NCEA Level 3 Waves Practice Test (Sample)

Study Guide

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Questions

1. **What do we call the point of maximum negative displacement in a transverse wave?**
   - **A. Crest**
   - **B. Trough**
   - **C. Amplitude**
   - **D. Node**

2. **What occurs at the critical angle in optics?**
   - **A. Light is completely absorbed**
   - **B. Light refracts at a right angle**
   - **C. Total internal reflection happens**
   - **D. Light is completely transmitted**

3. **Which of the following statements is true regarding standing waves?**
   - **A. They can only exist in a vacuum**
   - **B. They have fixed points called nodes and antinodes**
   - **C. They always produce sound**
   - **D. They can be produced without any medium**

4. **What is the phenomenon called when oscillation occurs at the same frequency as a system's natural frequency?**
   - **A. Interference**
   - **B. Resonance**
   - **C. Damping**
   - **D. Coupling**

5. **What is an exact multiple of the fundamental frequency of an oscillation called?**
   - **A. Wave frequency**
   - **B. Harmonic**
   - **C. Resonance**
   - **D. Fundamental**

6. What describes a situation where two waves combine completely and cancel each other out?

A. Constructive interference

B. Destructive interference

C. Standing wave condition

D. Resonant frequency

7. If a wave's speed is 340 m/s and its wavelength is 0.85 m, what is its frequency?

A. 255 Hz

B. 400 Hz

C. 425 Hz

D. 300 Hz

8. What is produced when two opposing waves interact in such a way that they cancel each other out?

A. Resonance

B. Destructive interference

C. Constructive interference

D. Stationary wave

9. What describes sound waves with frequencies lower than 20 Hz?

A. Sonorous

B. Infrasonic

C. Ultrasonic

D. Audible

10. What application does the Pythagorean theorem have in wave theory?

A. It calculates wave speed only

B. It is used for calculating wave frequency

C. It is applied to calculate resultant wave displacement in two-dimensional interactions

D. It is used for measuring sound intensity

Answers

1. B
2. C
3. B
4. B
5. B
6. B
7. B
8. B
9. B
10. C

Explanations

1. What do we call the point of maximum negative displacement in a transverse wave?

A. Crest

B. Trough

C. Amplitude

D. Node

In a transverse wave, the point of maximum negative displacement is referred to as a trough. This terminology arises from the way waves are visualized: the crest represents the highest point of the wave, while the trough is the lowest point. Displacement in this context measures how far a point on the wave is from its equilibrium position; negative displacement indicates a position below this equilibrium, which is exactly where the trough is found. Understanding this concept is essential, particularly in recognizing the characteristics of wave behavior, including wave amplitude and frequency. Amplitude describes the maximum displacement from the equilibrium position, encompassing both crests and troughs, but it does not specifically define the maximum negative displacement. Nodes are points where there is no displacement at all in standing waves and are unrelated to the concepts of crests and troughs in this context. Hence, identifying the trough as the point of maximum negative displacement is key in analyzing wave patterns effectively.

2. What occurs at the critical angle in optics?

A. Light is completely absorbed

B. Light refracts at a right angle

C. Total internal reflection happens

D. Light is completely transmitted

At the critical angle in optics, total internal reflection occurs. This phenomenon happens when light attempts to pass from a denser medium to a less dense medium and hits the interface at an angle greater than the critical angle. At this specific angle, all of the light is reflected back into the denser medium instead of being refracted into the less dense medium. The critical angle is determined by the refractive indices of the two media involved. When the angle of incidence equals this critical angle, the refracted ray travels along the boundary between the two media, and any increase in the angle of incidence will result in no refraction occurring at all, leading to total internal reflection. This principle is essential in various optical applications, such as fiber optics and prisms, where retaining light within the medium is crucial. Other potential scenarios such as complete absorption, light refracting at a right angle, or entirely transmitting light do not accurately describe what happens at the critical angle. Instead, it is the unique condition of total internal reflection that is observed.

3. Which of the following statements is true regarding standing waves?

A. They can only exist in a vacuum

B. They have fixed points called nodes and antinodes

C. They always produce sound

D. They can be produced without any medium

Standing waves are characterized by their formation of fixed points known as nodes and antinodes, making the statement that they have these features true. Nodes are points along the medium where there is minimal or no displacement of particles, while antinodes are points where maximum displacement occurs. This structure arises due to the interference of two waves traveling in opposite directions, typically in a medium. The other statements do not accurately describe standing waves. For instance, standing waves can exist in various media—such as strings, air columns, or water—rather than being restricted to a vacuum. They are also not exclusively linked to sound; they can involve other types of waves, including electromagnetic and mechanical waves. Lastly, standing waves require a medium for their formation, as they rely on the waves interacting within that medium to create the nodes and antinodes. Thus, the key characteristic of having nodes and antinodes solidifies the truth of the correct statement regarding standing waves.

4. What is the phenomenon called when oscillation occurs at the same frequency as a system's natural frequency?

A. Interference

B. Resonance

C. Damping

D. Coupling

Resonance is the phenomenon that occurs when a system oscillates at its natural frequency in response to an external force that is applied at the same frequency. Every system that can oscillate has a natural frequency or frequencies determined by its physical properties such as mass and stiffness. When the frequency of the external driving force matches this natural frequency, the amplitude of the oscillations can increase significantly, leading to large and potentially destructive motions. This effect can be observed in various contexts, such as in musical instruments, bridges, and even in the design of buildings to withstand earthquakes. The energized oscillations create a state where the system is in sync with the frequency of the external influence, resulting in a dramatic increase in energy within the system. Resonance is a critical concept not only in physics but also in engineering and a variety of applications where oscillatory systems are present.

