CBSE

WAVES WS 4

Class 11 - Physics

Section A

1. A string is tied on a sonometer, second end is hanging downward through a pulley with tension T. The velocity of the transverse wave produced is proportional to **[1]**

   a) $\frac{1}{T}$ b) T

   c) $\sqrt{T}$ d) $\frac{1}{\sqrt{T}}$

2. A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance of 1.21 A between them. The wavelength of the standing wave is: **[1]**

   a) 1.21 $\mathring{A}$ b) 2.42 $\mathring{A}$

   c) 3.63 $\mathring{A}$ d) 6.05 $\mathring{A}$

3. A source of frequency ν gives 5 beats/second when sounded with a source of frequency 200 Hz. The second harmonic of frequency 2ν of source gives 10 beats/second when sounded with a source of frequency 420 Hz The value of ν is **[1]**

   a) 210 Hz b) 200 Hz

   c) 205 Hz d) 195 Hz

4. Standing waves are produced in 10 m long stretched string. If the string vibrates in 5 segments and wave velocity is 20 m/s, its frequency is **[1]**

   a) 2Hz b) 5 Hz

   c) 4 Hz d) 10 Hz

5. The disc of a siren containing 60 holes rotates at a constant speed of 360 rpm. The emitted sound is in unison with a tuning fork of frequency: **[1]**

   a) 10 Hz b) 360 Hz

   c) 6 Hz d) 216 Hz

6. A wave of frequency 100 Hz travels along a string towards its fixed end. When this wave travels back, after reflection, a node is formed at a distance of 10 cm from the fixed end. The speed of the wave (incident and reflected) is **[1]**

   a) 40 m/s b) 10 m/s

   c) 5 m/s d) 20 m/s

7. Two closed organ pipes, when sounded simultaneously gave 4 beats per sec. If longer pipe has a length of 1 m, then length of shorter pipe is (v = 300 m/s) **[1]**

   a) 80 cm b) 94.9 cm

c) 90 cm

d) 185.5 cm

8. A resonance air column of length 40 cm resonates with a tuning fork of frequency 450 Hz. Ignoring end correction, the velocity of sound in air will be **[1]**

a) 820 m/s

b) 720 m/s

c) 1020 m/s

d) 920 m/s

9. When the length of the vibrating segment of a sonometer wire is increased by 1%, the percentage change in its frequency is **[1]**

a) 1

b) 2

c) $\frac{100}{101}$

d) $\frac{99}{100}$

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: **[1]**

a) 0.01

b) 0.03

c) 0.04

d) 0.02

11. Two waves are represented by $y_1 = a\sin\left(\omega t + \frac{\pi}{6}\right)$ and $y_2 = a\cos\omega t$. What will be their resultant amplitude? **[1]**

a) a

b) 2a

c) $\sqrt{3}a$

d) $\sqrt{2}a$

12. Resonance is an example of **[1]**

a) forced vibration

b) damped vibration

c) free vibration

d) tuning fork

13. Two waves represented by $Y_1 = a_1 \sin \omega t$ and $Y_2 = a_2 (\sin \omega t + \Delta)$ and $\Delta = \frac{\pi}{2}$ are superimposed at a point at a particular instant. The amplitude of the resultant wave is: **[1]**

a) $a_1 + a_2$

b) $\sqrt{a_1^2 - a_2^2}$

c) $\sqrt{a_1^2 + a_2^2}$

d) $a_1 - a_2$

14. **Assertion (A):** The amplitude A(ϕ) of the resultant of the two waves is given by equations $y_1(x, t) = A \sin(kx - \omega t)$ and $y_2(x, t) = A \sin(kx - \omega t + \phi)$ is decreasing as ϕ increases from 0 to π. **[1]**

Reason (R): The amplitude of the resultatnt of the two waves is given by $A(\phi) = 2A \cos \frac{\phi}{2}$ which is decreasing for $0 \leq \phi \leq \pi$.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** In nth normal mode of a stretched string, there are n antinodes and (n + 1) nodes. **[1]**

Reason (R): The ends of string are nodes, so the number of node is one more than the number of antinodes.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

16. **Assertion (A):** When the tuning forks of frequency 256 Hz and 324 Hz are vibrating together. Beats will not be heard. **[1]**

Reason (R): The principle of superposition of waves is applicable only if frequencies of oscillating bodies are nearly equal.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

17. **Assertion (A):** Harmonics are the notes (a single sound of a certain pitch and wavelength) of frequencies which are integral multiple of the fundamental frequency. **[1]**

Reason (R): Tones of frequencies higher than fundamental note are called overtones.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

18. **Assertion (A):** The superposition of the waves y_1 - A sin (kx - ωt) and y_2 = 5A sin (kx + ωt) is a pure stationary wave plus a travelling wave moving in the negative x-direction. **[1]**

Reason (R): The resultant of y_1 and y_2 is y = 2A sin kx cos ωt + 4A sin (kx + ωt).

