



Fundamental Physics for Food Technology and Innovation (4011106)

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Physics Fundamentals: Units, Mass, and Volume

"Understanding the Building Blocks of Physical Measurement"

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Overview of topics to be covered:

- A. Introduction to Physics
- B. Fundamental Concepts
- C. Units and Measurements
- D. Mass
- E. Volume
- F. Density
- G. Practical Applications
- H. Review and Key Takeaways



Introduction to Physics.



What is Physics?

Definition of physics: *The study of matter, energy, and their interactions.*

Branches of physics: *Mechanics, thermodynamics, electromagnetism, optics, quantum mechanics, etc.*

Importance in everyday life: *From smartphones to medical imaging.*

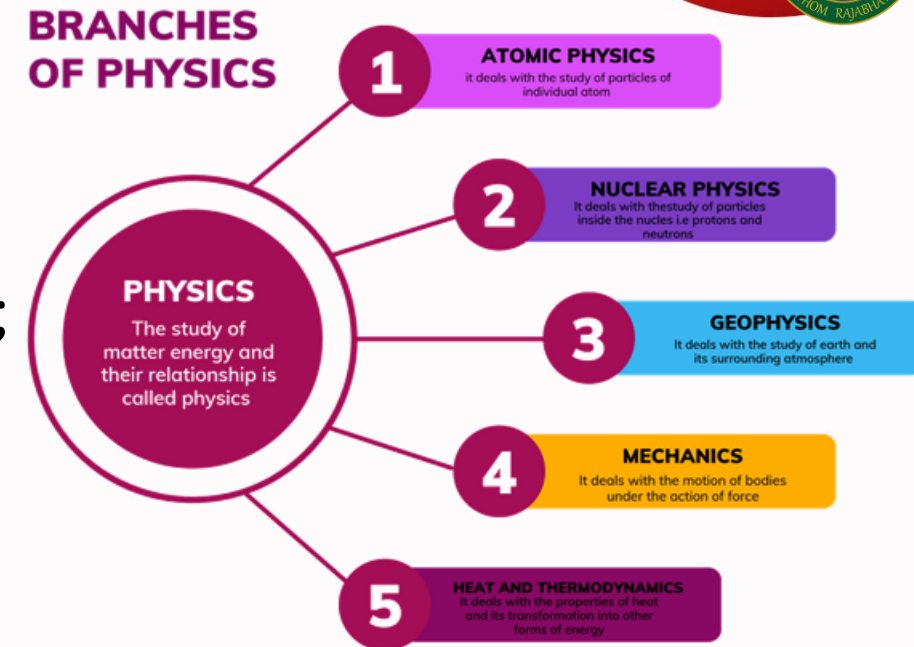


Figure 1: Branch of Physics



Fundamental Concepts.

Fundamental Concepts in Physics

Matter and energy: *The building blocks of the universe.*

Forces and motion: *How objects interact and move.*

Space and time: *The framework in which events occur.*

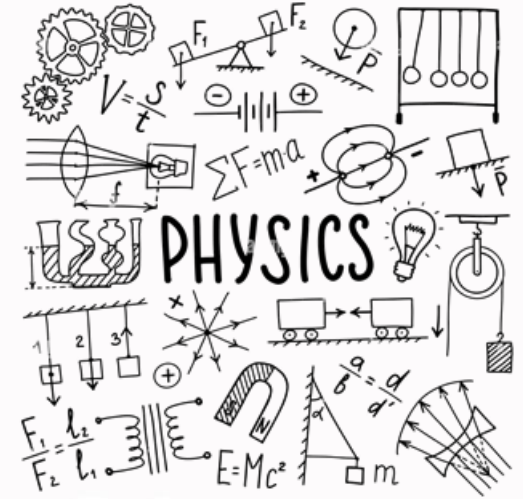


Figure 2: *Fundamental Physics Concept*



Units and Measurements.



Units and Measurements

Importance of units: *Ensuring consistency and reproducibility in scientific measurements.*

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SI units (International System of Units):
The modern metric system used globally.

