

Simple harmonic motion · supported focus

International Baccalaureate · IB Diploma · Physics · HL

Scope and prerequisites

Supported HL focus. First assessment 2025; full Physics guide acquired (84 PDF pages). Remaining guide, assessment and practical requirements retain their recorded holds.

Prerequisites: read the stated quantities and units, use arithmetic and the model conditions below. Each lesson develops its own method before independent transfer.

These are original or explicitly fictional teaching examples, not actual measurements or completed assessed learner investigations.

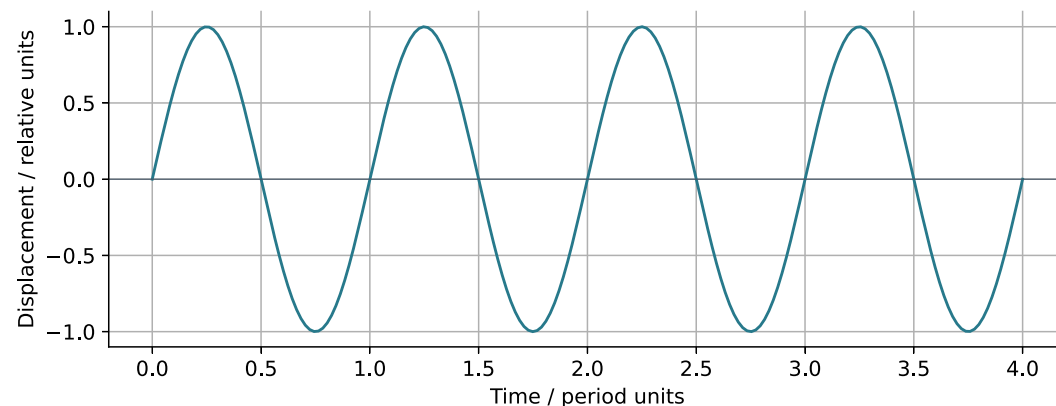
Oscillation, resonance and phase

■ What would explain this observation?

- A swing gains a large amplitude when pushes arrive with the right timing. The forcing frequency and **damping** help determine the response.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Simple harmonic motion has acceleration proportional to displacement and directed toward equilibrium. Period is time per cycle; frequency is its reciprocal. Damping transfers energy away from the oscillating system.
- **resonance**: A large response to periodic forcing near a natural frequency; damping: Energy transfer out of an oscillating system.



■ Choose evidence that can test it

- Velocity is greatest near equilibrium for ideal SHM, while acceleration magnitude is greatest at extreme displacement. Resonance can occur near the natural frequency under periodic driving, with amplitude limited by damping.
- Measure time for several complete oscillations and divide. Define a cycle consistently and use a small displacement when the model requires it. Keep pendulum paths clear and record damping effects rather than assuming perfect motion.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: 20 cycles take 32 s. $T = \text{total time} / \text{cycles} = 32 / 20 = 1.6$ s. Frequency $= 1/T = 1/1.6 = 0.625$ Hz. A shorter total timing interval would make reaction-time error a larger fraction of the measurement.

Example:

30 cycles take 45 s. Find period. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- Not every repeated motion is SHM. A force proportional to displacement but directed away from equilibrium does not produce SHM.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Every periodic motion satisfies the condition for simple harmonic motion. This claim is false: Not every repeated motion is SHM. A force proportional to displacement but directed away from equilibrium does not produce SHM.

Key:

Oscillation, resonance and phase: Velocity is greatest near equilibrium for ideal SHM, while acceleration magnitude is greatest at extreme displacement. Resonance can occur near the natural frequency under periodic driving, with amplitude limited by damping.