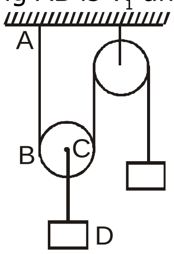
Exercise - I (Objective Problems)

1. A transverse wave is described by the equation $Y = Y_0 \sin 2\pi (ft - x/\lambda)$. The maximum particle velocity is equal to four times the wave velocity if
(A) $\lambda = \pi Y_0/4$ (B) $\lambda = \pi Y_0/2$
(C) $\lambda = \pi Y_0$ (D) $\lambda = 2\pi Y_0$

2. Both the strings, show in figure, are made of same material and have same cross section. The pulleys are light. The wave speed of a transverse wave in the string AB is v_1 and in CD it is v_2. The v_1/v_2 is



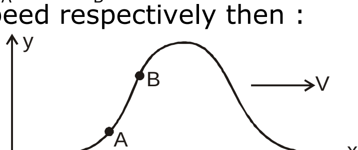
(A) 1 (B) 2 (C) $\sqrt{2}$ (D) $1/\sqrt{2}$

3. A transverse wave of amplitude 0.50 m, wavelength 1 m and frequency 2 hertz is propagating in a string in the negative x-direction. The expression form of the wave is
(A) $y(x,t) = 0.5 \sin (2\pi x - 4\pi t)$
(B) $y(x,t) = 0.5 \cos (2\pi x + 4\pi t)$
(C) $y(x,t) = 0.5 \sin (\pi x - 2\pi t)$
(D) $y(x,t) = 0.5 \cos (2\pi x - 2\pi t)$

4. Two stretched wires A and B of the same lengths vibrate independently. If the radius, density and tension of wire A are respectively twice those of wire B, then the fundamental frequency of vibration of A relative to that of B is
(A) 1:1 (B) 1:2 (C) 1:4 (D) 1:8

5. A copper wire is held at the two ends by rigid supports. At 30°C the wire is just taut, with negligible tension, The speed of transverse waves in this wire at 10°C is :
($\alpha = 1.7 \times 10^{-5}$/°C, $Y = 1.3 \times 10^{11}$ N/m^2, $d = 9 \times 10^3$ kg/m^3).
(A) 80 m/s (B) 90 m/s (C) 100 m/s (D) 70 m/s

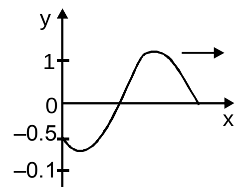
6. A wave pulse is generated in a string that lies along x-axis. At the points A and B, as shown in figure, if R_A and R_B are ratio of wave speed to the particle speed respectively then :



(A) $R_A > R_B$ (B) $R_B > R_A$ (C) $R_A = R_B$
(D) Information is not sufficient to decide.

7. A wave is propagating along x-axis. The displacement of particles of the medium in Z-direction at t=0 is given by: $z = \exp[-(x+2)^2]$, Where 'x' is in meters. At t=1s, the same wave disturbance is given by: $z = \exp[-(2-x)^2]$, Then the wave propagation velocity is
(A) 4 m/s in + x direction
(B) 4 m/s in −x direction
(C) 2 m/s in + x direction
(C) 2 m/s in −x direction

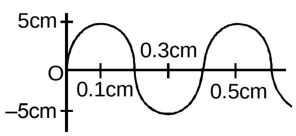
8. The equation of a wave travelling along the positive x-axis, as shown in figure at t=0 is given by



(A) $\sin\left(kx - \omega t + \frac{\pi}{6}\right)$ (B) $\sin\left(kx - \omega t - \frac{\pi}{6}\right)$

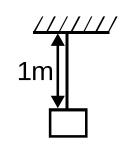
(C) $\sin\left(\omega t - kx + \frac{\pi}{6}\right)$ (D) $\sin\left(\omega t - kx - \frac{\pi}{6}\right)$

9. Figure shown the shape of part of a long string in which transverse waves are produced by attaching one end of the string to tuning fork of frequency 250Hz. What is the velocity of the waves?



