EDO UNIVERSITY IYAMHO
Department of Physics
PHY 111 GENERAL PHYSICS I

Instructors:
1. Olayinka, S. A. (Ph.D.)
   Email: akinola.olayinka@edouniversity.edu.ng
   Phone: (+234) 8062447411

2. Adekoya, M. A
   Email: adekoya.mathew@edouniversity.edu.ng
   Phone: (+234) 7038891545

3. Ukhurebor, Kingsley Eghonghon
   Email: ukhurebor.kingsley@edouniversity.edu.ng
   Phone: (+234) 8035383194

   Lectures: Monday, 9.00am – 10.00am and Wednesday, 8.00am – 10.00am
   Venue: NLT1,
   Office hours: Monday-Friday, 8.00am to 6.00 pm, Office: Dept of Physics, Floor 2 Rm 4

Description: This course is intended to give the students a thorough knowledge of physics in relation to modern mechanics and its applications.
This course covers topics such as Measurements, Rectilinear Motion, Vector Space, Kinematics and Dynamics, Work, Energy and Power etc.

Prerequisites: Students should be;
familiar some terms in physics and able to differentiate between Fundamental and Derived Units.
to solve some basic problems using (Arithmetic, Multiplication. Division etc).

Assignments: We expect to have 5 individual homework assignments throughout the course in addition to a Mid-Term Test and a Final Exam. Home works are due at the beginning of the class on the due date. Home works are organized and structured as preparation for the midterm and final exam and are meant to be a studying material for both exams. There will also be 3 individual programming projects in this class. The goal of these projects is to have the students experiment with very practical aspects of compiler construction and program analysis.

Grading: We will assign 10% of this class grade to home works, 10% for the projects, 10% for the mid-term test and 70% for the final exam. The Final exam is comprehensive.

Textbook: The recommended textbooks for this class are as stated:
Title: Fundamentals of Physics

Authors: Halliday and Resnick
Edition : 9th Edition

Title: Applied Physics
Author: Arthur Beiser
Publisher: McGraw Hill
Edition: 4th Edition

Title: College Physics
Authors: Chris Vuille and Raymond Serway
Publisher: Brooks/ Cole
Edition: 8th Edition

Lectures: Below is a description of the contents.

Measurement

Measurements of physical quantities take place by means of a comparison with a standard. For example: a meter stick, a weight of 1 kilogram, etc.

Fundamental Units

Those physical quantities which are independent to each other are called fundamental quantities and their units are called fundamental units.

S/N	**Fundamental Quantities**	**Fundamental Units**	**Symbol**
1	Length	Metre	m
2	Mass	Kilogram	kg
3	Time	Second	s
4	Temperature	Kelvin	K
5	Amount of Substance	Mole	Mole
6	Electric Current	Ampere	A
7	Luminous Intensity	Candela	Cd

Supplementary Fundamental Units

Radian and steradian are two supplementary fundamental units. It measures plane angle and solid angle respectively.

S/N	**Supplementary Fundamental Quantities**	**Supplementary Unit**	**Symbol**
1	Plane angle	radian	rad
2	Solid angle	steradian	Sr

Those physical quantities which are derived from fundamental quantities are called **derived quantities** and their units are called **derived units**. e.g., velocity, acceleration, force, work etc

Systems of Units

A system of units is the complete set of units, both fundamental and derived, for all kinds of physical quantities. The common system of units which is used in mechanics is given below:

1. **CGS System** In this system, the unit of length is centimetre, the unit of mass is gram and the unit of time is second.
2. **FPS System** In this system, the unit of length is foot, the unit of mass is pound and the unit of time is second.
3. **MKS System** In this system, the unit of length is metre, the unit of mass is kilogram and the unit of time is second.
4. **SI System** This system contains seven fundamental units and two supplementary fundamental units.

