Graphical Questions

1. (c) Speed = $n\lambda = n(4ab) = 4n\times ab$ $\left(\text{As } ab = \frac{\lambda}{4}\right)$

Path difference between b and e is $\frac{3\lambda}{4}$

So the phase difference $= \frac{2\pi}{\lambda}$. Path difference

$$= \frac{2\pi}{\lambda}.\frac{3\lambda}{4} = \frac{3\pi}{2}$$

2. (b) After 2 sec the pulses will overlap completely. The string becomes straight and therefore does not have any potential energy and its entire energy must be kinetic.

3. (a) When the train is approaching the stationary observer frequency heard by the observer $n' = \frac{v+v_0}{v}n$

when the train is moving away from the observer then frequency heard by the observer $n'' = \frac{v-v_0}{v}n$

it is clear that n' and n'' are constant and independent of time. Also and $n' > n''$.

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

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

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

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 at $\pi/2$.

5. (d) Points *B* and *F* are in same phase ass they are λ distance apart.

6. (c) The particle velocity is maximum at *B* and is given by $\frac{dy}{dt} = (v_p)_{\max} = \omega A$

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

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

7. (d) When pulse is reflected from a rigid support, the pulse is inverted both lengthwise and sidewise

8. (d) Given equation $y = y_0\sin(\omega t - \phi)$

at $t = 0$, $y = -y_0\sin\phi$

this is the case with curve marked *D*.

9. (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.

10. (c) Energy density (E) $= \frac{I}{v} = 2\pi^2\rho n^2A^2$

$v_{\max} = \omega A = 2\pi nA \Rightarrow E \propto (v_{\max})^2$

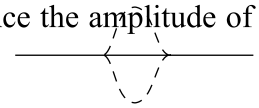
i.e., graph between *E* and $v_{\max}$ will be a parabola symmetrical about *E* axis.

11. (c) Here $A = 0.05m$, $\frac{5\lambda}{2} = 0.025 \Rightarrow \lambda = 0.1m$

Now standard equation of wave

$y = A\sin\frac{2\pi}{\lambda}(vt - x) \Rightarrow y = 0.05\sin 2\pi(33t - 10x)$

12. (c) After two seconds each wave travel a distance of 2.5 × 2 = 5 *cm i.e.* the two pulses will meet in mutually opposite phase and hence the amplitude of resultant will be zero.



13. (c) $n_Q = 341 \pm 3 = 344\,Hz$ or $338\,Hz$

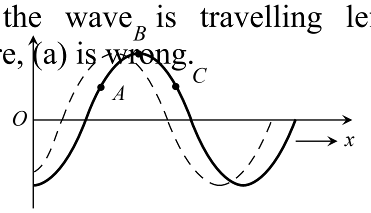
on waxing *Q*, the number of beats decreases hence $n_Q = 344\,Hz$

14. (b) For observer approaching a stationary source

$n' = \frac{v+v_0}{v}.n$ and given $v_0 = at \Rightarrow n' = \left(\frac{an}{v}\right)t + n$

this is the equation of straight line with positive intercept *n* and positive slope $\left(\frac{n}{v}\right)$.

15. (b,d) Since *A* is moving upwards, therefore, after an elemental time interval the wave will be as shown dotted in following fig. It means, the wave is travelling leftward. Therefore, (a) is wrong.



Displacement amplitude of the wave means maximum possible displacement of medium particles due to propagation of the wave, which is equal to the displacement at *B* at the instant shown in fig. Hence (b) is correct.

From figure, it is clear that *C* is moving downwards at this instant. Hence (c) is wrong.

The phase difference between two points will be equal to $\frac{\pi}{2}$ if distance between them is equal to $\frac{\lambda}{4}$. Between *A* and *C*, the distance is less than $\frac{\lambda}{2}$. It may be equal to $\frac{\lambda}{4}$. Hence, phase difference between these two points may be equal to $\frac{\pi}{2}$.

