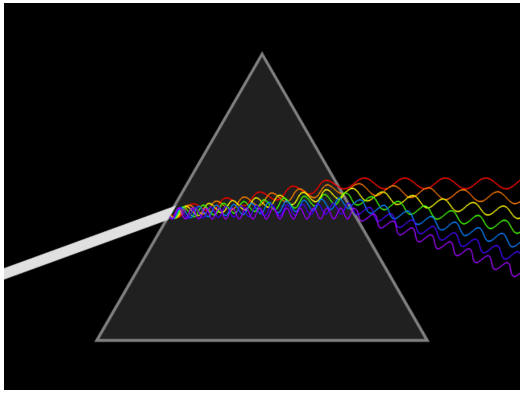
Properties of Traveling Waves

IB PHYSICS | WAVES - SOUND

What is a Wave?



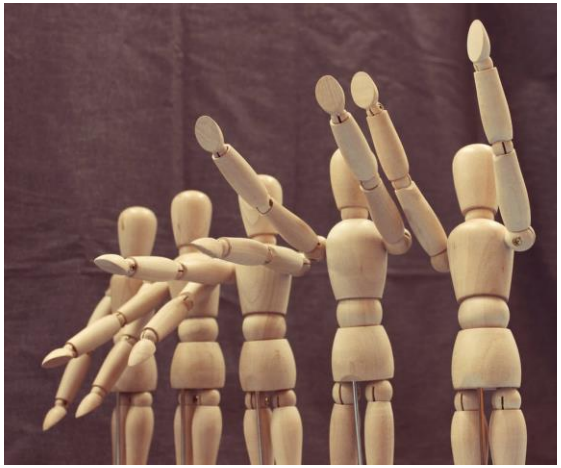
What is a Wave?

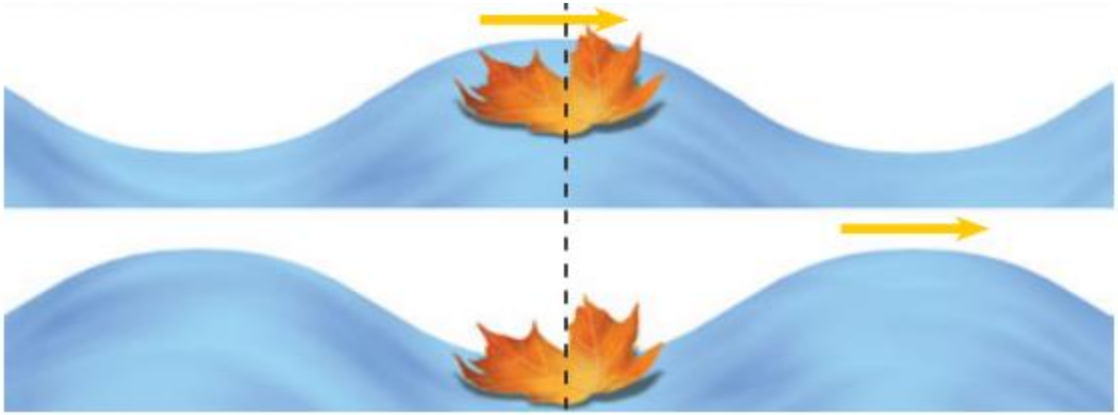
A wave is a disturbance that carries ___energy___ through matter or space

matter through which a wave travels → medium

Is the Medium Moving?

