Frequency and Velocity of Waves

Answer the following questions:

1. State what is transferred by waves.
   Energy is transferred by waves.

2. State the definition of a longitudinal wave.
   A longitudinal wave is a wave where the oscillati[on] [...] **to the direction of energy transfer**

3. What is frequency?
   The number of waves that pass a point each seco[nd,] unit is Hertz (Hz)

4. Arianna Grande can sing to a high pitch and have a loud volume. Describe what the sound waves would look like.
   The sound wave would have a high amplitude and a high frequency

5. Calculate the frequency is 20 waves pass a point in 5 seconds
   20/5 = 4Hz

Stretch: State the equation for velocity (hint - similar to speed)

Reminder!
Whiteboard on desk

Do Now
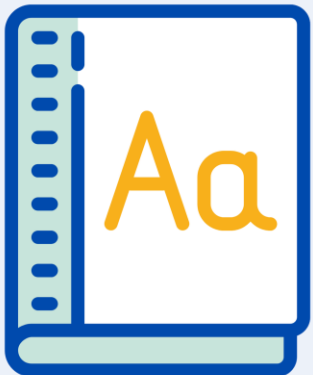
Frequency and Velocity of Waves

P3.3.4

Science
Mastery

Following this lesson, students will be able to:

- Calculate the frequency and time of a wave.

- State the equations that can be used to calculate velocity of a wave

- Calculate the velocity of different waves

Key Words:

velocity

frequency

wavelength

displacement

time period

Calculating Frequency

Sometimes you will not be told how many waves pass a point; therefore, we use this equation to calculate the frequency

$$Frequency = \frac{1}{Time\ Period}$$

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

I DO: What is the frequency if it takes two seconds for a wave to pass a point?

Time Period = 2 seconds

$$Frequency = \frac{1}{Time\ Period}$$

$$Frequency = \frac{1}{2}$$

Frequency = 0.5 Hz

Calculating Frequency

MWB: What is the frequency if it takes 8 seconds for a wave to pass a point?

Time Period = 8 seconds

$$Frequency = \frac{1}{Time\ Period}$$

$$Frequency = \frac{1}{8}$$

Frequency = 0.125 Hz

MWB: What is the frequency if it takes 30 milliseconds for a wave to pass a point?

Time Period = 30 milliseconds
Time period = 0.03 seconds

$$Frequency = \frac{1}{Time\ Period}$$

$$Frequency = \frac{1}{0.03}$$

Frequency = 3.33 Hz

Independent practice

Silent solo

5 minutes

Calculating frequency

1. A wave has a time period of 0.25 seconds

What is its frequency?

2. The time period of a sound wave is 0.005 seconds

Calculate the frequency of the wave.

3. If a wave completes one cycle in 2 milliseconds

What is its frequency in hertz (Hz)?

4. A wave takes 0.1 seconds to complete one oscillation.

Find the frequency of the wave.

Calculating time-period

1] A wave has a frequency of 40 Hz, what is the time period?

2] A wave has a frequency of 2Hz, what is the time period?

Answers

Calculating frequency

1. A wave has a time period of 0.25 seconds

   What is its frequency? $Frequency = \dfrac{1}{0.25}$

   Frequency = 4 Hz

2. The time period of a sound wave is 0.005 seconds

   Calculate the frequency of the wave. $Frequency = \dfrac{1}{0.005}$

   Frequency = 200 Hz

3. If a wave completes one cycle in 2 milliseconds

   What is its frequency in hertz (Hz)? $Frequency = \dfrac{1}{0.002}$

   Time Period = 2 milliseconds
   Time period = 0.002 seconds

   Frequency = 500 Hz

4. A wave takes 0.1 seconds to complete one oscillation.

   Find the frequency of the wave. $Frequency = \dfrac{1}{0.1}$

   Frequency = 10 Hz

Answers

<u>Calculating time-period</u>

1) A wave has a frequency of 40 Hz, what is the <u>time period</u>?

$$40Hz = \frac{1}{Time\ period} \quad 40\ Hz \times time\ period = 1 \quad Time\ period = \frac{1}{40\ Hz}$$

$$0.0025\ seconds$$

2) A wave has a frequency of 2Hz, what is the <u>time period</u>?

$$2Hz = \frac{1}{Time\ period} \quad 2\ Hz \times time\ period = 1 \quad Time\ period = \frac{1}{2\ Hz}$$

$$0.5\ seconds$$

3) A wave has a frequency of 67 Hz, what is the <u>time period</u>?

$$67Hz = \frac{1}{Time\ period} \quad 67\ Hz \times time\ period = 1 \quad Time\ period = \frac{1}{67\ Hz}$$

$$0.015\ seconds$$

4) A wave has a frequency of 4.5Hz, what is the <u>time period</u>?