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

here $\frac{a_A}{a_B}=\frac{2}{1}$ and $\frac{\omega_A}{\omega_B}=\frac{1}{2}\Rightarrow$

$\frac{I_A}{I_B}=\left(\frac{2}{1}\right)^2\times\left(\frac{1}{2}\right)^2=\frac{1}{1}$

17. (b) At $t = 0$ and $x=\frac{\pi}{2k}$. The displacement

$y=a_0\sin\left(\omega x_0-k\times\frac{\pi}{2x}\right)=-a_0\sin\frac{\pi}{2}=-a_0$

from graph. Point of maximum displacement (a_0) in negative direction is *Q*.

18. (d) Particle velocity $(v_p)=-v\times$ Slope of the graph at that point

At point 1 : Slope of the curve is positive, hence particle velocity is negative or downward (↓)

At point 2 : Slope negative, hence particle velocity is positive or upwards (↑)

At point 3 : Again slope of the curve is positive, hence particle velocity is negative or downward (↓)

Assertion and Reason

1. (a) Sound waves require material medium to travel. As there is no atmosphere (vacuum) on the surface of moon, therefore the sound waves cannot reach from one person to another.

2. (b) Transverse waves travel in the form of crests and troughs involving change in shape of the medium. As liquids and gases do not possess the elasticity of shape, therefore, transverse waves cannot be produced in liquid and gases. Also light wave is one example of transverse wave.

3. (b) Sound waves cannot propagate through vacuum because sound waves are mechanical waves. Light waves can propagate through vacuum because light waves are electromagnetic waves. Since sound waves are longitudinal waves, the particles moves in the direction of propagation, therefore these waves cannot be polarised.

4. (c) Velocity of sound in gas medium is $v=\sqrt{\frac{K}{\rho}}$

$=\sqrt{\frac{\gamma p}{\rho}}$

γ is ratio of its principal heat capacities (C_P/C_v). For moist air ρ is less than that for dry air and γ is slightly greater.

$\therefore$ velocity of sound increases with increase in humidity.

5. (c) Ocean waves are transverse waves travelling in concentric circles of ever increasing radius. When they hit the shore, their radius of curvature is so large that they can be treated as plane waves. Hence they hit the shore nearly normal to the shore.

6. (a) A compression is a region of medium in which particles come closer *i.e.*, distance between the particles becomes less than the normal distance between them. Thus there is a temporary decrease in volume and a consequent increase in density of medium. Similarly in rarefaction, particle get farther apart and a consequent decrease in density.

7. (e) Since transverse wave can propagate through medium which posses elasticity of shape. Air posses only volume elasticity therefore transverse wave cannot propagate through air.

8. (c) The velocity of sound in a gas is directly proportional to the square root of its absolute temperature (as $v=\sqrt{\frac{\gamma RT}{M}}$). Since temperature of a hot day is more than cold winter day, therefore sound would travel faster on a hot summer day than on a cold winter day.

9. (c) According to Laplace, the changes in pressure and volume of a gas, when sound waves propagated through it, are not isothermal, but adiabatic. A gas is a bad conductor of heat. It does not allow the free exchange of heat between compressed layer, rarefied layer and surrounding.

10. (e) The velocity of every oscillating particle of the medium is different of its different positions in one oscillation but the velocity of wave motion is always constant *i.e.*, particle velocity vary with respect to time, while the wave velocity is independent of time.

Also for wave propagation medium must have the properties of elasticity and inertia.

11. (d) A bucket can be treated as a pipe closed at one end. The frequency of the note produced $=\frac{v}{4L}$, here L equal to depth of water level from the open end. As the bucket is filled with water L decreases, hence frequency increases. Therefore, frequency or pitch of sound produced goes on increasing.

Also, the frequency of woman voice is usually higher than that of man.

12. (b) A tuning fork is made of a material for which elasticity does not change. Since the alloy of nickel, steel and chromium (elinvar) has constant elasticity, therefore it is used for the preparation of tuning fork.

13. (e) Speed of sound in cases in independent of pressure because $v=\sqrt{\frac{\gamma P}{\rho}}$. At constant temperature, if P changes then ρ also changes in such a way that the ratio $\frac{P}{\rho}$ remains constant hence there is no effect of the pressure change on the speed of sound.