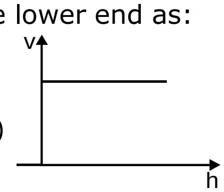
(A) 1.0 ms^{-1} (B) 1.5 ms^{-1} (C) 2.0 ms^{-1} (D) 2.5 ms^{-1}

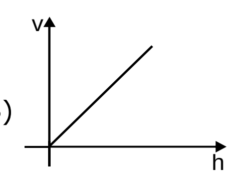
10. A block of mass 1 kg is hanging vertically from a string of length 1 m and Mass/length =0.001 kg/m. A small pulse is generated at its lower end. The Pulse reaches the top end in approximately.

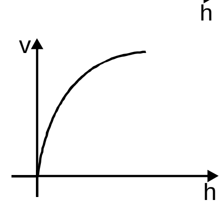


(A) 0.2sec (B) 0.1sec (C) 0.02sec (D) 0.01sec

11. A uniform rope having some mass hanges vertically from a rigid support. A transverse wave pulse is produced at the lower end. The speed (v) of the wave pulse varies with height (h) from the lower end as:

(A)


(B)


(C)


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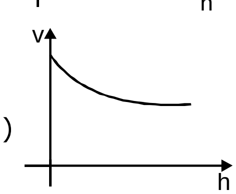
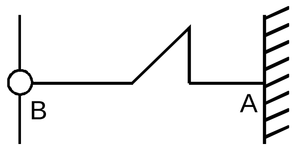
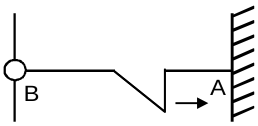


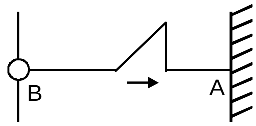
12. A wire of $10^{-2}\,kg\,m^{-1}$ passes over a frictionless light pulley fixed on the top of a frictionless inclined plane, which makes an angle of 30^0 with the horizontal. Masses m and M are tied at two ends of wire such that m rests on the plane and M hangs freely vertically downwards. The entire system is in equilibrium and a transverse wave propagates along the wire with a velocity of $100\,ms^{-1}$.

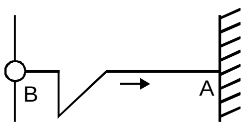
(A) M=5 kg (B) $\frac{m}{M}=\frac{1}{4}$ (C) m=20 kg (D) $\frac{m}{M}=4$

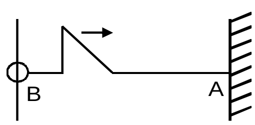
13. A pulse shown here is reflected from the rigid wall A and then from free end B. The shape of the string after these 2 Reflection will be.



(A) 

(B) 

(C) 

(D) 

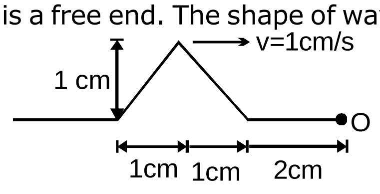
14. A composition String is made up by joining two strings of different masses per unit length $\rightarrow \mu\, and\ 4\mu$. the composite string is under the same tension. A transverse wave pulse: Y = (6mm) sin (5t+40x), Where 't' is in seconds and 'x' in meters, is sent along the lighter string towards the joint. The joint is at x=0. The equation of the wave pulse reflected from the joint is

(A) (2mm) sin (5t-40x)
(B) (4 mm) sin (40x-5t)
(C) –(2 mm) sin (5t-40x)
(D) (2 mm) sin (5t-10x)

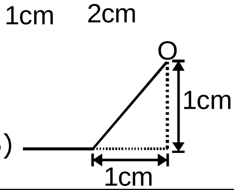
15. In the previous question, the percentage of power transmitted to the heavier string through the joint is approximately