The medium particles oscillate back and forth

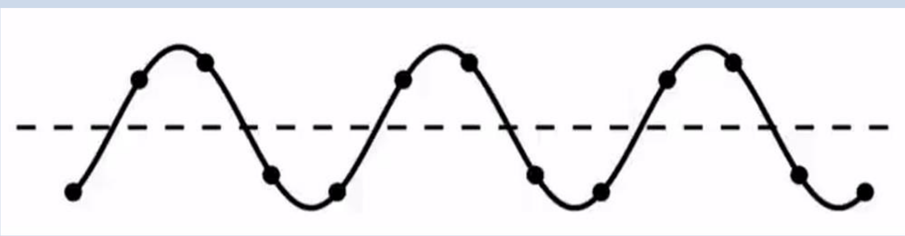




Two Types of Waves

Transverse

Particles move **perpendicular** to the wave's motion

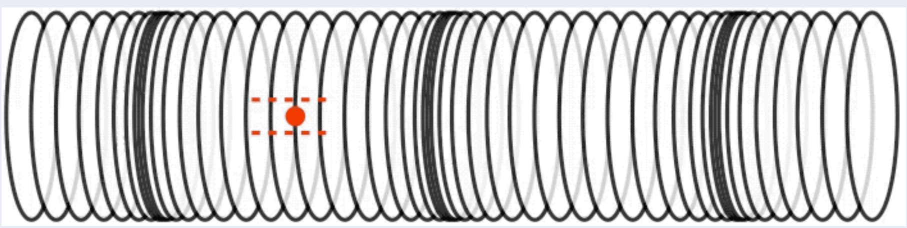


Examples:

- Ripples in a pond
- Light Waves

Longitudinal

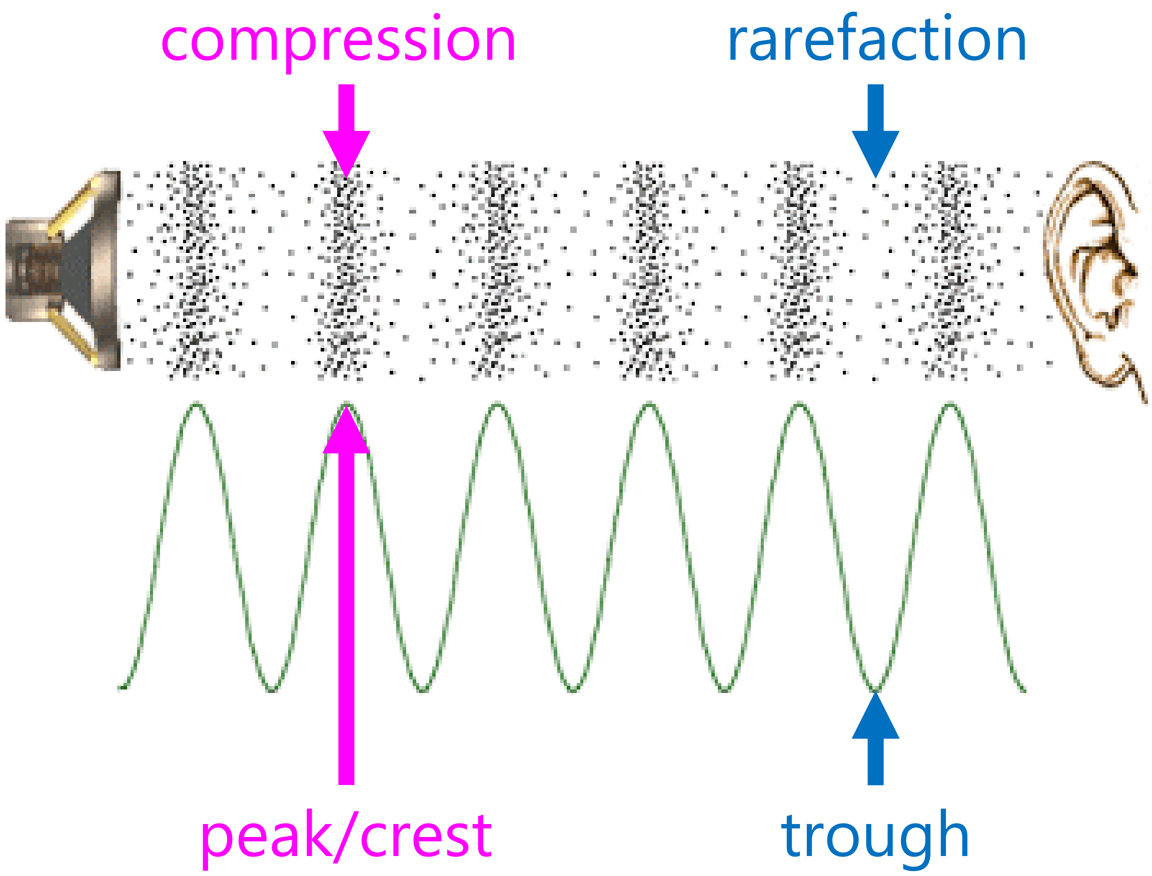
Particles move **parallel** to the wave's motion



