Waves and Oscillation

Course- PHY 2105 / PHY 105

Lecture 1

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UNITED INTERNATIONAL UNIVERSITY

Course- Physics

Part 1

Simple harmonic oscillators
Damped oscillators
Driven oscillators
Properties of wave

Part II

Electric field
Electric potential
Electric circuitry
Magnetism

Part III

Quantum theory
Properties of light
Quantum mechanics
Nuclear Physics

Assessment

Assessment Types	No.	Marks
Attendance	24	5%
Assignments	4	5%
Class Tests	4 (best 3)	20%
Mid Term	1	30%
Final Exam	1	40%

Letter Grade	Marks %	Grade Point	Letter Grade	Marks %	Grade Point
A (Plain)	90-100	4.00	C+ (Plus)	70-73	2.33
A- (Minus)	86-89	3.67	C (Plain)	66-69	2.00
B+ (Plus)	82-85	3.33	C- (Minus)	62-65	1.67
B (Plain)	78-81	3.00	D+ (Plus)	58-61	1.33
B- (Minus)	74-77	2.67	D (Plain)	55-57	1.00
			F (Fail)	<55	0.00

Reference Texts

- *University Physics (13th Edition),*
  Hugh D Young, Roger A Freedman
- *Physics [Volume One] (5th Edition),*
  Robert Resnick, David Halliday, Kenneth Krane
- *Fundamentals of Physics (10th Edition),*
  Resnick and Halliday

What to do in this course

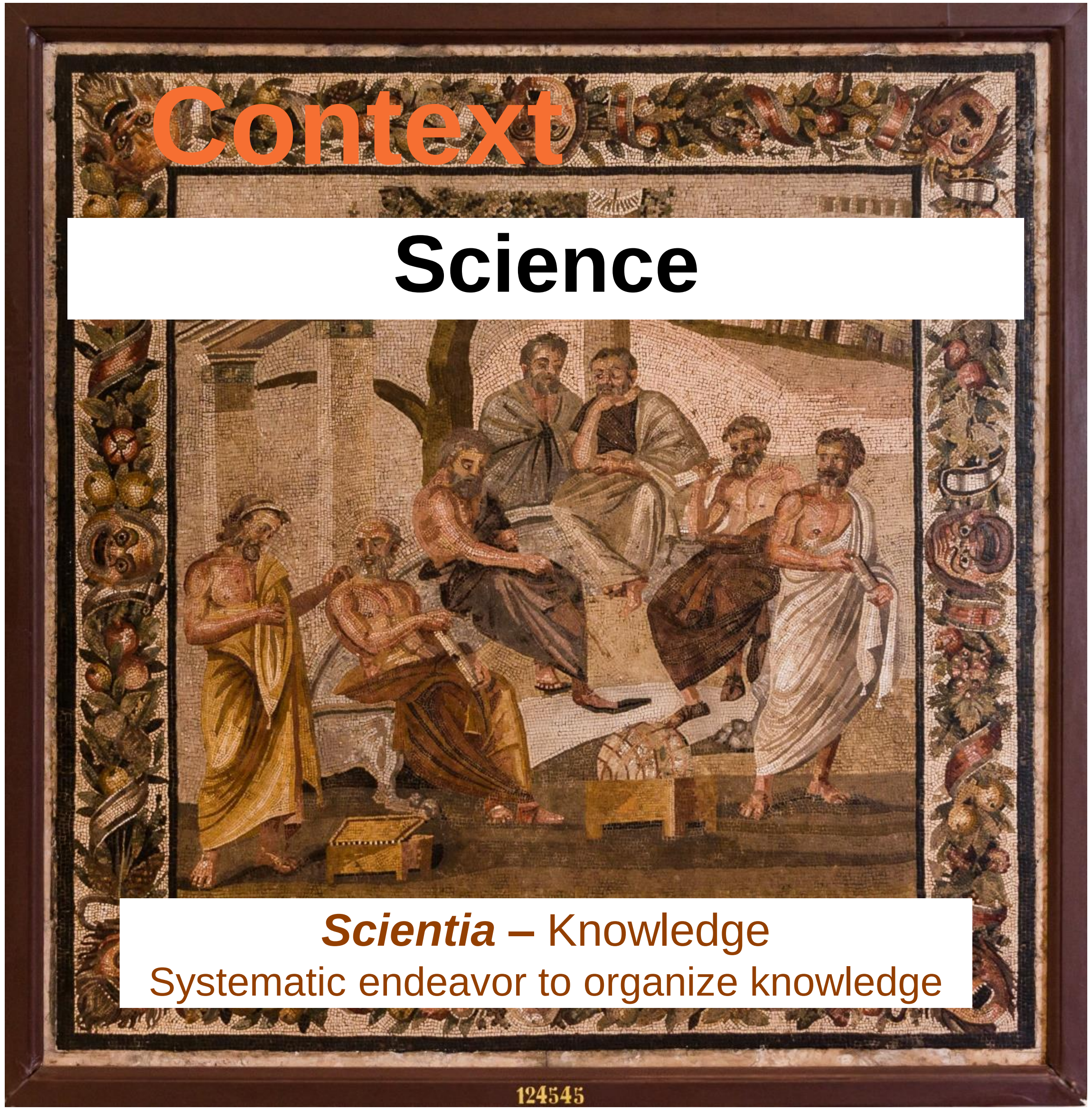
1. Read the relevant sections in the textbook …
   the course notes will guide you.