$$4.5Hz = \frac{1}{Time\ period} \quad 4.5\ Hz \times time\ period = 1 \quad Time\ period = \frac{1}{4.5\ Hz}$$

$$0.22\ seconds$$

Calculating the velocity of a wave

Velocity is the speed of a wave in the direction it is travelling

Velocity of the wave (m/s) = <u>displacement (m)</u>
time (s)

Velocity of the wave (m/s) = frequency (Hz) x wavelength (m)

$$v = \frac{d}{t}$$

$$v = f \times \lambda$$

Calculating velocity of a wave

A wave has <u>wavelength of 2 metres</u> and a <u>frequency of 1400 Hz</u>.

Calculate the velocity of the wave.

Velocity = ?   Wavelength = 2 m   Frequency = 1400 Hz

$$v = f \times \lambda$$

$$v = 1400 \times 2$$

Velocity = 2800 m/s

V: Values

E: Equation

S: Substitution

C: Calculation

U: Units

Calculating velocity of a wave

A wave has <u>wavelength of 8 metres</u> and a <u>frequency of 200 Hz.</u>

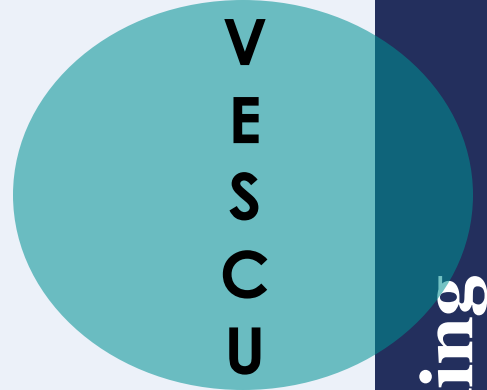Calculate the velocity of the wave.

Velocity = ?   Wavelength = 8 m   Frequency = 200 Hz

$$v = f \times \lambda$$

$$v = 200 \times 8$$

Velocity = 1600 m/s

V: Values

E: Equation

S: Substitution

C: Calculation

U: Units

Calculating velocity of a wave

A wave has <u>wavelength of 0.75 meter</u>s and<u> a frequenc</u>y of <u>8000 Hz</u>.

Calculate the velocity of the wave.

Velocity = ?   Wavelength = 0.75 m   Frequency = 8000 Hz

$$v = f \times \lambda$$

$$v = 0.75 \times 8000$$

Velocity = 6000 m/s

V: Values

E: Equation

S: Substitution

C: Calculation

U: Units

Check for understanding

Identify the incorrect steps in this calculation
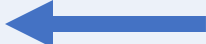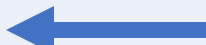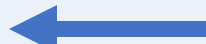
A wave has a frequency of 2.5 Hz and a wavelength of 0.02 km. Calculate the wave speed.

$v = f \times \lambda$
$v = 2.5 \times 0.02$
$v = 0.05$ Hz

Choose the correct answer

1. What is the equation that links velocity, displacement and time?
    A. Velocity of wave = displacement x time
    B. Velocity of wave = displacement/time ⬅
    C. Velocity of wave = time/displacement

2. What is the equation that links velocity, frequency and wavelength?
    A. Velocity of wave = frequency x wavelength ⬅
    B. Velocity of wave = frequency/wavelength
    C. Velocity of wave = wavelength/ frequency

3. What is the equation that links time period and frequency?
    A. Time period = frequency^2
    B. Time period = 1 x frequency
    C. Time period = 1/frequency ⬅

Complete the worksheet

V: Values

E: Equation

S: Substitution

C: Calculation

U: Units

Answer the questions in your book, showing your workings

Calculating Velocity of Waves

Use this equation to help the questions below:

Velocity of the wave (m/s) = $\dfrac{displacement\ (m)}{time\ (s)}$

1. A woman claps. It takes 0.02 s for her friend to hear the clap. Her friend is standing 7 m away. What is the speed of sound?

2. A dolphin makes a clicking noise. His dolphin friend is 60 m away and hears the noise 0.04 s later. What is the speed of sound in water?

3. A duck quacks and 1.2 seconds later an echo comes back. How far from the wall is the duck? The speed of sound in air is 340 m/s.

4. A dog barks near a wall. 0.7 seconds later she hears an echo. How far away from the wall is the dog?

5. A woman claps near a wall. She is standing 15 m away from the wall. How long will it be before she hears an echo? The speed of sound is 340 m/s

6. An iceberg is 3,000 metres from a submarine. The submarine emits ultrasound. How long until the submarine detects the iceberg?

