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DPP – 2 (Waves)

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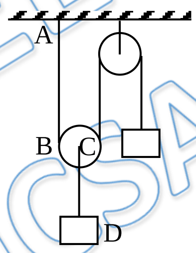
Q 1. A heavy uniform rope is suspended from a rigid support. A wave pulse is set up at the upper end, then
(a) the pulse will travel with uniform speed
(b) the pulse will travel with increasing speed
(c) the pulse will travel with decreasing speed
(d) the pulse cannot travel through the rope

Q 2. A transverse wave described by y = (0.02m) sin [$(1.0m^{-1})$ x + $(30\ s^{-1})$ t] propagates on a stretched string having a linear mass density of 1.2×10^{-4} kg/m. Find the tension in the string.
(a) 0.108 N (b) 1 N (c) .02 N (d) 2 N

Q 3. Both the strings, shown 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. Then V_1 / V_2 is–



(a) 1 (b) 2 (c) $\sqrt{2}$ (d) $1/\sqrt{2}$

Q 4. A progressive wave on a string having linear mass density ρ is represented by $y = A \sin\left(\frac{2\pi}{\lambda}x - \omega t\right)$ where y is in mm. Find the total energy (in μJ) passing through origin from t = 0 to t = $\frac{\pi}{2\omega}$.
[Take: $\rho = 3 \times 10^{-2}$ kg/m, A = 1mm, ω = 100 rad/s, λ = 16 cm]
(a) 6 (b) 7 (c) 8 (d) 9

Q 5. A uniform ring of radius R is rotating with constant angular speed ω. A transverse pulse is produced on it. Speed of pulse with respect to ring is
(a) ωR (b) ωR/2 (c) ωR/4 (d) ωR/3

Q 6. Power of a transverse wave on string is 10 mW and frequency of wave is 100 Hz. Energy of one wavelength of string is
(a) 1 mJ (b) 10mJ (c) .1 mJ (d) .01mJ

Q 7. In a gravity free space, a wire of mass m and length L is rotating with angular velocity ω about an axis perpendicular to rod and passing through its one end. A Transverse pulse is produced near axis. Retardation of this pulse is R and distance from axis is x then

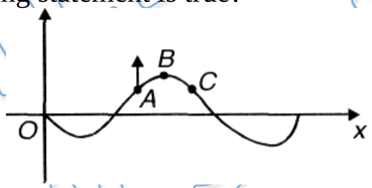
(a) R ∝ $\sqrt{x}$ (b) R ∝ x (c) R ∝ $x^{3/2}$ (d) R ∝ $x^{5/2}$

Q 8. One end of string of length L is tied to ceiling of lift accelerating upwards with an acceleration 3g. The other end of the string is free. The linear mass density of string varies linearly from 0 to μ, from bottom to top. Then correct statement for wave travelling in string
(a)Wave speed is increasing as it travels from bottom to top
(b)Acceleration of wave on string is uniform
(c)Time taken by pulse to reach from bottom to top will be $\sqrt{\frac{2L}{g}}$
(d) All of these

Q 9. A nonuniform rope is hanging vertically. A transverse pulse is produced at its bottom end and it is observed that pulse is moving up with constant velocity. If x is distance from lower end, then linear mass density of rope is directly proportional to
(a) x (b) x^2 (c) $\sqrt{x}$ (d) None of these

Q 10. For a transverse wave propagating on string
(a) Kinetic energy per unit length is maximum at mean position
(b) Kinetic energy per unit length is maximum at extreme position
(c) Potential energy per unit length is maximum at mean position
(d) Potential energy per unit length is maximum at mean position