2. Do all homework and problem sets.

3. Get help early … from Course Teacher.

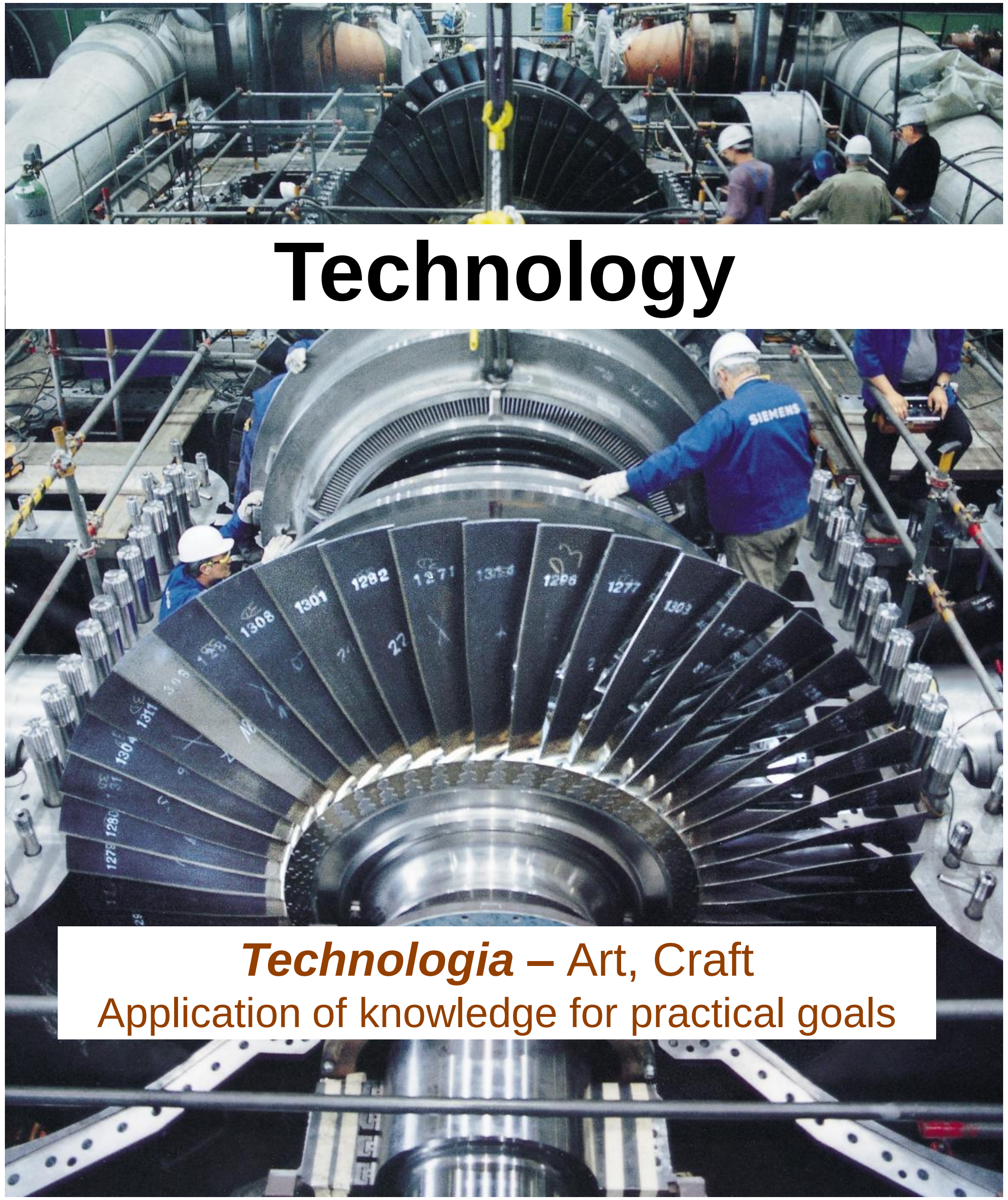
4. There are no shortcuts … put effort in to understand things.