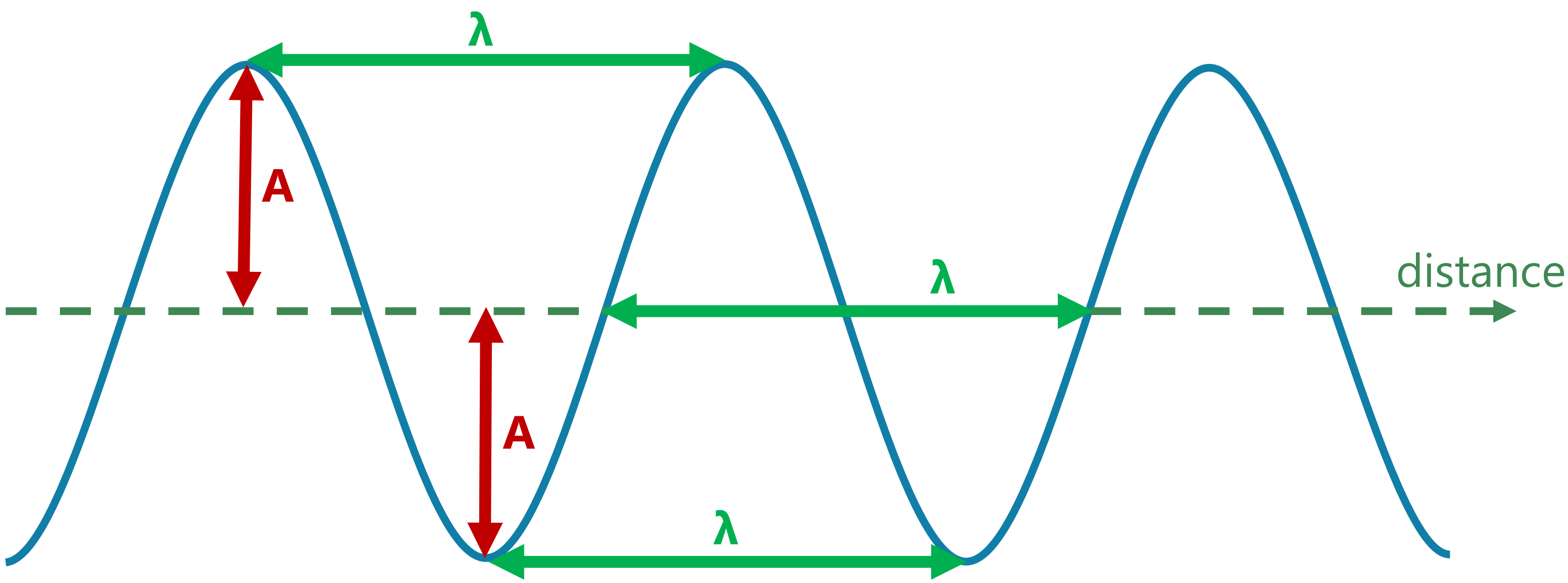
Examples:

- Sound Waves
- Earthquake Waves

Properties of a Wave

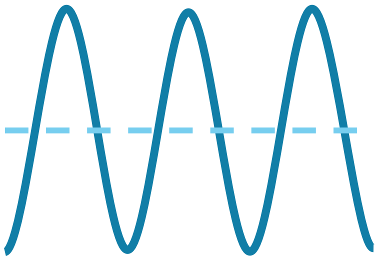


Properties of a Wave



Property	Symbol	Unit
Amplitude	**A**	**[m]**
Wavelength	**λ**	**[m]**

Waves and Energy



↑ Amplitude = ↑ Energy

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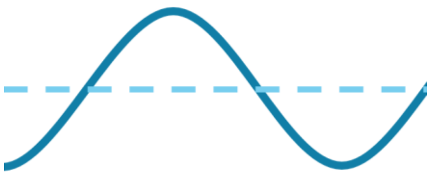
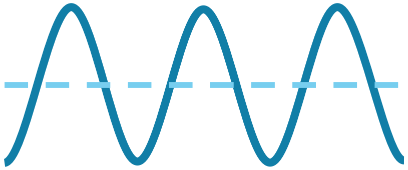


