Edexcel IAL Physics A-Level

Topic 5.3 - Oscillations

Flashcards

What is simple harmonic motion?

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An oscillation in which the force is proportional to the displacement and is in the opposite direction:

$$F = - kx$$

Considering a spring oscillating, give the definitions of the following:

Displacement

Amplitude

Period

Frequency

Considering a spring oscillating, give the definitions of the following:

Displacement - distance from the equilibrium position (vector).

Amplitude - maximum displacement.

Period - time taken for a complete oscillation.

Frequency - number of oscillations per second.

State the equation relating angular frequency and time period.

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$$\omega = 2\pi/T$$

Where ω = angular frequency, T = time period

What are the conditions for SHM?

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- Acceleration (and force) must be proportional to displacement from the equilibrium point.
- It must act towards the equilibrium point.
- $a \propto -x$

What are the two main examples of systems which undergo SHM?

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- A mass spring system
- A pendulum

What is the constant of proportionality linking acceleration and displacement?

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$$-\omega^2$$

True or false: Velocity is a maximum when displacement is maximum.

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False.

The velocity is a minimum at the amplitude of oscillation.

Velocity is a maximum when it passes through the equilibrium position.

How can you calculate the maximum speed using ω and A?

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$$V_{max} = \omega A$$

State the equations for x,v,a in terms of trig functions and A, ω and t.

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$$x = A\cos\omega t$$

$$v = -A\omega \sin\omega t$$

$$a = -A\omega^2 \cos\omega t$$

State the equations for T for a SHO and a simple pendulum.

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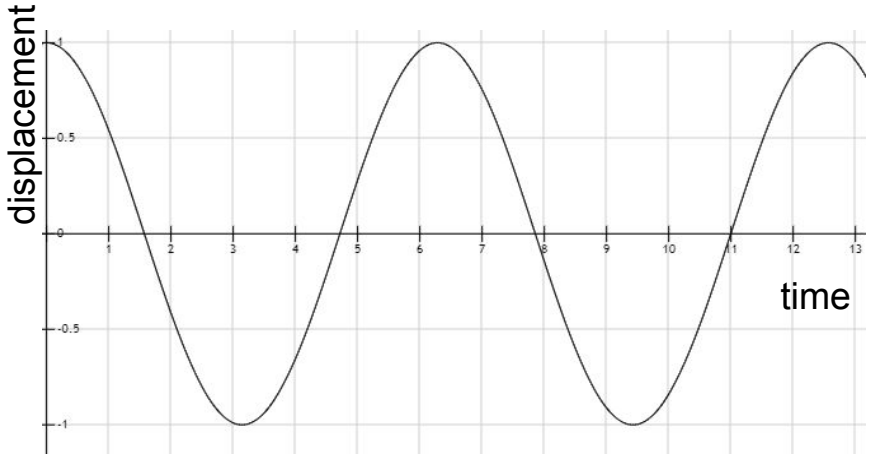
SHO

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

Pendulum

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

If the following graph shows displacement against time, what would the velocity-time graph look like?



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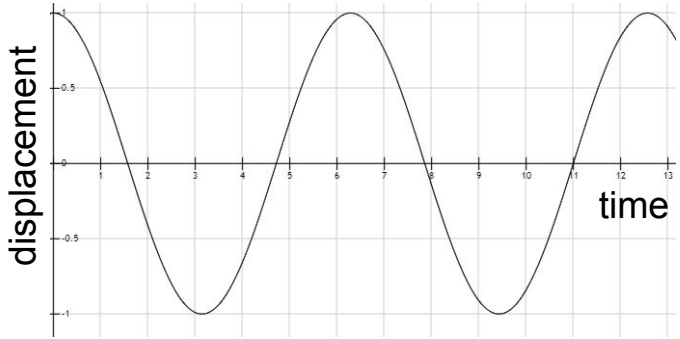
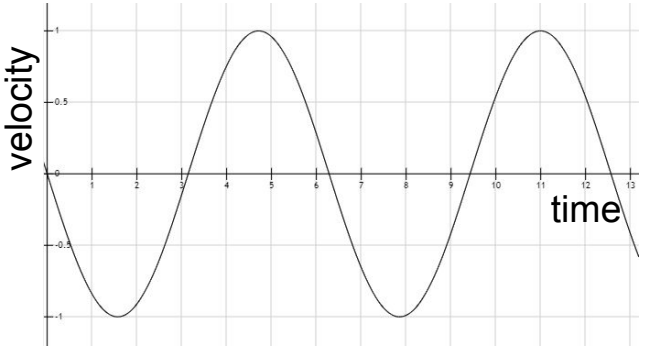
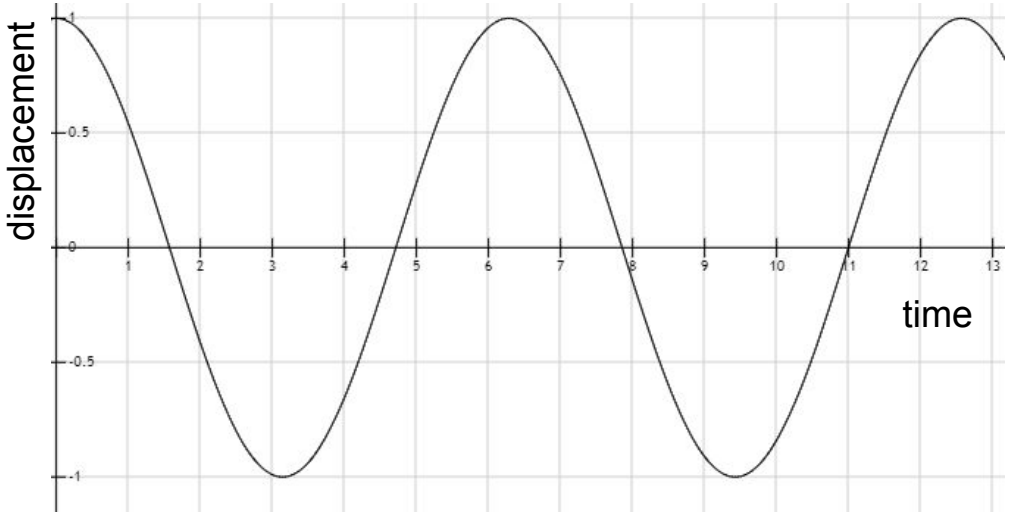