Context



Science

***Scientia* – Knowledge**
Systematic endeavor to organize knowledge



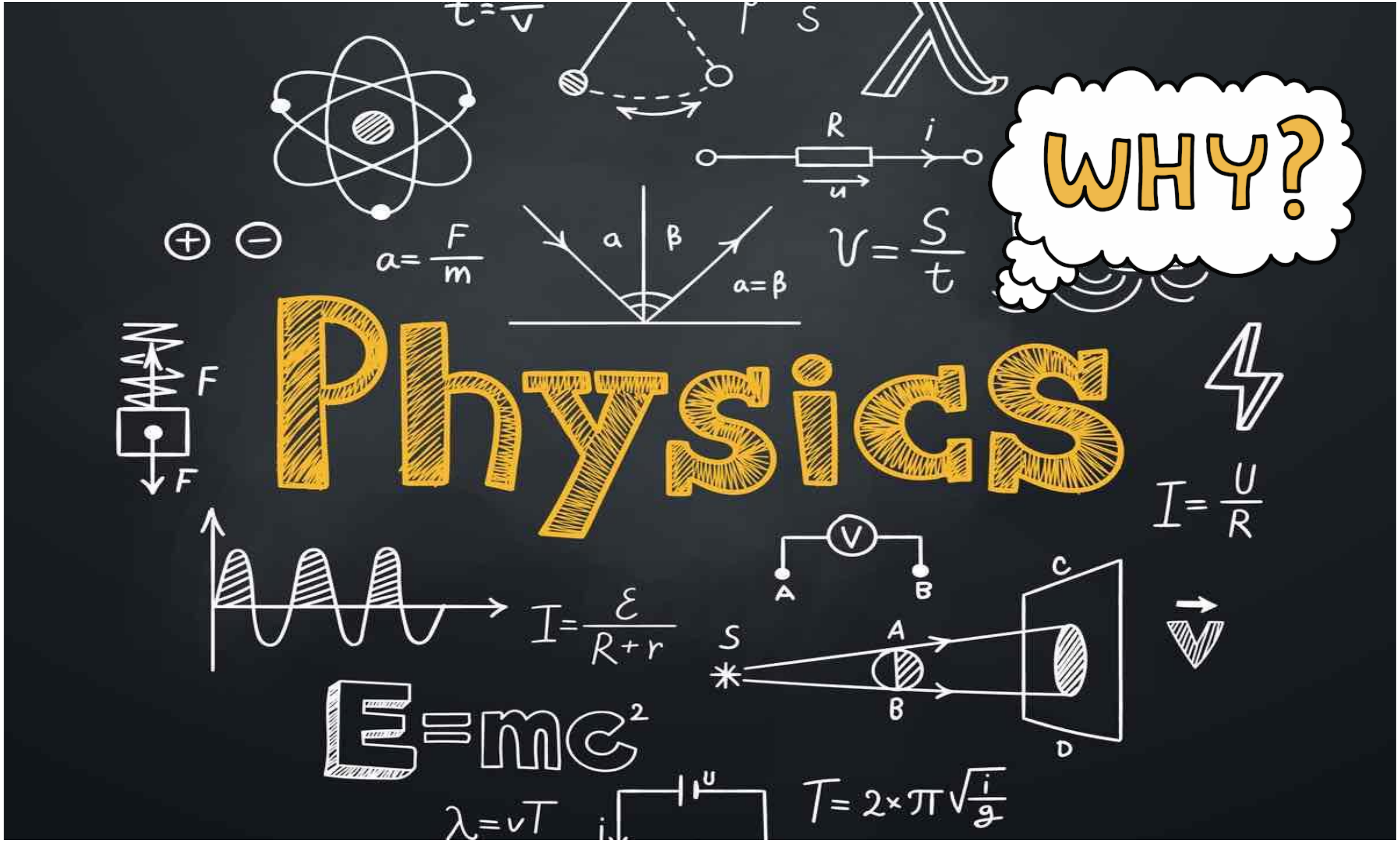
Technology

***Technologia* – Art, Craft**
Application of knowledge for practical goals

Physika

Study of Nature

The branch of science that concerns observation and understanding of nature and its fundamental constituents