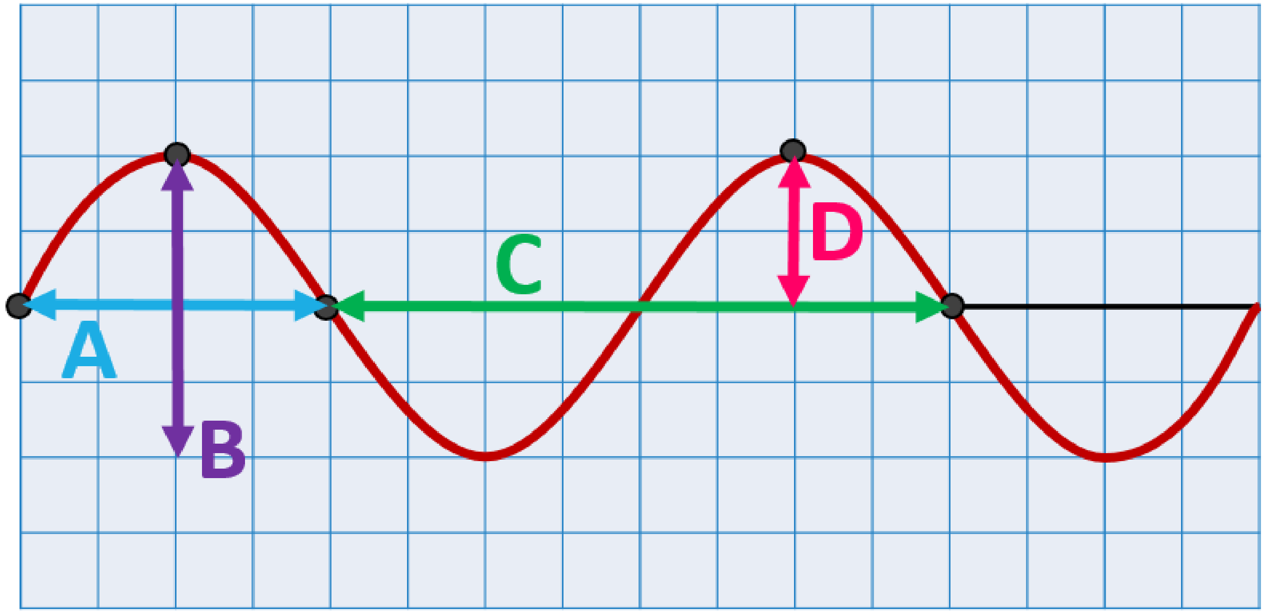
↑ Wavelength = ↓ Energy



↓ Wavelength = ↑ Energy

Label this wave

Can you identify the wave properties from this diagram?

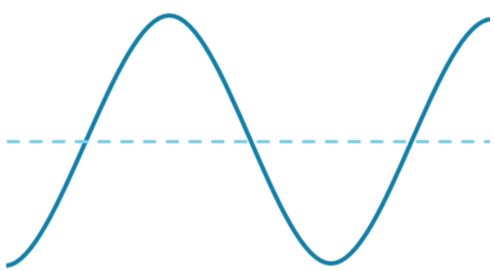


Amplitude? **D**

Wavelength? **C**

How Many Waves?

1.5



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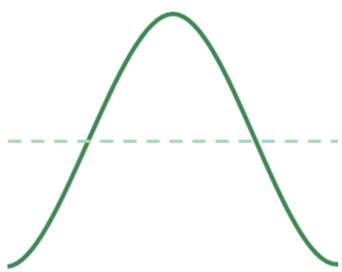

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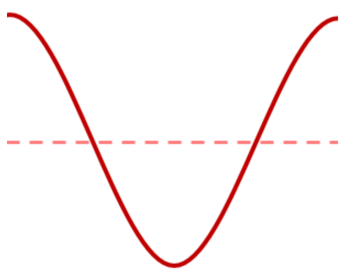
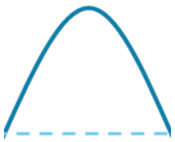
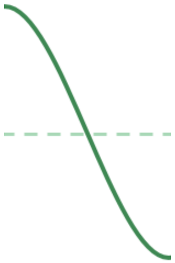