5. What is an exact multiple of the fundamental frequency of an oscillation called?

A. Wave frequency

B. Harmonic

C. Resonance

D. Fundamental

The term that describes an exact multiple of the fundamental frequency of an oscillation is known as a harmonic. In the context of waves and oscillatory systems, the fundamental frequency is the lowest frequency at which a system vibrates. Harmonics are higher frequencies that occur at integer multiples of this fundamental frequency. For example, if the fundamental frequency is \(f\), then the first harmonic would be \(2f\), the second harmonic \(3f\), and so on. Harmonics play a crucial role in music and acoustics, as they determine the timbre or quality of a sound produced by musical instruments. Each harmonic contributes to the overall sound by adding complexity to the fundamental tone. Understanding harmonics is essential in various fields, including music theory, physics, and engineering, as they help explain phenomena such as resonance and sound wave propagation.

6. What describes a situation where two waves combine completely and cancel each other out?

A. Constructive interference

B. Destructive interference

C. Standing wave condition

D. Resonant frequency

In the context of wave behavior, when two waves meet and their effects completely cancel each other, this is referred to as destructive interference. This phenomenon occurs when the crests of one wave align with the troughs of another wave. When these opposing phases meet, they effectively negate each other, leading to a situation where the net amplitude of the resulting wave is zero. In essence, the two waves are completely out of phase. Destructive interference is a significant concept in understanding wave interactions, including applications in various fields such as acoustics, optics, and even engineering. It explains why certain sounds can be silenced in specific environments or how certain materials can be designed to minimize unwanted vibrations. Each of the other terms represents different wave behaviors that do not relate to this cancellation effect: constructive interference enhances the amplitude, standing waves are a result of interference under specific conditions, and resonant frequency refers to the natural frequency at which a system tends to oscillate with maximum amplitude.

7. If a wave's speed is 340 m/s and its wavelength is 0.85 m, what is its frequency?

A. 255 Hz

B. 400 Hz

C. 425 Hz

D. 300 Hz

To determine the frequency of a wave when you know its speed and wavelength, you can use the wave equation, which is: frequency = wave speed / wavelength. In this case, the wave speed is given as 340 m/s and the wavelength is 0.85 m. Plugging these values into the equation gives: frequency = 340 m/s / 0.85 m = 400 Hz. This result indicates that the frequency of the wave is 400 Hz. It makes sense as the frequency represents how many cycles of the wave occur per second, and a speed of 340 m/s with a wavelength of 0.85 m results in that specific frequency.

8. What is produced when two opposing waves interact in such a way that they cancel each other out?

A. Resonance

B. Destructive interference

C. Constructive interference

D. Stationary wave

When two opposing waves interact in such a way that they cancel each other out, this phenomenon is known as destructive interference. In this scenario, the peaks of one wave align with the troughs of another wave, leading to a reduction in the overall amplitude of the resultant wave. When the waves are perfectly out of phase, they can completely cancel each other, resulting in no wave at all at certain points. This occurs in various contexts, such as sound waves and water waves. On the other hand, resonance refers to the phenomenon where an object vibrates with increasing amplitude at its natural frequency due to external periodic forces. Constructive interference happens when waves are in phase, resulting in an increase in amplitude. A stationary wave is a pattern formed by the interference of two waves traveling in opposite directions, but it does not specifically imply cancellation. Destructive interference distinctly embodies the idea of cancellation between waves.

9. What describes sound waves with frequencies lower than 20 Hz?

A. Sonorous

B. Infrasonic

C. Ultrasonic

D. Audible

Sound waves with frequencies lower than 20 Hz are classified as infrasonic. This range of sound is below the threshold of human hearing, which typically starts at about 20 Hz and extends to around 20 kHz. Infrasonic waves are often associated with natural phenomena, such as earthquakes and volcanic eruptions, as well as some man-made sources, like heavy machinery. Understanding this classification helps in distinguishing the types of sound waves based on their frequencies. For instance, sonorous typically refers to sounds that are deep and resonant but does not specifically denote their frequency. Ultrasonic refers to sounds above 20 kHz, and audible sounds are those within the range of human hearing. Thus, the designation of a wave as infrasonic specifically highlights its frequency range being below the human auditory threshold.

10. What application does the Pythagorean theorem have in wave theory?

A. It calculates wave speed only

B. It is used for calculating wave frequency

C. It is applied to calculate resultant wave displacement in two-dimensional interactions

D. It is used for measuring sound intensity

The Pythagorean theorem is indeed useful in wave theory, particularly in the context of calculating resultant wave displacement during two-dimensional interactions. When waves interact, such as in the case of superposition, their individual displacements can be represented as vectors. In a two-dimensional plane, these vectors can be visualized as forming a right triangle, where the individual wave displacements are the legs of the triangle, and the resultant displacement is the hypotenuse. By applying the Pythagorean theorem, you can find the magnitude of the resultant wave displacement by taking the square root of the sum of the squares of the individual displacements. This is crucial in understanding phenomena such as interference patterns, where multiple waves combine to form a new wave pattern with its own amplitude and direction. This understanding of wave interactions through geometry is essential for analyzing complex wave behavior in various physical contexts, such as sound waves, water waves, and electromagnetic waves. Other choices focus on specific aspects of wave properties, such as speed, frequency, and intensity, which are important concepts in wave theory but do not utilize the geometric relationship provided by the Pythagorean theorem in the same way that calculating resultant displacement does.