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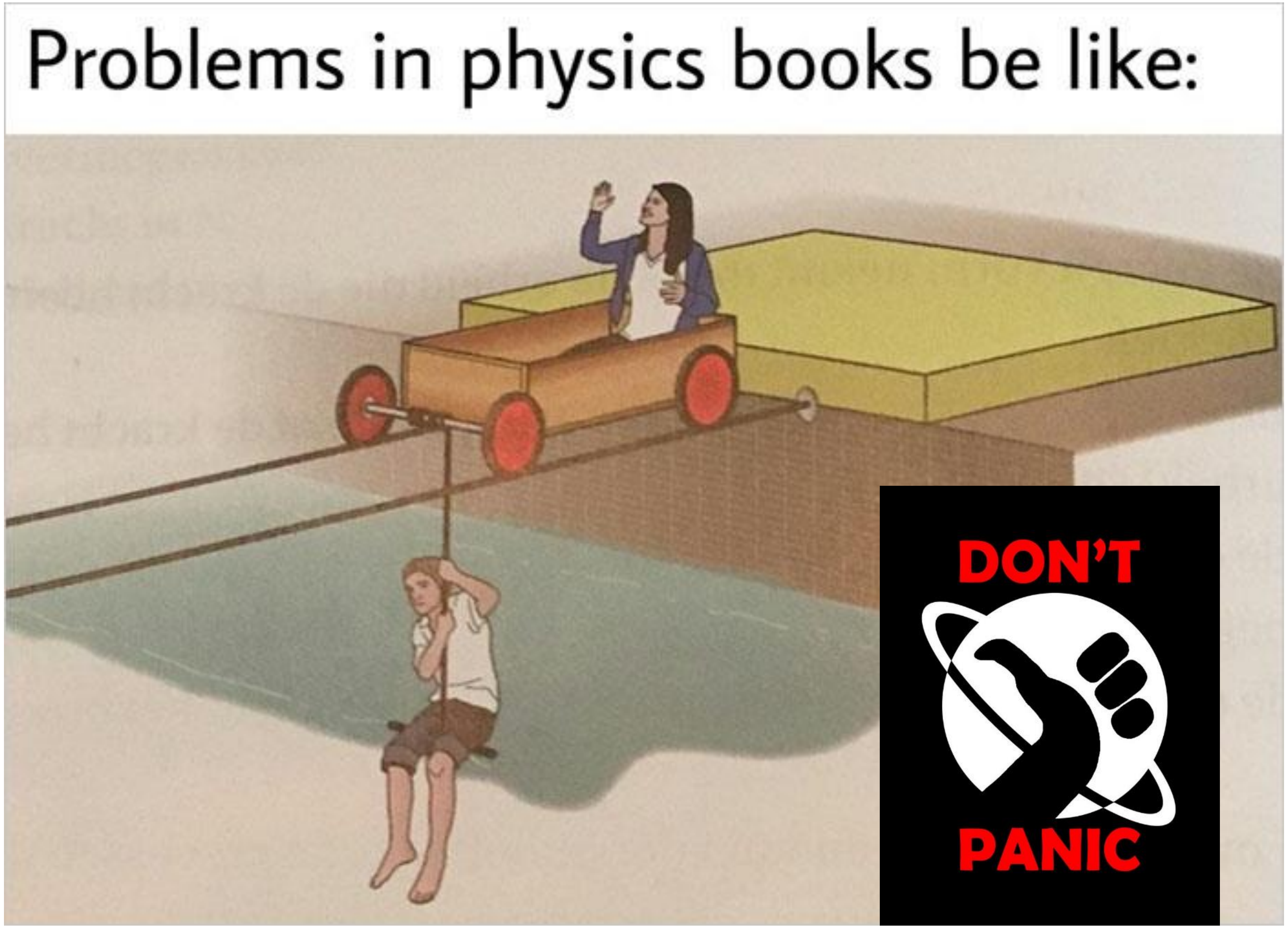
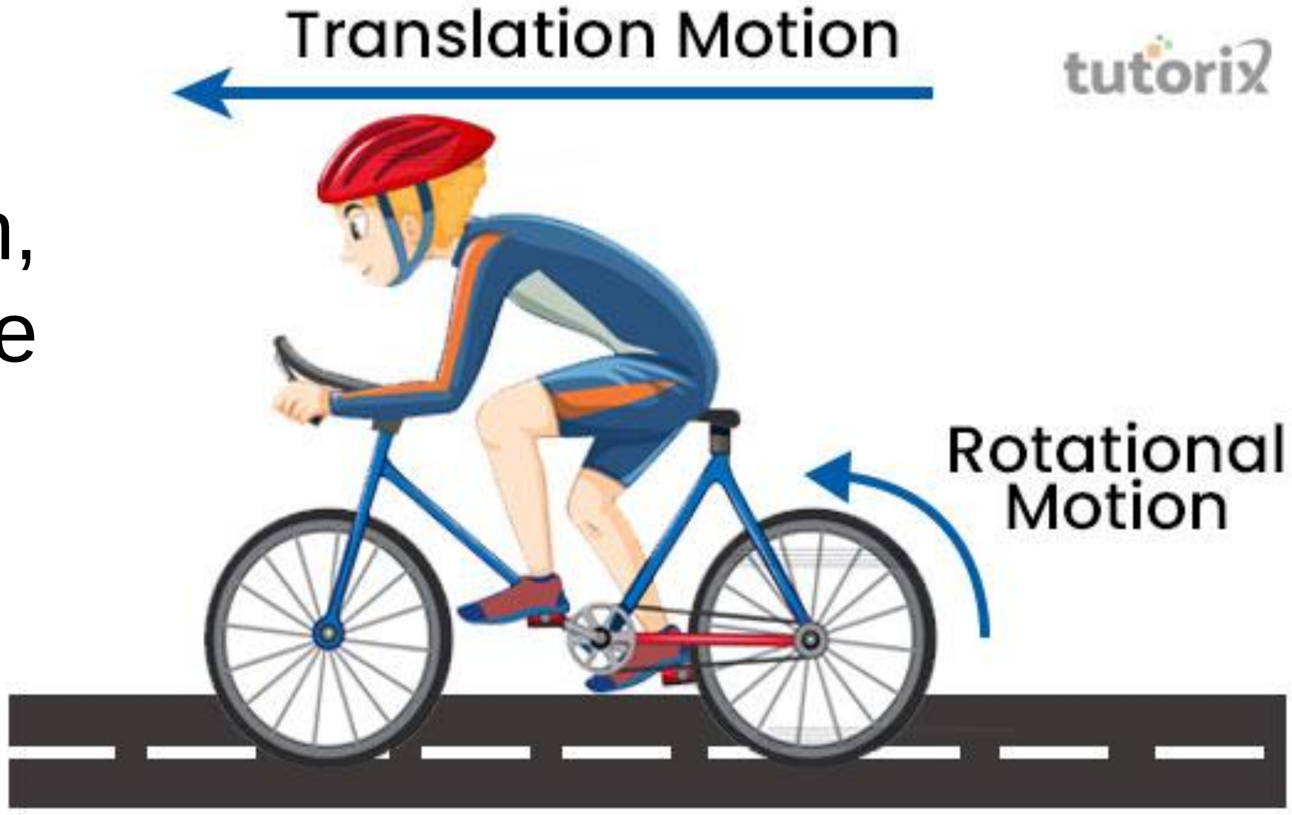

