

A Wave Emitted From A Source Has A Frequency Of 10.8 Hz And Wavelength 1.1 How Much Time Will It Take

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Introduction

Understanding wave properties such as frequency, wavelength, and the time it takes for a wave to travel a certain distance is fundamental in physics. These concepts are crucial for various applications, from telecommunications to acoustics, and even in understanding natural phenomena like seismic waves. In this article, we explore a specific scenario where a wave is emitted from a source with a given frequency and wavelength, and our goal is to determine the time it takes for the wave to propagate or complete a certain cycle.

By analyzing the wave's frequency of 10.8 Hz and wavelength of 1.1 meters, we will delve into the core principles of wave mechanics, including wave speed, period, and the relationship between these quantities. Whether you're a student studying physics, an educator preparing lesson content, or simply curious about how waves behave, this comprehensive guide will clarify these concepts with detailed calculations and explanations.

Understanding Wave Properties

What Is a Wave?

A wave is a disturbance that travels through a medium, transferring energy from one point to another without the transfer of matter. Waves can be classified into various types such as mechanical waves (sound waves, water waves) and electromagnetic waves (light, radio waves). The wave properties we focus on—frequency, wavelength, and wave speed—are fundamental to understanding wave behavior.

Key Wave Parameters

- Frequency (f): The number of wave cycles that pass a point per second, measured in Hertz (Hz).
- Wavelength (λ): The distance between successive crests or troughs of a wave, measured in meters (m).
- Wave Speed (v): The rate at which the wave propagates through the medium, measured in meters per second (m/s).
- Period (T): The time taken for one complete wave cycle, measured in seconds (s).

Relationship Between Wave Parameters

The fundamental relationship connecting these parameters is:

$$v = f \times \lambda$$

This equation indicates that the wave speed is the product of its frequency and wavelength. Additionally, the period is inversely related to the frequency:

$$T = \frac{1}{f}$$

Understanding these relationships allows us to compute any unknown wave property when the others are known.

Calculating Wave Speed

Given the wave's frequency and wavelength, the first step is to determine its speed.

Data Provided

- Frequency (f): 10.8 Hz
- Wavelength (λ): 1.1 meters

Calculation

Using the wave speed formula:

$$v = f \times \lambda$$

Substitute the known values:

$$v = 10.8 \, \text{Hz} \times 1.1 \, \text{m}$$

$$v = 11.88 \, \text{m/s}$$

Result: The wave propagates at approximately 11.88 meters per second.

Determining the Period of the Wave

The period represents how long it takes for one complete cycle of the wave to pass a fixed point.

Calculation

Using the relationship:

$$T = \frac{1}{f}$$

Substituting the given frequency:

$$T = \frac{1}{10.8 \text{ Hz}}$$

$$T \approx 0.0926 \text{ seconds}$$

Result: The period of the wave is approximately 0.0926 seconds.

How Much Time Will It Take for the Wave to Travel a Certain Distance?

Understanding the wave's propagation time over a specific distance involves calculating the travel duration based on wave speed.

General Formula

$$\text{Time } (t) = \frac{\text{Distance } (d)}{\text{Wave speed } (v)}$$

Example: Calculating Time for a Wave to Travel 10 Meters

Suppose we want to know how long it takes for the wave to travel 10 meters.

$$t = \frac{d}{v} = \frac{10 \text{ m}}{11.88 \text{ m/s}} \approx 0.842 \text{ seconds}$$

Interpretation: It will take approximately 0.842 seconds for the wave to cover 10 meters.

Multiple Scenarios for Different Distances

Distance (meters)	Travel Time (seconds)	Calculation
5	0.421	5 / 11.88
20	1.68	20 / 11.88
50	4.21	50 / 11.88

This straightforward calculation helps in designing systems where timing of wave propagation is critical, such as in sonar, radar, or communication systems.

Determining the Time for a Complete Wave Cycle

Another important aspect is understanding how long it takes for an entire wave cycle to pass a fixed point, which is simply the period.

Application

If a wave is emitted with a period of approximately 0.0926 seconds, then:

- Every 0.0926 seconds, a new cycle begins.
- The wave's oscillations repeat every 0.0926 seconds.

This information is vital when analyzing wave interactions, interference, or signal timing in various applications.