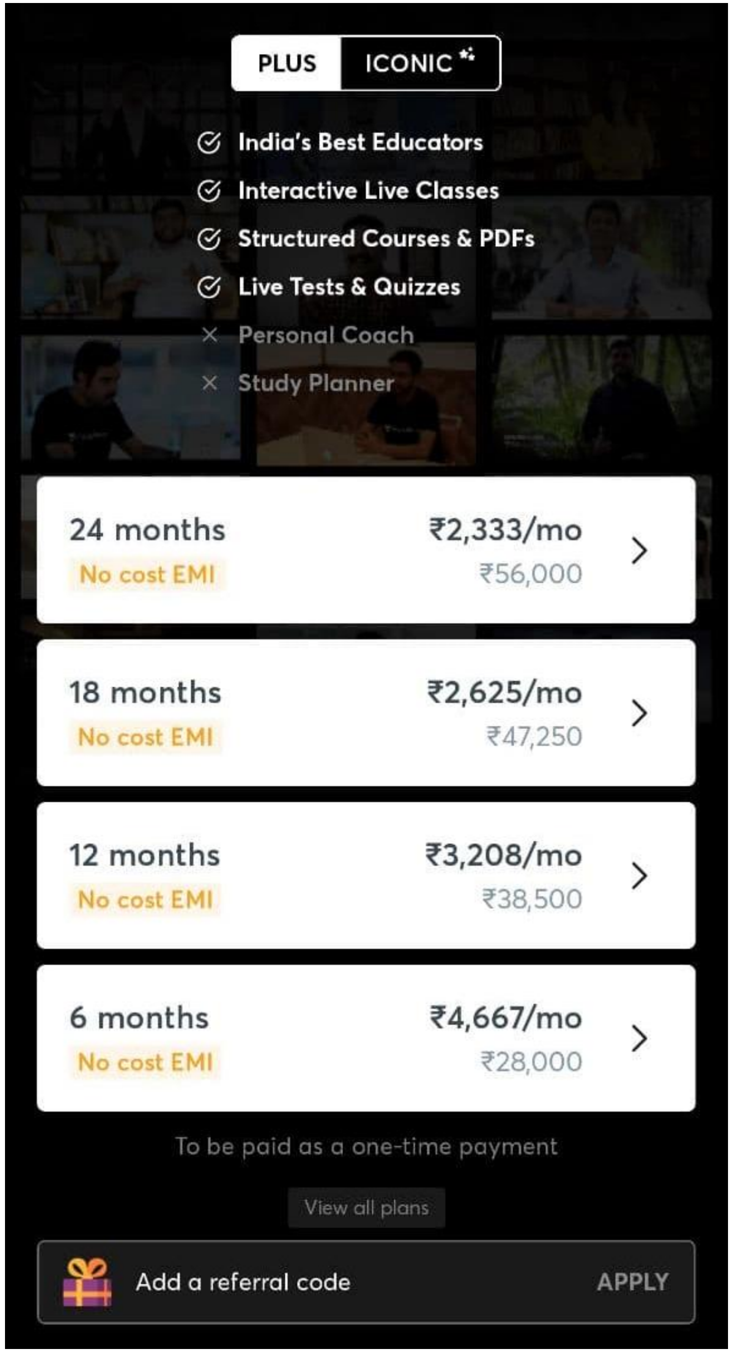
Q 11. At any instant, wave travelling along a string is shown in figure. Here point A is moving upwards. Which of following statement is true?



(a) At point A power is transferred by string left to a to string right to A
(b) At point A power is transferred by string right to a to string left to A
(c) Power is zero at A
(d) None of these