Problems in physics books be like:
DON'T
PANIC

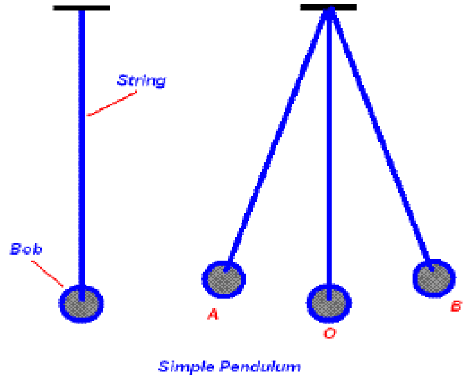
The world of Motion

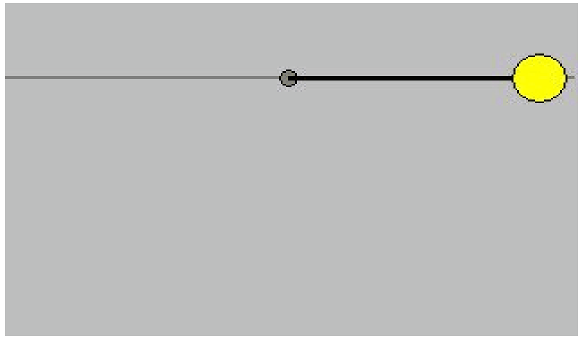
Motion
Change of position,
with respect to time



The science of movement

Linear Motion





Uniform Circular Motion

Oscillatory Motion (Simple Pendulum)

Oscillatory Motion
(Spring Mass)

Periodic Motion

A motion that repeats itself after an equal interval of time.

Periodicity

Examples:

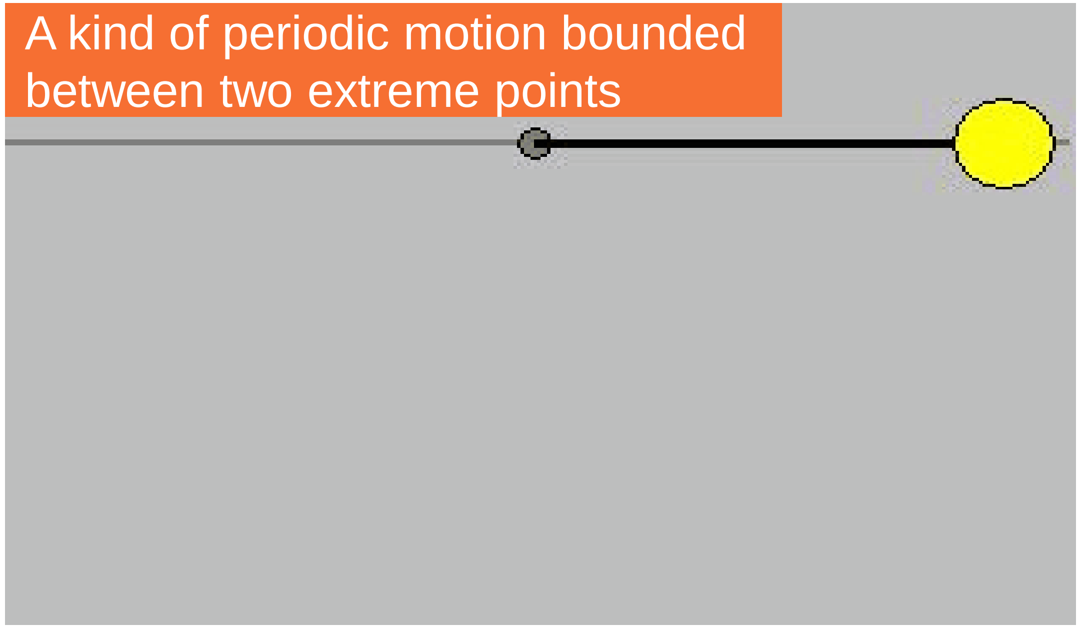
- the Earth in its orbit
- ceiling fan
- analog clock
- a water wave

Oscillatory Motion

Periodic motion of an object that moves on either side of the equilibrium (or) mean position is an oscillatory motion.