Use this equation to answer the questions below:

Calculate velocity of wave: Velocity of the wave (m/s) = frequency (Hz) x wavelength (m)

7. Calculate the speed of a sound wave in steel with a frequency of 500 Hz and a wavelength of 3.0 metres.

Answers

1. A woman claps. It takes 0.02 s for her friend to hear the clap. Her friend is standing 7 m away. What is the speed of sound?

s = ?

d = 7 m

t = 0.02 s

s = d/t

s = 7/0.02

s = 350 m/s

2. A dolphin makes a clicking noise. His dolphin friend is 60 m away and hears the noise 0.04 s later. What is the speed of sound in water?

s = ?

d = 60 m

t = 0.04 s

s = d/t

s = 60/0.04

s = 1500 m/s

Answers

3. A duck quacks and 1.2 seconds later an echo comes back. How far from the wall is the duck?   The speed of sound in air is 340 m/s.

d = ?

t = 1.2 s

s = 340 m/s

s = d/t

340 = d/1.2

d = 340 x 1.2s

d = 408 m

408/2 = 204 m

4. A dog barks near a wall. 0.7 seconds later she hears an echo. How far away from the wall is the dog? The speed of sound in air is 340 m/s.

d = ?

t = 0.7s

s = 340 m/s

s = d/t

340 = d/0.7

d = 340 x 0.7s

d = 238 m

238/2 = 119 m

Answers

5. A woman claps near a wall. She is standing 15 m away from the wall. How long will it be before she hears an echo? The speed of sound is 340 m/s

t = ?

d = 15 x 2 = 30 m

s = 340 m/s

s = d/t

340 = 15/t

t = 15/340

t = 0.09 s

6. An iceberg is 3,000 metres from a submarine. The submarine emits ultrasound. How long until the submarine detects the iceberg? The speed of ultrasound in water is 1500 m/s

t = ?

d = 3000 x 2 = 6000 m

s = 1500 m/s

s = d/t

1500 = 6000/t

t = 6000/1500

t = 4 s

Activity

Answers

7. Calculate the speed of a sound wave in steel with a frequency of 500 Hz and a wavelength of 3.0 metres.

v = ?

f = 500 Hz

λ = 3 m

v = f λ

v = 500 x 3

v = 1500 m/s

8. Calculate the speed of a ripple on a pond with a frequency of 2 Hz and a wavelength of 0.4 metres.

v = ?

f = 2 Hz

λ = 0.4 m

v = f λ

v = 2 x 0.4

v = 0.8 m/s

Activity

Answers

9. Calculate the wavelength of a wave on a slinky spring with a frequency of 2 Hz travelling at 3 m/s.

λ = ?
v = 3 m/s
f = 2 Hz
v = f
3 = 2 x λ
$λ=\frac{3}{2}$
λ = 1.5 m

10. Calculate the wavelength of an ultrasound wave with a frequency 40,000 Hz travelling at 1450 m/s in fatty tissue.

λ = ?
v = 1450 m/s
f = 40000 Hz
v = f λ
1450 = 40000 x λ
$λ=\frac{1450}{4000}$
λ = 0.4 m

Answers

11. Calculate the frequency of a sound wave of wavelength 10 metres travelling at 340 metres per second in air.

f = ?

v = 340 m/s

λ = 10 m

v = f λ

340 = f x 10

$f = \frac{340}{10}$

f = 34 Hz

12. Calculate the frequency of a transverse wave with a wavelength of 0.02 m travelling at 300000000 m/s

f = ?

v = 300000000 m/s

λ = 0.01 m

v = f λ

300000000 = f x 0.02

$f = \frac{300000000}{0.01}$

f = 15000000000 Hz

Answers

13. If the period of a wave is 2.5 s, what is the frequency?

T = 2.5 s

f = 1/T

f = 1/ 2.5

f = 0.4 Hz

14. If the frequency of a wave is 34 Hz, what is the period?

f = 34 Hz
T = 1/f
T = 1/ 34
T = 0.03 s

Activity

Answer the questions below.

1. What is the equation that links velocity of wave, frequency and wavelength?
❑ A. velocity = frequency/wavelength
❑ B. velocity = wavelength/frequency
☑ C. velocity = frequency x wavelength

2. What is the velocity of a wave with a frequency of 400 Hz and a wavelength of 0.2 m?
❑ A. 0.0005 m/s
❑ B. 2000 m/s
☑ C. 80 m/s

3. What is the frequency of a wave with velocity of 10 m/s and wavelength 0.1 m?
☑ A. 100 Hz
❑ B. 1 Hz
❑ C. 0.01 Hz