Units and Measurements

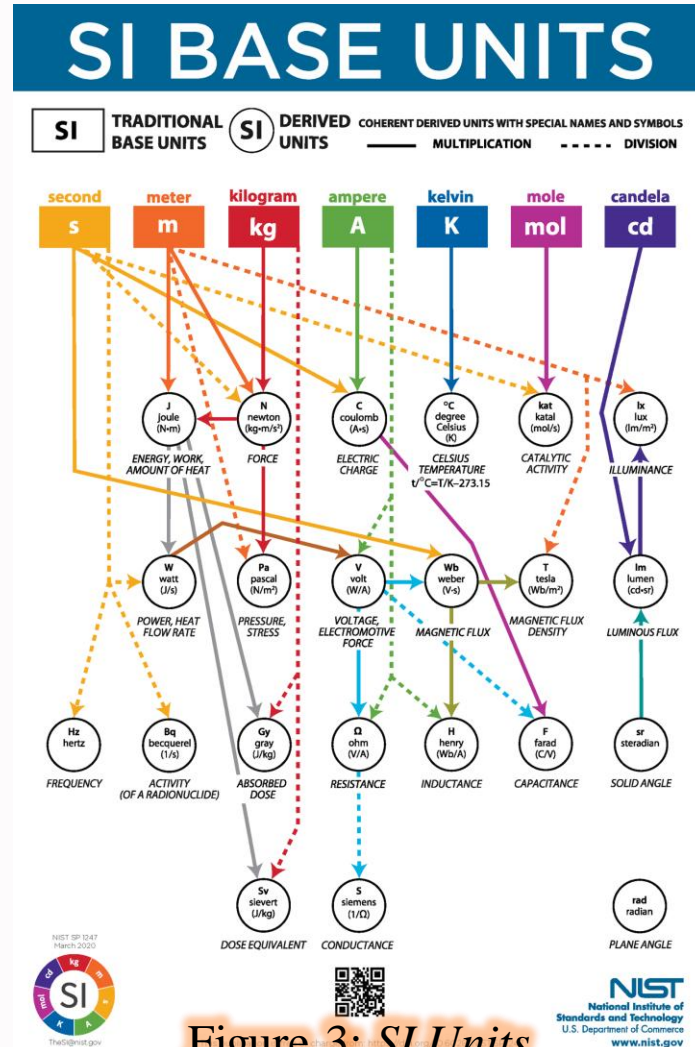


Figure 3: SI Units



Units and Measurements

Base units: *Length (m), mass (kg), time (s), electric current (A), temperature (K), amount of substance (mol), luminous intensity (cd)*

Derived units: *Formed by combining base units (e.g., force, energy)*

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Mass.

NPRU

Mass

Definition of mass: *The amount of matter in an object.*

Difference between mass and weight: *Mass is constant, weight varies with gravity.*

Units of mass: *kilogram (kg), gram (g), milligram (mg)*

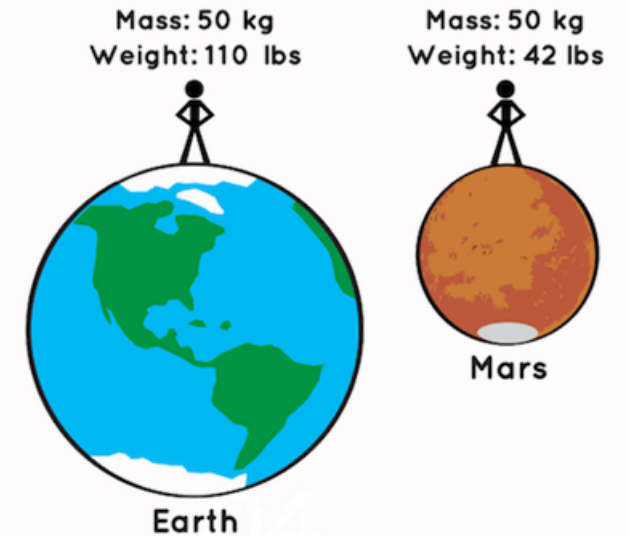


Figure 4: *Mass & Weight Comparison*

Mass

Equation: $F = ma$ (*Newton's Second Law*)

where:

F = *force (measured in Newtons, N)*

m = *mass (measured in kilograms, kg)*

a = *acceleration (measured in meters per second squared, m/s^2)*

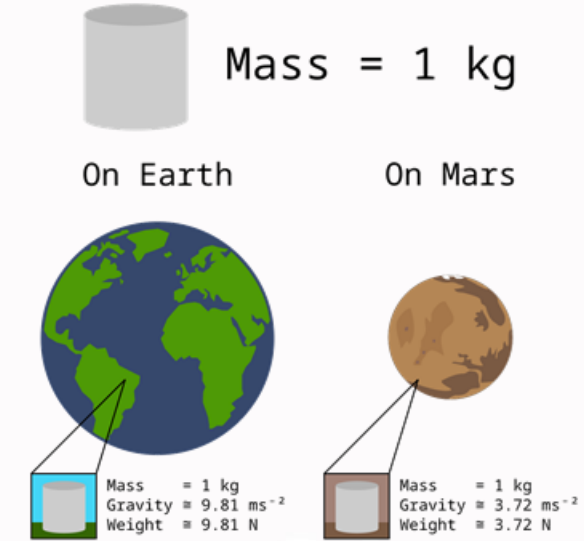


Figure 5: *Mass & Weight Comparison*



Measuring Mass.