Examples:

- Power line oscillates when the wind blows past it
- Earthquake oscillations move buildings
- Block attached to a spring
- Motion of a swing
- Motion of a pendulum
- Vibrations on a stringed musical instrument
- Back and forth motion of a piston
- Vibrations of a Quartz crystal

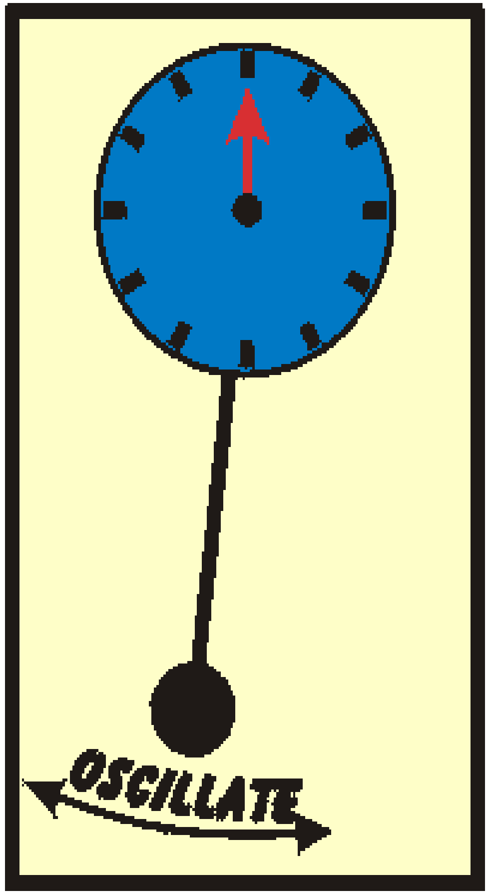


Differences

Generic Periodic Motion

- There is no equilibrium position.
- There is no restoring force

An oscillatory motion is always periodic. A periodic motion may or may not be oscillatory



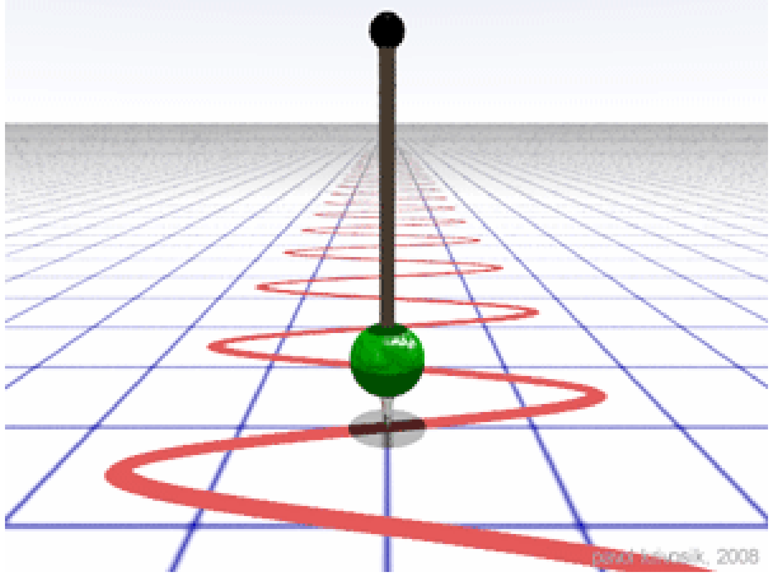
Oscillatory Motion

- There will be a restoring force directed towards the stable equilibrium position (or) mean position

Simple Harmonic Motion

The simplest kind of oscillation occurs when the **restoring** force F_x is directly proportional to the displacement from the equilibrium x, given by equation

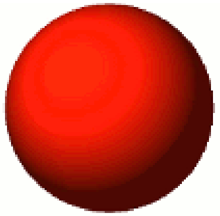
$$F_x = -kx$$



This oscillation is called a

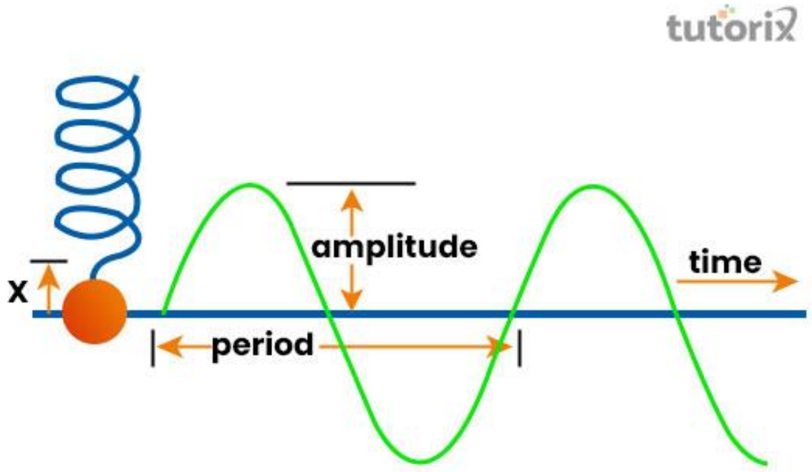
Simple Harmonic Motion(SHM).