Answer Key

Q.1 c	Q.2 a	Q.3 d	Q.4 a	Q.5 a
Q.6 c	Q.7 b	Q.8 d	Q.9 d	Q.10 a, c
Q.11 b				



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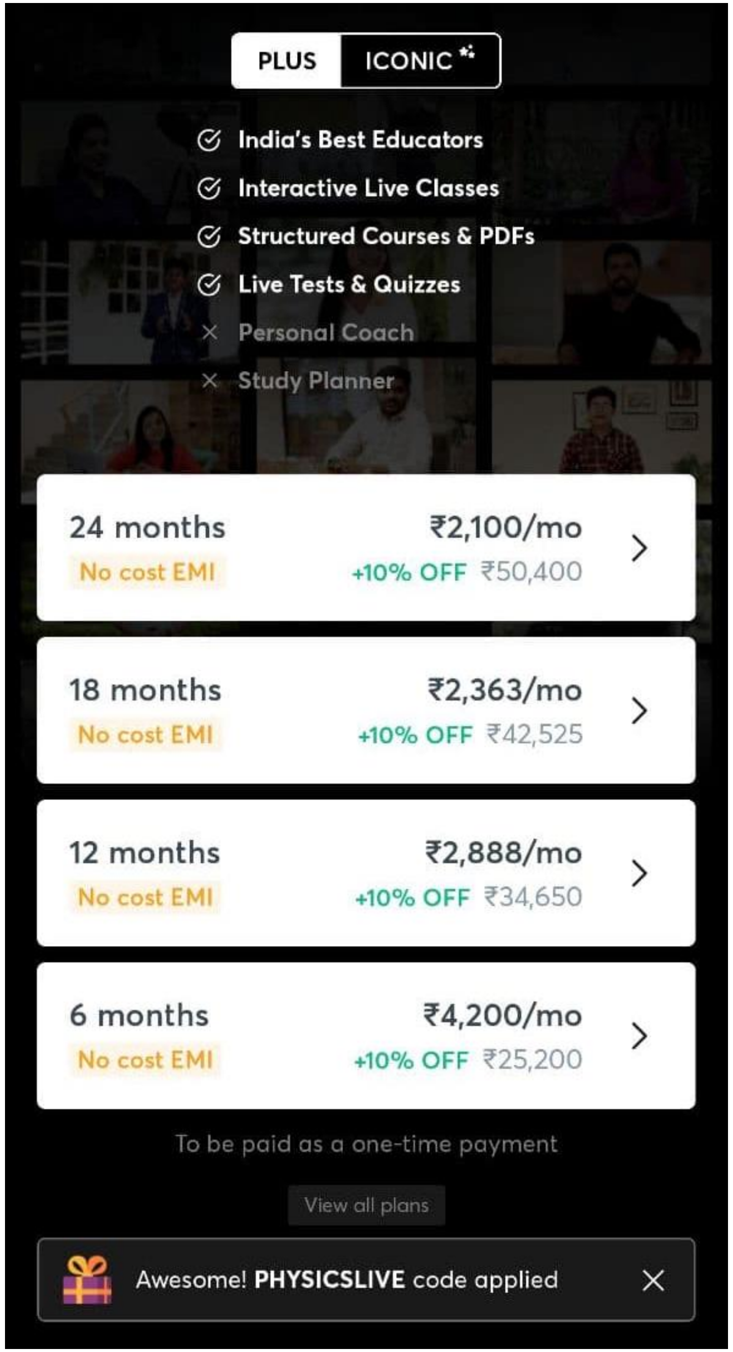