Measuring Mass.

Balances and scales: *Tools for measuring mass.*

Inertial mass vs. gravitational mass:
Equivalence principle in physics.

Conservation of mass: *Mass cannot be created or destroyed in chemical reactions.*



Figure 6: *Type of balances*



Volume.

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Volume.

Definition of volume: *The amount of three-dimensional space occupied by an object.*

Units of volume: *cubic meter (m^3), liter (L), milliliter (mL)*

Relationship between volume and dimensions.



Figure 7: Volume Measurement Methods



Volume.

Equation: $V = l \times w \times h$ (*for rectangular objects*)

where:

$V = \text{volume}$

$l = \text{length}$

$w = \text{width}$

$h = \text{height}$

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Measuring Volume.

Measuring Volume.

Graduated cylinders: *For measuring liquid volume.*

Displacement method: *For measuring volume of irregular solids.*

Irregular shapes: *Using water displacement or 3D scanning techniques.*

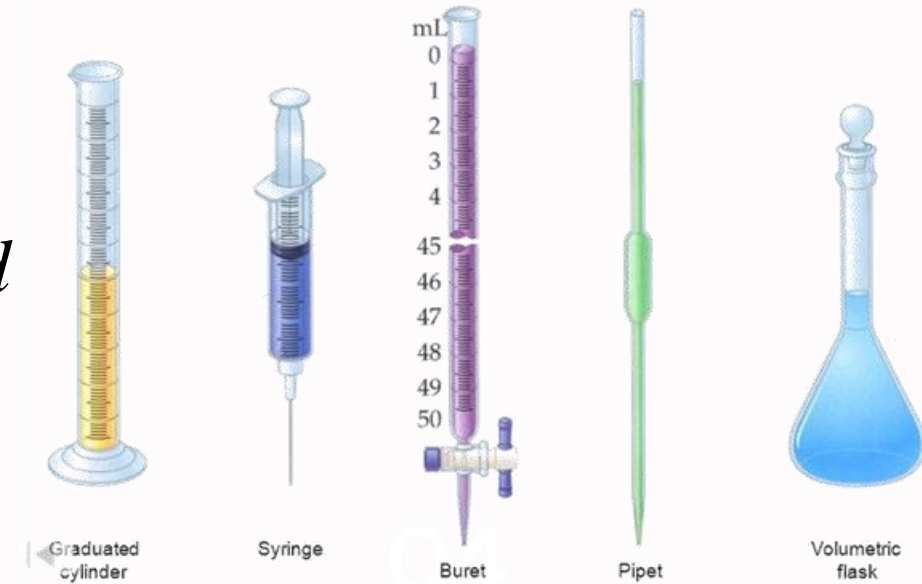


Figure 8: Volume Measurement Tools



Density.

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Density.

Definition of density: *Mass per unit volume of a substance.*

Relationship between mass and volume:
Density as an intensive property.

Units of density: *kilograms per cubic meter (kg/m^3), grams per cubic centimeter (g/cm^3).*

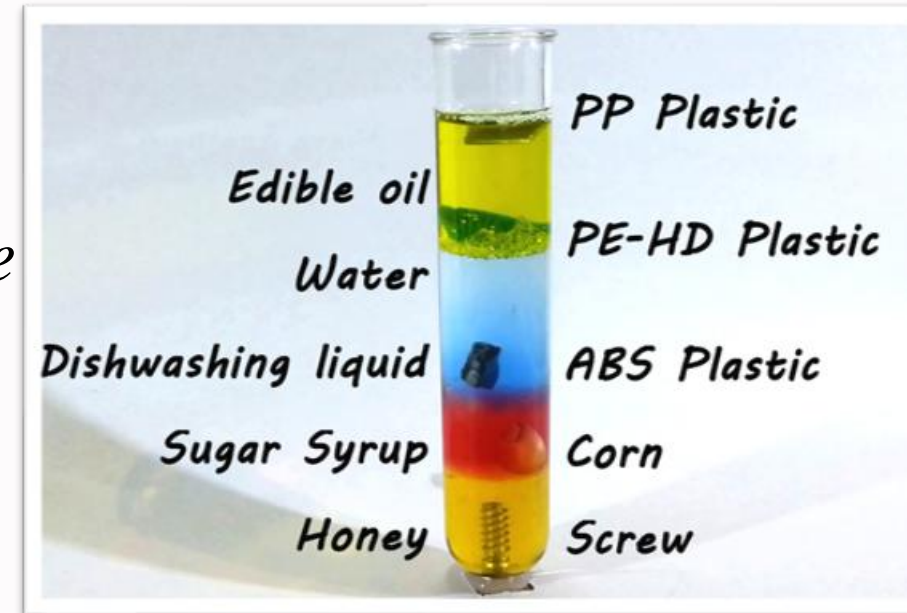


Figure 9: Density Comparison of Materials



Density.