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

19. **Assertion (A):** In stationary wave, a person hear a loud sound at the nodes as compared to the antinodes. **[1]**

Reason (R): In a stationary wave all the particles of the medium vibrate in phase.

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

20. Name two instruments based on the superposition of waves. **[1]**
21. How does the frequency of a tuning fork change, when the temperature is increased? **[1]**
22. When two waves of almost equal frequencies n_1 and n_2 reach at a point, simultaneously. What is the time interval between successive maxima? **[1]**
23. What is the function of the wooden box in the sonometer? Does it increase or decrease the duration of emission? **[1]**
24. When the wire of a sonometer is plucked, what is the nature of the waves in **[1]**
    i. the string
    ii. in air?
25. What is the distance between a node and the nearest antinode? **[1]**

Section B

26. **State True or False:** **[2]**
    (a) All harmonics are overtones but all overtone are not harmonic. **[1]**
    (b) In destructive interference, if a crest of one wave meets a trough of another wave, then the magnitude of the displacements is equal to the difference in the individual magnitudes. **[1]**
27. A stretched wire emits a fundamental note of 256 Hz. Keeping the stretching force constant and reducing the **[2]**

length of wire by 10 cm, the frequency becomes 320 Hz. Calculate the original length of the wire.

28. Calculate the fundamental frequency of a sonometer wire of length = 20 cm, tension 25 N, cross-sectional area $=10^{-2}$ cm^2 and density of the material of wire = 10^4 kg m^{-3}. **[2]**

29. Prove that a pipe of length 2 L open at both ends has same fundamental frequency as another pipe of length L closed at the other end. Also, state whether the total sound will be identical for two pipes. **[2]**

30. One end of a long string of linear mass density 8.0×10^{-3} kg m^{-1} is connected to an electrically driven tunning folk of frequency 256 H_z. The other end passes over a pulley and is tied to a pan containing a mass of 90 kg. The pulley end absorbs all the incoming energy so that reflected waves at this end have negligible amplitude. At t = 0, the left end of the string x = 0 has zero transverse displacement (y = 0) and is mowing along positive y-direction. The amplitude of the wave is 5.0 cm. Write down the transverse displacement y as a function of x and t that describes the Wave on the string. **[2]**

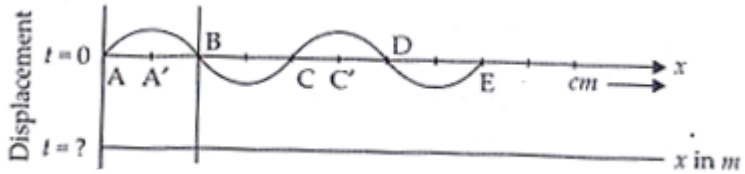
31. State the principle of superposition of waves. **[2]**

32. The fundamental frequency of a sonometer wire increases by 5 Hz if its tension is increased by 21%. How will the frequency, be affected if its length is increased by 10%? **[2]**

33. In Melde's experiment, a string vibrates in 3 loops when 8 grams were placed in the pan. What mass must be placed in the pan to make the string vibrate in 5 loops? **[2]**

Section C

34. The pattern of standing waves formed on a stretched string at two instants of time is shown in Figure. The velocity of two waves super-imposing to form stationary waves is 360 $ms^{-1}$and their frequencies are 256 Hz. **[3]**



a. Calculate the time at which the second curve is plotted.

b. Mark nodes and antinodes on the curve.

c. Calculate the distance between A′ and C ′.

35. Show that the wave obtained as a result of interference of two sinusoidal waves is also a sinusoidal wave. **[3]**

Section D

36. **Fill in the blanks:** **[5]**

(a) When two identical waves travelling in opposite directions through a medium superpose each other, _____ waves are produced. **[1]**

(b) When two waves of slightly different frequencies moving with the same speed in the same direction in a medium superpose each other, they produce _____. **[1]**

(c) When the wire of a sonometer is plucked, the waves produced in the string are _____ and that in the air are _____. **[1]**

(d) When waves interfere in phase, it is called _____ interference. **[1]**

(e) The principle of _____ states that when two or more pulses overlap, the resultant displacement is the algebraic sum of the displacements due to each pulse. **[1]**

37. Determine the possible harmonics in the longitudinal vibration of a rod clamped in the middle. **[5]**

38. For the plane wave $y = 2.5 \times 10^{-0.02x} \cos (800\ t - 0.82\ x + \frac{\pi}{2})$ **[5]**

write down

i. the general expression for phase ϕ

ii. the phase at x = 0, t = 0

iii. the phase difference between the points separated by 20 cm along x-axis.

iv. the change in phase at a given place 0.6 milli second and

v. the amplitude at x = 100 m

Take units of y, t, x as 10^{-5} cm, s and m respectively.

39. A pipe, 30.0 cm long, is open at both ends. Which harmonic mode of the pipe resonates a 1.1 kHz source? Will resonance with the same source be observed if one end of the pipe is closed? Take the speed of sound in air as 330 ms^{-1}. **[5]**