Episode 300: Preparation for simple harmonic motion topic

Simple harmonic motion (SHM) follows logically on from linear motion and circular motion. It is one of the more demanding topics of Advanced Physics. It gives you opportunities to revisit many aspects of physics that have been covered earlier.

The topic is quite mathematical for many students (mostly algebra, some trigonometry) so the pace might have to be judged accordingly. Good physical insight can lead to a good qualitative/descriptive understanding, but in exams students will be expected to tackle numerical questions.

You will need to draw out the lesson that SHM is just one type of oscillatory motion. Other types can often be broken down into a sum of SHMs of different frequencies. This is a characteristic of physics – we choose a simple system which we can analyse, and then use our understanding to tackle more complex systems.

Episode 301: Recognising SHM

Episode 302: Getting mathematical

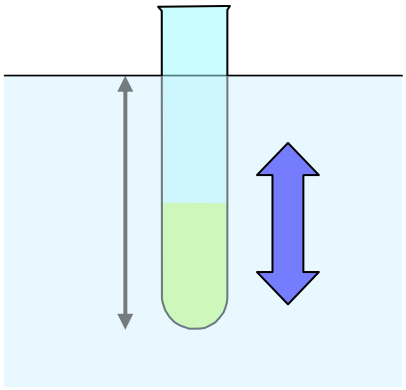
Episode 303: Mass-spring systems

Episode 304: Simple pendulum

Episode 305: Energy in SHM

Episode 306: Damped SHM

Episode 307: Resonance



Advance warning

This topic has many mathematical aspects. However, you will also want your students to gain a feel for the characteristics of simple harmonic motion. To this end, it will be useful if you can set up some large, slow oscillators, such as:

- ✓ a very long pendulum
- ✓ a mass on a long vertical spring
- ✓ a trolley or other mass tethered horizontally between springs

In addition, it will be useful if you can use an **oscilloscope** connected to a slow **signal generator** (frequency 1 Hz) to show a spot moving with SHM.

Look out for a **video clip** of the Tacoma Narrows Bridge disaster.

Pictures and a short video clip are available at: (as at September 2005)

http://www.enm.bris.ac.uk/research/nonlinear/tacoma/tacoma.html#file

Main aims

Students will:

1. Recognize the characteristics of SHM.
2. State the condition required for SHM.

3. Use equations and graphs which represent the variation of displacement, velocity and acceleration with time.
4. Investigate mass-spring systems and the simple pendulum.
5. Discuss the effects of damping on SHM.
6. Describe energy changes during SHM.
7. State the conditions required for resonance to occur, and its effects.

Prior knowledge

This topic draws on several areas of mechanics which students are likely to have covered previously. You can use this topic to reinforce understanding of the following points:

- Basic linear dynamics especially Newton's Second Law in the form $F = ma$
- Hooke's Law
- Resolving to find components of vectors
- Graphs of sin θ and cos θ
- Circular measure (radians)
- Motion in a circle (angular velocity ω, centripetal acceleration v^2/r)
- If students are not already familiar with small angle approximations, you can use this topic to introduce them (sin $\theta \sim \theta$, cos $\theta \sim 1$ for small θ; θ in radians). See the question 1 in the link below

LINK TAP 225-1: Radians and angular speed

Where this leads

This topic leads naturally into the topic of waves. Sinusoidal waveforms arise from sources executing SHM; in addition, the equations for SHM are similar to those for wave motion.