Wave Resonance

IB Physics Content Guide

Big Ideas

- Simple harmonic motion is a repeating relationship between an object's position, velocity, and acceleration
- Waves are formed and transferred by particles oscillating in a medium
- All waves have properties can be measured and mathematically related
- Instruments resonate at specific frequencies due to the number of standing waves that fit in the length

1 – Simple Harmonic Motion

I can describe simple harmonic motion using period and frequency			
I can calculate period, frequency, and angular frequency			
I can describe the direction and calculate the magnitude of force for an oscillating spring system			
I can describe the properties of a spring or pendulum system that impact period			

2 – Graphing Simple Harmonic Motion

I can graph displacement, velocity, and acceleration vs time for simple harmonic motion			
I can graph kinetic and potential energy vs time for SHM			
I can graph acceleration and velocity vs displacement for simple harmonic motion			
I can describe the phenomenon of resonance			
I can describe the effect of damping and recognize scenarios where an oscillation is underdamped, overdamped, or critically damped			

3 – Wave Properties

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			

4 – Sound

I can relate the pitch of a sound to the frequency of the sound wave			
I can describe why sound travels at different speeds in different media			
I can calculate how far a distant object is by timing an echo			

5 – Instruments

I can identify and label the node and antinodes on a standing wave diagram			
I can describe the end conditions and nodes/antinodes for open/closed pipes and strings			
I can relate length and wavelength for open/closed pipes and vibrating strings			
I can calculate the length of a pipe/string required to resonate a specific frequency			

Simple Harmonic Motion

$$a = -\omega^2 x$$

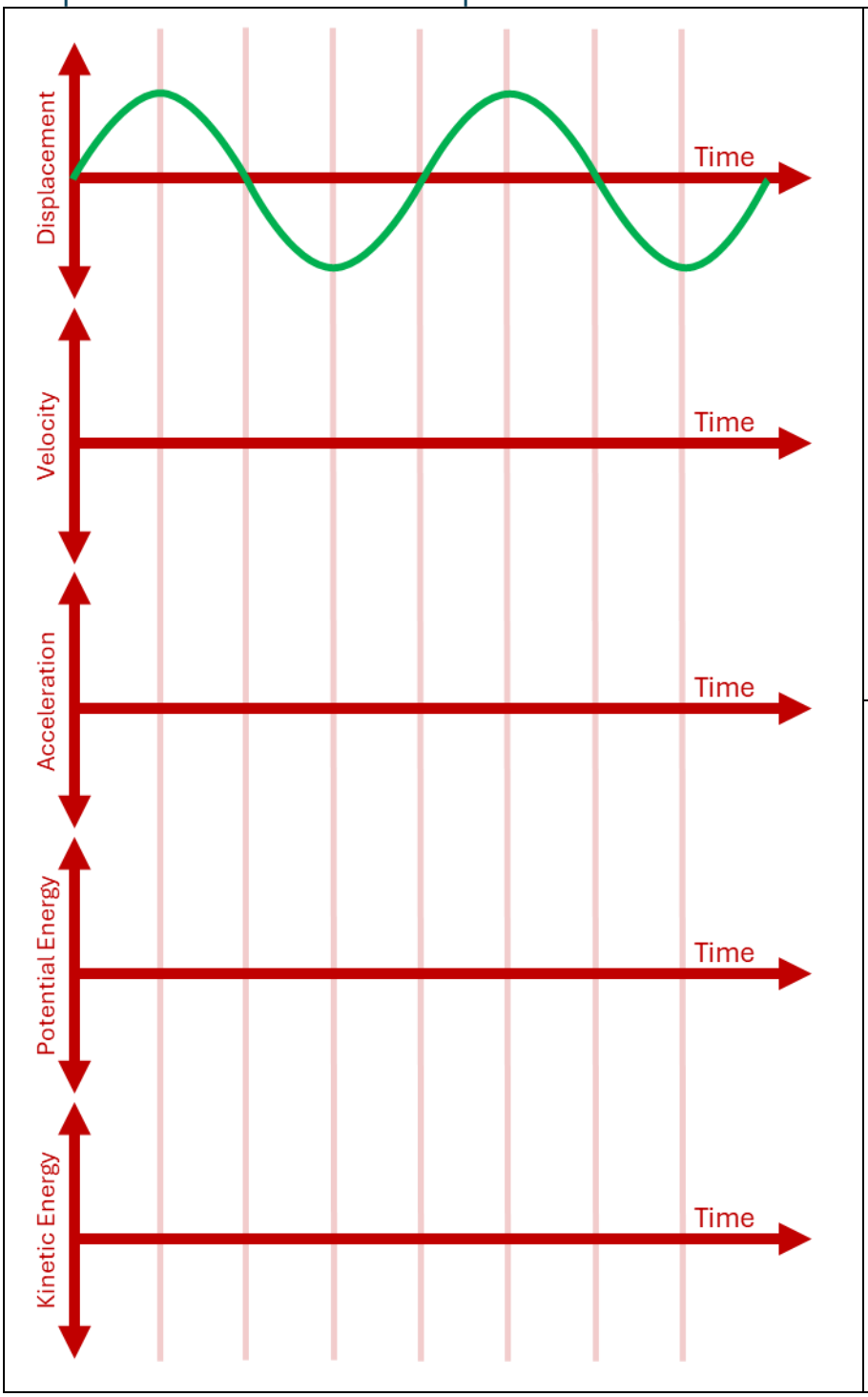
$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