If the following graph shows displacement against time, what would the acceleration-time graph look like?



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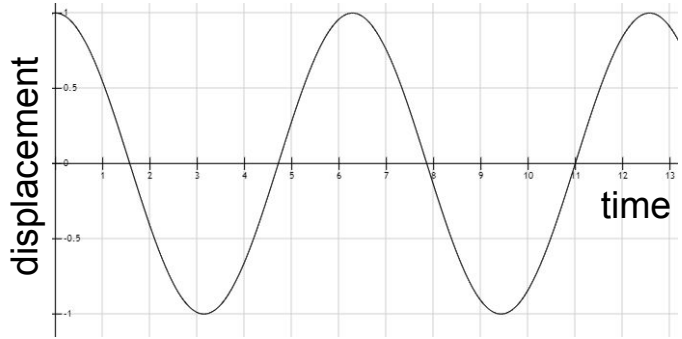

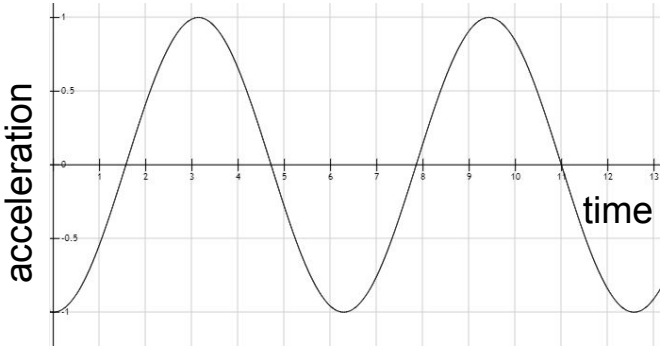

What is damping?

What is damping?

Damping is the process by which the amplitude of the oscillations decreases over time. This is due to energy loss to resistive forces such as drag or friction.

With a diagram to help, explain the difference between light damping, heavy damping and critical damping.

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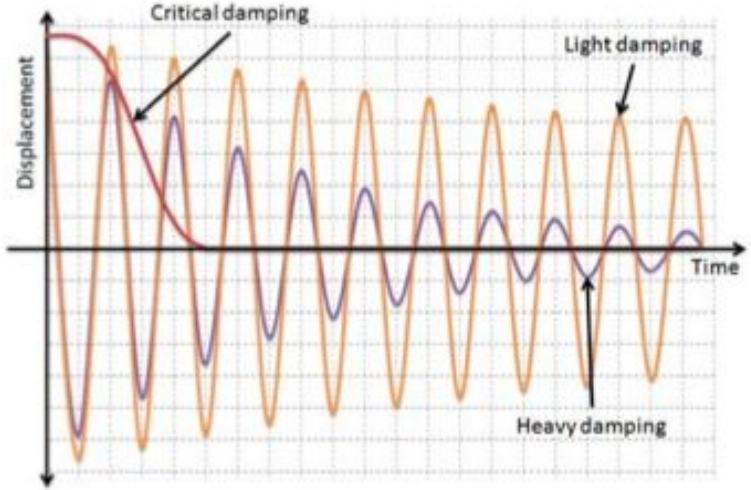
Light damping occurs naturally (e.g. pendulum oscillating in air), and the amplitude decreases exponentially. When heavy damping occurs (e.g. pendulum oscillating in water) the amplitude decreases dramatically. In critical damping (e.g. pendulum oscillating in treacle) the object stops before one oscillation is completed.



What is the difference between free and forced oscillations?

What is the difference between free and forced oscillations?

When an object oscillates without any external forces being applied, it oscillates at its natural frequency. This is known as free oscillation. Forced oscillation occurs when a periodic driving force is applied to an object, which causes it to oscillate at a particular frequency.

What is resonance?

What is resonance?

When the driving frequency of the external force applied to an object is the same as the natural frequency of the object, resonance occurs. This is when the amplitude of oscillation rapidly increases, and if there is no damping, the amplitude will continue to increase until the system fails. As damping is increased, the amplitude will decrease at all frequencies, and the maximum amplitude occurs at a lower frequency.

Describe experimental technique to investigate the resonance of an object

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- Suspend a mass between 2 springs attached to an oscillator.
- Place a millimetre ruler parallel to the spring-mass system to measure the mass's amplitude.
- Increase the driving frequency from 0 so the mass oscillates with increasing amplitude until the driver frequency reaches the natural frequency of the system (max amplitude as resonance), the amplitude of oscillation will decrease again as frequency is increased. The air will damp the system.
- To increase accuracy, the system can be filmed and the amplitude value recorded from video stills.