Written Solution

DPP-2 Waves: Waves on String & Energy related to Travelling wave

By Physicsaholics Team

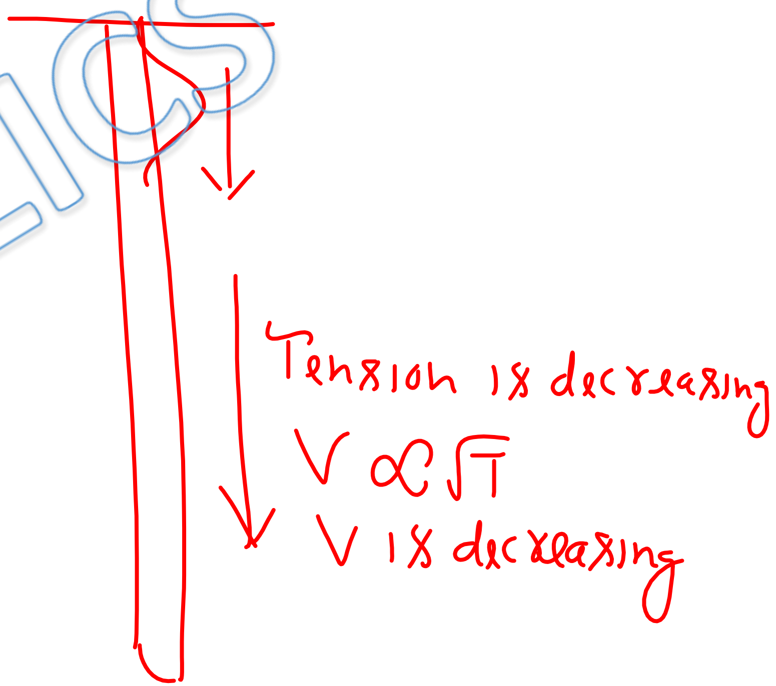
Q1) A heavy uniform rope is suspended from a rigid support. A wave pulse is set up at the upper end, then

(a) the pulse will travel with uniform speed

(b) the pulse will travel with increasing speed

(c) the pulse will travel with decreasing speed

(d) the pulse cannot travel through the rope



Q2) A transverse wave described by y = (0.02m) sin $[(1.0 m^{-1})$ x + $(30\ s^{-1})$ t] propagates on a stretched string having a linear mass density of 1.2×10^{-4} kg/m. Find the tension in the string.

$$V = \sqrt{\frac{T}{\mu}} = \frac{\omega}{k}$$

$$\frac{30}{1} = \sqrt{\frac{T}{1.2 \times 10^{-4}}}$$

$$T = .108\,N$$

(a) 0.108 N

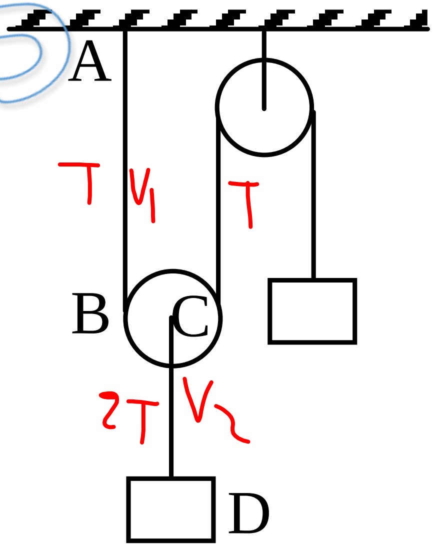
(b) 1 N

(c) .02 N

(d) 2 N

Ans. a

Q3) Both the strings, shown 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. Then V_1 / V_2 is–



$V_1 = \sqrt{T/\mu}$

$V_2 = \sqrt{2T/\mu}$

$\frac{V_1}{V_2} = \frac{1}{\sqrt{2}}$

(a) 1

(b) 2

(c) $\sqrt{2}$

(d) $1/\sqrt{2}$

Q4) A progressive wave on a string having linear mass density ρ is represented by $y = A\sin\left(\frac{2\pi}{\lambda}x - \omega t\right)$ where y is in mm. Find the total energy (in μJ) passing through origin from t = 0 to t = $\frac{\pi}{2\omega}$.

[Take: $\rho = 3 \times 10^{-2}$ kg/m, A = 1mm, ω = 100 rad/s, λ = 16 cm]