Equation: $\rho = m / V$

where:

ρ (rho) = *density*

m = *mass*

V = *volume*

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Practical Applications.

Practical Applications.

Buoyancy and Archimedes' principle:
Objects immersed in fluid experience an upward force.

Material science and engineering: *Selecting materials based on density for specific applications.*

Archimedes' principle

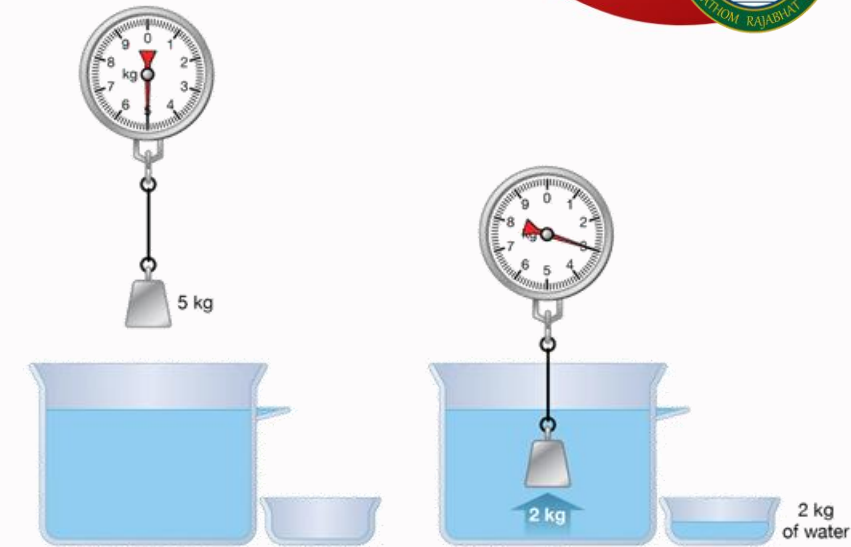


Figure 10: Archimedes principle diagram



Practical Applications.

Equation: $FB = \rho_{fluid} \times V \times g$ (*Buoyant force*)

where:

FB = *buoyant force* ρ_{fluid} = *density of the fluid*

V = *volume of fluid displaced* g = *acceleration due to gravity (approximately 9.8 m/s^2 on Earth)*

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Review and Key Takeaways.

Review and Key Takeaways.

Importance of units in physics: *Ensuring clear communication and reproducibility in scientific measurements.*

Relationship between mass, volume, and density: *Understanding how these properties interact.*

Real-world applications: *From designing ships to creating new materials.*

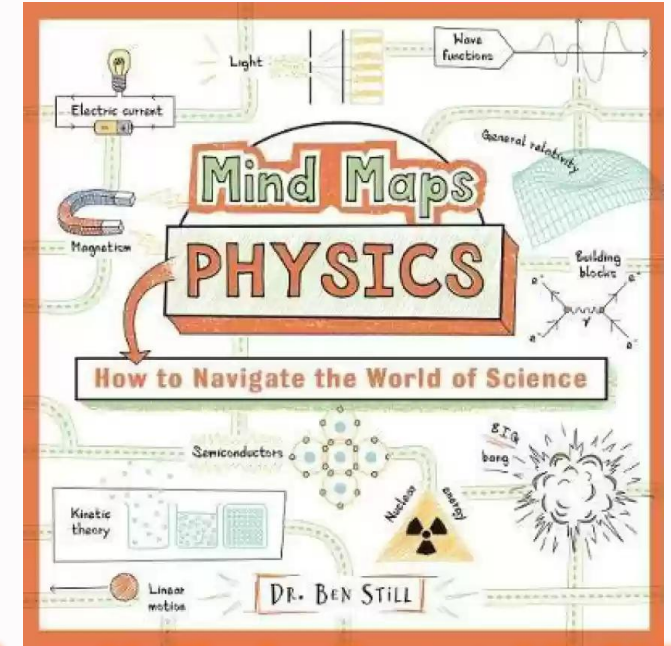


Figure 11: Physics Concepts Mind Map



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