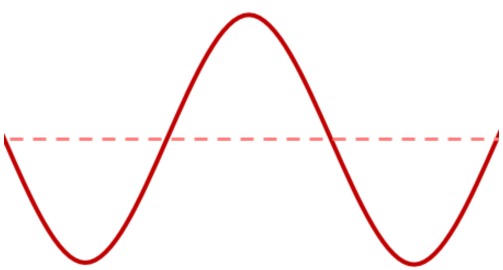
0.5



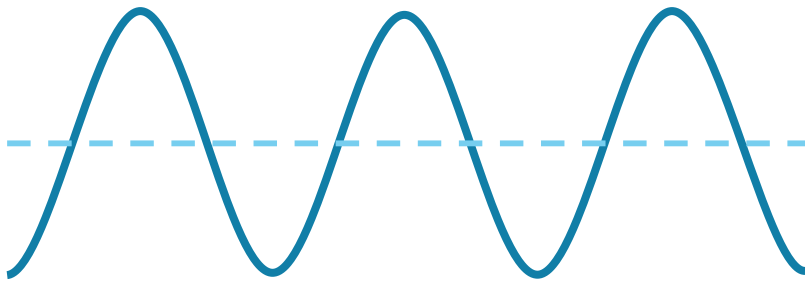
0.5



1.5

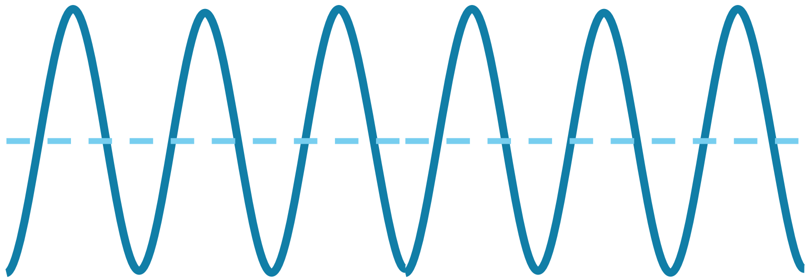


Wavelength is related to frequency



Longer wavelength

Lower frequency



Shorter wavelength

Higher frequency

Wave Speed Equation

Speed = Frequency × Wavelength

Symbols	v	=	f	×	λ
Units	[m s^{-1}]	=	[Hz]	×	[m]
			[s^{-1}]		

IB Physics Data Booklet

Sub-topic 4.1 – Oscillations	Sub-topic 4.4 – Wave behaviour
$T = \frac{1}{f}$	$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$ $s = \frac{\lambda D}{d}$ Constructive interference: path difference $= n\lambda$ Destructive interference: path difference $= (n + \frac{1}{2})\lambda$
Sub-topic 4.2 – Travelling waves	
$c = f\lambda$	
Sub-topic 4.3 – Wave characteristics	
$I \propto A^2$ $I \propto x^{-2}$ $I = I_0 cos^2\,\theta$	

*Note: "c" represents the speed of light but the relationship is the same for all wave speeds

Try this…

A piano string vibrates with a frequency of 262 Hz. If these sound waves have a wavelength in the air of 1.30 m, what is the speed of sound?