Relationship between Some Mechanical SI Unit and Commonly Used Units

S/N	Physical Quantity	Unit
1	Length	(a) 1 micrometre = 10^{-6} m (b) 1 angstrom =10^{-10} m
2	Mass	(a) 1 metric ton = 10^{3} kg (b) 1 pound = 0.4537 kg (c) 1 amu = 1.66 x10^{-23} kg
3	Volume	
4	Force	(a) 1 dyne = 10^{-5} N (b) 1 kgf = 9.81 N
5	Pressure	(a) 1 kgfm2 = 9.81Nm^{-2} (b) 1 mm of Hg = 133 Nm^{-2} (c) 1 pascal = 1 Nm^{-2} (d) 1 atmosphere pressure = 76 cm of Hg = 1.01 x 10^{5} pascal
6	Work and energy	(a) 1 erg =10^{-7} J

		(b) 1 kgf-m = 9.81 J (c) 1 kWh = 3.6×10^6 J (d) 1 eV = 1.6×10^{-19} J
7	Power	1 horse power = 746 W

Some Practical Units

1. 1 fermi =10^{-15} m
2. 1 X-ray unit = 10^{-13} m
3. 1 astronomical unit = 1.49×10^{11} m (average distance between sun and earth)
4. 1 light year = 9.46×10^{15} m
5. 1 parsec = 3.08×10^{16} m = 3.26 light year

Some Approximate Masses

Object	**Kilogram**
Our galaxy	2×10^{41}
Sun	2×10^{30}
Moon	7×10^{22}
Asteroid Eros	5×10^{15}

Dimensions

Dimensions of any physical quantity are those powers which are raised on fundamental units to express its unit. The expression which shows how and which of the base quantities represent the dimensions of a physical quantity, is called the dimensional formula

S/N	**Physical Quantity**	**Dimensional Formula**	**MKS Unit**
1	Area	L^2	metre^2
2	Volume	L^3	metre3
3	Velocity	LT^{-1}	ms^{-1}
4	Acceleration	LT^{-2}	ms^{-2}
5	Force	MLT^{-2}	newton (N)
6	Work or energy	ML^2T^{-2}	joule (J)
7	Power	ML^2T^{-3}	J s^{-1} or watt

8	Pressure or stress	$ML^{-1}T^{-2}$	Nm^{-2}
9	Linear momentum or Impulse	MLT^{-1}	kg ms^{-1}
10	Density	ML^{-3}	kg m^{-3}
11	Strain	Dimensionless	Unitless
12	Modulus of elasticity	$ML^{-1}T^{-2}$	Nm^{-2}
13	Surface tension	MT^{-2}	Nm^{-1}
14	Velocity gradient	T^{-1}	$second^{-1}$
15	Coefficient of viscosity	$ML^{-1}T^{-1}$	kg $m^{-1}s^{-1}$
16	Gravitational constant	$M^{-1}L^{3}T^{-2}$	$Nm^{2}kg^{-2}$
17	Moment of inertia	ML^{2}	kg m^{2}
18	Angular velocity	T^{-1}	rad/s
19	Angular acceleration	T^{-2}	rad/S^{2}
20	Angular momentum	$ML^{2}T^{-1}$	kg $m^{2}S^{-1}$

Homogeneity Principle

If the dimensions of left hand side of an equation are equal to the dimensions of right hand side of the equation, then the equation is dimensionally correct. This is known as **homogeneity principle.**

Mathematically [LHS] = [RHS]

Example

Applications of Dimensions

1. To check the accuracy of physical equations.
2. To change a physical quantity from one system of units to another system of units.
3. To obtain a relation between different physical quantities.

Limitation of Dimensions

1. It does not give information about the dimension constant
2. It gives no information whether a physical quantity is scalar or vector

Motion in a Straight Line

The world, and everything in it, moves. Even seemingly stationary things, such as a roadway, move with Earth's rotation, Earth's orbit around the Sun, the Sun's orbit around the center of the Milky Way galaxy, and that galaxy's migration relative to other galaxies. The classification and comparison of motions (called **kinematics**) is often challenging.

Displacement, Velocity and Speed

The displacement of a particle is defined as its change in position. As it moves from an initial position x_i to a final position x_f its displacement is given by $x_f - x_i$. Therefore, the displacement, or change in position, of the particle as

$$\Delta x = x_f - x_i \quad (1)$$

Displacement is an example of a vector quantity. Many other physical quantities, including velocity and acceleration, also are vectors. In general, a vector is a physical quantity that requires the specification of both direction and magnitude. By contrast, a scalar is a quantity that has magnitude and no direction.