14. (a) For the propagation of transverse waves, medium must have the property of rigidity. Because gases have no rigidity, (they do not posses shear elasticity), hence transverse waves cannot be produced is gases. On the other hand, the solids possess both volume and shear elasticity and likewise both the longitudinal and transverse waves can be transmitted through them.

15. (c) Velocity of sound in a gas $v=\sqrt{\frac{\gamma P}{\rho}}$. For monoatomic gas $\gamma = 1.67$; for diatomic $\gamma = 1.40$. Therefore v is larger in case of monoatomic gas compared to its values in diatomic gas.

16. (a) The velocity of sound in solid is given by, $v=\sqrt{E/\rho}$. Though ρ is large for solids, but their coefficient of elasticity E is much larger (compared to that of liquids and gases). That is why v is maximum in case of solid.

17. (d) When moisture is present in air, the density of air decreases. It is because the density of water vapours is less than that of dry air. The velocity of sound is inversely proportional to the square root of density, hence sound travel faster in moist air than in the dry air. Therefore, on a rainy day sound travels faster than on a dry day.

18. (b) According to the property of persistence of hearing, the impression of a sound heard persists on our mind for $\frac{1}{10}$ *sec*. Therefore, number of beats per *sec* should be less than 10. Hence difference in frequencies of two sources must be less than 10.

19. (b) Sound produced by an open organ pipe is richer because it contains all harmonics and frequency of fundamental note in an open organ pipe is twice the fundamental frequency in a closed organ pipe of same length.

Reason is also correct, but it is not explaining the assertion.

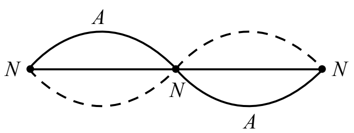
20. (a) Since the initial phase difference between the two waves coming from different violins changes, therefore, the waves produced by two different violins does not interfere because two waves interfere only when the phase difference between them remain constant throughout.

21. (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.

22. (c) 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 heard due to variation of pressure.

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

23. (a) Stationary wave



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

24. (c) The principle of superposition does not state that the frequencies of the oscillation should be nearly equal. For beats to be heard the condition is that difference in frequencies of the two oscillations should not be more than 10 times per seconds for a normal human ear to recognise it. Hence we cannot hear beats in the case of two tuning forks vibrating at frequencies 256 *Hz* and 512 *Hz* respectively.

25. (a) The fundamental frequency of an open organ pipe is $n = \frac{v}{2l}$. As temperature increases, both v and l increase but v increases more rapidly than l. Hence, the fundamental frequency increases as the temperature increases.

26. (b) Since, velocity of sound,

$$v = \sqrt{\frac{E}{\rho}}$$

As, the elasticity of solid is large than that of gases. Hence, it is obvious that velocity of sound is greater in solids than in gases.

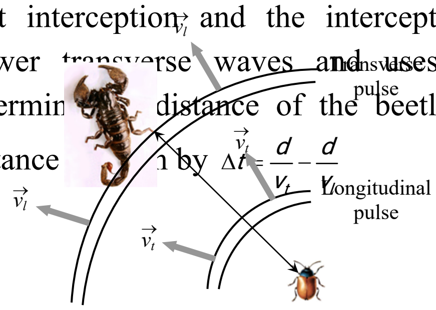
27. (d)

28. (b) Velocity of wave $= \frac{\text{Distance travelled by wave}(\lambda)}{\text{Time period}(T)}$

Wavelength is also defined as the distance between two nearest points in phase.

29. (c) Speed of light is greater than that of sound, hence flash of lightening is seen before the sound of thunder.

30. (a) A beetle motion sends fast longitudinal pulses and slower transverse waves along the sends surface. The sand scorpion first intercept the longitudinal pulses and learns the direction of the beetle; it is in the direction of which ever leg is disturbed earliest by the pulses. The scorpion then senses the time interval (Δt) between that first interception and the interception of slower transverse waves and uses it to determine the distance of the beetle. The distance is given by $\Delta t = \frac{d}{v_t} - \frac{d}{v_l}$



31. (e)