Practical Applications of Wave Time Calculations

Understanding how to compute wave travel time has numerous practical applications:

1. Communication Systems

- Radio waves: Knowing how long signals take to reach a receiver aids in designing efficient communication networks.
- Optical fibers: Calculating signal delay helps optimize data transmission.

2. Acoustics and Sound Engineering

- Sound propagation: Timing of sound waves over distances influences concert hall designs and noise control.

3. Seismology

- Earthquake waves: Estimating wave travel times allows scientists to pinpoint earthquake epicenters.

4. Medical Imaging

- Ultrasound: Precise timing helps produce accurate images of internal organs.

5. Scientific Research

- Wave experiments: Timing of wave propagation is essential in laboratory physics studies.

Summary of Key Calculations

Parameter	Value	Explanation
Wave speed (v)	11.88 m/s	Calculated from frequency and wavelength
Wave period (T)	0.0926 seconds	Inverse of the frequency
Time to travel 10 meters	0.842 seconds	Distance divided by wave speed

Conclusion

In this comprehensive analysis, we've determined the fundamental properties of a wave emitted from a source with a frequency of 10.8 Hz and a wavelength of 1.1 meters. The wave travels at approximately 11.88 meters per second, with a period of about 0.0926 seconds.

Understanding how to calculate the time it takes for a wave to travel a specific distance or complete a cycle is essential in many scientific and engineering disciplines. Whether designing communication systems, analyzing seismic activity, or exploring acoustic phenomena, these calculations form the backbone of wave physics.

By mastering these concepts, students and professionals can better interpret wave behavior, optimize technological applications, and deepen their comprehension of the physical universe.

Frequently Asked Questions (FAQs)

1. Why is the wave speed important?

Wave speed determines how quickly a wave propagates through a medium, affecting signal transmission, energy transfer, and wave interactions.

2. Can the wave speed change?

Yes, wave speed depends on the properties of the medium. For mechanical waves, changes in the medium's density or elasticity can alter wave speed.

3. How does frequency affect the wave's behavior?

Higher frequency waves have shorter periods and can carry more information in communication systems but may have shorter travel distances in certain media.

4. What real-world devices use these wave principles?

Radios, microphones, ultrasound machines, seismic sensors, and fiber-optic communication systems all rely on wave properties and timing calculations.

References

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By understanding the relationship between frequency, wavelength, and wave travel time, you can analyze and predict wave behavior accurately in various scientific and engineering contexts.

Frequently Asked Questions

What is the given frequency and wavelength of the wave emitted from the source?

The wave has a frequency of 10.8 Hz and a wavelength of 1.1 meters.

How is the wave's velocity calculated using frequency and wavelength?

The wave's velocity is calculated by multiplying the frequency by the wavelength: $v = f \times \lambda$.

What is the formula to find the time taken for one wave cycle?

Time for one cycle (period T) is given by $T = 1/f$.

What is the period of the wave with a frequency of 10.8 Hz?

The period $T = 1/10.8 \approx 0.0926$ seconds.

If the wave's wavelength is 1.1 meters, what is the wave's velocity?

$V = f \times \lambda = 10.8 \text{ Hz} \times 1.1 \text{ m} = 11.88$ meters per second.

How long does it take for the wave to travel a certain distance?

The travel time for a specific distance D is $T = D / v$, where v is the wave velocity.

What additional information is needed to find the time for a wave to cover a certain distance?

You need to know the distance the wave travels to calculate the time using $T = D / v$.

Additional Resources

A wave emitted from a source has a frequency of 10.8 Hz and wavelength of 1.1 meters. How much time will it take? This question touches on fundamental principles of wave physics, specifically the relationship between frequency, wavelength, and wave speed. Understanding these concepts is essential not only for academic pursuits but also for practical applications in fields such as telecommunications, acoustics, and physics research. In this comprehensive guide, we will explore the core concepts, walk through the calculations step-by-step, and analyze the significance of the results.

Understanding the Basics: Waves, Frequency, Wavelength, and Speed

Before delving into the calculations, it's important to clarify some foundational concepts:

What is a Wave?

A wave is a disturbance that transfers energy from one point to another without the transfer of matter. Waves can be mechanical (requiring a medium) like sound waves or electromagnetic (do not require a medium) like light waves.