Can a motion be oscillatory, but not simple harmonic?



When a ball is dropped from a height on a perfectly elastic plane surface, the motion of ball is oscillatory but not simple harmonic as restoring force $F=mg=$ constant and not $F \propto -y$

Definitions



Amplitude, A

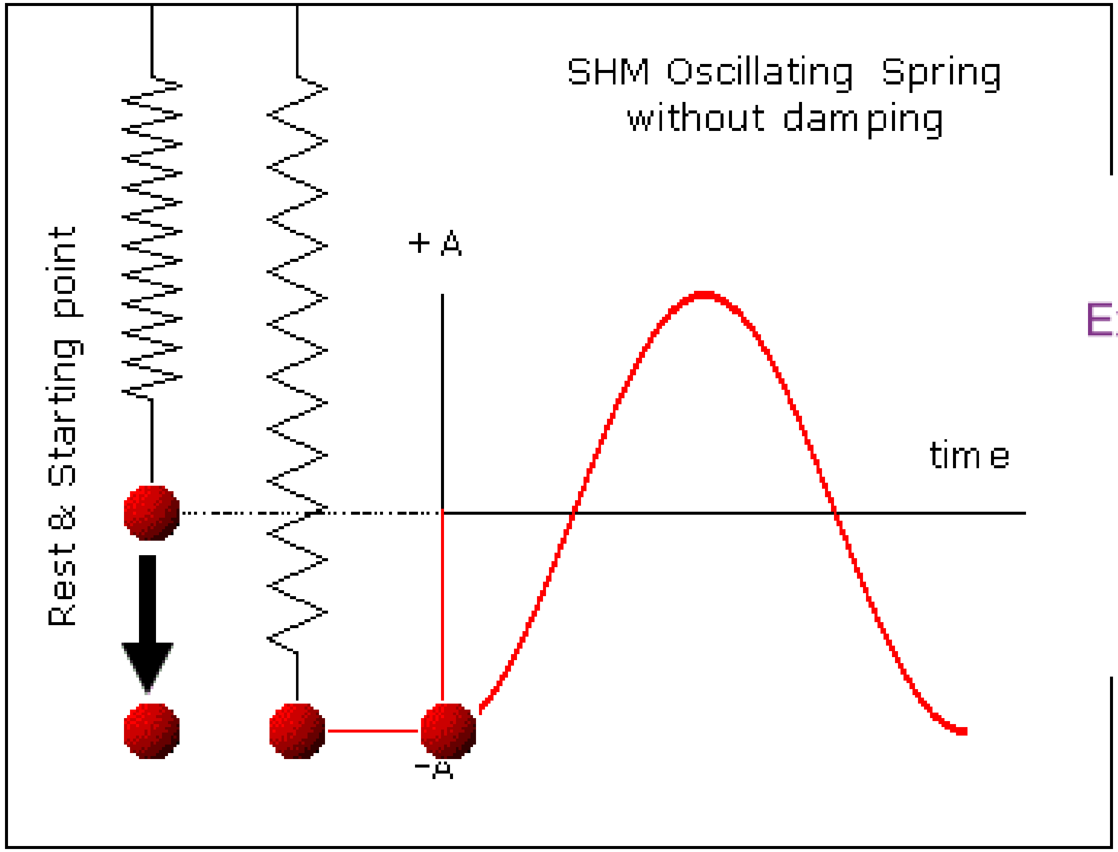
The amplitude of the motion, denoted by A, is the maximum magnitude of displacement from the equilibrium position. It is always positive

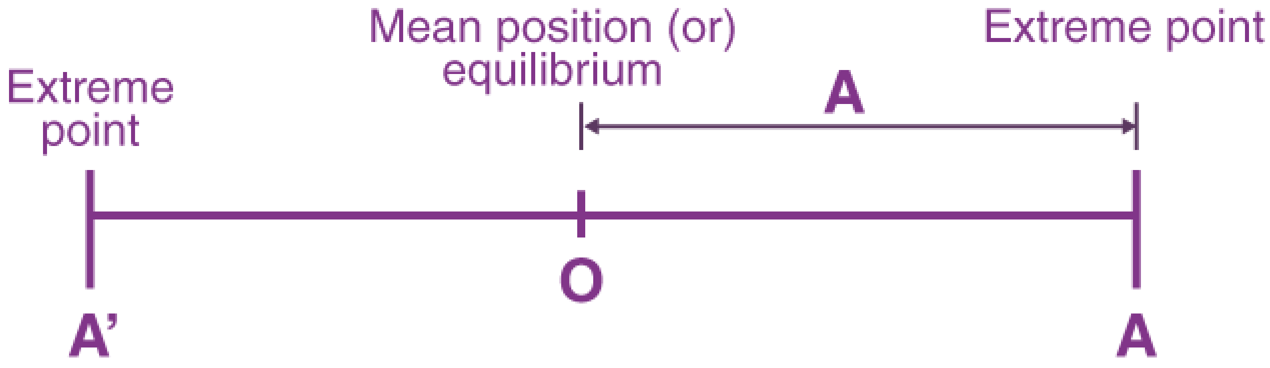
Period, T

The period T, is the time required for one complete oscillation, or a cycle.