An object that changes its position has a non-zero velocity. The average velocity $\overline{v_x}$ of a particle is defined as the particle's displacement Δx divided by the time interval Δt during which that displacement occurred:

$$\overline{v_x} = \frac{\Delta x}{\Delta t} \quad (2)$$

where the subscript x indicates motion along the x axis.

In everyday usage, the terms *speed* and *velocity* are interchangeable. The average speed of a particle, a scalar quantity, is defined as the total distance traveled divided by the total time it takes to travel that distance:

$$Average\,speed = \frac{Total\ dis\tan ce}{Time\ Taken} \quad (3)$$

Instantaneous Velocity and Speed

Instantaneous velocity v_x equals the limiting value of the ratio $\Delta x / \Delta t$ as Δt approaches zero

$$v_x \equiv \lim_{x \to 0} \frac{\Delta x}{\Delta t} \quad (4)$$

In calculus notation, this limit is called the *derivative* of x with respect to t, written dx/dt:

$$v_x \equiv \lim_{x \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} \quad (5)$$

The instantaneous velocity can be positive, negative, or zero. The instantaneous speed of a particle is defined as the magnitude of its velocity. As with average speed, instantaneous speed has no direction associated with it and hence carries no algebraic sign

Acceleration

The average acceleration of the particle is defined as the *change* in velocity Δv_x divided by the time interval Δt during which that change occurred:

$$\overline{a_x} \equiv \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{t_f - t_i} \quad (6)$$

In some situations, the value of the average acceleration may be different over different time intervals. It is therefore useful to define the *instantaneous acceleration* as the limit of the average acceleration as Δt approaches zero. Instantaneous acceleration is given as:

$$a_x \equiv \lim_{x \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt} \quad (7)$$

That is, the instantaneous acceleration equals the derivative of the velocity with respect to time, which by definition is the slope of the velocity–time graph.

One-Dimensional Motion with Constant Acceleration

If the acceleration of a particle varies in time, its motion can be complex and difficult to analyze. However, a very common and simple type of one-dimensional motion is that in which the acceleration is constant. When this is the case, the average acceleration over any time interval equals the instantaneous acceleration at any instant within the interval, and the velocity changes at the same rate throughout the motion.

If we replace $\overline{a_x}$ by a_x in Equation 5 and take $t_i = 0$ and t_f to be any later time t, we find that

$$a_x = \frac{v_{xf} - v_{xi}}{t}$$

Or

$$v_{xf} = v_{xi} + a_x t \qquad (8)$$

Because velocity at constant acceleration varies linearly in time according to Equation 7, we can express the average velocity in any time interval as the arithmetic mean of the initial velocity v_{xi} and the final velocity v_{xf} :

$$\overline{v}_x = \frac{v_{xi} + v_{xf}}{2} \qquad (9)$$

We can now use Equations 1, 2, and 9 to obtain the displacement of any object as a function of time

$$x_f - x_i = \overline{v}_x t = \frac{1}{2}\left(v_{xi} + v_{xf}\right)t \qquad (10)$$

We can obtain another useful expression for displacement at constant acceleration by substituting Equation 8 into Equation 10:

$$x_f - x_i = \frac{1}{2}\left(v_{xi} + v_{xi} + a_x t\right)t$$
$$x_f - x_i = v_{xi}t + \frac{1}{2}a_x t^2 \qquad (11)$$

We can check the validity of Equation 11 by moving the x_i term to the right-hand side of the equation and differentiating the equation with respect to time

$$v_{xf} = \frac{dx_f}{dt} = \frac{d}{dt}\left(x_i + v_{xi}t + \frac{1}{2}a_x t^2\right) = v_{xi} + a_x t \qquad (12)$$

Finally, we can obtain an expression for the final velocity that does not contain a time interval by substituting the value of t from Equation 8 into Equation 10:

$$x_f - x_i = \frac{1}{2}\left(v_{xi} + v_{xf}\right)\left(\frac{v_{xf} - v_{xi}}{a_x}\right) = \frac{{v_{xf}}^2 - {v_{xi}}^2}{2a_x}$$

$$v_{xf}^{\ 2} = v_{xi}^{\ 2} + 2a_x\left(x_f - x_i\right) \quad (13)$$