$f = 262\ Hz$

$\lambda = 1.30\ m$

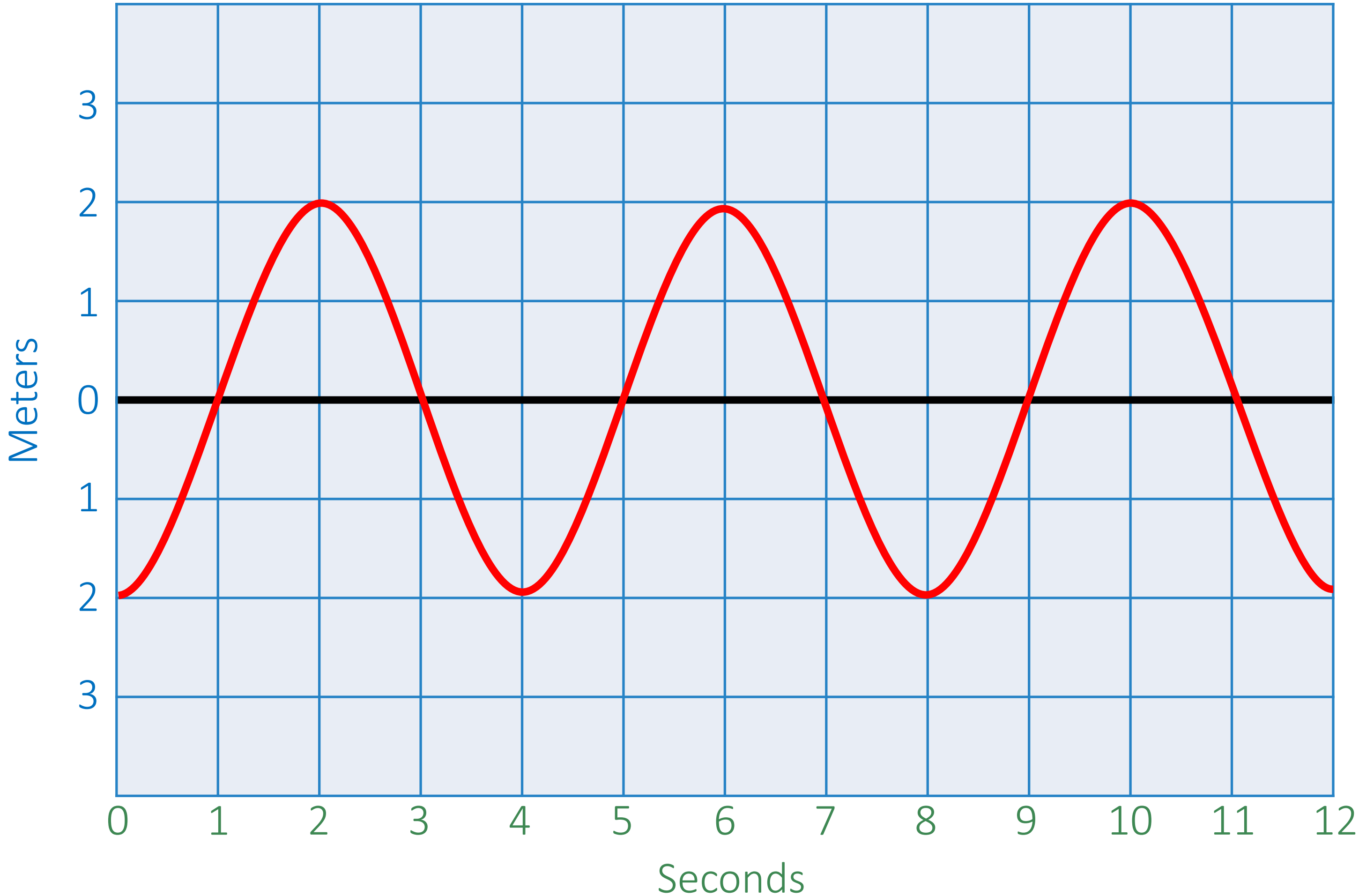
$v = ??$

$$v = f\lambda = (262)(1.30) = 340.6\ m/s$$

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

Read a Wave #1

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



# of Waves

3

Period

4 s

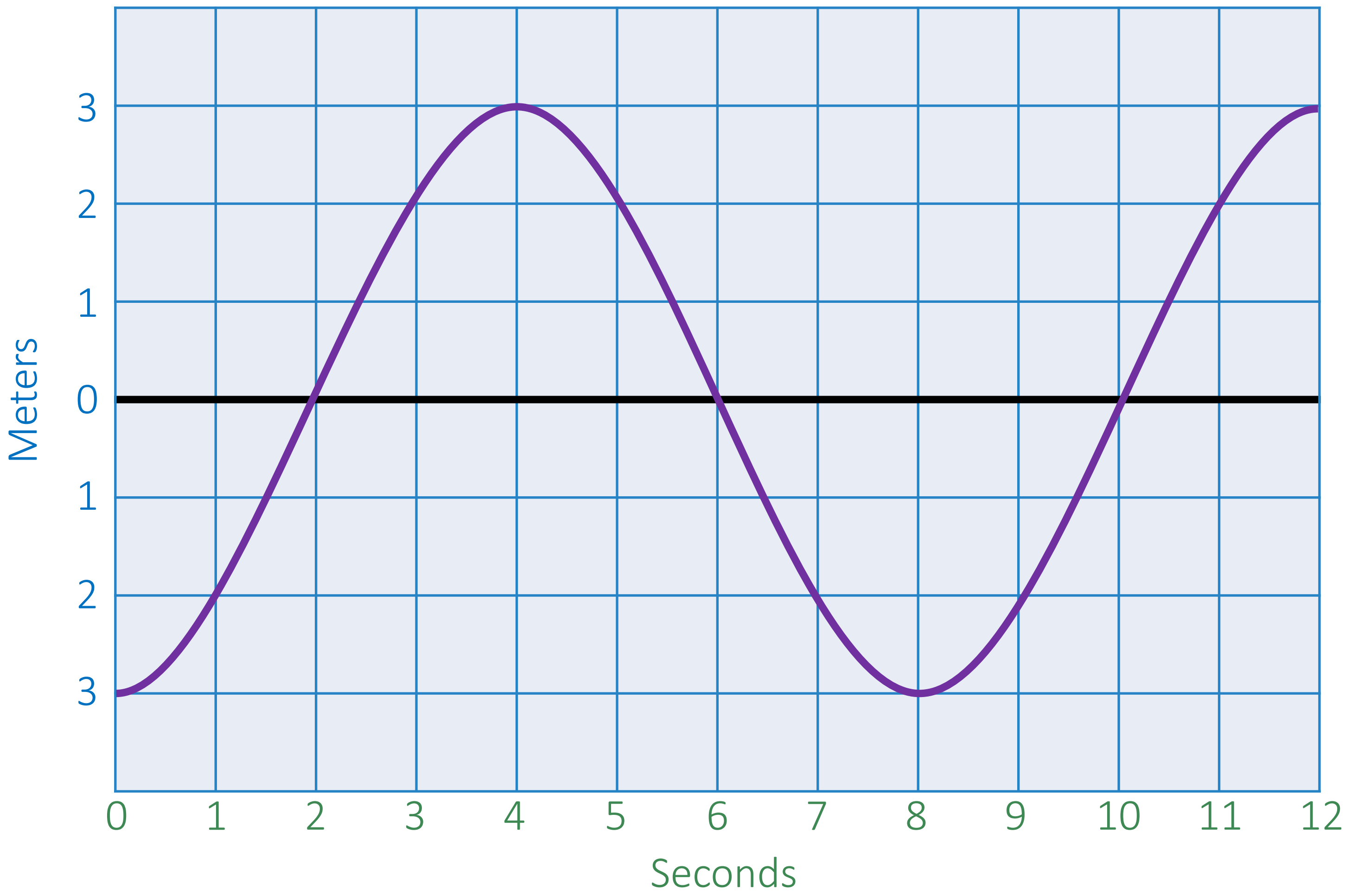
Amplitude

2 m

Frequency

0.25 Hz

$f = \frac{1}{T}$ Read a Wave #2 $T = \frac{1}{f}$



# of Waves

1.5

Period

8 s

Amplitude

3 m

Frequency

0.125 Hz

One Final Question...

The crests of waves passing into a harbor are 2.1 m apart and have an amplitude of 60 cm. 12 waves pass an observer every minute.

What is their frequency?

$$\frac{12\ waves}{1\ \cancel{min}} \times \frac{1\ \cancel{min}}{60\ s} = 0.2\ \frac{waves}{s}$$

$$f = \mathbf{0.2\ Hz}$$

What is their speed?

$$v = f\lambda$$

$$= (0.2)(2.1)$$

$$= \mathbf{0.42\ m\ s^{-1}}$$

Lesson Takeaways

- ❑ I can describe how waves carry energy through a medium
- ❑ I can compare the properties of transverse and longitudinal waves
- ❑ I can read a wave's amplitude, wavelength, period, and frequency from a graph
- ❑ I can describe the number of complete wavelengths represented in a picture
- ❑ I can use the wave speed equation to mathematically relate speed, wavelength, and frequency