$V = \frac{\omega}{K} = \frac{100 \times .16}{2\pi} = 8/\pi$

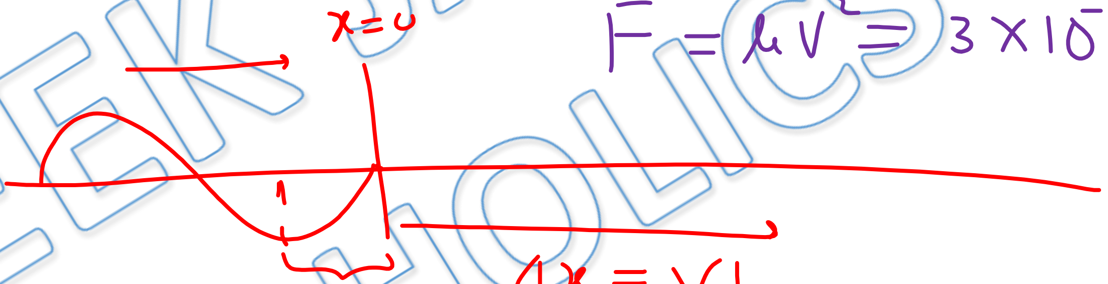
$F = \mu V^2 = 3 \times 10^{-2} \times \frac{64}{\pi^2}$

(a) 6

(b) 7

(c) 8

(d) 9



$\Delta x = Vt$

$= \frac{\omega}{K} \times \frac{\pi}{2\omega} = \frac{\pi}{2} \times \frac{\lambda}{2\pi} = \frac{\lambda}{4}$

$= 4\,cm$

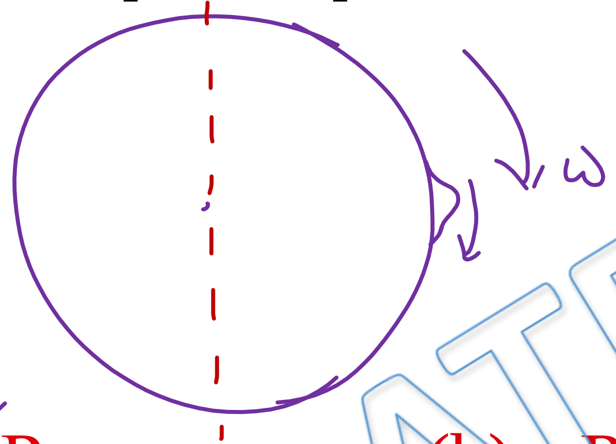
Energy passed through origin

= Energy of 1/4 wave

$= \frac{FA^2\omega^2}{2V^2} \times (\Delta x) = \frac{3 \times 64 \times 10^{-2} \times 10^{-6} \times 10^4 \times 4 \times 10^{-2}}{\pi^2 \times 2 \times \frac{64}{\pi^2}}$

$= 6 \times 10^{-6}\,J = 6\,\mu J$

Q5) A uniform ring of radius R is rotating with constant angular speed ω. A transverse pulse is produced on it . Speed of pulse with respect to ring is



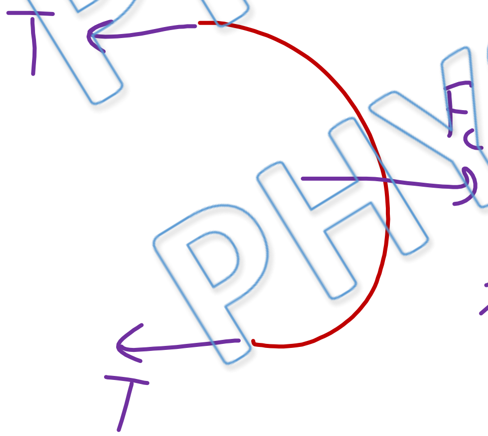
(a) ωR (b) ωR/2 (c) ωR/4 (d) ωR/3

Velocity of pulse w r t ring

$= \sqrt{\frac{T}{\lambda}}$ (λ → mass per unit length.)