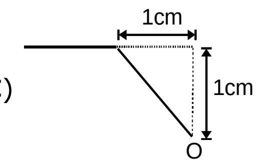
(A) 33% (B) 89% (C) 67% (D) 75%

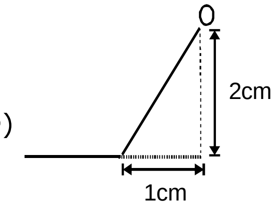
16. A Wave pulse on a string has the dimension shown in figure. The waves speed is v=1 cm/s. If point O is a free end. The shape of wave at time t=3 s is:



(A) 

(B) 

(C) 

(D) 

17. A string 1m long is drawn by a 300Hz vibrator attached to its end. The string vibrates in 3 segments. The speed of transverse waves in the string is equal to

(A) 100m/s (B) 200m/s (C) 300m/s (D) 400m/s

18. The frequency of a sonometer wire is f, but when the weights producing the tensions are completely immersed in water the frequency becomes f/2 and on immersing the weights in a certain liquid the frequency becomes f/3. The specific gravity of the liquid is:

(A) $\frac{4}{3}$ (B) $\frac{16}{9}$ (C) $\frac{15}{12}$ (D) $\frac{32}{27}$

19. For a wave displacement amplitude is 10^{-8} m, density of air 1.3 kg m^{-3}, velocity in air 340 ms^{-1} and frequency is 2000 Hz. The intensity of wave is -

(A) $5.3 \times 10^{-4}\ Wm^{-2}$ (B) $5.3 \times 10^{-6}\ Wm^{-2}$
(C) $3.5 \times 10^{-8}\ Wm^{-2}$ (D) $3.5 \times 10^{-6}\ Wm^{-2}$

20. A wave moving with constant speed on a uniform string passes the point x = 0 with amplitude A_0, angular frequency ω_0 and average rate of energy transfer P_0. As the wave travels down the string it gradually loses energy and at the point x = ℓ, the average rate of energy transfer becomes $\frac{P_0}{2}$. At the point x = ℓ, angular frequency and amplitude are respectively.

(A) ω_0 and $A_0/\sqrt{2}$ (B) $\omega_0/\sqrt{2}$ and A_0

(C) less than ω_0 and A_0 (D) $\omega_0/\sqrt{2}$ and $A_0/\sqrt{2}$

21. Two waves of equal amplitude A, and equal frequency travels in the same direction in a medium. The amplitude of the resultant wave is

(A) 0 (B) A (C) 2A
(D) between 0 and 2A

22. When two waves of the same amplitude and frequency but having a phase difference of ϕ, travelling with the same speed in the same direction (positive x), interfere, then

(A) their resultant amplitude will be twice that of a single wave but the frequency will be same
(B) their resultant amplitude and frequency will both be twice that of a single wave
(C) their resultant amplitude will depend on the phase angle while the frequency will be the same
(D) the frequency and amplitude of the resultant wave will depend upon the phase angle.

23. A wave pulse, travelling on a two piece string, gets partially reflected and partially transmitted

at the junction. The reflected wave is inverted in shape as compared to the incident one. If the incident wave has wavelength λ and the transmitted wave λ'.
(A) $\lambda' > \lambda$ (B) $\lambda' = \lambda$ (C) $\lambda' < \lambda$
(D) nothing can be said about the relation of λ and λ'.

24. The rate of transfer of energy in a wave depends
(A) directly on the square of the wave amplitude and square of the wave frequency
(B) directly on the square of the wave amplitude and square root of the wave frequency
(C) directly on the wave frequency and square of the wave amplitude
(D) directly on the wave amplitude and square of the wave frequency.

25. Two wave pulses travel in opposite directions on a string and approach each other. The shape of the one pulse in inverted with respect to the other.
(A) the pulses will collide with each other and vanish after collision.
(B) the pulses will reflect from each other i.e., the pulse going towards right will finally move towards left and vice versa.
(C) the pulses will pass through each other but their shapes will be modified
(D) the pulses will pass through each other without any change in their shape.