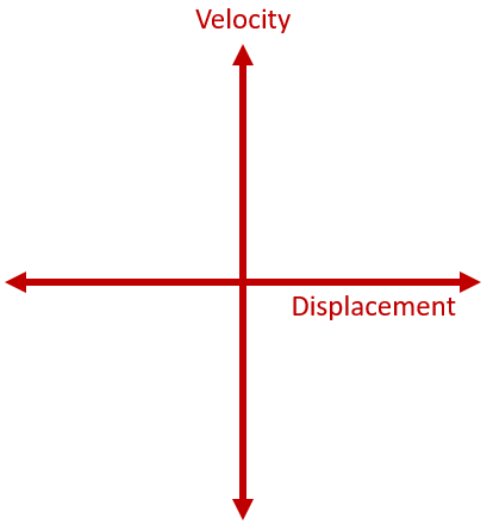
$$T = 2\pi\sqrt{\frac{l}{g}}$$

Variable Symbol	Description	Unit
a		
ω		
x		
T		
f		
m		
k		
l		
g		

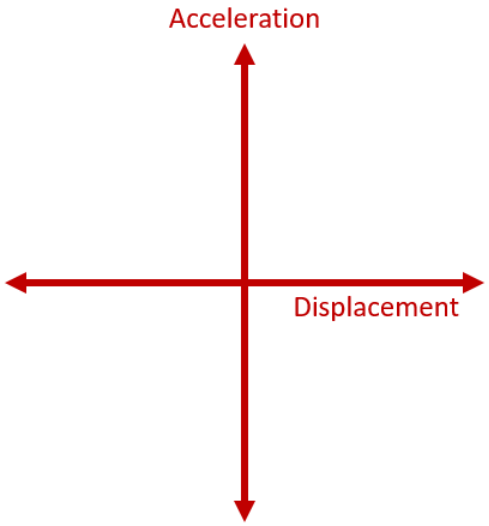
Simple Harmonic Motion Graphs



Velocity vs Displacement



Acceleration vs Displacement



Types of Waves	Picture	Definition	Examples
Transverse			
Longitudinal			

Wave Model

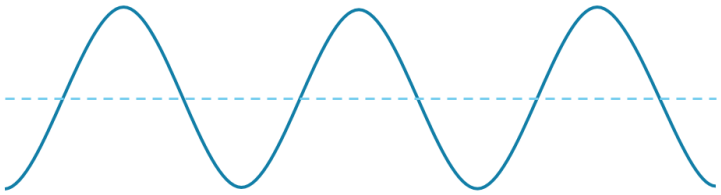
$$v = f\lambda = \frac{\lambda}{T}$$

Variable Symbol	Description	Unit
v		
f		
λ		
T		

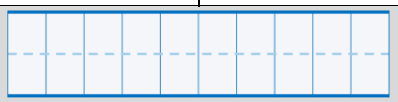
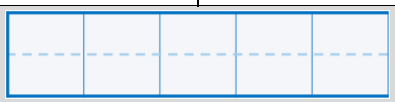
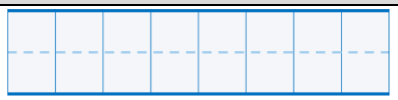
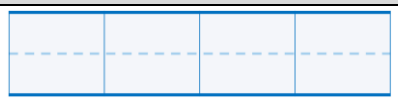
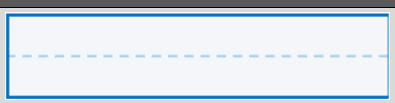
Parts of a Wave

Label the Wave:

- Amplitude
- Wavelength
- Crest
- Trough



Harmonics

	Open Pipe	Closed Pipe	String
End Conditions			
5th Harmonic	 L = ( ) × λ	 L = ( ) × λ	L = ( ) × λ
4th Harmonic	 L = ( ) × λ		L = ( ) × λ
3rd Harmonic	L = ( ) × λ	L = ( ) × λ	L = ( ) × λ
2nd Harmonic	 L = ( ) × λ		L = ( ) × λ
1st Harmonic (Fundamental)	L = ( ) × λ	 L = ( ) × λ	L = ( ) × λ