Frequency, f

The frequency, f, is the number of cycles completed in a unit time.


SHM Oscillating Spring
without damping
Rest & Starting point
+ A
time
-A


Extreme point
Mean position (or)
equilibrium
Extreme point
A
A'
O
A

Formulae

For displacement x, velocity v, acceleration a, frequency f, time t, oscillation period T and angular frequency ω

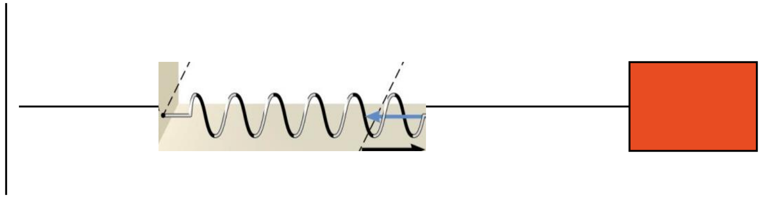
$$v = \frac{dx}{dt}$$

$$a = \frac{dv}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$$

$$f = \frac{1}{T}$$

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

BE MINDFUL OF THE UNITS



$$F = ma = -kx$$

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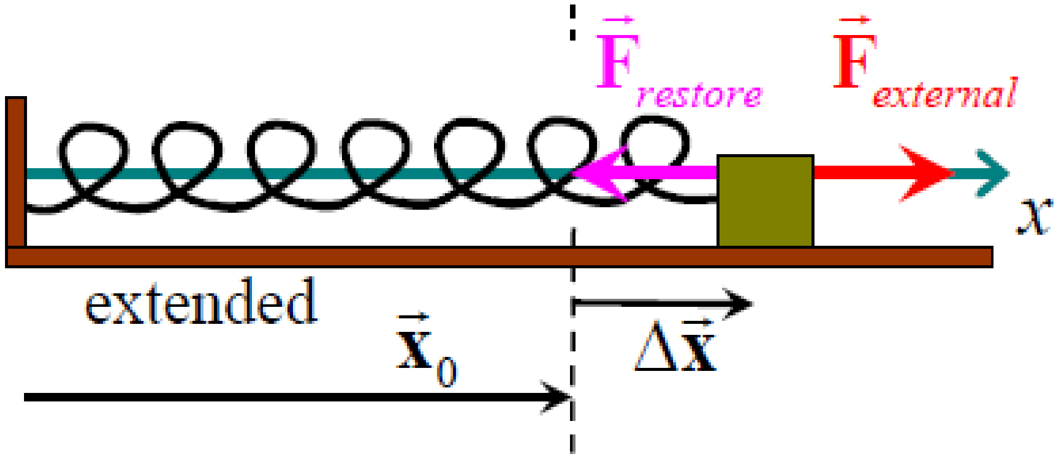
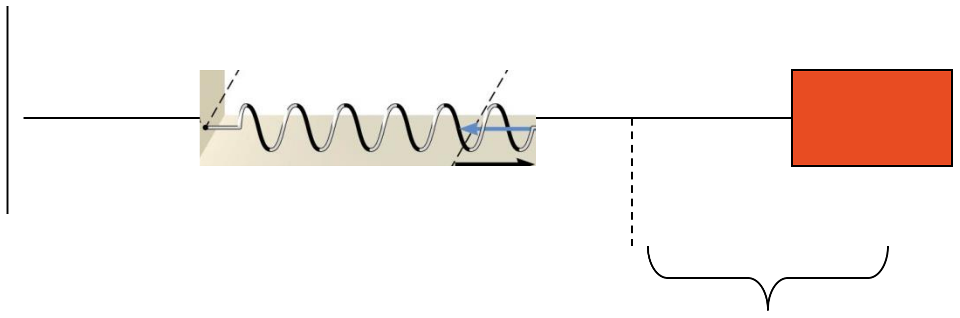
Check Your Understanding

A 0.42-kg block is attached to the end of a horizontal ideal spring and rests on a frictionless surface. The block is pulled so that the spring stretches by 2.1 cm relative to its unstrained length. When the block is released, it moves with an acceleration of 9.0 m/s^2. What is the spring constant of the spring?



180 N/m



kx = ma

$$k \times \frac{2.1}{100} = 0.42 \times 9.0 m/s^2$$

$$k = \frac{0.42 \times 9.0}{2.1} \times 100 = 180 N/m$$

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