Oscillations And Waves JEE Main PYQ - 3

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Oscillations And Waves

1. A sonometer wire of length $114\,cm$ is fixed at both the ends. Where should the two bridges be placed so as to divide the wire into three segments whose fundamental frequencies are in the ratio $1:3:4$? **(+4, -1)**

[Online April 23, 2013]

a. At 36 cm and 84 cm from one end

b. At 24 cm and 72 cm from one end

c. At 48 cm and 96 cm from one end

d. At 72 cm and 96 cm from one end

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2. The total length of a sonometer wire between fixed ends is $110\,cm$. Two bridges are placed to divide the length of wire in ratio $6:3:2$. The tension in the wire is $400\,N$ and the mass per unit length is $0.01\,kg/m$. What is the minimum common frequency with which three parts can vibrate ? **(+4, -1)**

[Online April 19, 2014]

a. 1100 Hz

b. 1000 Hz

c. 166 Hz

d. 100 Hz

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3. What should be the length of a half-wave dipole antenna for a carrier wave having frequency 3×10^{8} Hz? **(+4, -1)**

[12 April 2019 II]

a. (A) 0.5 m

b. (B) 5 m

c. (C) 1 m

d. (D) 0.1 m

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4. A steel wire with mass per unit length $70 \times 10^{-3} kg\, m^{-1}$ is under tension of $70\, N$. The speed of transverse waves in the wire will be: (+4, -1)

[1-Feb-2023 Shift 1]

a. $10\, m/s$

b. $100\, m/s$

c. $200\, \pi m/s$

d. $50\, m/s$

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5. The amplitude of $15 \sin(1000\pi t)$ is modulated by $10 \sin(4\pi t)$ signal The amplitude modulated signal contains frequency (ies) of A $500\, Hz$ B $2\, Hz$ C $250\, Hz$ D $498\, Hz$ E $502\, Hz$ Choose the correct answer from the options given below: (+4, -1)

[12 April 2019 II]

a. B Only

b. A and B Only

c. A, D and E Only

d. A Only

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6. For a solid rod, the Young's modulus of elasticity is $32 \times 10^{11} Nm^{-2}$ and density is $8 \times 10^{3} kgm^{-3}$ The velocity of longitudinal wave in the rod will be (+4, -1)

a. $3.65 \times 10^{3} ms^{-1}$

b. $18.96 \times 10^{3} ms^{-1}$

c. $145.75 \times 10^{3} ms^{-1}$

d. $6.32 \times 10^{3} ms^{-1}$

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7. Given below are two statements : (+4, -1)
Statement I : For transmitting a signal, size of antenna (f) should be comparable to wavelength of signal (at least $l = \frac{\lambda}{4}$ in dimension)
Statement II : In amplitude modulation, amplitude of carrier wave remains

constant (unchanged)
In the light of the above statements, choose the most appropriate answer from the options given below,

a. Statement I is correct but Statement II is incorrect

b. Both Statement I and Statement II are incorrect

c. Both Statement I and Statement II are correct

d. Statement I is incorrect but Statement II is correct

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8. A travelling wave is described by the equation $y(x,t) = [0.05\sin(8x - 4t)]m$ The velocity of the wave is : [all the quantities are in SI unit] **(+4, -1)**

[24-Jan-2023 Shift1]

a. $4\,ms^{-1}$

b. $8\,ms^{-1}$

c. $0.5\,ms^{-1}$

d. $2\,ms^{-1}$

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9. A car is moving with a speed of 15 m/s towards a stationary wall. A person in the car pressed the horn and experienced a change in frequency of 40 Hz due to reflection from the stationary wall. Find the frequency of the horn. (Use v_{sound} = 330 m/s) **(+4, -1)**

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10. The amplitude of a particle executing SHM is $3\,cm$ The displacement at which its kinetic energy will be 25% more than the potential energy is:_______ cm **(+4, -1)**

Answers

1. **Answer: d**

Explanation:

Total length of the wire, $L = 114\,cm$ $n_2 : n_2 : n_3 = 1 : 3 : 4$ Let L_1, L_2 and L_3 be the lengths of the three As $n \propto \frac{1}{L}$ $\therefore L_1 : L_2 : L_3 = \frac{1}{1} : \frac{1}{3} : \frac{1}{4} = 12 : 4 : 3$ $\therefore L_1 = 72\,cm\left(\frac{12}{12+4+3} \times 114\right)$ $L_2 = 24\,cm\left(\frac{4}{19} \times 114\right)$ and $L_3 = 18\,cm\left(\frac{3}{19} \times 114\right)$ Hence the bridges should be placed at $72\,cm$ and $72 + 24 = 96\,cm$ from one end. parts

Concepts:

1. **Waves:**

Waves are a disturbance through which the energy travels from one point to another. Most acquainted are surface waves that tour on the water, but sound, mild, and the movement of subatomic particles all exhibit wavelike properties. inside the most effective waves, the disturbance oscillates periodically (see periodic movement) with a set frequency and wavelength.