$= R\omega$

FBD of right half ring

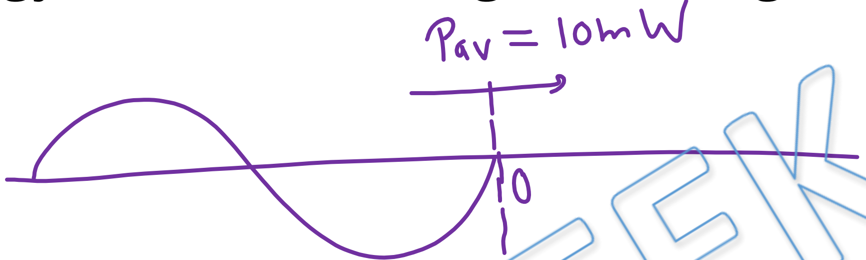


$F_c = (\lambda \times \pi R)\left(\frac{2R}{\pi}\right)\omega^2$ (mass, x_{cm})

$2T = 2\lambda R^2\omega^2$

$T/\lambda = R^2\omega^2$

Q6) Power of a transverse wave on string is 10 mW and frequency of wave is 100 Hz. Energy of one wavelength of string is



(a) 1 mJ (b) 10mJ (c) .1 mJ (d) .01mJ

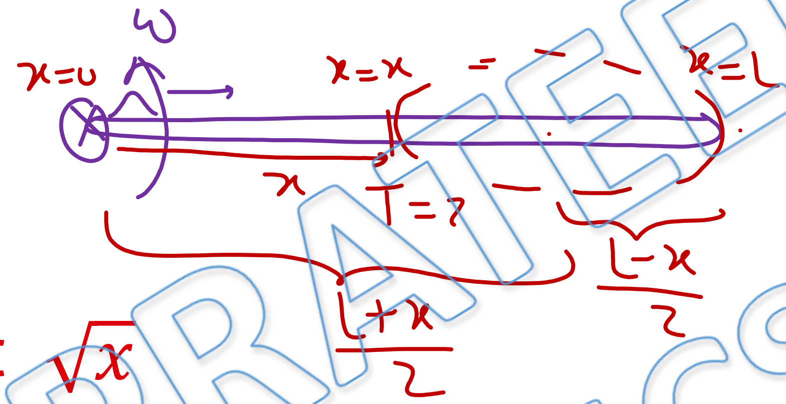
Time taken by one wave to move through O

$= T = \frac{1}{f} = 10^{-2}$ Sec

Energy of 1 wavelength $= P_{av} \cdot T = 10 \times 10^{-3} \times 10^{-2}$

$= 10^{-4}$ J $= .1$ mJ

Q7) In a gravity free space a wire of mass m and length L is rotating with angular velocity ω about an axis perpendicular to rod and passing through its one end. A Transverse pulse is produced near axis. Retardation of this pulse is R and distance from axis is x then



Tension at x = x

= Centrifugal force on x = x to x = L

$$T = \left[\frac{m}{L}(L-x)\right]\left(\frac{L+x}{2}\right)\omega^2$$

(a) $R \propto \sqrt{x}$

(b) $R \propto x$

(c) $R \propto x^{3/2}$

(d) $R \propto x^{5/2}$

$$\mu v^2 = \frac{m}{2L}(L^2 - x^2)\omega^2$$

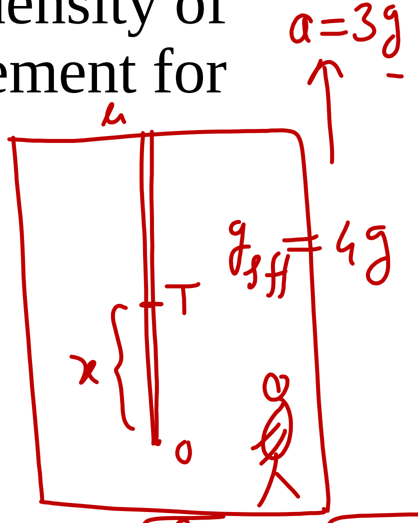
$$2v\frac{dv}{dx} = -\frac{1}{2} \times 2x\omega^2$$

$$R = \frac{\omega^2 x}{2}$$

Q8) One end of string of length L is tied to ceiling of lift accelerating upwards with an acceleration 3g. The other end of the string is free. The linear mass density of string varies linearly from 0 to μ, from bottom to top. Then correct statement for wave travelling in string

