

$v_t=v$

$f_B=2150$ Hz

Reflected wave frequency received by A, $f_A'=?$

Applying doppler's effect of sound,

$$f'=\frac{v_s f}{v_s-v_t}$$

here, $v_t=v_s\left(1-\frac{f_A}{f_B}\right)$

$$=343\left(1-\frac{1800}{2150}\right)$$

$v_t=55.8372$ m/s

Now, for the reflected wave,

$$\therefore \quad f_A' = \left(\frac{v_s + v_t}{v_s - v_t}\right) f_A$$

$$= \left(\frac{343 + 55.83}{343 - 55.83}\right) \times 1800$$

$= 2499.44 \approx 2500\text{Hz}$

34. (a) Standing waves are produced when two waves propagate in opposite direction

As z_1 & z_2 are propagating in +ve x-axis & –ve x-axis

so, $z_1 + z_2$ will represent a standing wave.

35. (d) Load supported by sonometer wire = 4 kg

Tension in sonometer wire = 4 g

If μ = mass per unit length

then frequency $\upsilon = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$$\Rightarrow \quad 416 = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$$

When length is doubled, i.e., $l' = 2l$

Let new load = L

As, $\upsilon' = \upsilon$

$$\therefore \quad \frac{1}{2l'}\sqrt{\frac{Lg}{\mu}} = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$$

$$\Rightarrow \quad \frac{1}{4l}\sqrt{\frac{Lg}{\mu}} = \frac{1}{2l}\sqrt{\frac{4g}{\mu}}$$

$\Rightarrow \sqrt{L} = 2 \times 2 \Rightarrow L = 16\,\text{kg}$

36. (b) Let the string vibrates in p loops, wavelength of the p^{th} mode of vibration is given by

$$\lambda_p = \frac{2l}{p}$$

Given, $y = 2\sin\left(\frac{4\pi x}{15}\right)\cos(96\pi t)$

or $y = 2\left[\sin\left(\frac{4\pi x}{15} + 96\pi t\right) + \sin\left(\frac{4\pi x}{15} - 96\pi t\right)\right]$

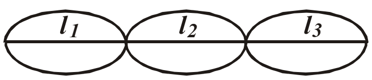
Comparing it with standard equation, we get

$$\upsilon = \frac{96\pi}{2\pi} = 48 \text{ Hz and } k = \frac{4\pi}{15}$$

$$\frac{1}{48} = \frac{2 \times 60}{p} \times \frac{4\pi}{15 \times 96\pi}$$

$\Rightarrow p = 16.$

37. (b)



$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

or, $n \propto \frac{1}{l}$ or nl = constant, K

$\therefore n_1 l_1 = K,$

$n_2 l_2 = K, n_3 l_3 = K$

Also, $l = l_1 + l_2 + l_3$

or, $\frac{K}{n} = \frac{K}{n_1} + \frac{K}{n_2} + \frac{K}{n_3}$

or, $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$

38. (a) Time taken for two syllables $t = \frac{2}{5}$ sec.

$$x + x = v \times t = 330 \times \frac{2}{5} \qquad \therefore x = 66\,\text{m}$$

39. (a) Velocity of sound $= \sqrt{\frac{\gamma RT}{M}}$

When water vapour are represent in air average molecular weight of air decreases and hence velocity increases.

40. (b) $\frac{I_{max}}{I_{min}} = \frac{(a+b)^2}{(a-b)^2} = 49 \qquad \therefore \frac{a+b}{a-b} = 7$

$7a - 7b = a + b$ or $6a = 8b$ or $\frac{a}{b} = \frac{8}{6} = \frac{4}{3}$

41. (a) By the concept of accoustic, the observer and source are moving towards each other, each with a velocity of 18 m s^{-1}.

$$\therefore \nu' = \frac{330 + 18}{330 - 18} \times 1000 \quad \approx 1115 \text{ Hz}$$

42. (c) Compare the given equation with standard form

$$y = r\sin\left[\frac{2\pi x}{\lambda} - \frac{2\pi t}{T}\right]$$

$$\frac{2\pi}{\lambda} = 3, \lambda = \frac{2\pi}{3} \text{ and } \frac{2\pi}{T} = 15$$

$$T = \frac{2\pi}{15}$$

Speed of propagation, $v = \frac{\lambda}{T} = \frac{2\pi/3}{2\pi/15} = 5$

43. (c) The contrast will be maximum, when $I_1 = I_2$ i.e. $a = b$. In that event, $I_{min} = (a-b)^2 = 0$, where a and b are the amplitudes of interfering waves.

44. (b) Fundamental frequency of closed organ pipe

$$V_c = \frac{V}{4l_c}$$

Fundamental frequency of open organ pipe

$$V_0 = \frac{V}{2l_0}$$

Second overtone frequency of open organ pipe = $\frac{3V}{2l_0}$

From question,

$$\frac{V}{4l_c} = \frac{3V}{2l_0}$$

$\Rightarrow \quad l_0 = 6l_c = 6 \times 20 = 120$ cm

45. (b) $y = 60\cos(180t - 6x)$ ....(1)

$\omega = 180, k = 6 \Rightarrow \frac{2\pi}{\lambda} = 6$

$$v = \frac{\omega}{k} = \frac{2\pi}{T} \times \frac{\lambda}{2\pi} = \frac{180}{6} = 30 \text{ m/s}$$

Differentiating (1) w.r.t. t,

$$v = \frac{dy}{dt} = -60 \times 180 \sin(180t - 6x)$$

$v_{max} = 60 \times 180$ μm/s

$= 10800$ μm/s $= 0.0108$ m/s

$$\frac{v_{max}}{v} = \frac{0.0108}{30} = 3.6 \times 10^{-4}$$