26. A harmonic wave is travelling on string 1. At a junction with string 2 it is partly reflected and partly transmitted. The linear mass density of the second string is four times that of the first string, and that the boundary between the two strings is at x =0. If the expression for the incident wave is, $y_i = A_i \cos(k_1x - \omega_1 t)$
Then findout the expression for the transmitted wave.
(A) $\frac{1}{3}A_i \cos(2k_1x - \omega_1 t)$ (B) $\frac{3}{2}A_i \cos(2k_1x - \omega_1 t)$
(C) $\frac{2}{3}A_i \cos(2k_1x - \omega_1 t)$ (D) None

27. A wave is represented by the equation
$y = 10\sin 2\pi(100t - 0.02X) + 10\sin 2\pi(100t + 0.02X)$.
The maximum amplitude and loop length are respectively
(A) 20 units and 30 units
(B) 20 units and 25 units
(C) 30 units and 20 units
(D) 25 units and 20 units

28. The resultant amplitude due to superposition of two waves
$Y_1 = 5\sin(wt - kx)$ and $y_2 = -5\cos(wt - kx - 150^0)$
(A) 5 (B) $5\sqrt{3}$ (C) $5\sqrt{2-\sqrt{3}}$ (D) $5\sqrt{2+\sqrt{3}}$

29. A wave represented by the equation $y = A\cos(kx - \omega t)$ is superimposed with another wave to form a statioary wave such that the point x=0 is a node. The equation of the other wave is:
(A) $-A\sin(kx+\omega t)$ (B) $-A\cos(kx+\omega t)$
(C) $A\sin(kx+\omega t)$ (D) $A\cos(kx+\omega t)$

30. A taut string at both ends vibrates in its n^{th} overtone. The distance between adjacent Node and antinode is found to be 'd' If the length of the string is L, then
(A) L=2d(n+1) (B) L=d(n+1)
(C) L=2dn (D) L = 2d(n – 1)

31. A metallic Wire of length L is fixed between two rigid supports. If the wire is cooled through a temperature difference ΔT (Y = young's modulus, ρ = density, α = coefficient of linear expansion) then the frequency of transverse vibration is proportional to:
(A) $\frac{\alpha}{\sqrt{\rho Y}}$ (B) $\sqrt{\frac{Y\alpha}{\rho}}$ (C) $\frac{\rho}{\sqrt{Y\alpha}}$ (D) $\sqrt{\frac{\rho\alpha}{Y}}$

32. A Standing Wave $y = A\sin(\frac{20}{3}\pi x)\cos(1000\pi t)$ is maintained in a taut string where y and x are expressed in meters. The distance between the successive points oscillating with the amplitude A/2 across a node is equal to
(A) 2.5 cm (B) 25 cm (C) 5 cm (D) 10 cm

33. A string of length 1m and linear mass density 0.01 kgm^{-1} is stretched to a tension of 100N.when both ends of the string are fixed, the three lowest frequencies for standing wave are f_1, f_2 and f_3. when only one end of the string is fixed, the three lowest frequencies for standing wave are n_1, n_2 and n_3. Then
(A) $n_3 = 5n_1 = f_3 = 125$ Hz
(B) $f_3 = 5f_1 = n_2 = 125$ Hz
(C) $f_3 = n_2 = 3f_1 = 150$ Hz
(D) $n_2 = \frac{f_1 + f_2}{2} = 75$ Hz

34. A wave represented by the equation y = a cos (kx – ωt) is superposed with another wave to form a stationary wave such that the point x = 0 is a node. The equation for other wave is :
(A) a sin (kx + ωt) (B) – a cos (kx + ωt)
(C) – a cos (kx – ωt) (D) – a sin (kx – ωt)

35. A stretched sonometer wire resonates at a frequency of 350 Hz and at the next higher frequency of 420 Hz. The fundamental frequency of this wire is :
(A) 350 Hz (B) 5 Hz (C) 70 Hz (D) 170 Hz

36. In a stationary wave represented by y = a sin ωt cos kx, amplitude of the component progressive wave is :
(A) $\frac{a}{2}$ (B) a (C) 2a (D) None