

Simple Harmonic Oscillators

There are a couple more equations to learn on this page I'm afraid. The experiment described at the bottom of the page shows where they come from, though, so that should help you remember them.

A Mass on a Spring is a Simple Harmonic Oscillator (SHO)

- 1) When the mass is **pushed to the left or pulled to the right of the equilibrium position**, there's a **force** exerted on it. The size of this force (in N) is:

$$F = -kx$$

where k is the **spring constant** (stiffness) of the spring in Nm^{-1} and x is the **displacement** in m.

- 2) After a bit of jiggery-pokery involving Newton's second law and some of the ideas on the previous page, you get the formula for the period of a mass oscillating on a spring:

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

T = period of oscillation in seconds

m = mass in kg

k = spring constant in Nm^{-1}

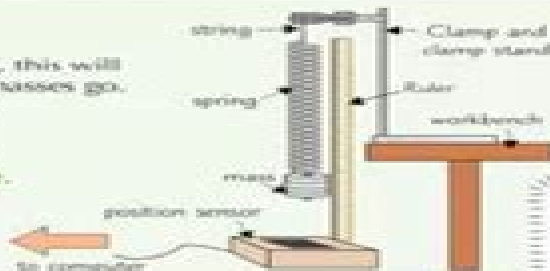


A simple theory of how atoms in a lattice (ie. a solid) behave can be worked out by considering them as masses oscillating on springs. So there you go.

You Can Check the Formula Experimentally

Practical Demonstration

- 1) Set up the equipment as shown in the diagram.
- 2) Pull the masses down a set amount, this will be your initial **amplitude**. Let the masses go.
- 3) The masses will now oscillate with **simple harmonic motion**.
- 4) The **position sensor** measures the displacement of the mass over time.
- 5) Connect the position sensor to a computer and create a **displacement-time graph**. Read off the period T from the graph.



You could also measure the period of an oscillation using a stop watch. It's sensible to measure the time taken for eg five oscillations, then divide by the number of oscillations to get an average, as it'll reduce the random error in your result.

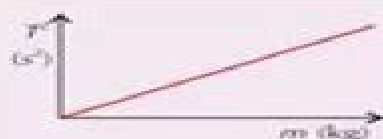
Because the spring in this experiment is hung vertically, the potential energy is both elastic and gravitational. For the horizontal spring system shown above, the potential energy is just elastic.

You Can Use This Set Up to Investigate Factors Which Affect the Period

- 1) Change the **mass, m** , by loading more masses onto the spring.
- 2) Change the **spring stiffness constant, k** , by using different combinations of springs.
- 3) Change the **amplitude, A** , by pulling the masses down by different distances.



You'll get the following results:



$$T \propto \sqrt{m} \quad \text{so} \quad T^2 \propto m$$



$$T \propto \sqrt{\frac{1}{k}} \quad \text{so} \quad T^2 \propto \frac{1}{k}$$



T doesn't depend on amplitude, A .

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SA Dillow



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Table of Contents Cgp Aqa A2 Physics Revision Guide

1. Understanding the eBook Cgp Aqa A2 Physics Revision Guide
 - The Rise of Digital Reading Cgp Aqa A2 Physics Revision Guide
 - Advantages of eBooks Over Traditional Books
2. Identifying Cgp Aqa A2 Physics Revision Guide
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Cgp Aqa A2 Physics Revision Guide
 - User-Friendly Interface
4. Exploring eBook Recommendations from Cgp Aqa A2 Physics Revision Guide
 - Personalized Recommendations
 - Cgp Aqa A2 Physics Revision Guide User Reviews and Ratings
 - Cgp Aqa A2 Physics Revision Guide and Bestseller Lists
5. Accessing Cgp Aqa A2 Physics Revision Guide Free and Paid eBooks
 - Cgp Aqa A2 Physics Revision Guide Public Domain eBooks
 - Cgp Aqa A2 Physics Revision Guide eBook Subscription Services
 - Cgp Aqa A2 Physics Revision Guide Budget-Friendly Options
6. Navigating Cgp Aqa A2 Physics Revision Guide eBook Formats

- ePub, PDF, MOBI, and More
- Cgp Aqa A2 Physics Revision Guide Compatibility with Devices
- Cgp Aqa A2 Physics Revision Guide Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Cgp Aqa A2 Physics Revision Guide
 - Highlighting and Note-Taking Cgp Aqa A2 Physics Revision Guide
 - Interactive Elements Cgp Aqa A2 Physics Revision Guide
- 8. Staying Engaged with Cgp Aqa A2 Physics Revision Guide
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Cgp Aqa A2 Physics Revision Guide
- 9. Balancing eBooks and Physical Books Cgp Aqa A2 Physics Revision Guide
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Cgp Aqa A2 Physics Revision Guide
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Cgp Aqa A2 Physics Revision Guide
 - Setting Reading Goals Cgp Aqa A2 Physics Revision Guide
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Cgp Aqa A2 Physics Revision Guide
 - Fact-Checking eBook Content of Cgp Aqa A2 Physics Revision Guide
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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