Key Properties of Waves

- Frequency (f): The number of wave cycles that pass a point per second, measured in Hertz (Hz).
- Wavelength (λ): The distance between successive crests or troughs, measured in meters.
- Wave Speed (v): The rate at which the wave propagates through the medium, typically in meters per second (m/s).

The Relationship Between Wave Properties

The fundamental relationship connecting these properties is:

$$v = f \times \lambda$$

Where:

- v is the wave speed (m/s)
- f is the frequency (Hz)
- λ is the wavelength (m)

This equation allows us to determine any one property if the other two are known.

Step-by-Step Calculation of Wave Speed

Given:

- Frequency (f) = 10.8 Hz
- Wavelength (λ) = 1.1 meters

Step 1: Applying the Wave Equation

Using the basic wave relationship:

$$v = f \times \lambda$$

Substituting the given values:

$$v = 10.8 \text{ Hz} \times 1.1 \text{ m}$$

$$v = 11.88 \text{ m/s}$$

Therefore, the wave propagates at approximately 11.88 meters per second.

How Long Does It Take for a Wave to Travel a Certain Distance?

The original question asks: How much time will it take? To fully answer this, we need to define the distance the wave travels. Since the problem does not specify a particular distance, we can analyze the general case or choose a specific example.

General formula for time:

$$t = d / v$$

Where:

- t is the time (seconds)
- d is the distance traveled (meters)
- v is the wave speed (meters per second)

Determining the Time for One Wave Cycle

Step 1: Calculate the period (T)

The period is the time it takes for one complete cycle of the wave, which is the reciprocal of the frequency:

$$T = 1 / f$$

Substituting the given frequency:

$$T = 1 / 10.8 \text{ Hz} \approx 0.0926 \text{ seconds}$$

This means each wave cycle lasts approximately 0.0926 seconds.

Step 2: Time for a wave to travel one wavelength

The time it takes for the wave to cover one wavelength (λ) is:

$$t_{\lambda} = \lambda / v$$

Substituting the known values:

$$t_{\lambda} = 1.1 \text{ m} / 11.88 \text{ m/s} \approx 0.0926 \text{ seconds}$$

Notice that this matches the period T , confirming that one cycle of the wave corresponds to traveling one wavelength in this case.

Practical Example: How Long to Cover a Specific Distance

Suppose you want to know how long it takes for the wave to travel 20 meters:

$$t = d / v = 20 \text{ m} / 11.88 \text{ m/s} \approx 1.68 \text{ seconds}$$

This means that a wave emitted from the source will take approximately 1.68 seconds to cover 20 meters.

Additional Insights and Applications

Understanding these calculations has practical implications:

1. Signal Propagation in Communications

In fiber optics or radio waves, knowing the wave's speed helps in designing systems with minimal latency.

2. Acoustic Engineering

Sound waves in air travel at approximately 343 m/s at room temperature. Comparing this to the calculated wave speed can help in understanding sound propagation and designing auditoriums or noise-canceling devices.

3. Scientific Research

Wave properties are fundamental in spectroscopy, quantum physics, and wave mechanics, where precise timing and wave behavior influence experimental outcomes.

Summary of Key Points

- The wave's speed (v) can be calculated using $v = f \times \lambda$.
- Given $f = 10.8 \text{ Hz}$ and $\lambda = 1.1 \text{ m}$, the wave speed is approximately 11.88 m/s.
- The period (T) of the wave is approximately 0.0926 seconds, indicating the time for one cycle.
- The time to travel a specific distance can be found with $t = d / v$.

Final Thoughts

Understanding how to determine the time it takes for a wave to travel a certain distance based on its frequency and wavelength is a fundamental skill in physics. It bridges theoretical concepts with real-world applications, from designing communication systems to analyzing natural phenomena. Always remember to verify your wave properties, ensure units are consistent, and interpret results within the context of the physical medium involved.

If you encounter more complex scenarios—such as waves traveling through different media or involving damping and dispersion—additional factors may need to be considered. For most basic wave analysis, however, the relationships covered here provide a solid foundation for understanding wave behavior and timing.

In conclusion, with a wave frequency of 10.8 Hz and wavelength of 1.1 meters, the wave propagates at approximately 11.88 meters per second. The time it takes for the wave to travel a specified distance depends on that distance and the wave's speed, allowing precise timing calculations essential in various scientific and engineering contexts.

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