Types of Waves:

Transverse Waves -

Waves in which the medium moves at right angles to the direction of the wave.

Examples of transverse waves:

- Water waves (ripples of gravity waves, not sound through water)
- Light waves
- S-wave earthquake waves
- Stringed instruments
- Torsion wave

The high point of a transverse wave is a crest. The low part is a trough.

Longitudinal Wave -

A longitudinal wave has the movement of the particles in the medium in the same dimension as the direction of movement of the wave.

Examples of longitudinal waves:

- Sound waves
- P-type earthquake waves
- Compression wave

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2. **Answer: b**

Explanation:

$\ell_1 : \ell_2 : \ell_3 = 6 : 3 : 2$ so $\ell_1 = 60\,cm\ \ \ell_2 = 30\,cm\ \ \ell_3 = 20\,cm\ \ 60, 30, 20\ \ \frac{\lambda}{2} = 10\,cm\ \ f = \frac{200}{2} = 1000\,Hz$

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3. **Answer: a**

Explanation:

Explanation:
Given:Frequency of the carrier wave = 3×10^{8} HzWe have to find the length of a half-wave dipole antenna.Let be the length of the half-wave dipole antenna. Then = $\frac{}{2}$ = $\frac{}{2}$ Using [=] = $\frac{3\times10^{8}}{2\times3\times10^{8}}$ = 0.5 mHence, the correct option is (A).

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4. **Answer: b**

Explanation:

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{70}{70\times10^{-3}}} = 100m/s$$

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5. **Answer: c**

Explanation:

Carrier wave frequency
$V_C = \frac{100\pi}{2\pi} = 500\ Hz$
Modulating wave frequency
$V_m = \frac{4\pi}{2\pi} = 2\ Hz$
$\therefore V_C - V_m, V_c, V_c + V_m$
$= 498\ Hz, 500\ Hz, 502\ Hz$

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6. **Answer: d**

Explanation:

The velocity of longitudinal wave in the rod will be :

$v = \sqrt{\frac{3.2\times10^{11}}{8\times10^{3}}}$

= $6.32 \times 10^3\ m/s$

The Correct Option is (D) $6.32 \times 10^3\ ms^{-1}$

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7. **Answer: a**

Explanation:

The Correct option is(A): Statement I is correct but Statement II is incorrect.

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8. **Answer: c**

Explanation:

From the given equation $k = 8\,m^{-1}$
and $\omega = 4\,rad/s$ Velocity of wave $= \frac{\omega}{k}$
$v = \frac{4}{8} = 0.5\,m/s$

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9. **Answer: 420 - 420**

Explanation:

$f = f_0(\frac{V+V_c}{V-V_c})$
$f = f_0(\frac{330+15}{330-15})$
$f = f_0\frac{345}{315}$
$f - f_0 = 40$
$f_0(\frac{345-315}{315}) = 40$
$f_0 = \frac{40\times315}{30}$
$f_0 = 420Hz$

So, the answer is $420\ Hz$

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10. **Answer: 2 - 2**

Explanation:

The correct answer is 2.

$KE = PE + \frac{PE}{4}$

$KE = \frac{5}{4}PE$

$\frac{1}{2}m\omega^2\left(A^2 - x^2\right) = \frac{5}{4} \times \frac{1}{2}m\omega^2x^2$

$\left[v = \omega\sqrt{A^2 - x^2}\right]$

$A^2 - x^2 = \frac{5}{4}x^2$

$\frac{9x^2}{4} = A^2$

$x = \frac{2}{3}A$

$\therefore x = \frac{2}{3} \times 3cm$

$x = 2\,cm$

Concepts:

1. **Oscillations:**

Oscillation is a process of repeating variations of any quantity or measure from its equilibrium value in time . Another definition of oscillation is a periodic variation of a matter between two values or about its central value.

The term vibration is used to describe the mechanical oscillations of an object. However, oscillations also occur in dynamic systems or more accurately in every field of science. Even our heartbeats also creates oscillations. Meanwhile, objects that move to and fro from its equilibrium position are known as oscillators.

Read More: Simple Harmonic Motion

Oscillation- Examples

The tides in the sea and the movement of a simple pendulum of the clock are some of the most common examples of oscillations. Some of examples of oscillations are vibrations caused by the guitar strings or the other instruments having strings are also and etc. The movements caused by oscillations are known as oscillating movements. For example, oscillating movements in a sine wave or a spring when it moves up and down.

The maximum distance covered while taking oscillations is known as the amplitude. The time taken to complete one cycle is known as the time period of the oscillation. The number of oscillating cycles completed in one second is referred to as the frequency which is the reciprocal of the time period.