Linear mass density $\rho = \frac{\mu}{L}x$

tension at $x = x$, $T = \int \rho\, dx\, g_{eff} = \frac{\mu g_{eff}}{L}\int_0^x x\, dx = \frac{\mu g_{eff} x^2}{2L}$



(a)Wave speed is increasing as it travels from bottom to top

(b)Acceleration of wave on string is uniform

$L = \frac{1}{2}\frac{g_{eff}}{4}t^2 \Rightarrow t = \sqrt{\frac{8L}{g_{eff}}} = \sqrt{\frac{8L}{4g}}$, $= \sqrt{\frac{2L}{g}}$

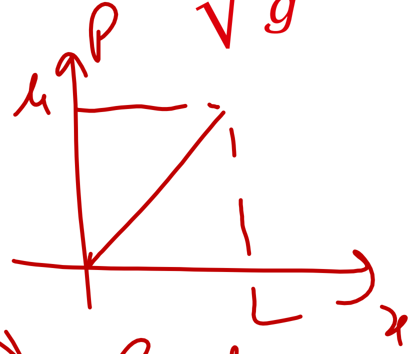
(c)Time taken by pulse to reach from bottom to top will be $\sqrt{\frac{2L}{g}}$

(d) All of these

Wave speed at $x = x$

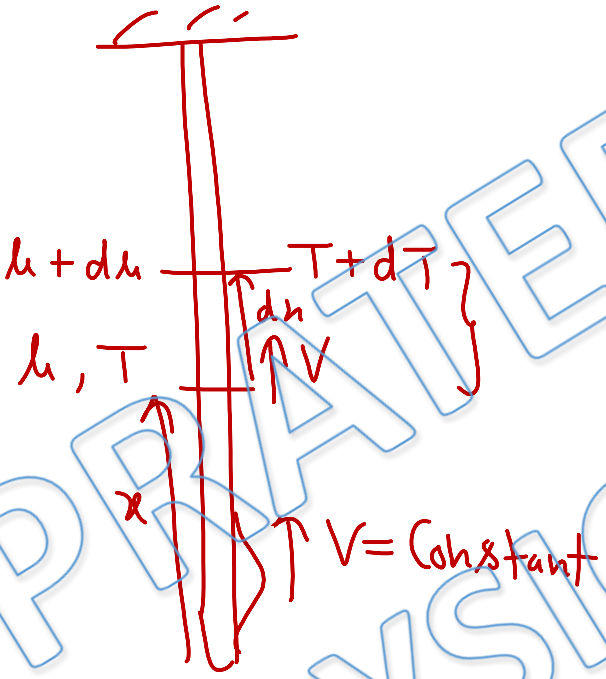
$V = \sqrt{\frac{\mu g_{eff} x^2}{2L \frac{\mu x}{L}}} = \sqrt{\frac{g_{eff}x}{2}}$

$V^2 = \frac{g_{eff}x}{2} \Rightarrow 2V\frac{dV}{dx} = \frac{g_{eff}}{2} \Rightarrow a = \frac{g_{eff}}{4}$



$\rho = \frac{\mu}{L}x$

Q9) A nonuniform rope is hanging vertically. A transverse pulse is produced at its bottom end and it is observed that pulse is moving up with constant velocity. If x is distance from lower end, then linear mass density of rope is directly proportional to



(a) x

(b) x^2

(c) $\sqrt{x}$

(d) None of these

$$V = \sqrt{\frac{T}{\mu}} \Rightarrow T = \mu V^2$$

$$dT = d\mu\, V^2$$

$$dT = \mu\, dx\, g \Rightarrow d\mu\, V^2 = \mu\, dx\, g$$

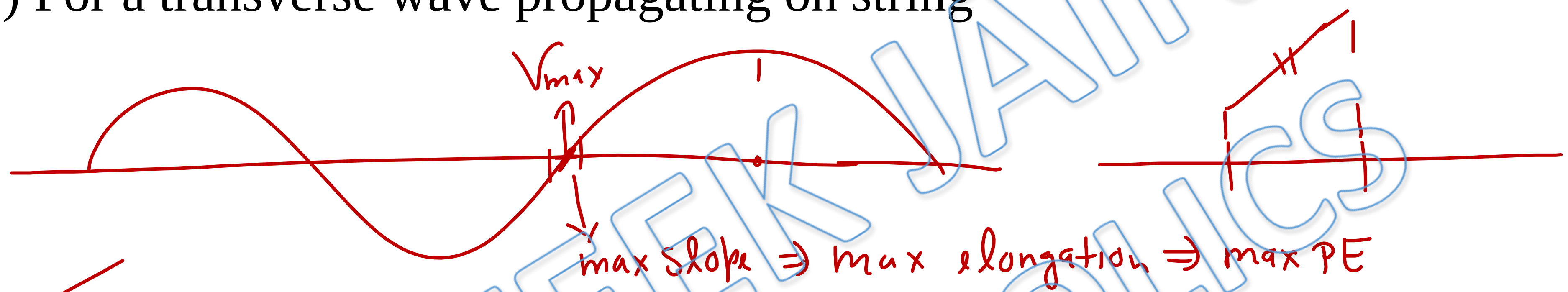
$$\int_{\mu_0}^{\mu} \frac{d\mu}{\mu} = \frac{g}{V^2}\int_0^x dx$$

$$\ln \frac{\mu}{\mu_0} = \frac{gx}{V^2}$$

$$\frac{\mu}{\mu_0} = e^{gx/V^2}$$

$$\mu = \mu_0 e^{gx/V^2}$$

Q10) For a transverse wave propagating on string



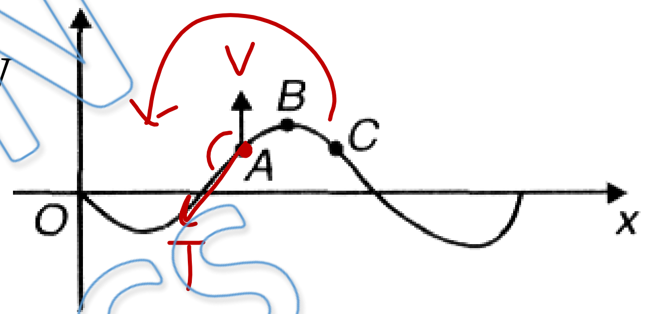
(a) Kinetic energy per unit length is maximum at mean position

(b) Kinetic energy per unit length is maximum at extreme position

(c) Potential energy per unit length is maximum at mean position

(d) Potential energy per unit length is maximum at mean position

Q11) At any instant, wave travelling along a string is show is moving upwards. Which of following statement is true?



Power by left portion on right portion $= \vec{T} \cdot \vec{V} = -ve$

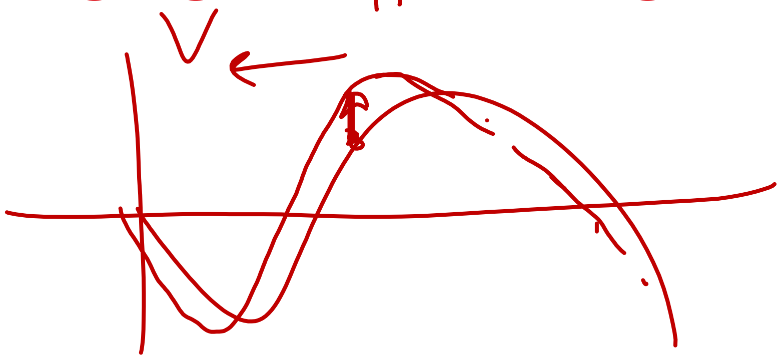
$\Rightarrow$ right portion is transferring power to left portion

(a) At point A power is transferred by string left to a to string right to A

(b) At point A power is transferred by string right to a to string left to A

(c) Power is zero at A

(d) None of these



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Chalo Niklo