Lecture # 01

Introduction To Physics

What is Physics ? explain

Physics :

Physics is a science and science work according to a scientific method. The scientific method does not except only reasons but they properly do experiment by complete process of reason, logics, and then according to a experimental evidence they tell that what is scientifically correct and what is not. Scientists do not believe simply, they test and keep testing until satisfied.

Laws Of Physics :

We cannot change laws of physics from place to place. Laws of physics today are the same as they were in the past.

This course will cover the following broad categories.

Classical Mechanics :

classical mechanics

↓

motion - movement

It is the study of motion under the action of force.
They also known as newtonian mechanics.

Electromagnetism :

electromagnetism

electricity ↓ magnetic field

charges - current
+ive and -ive

It is the study of charges under the action of electric and magnetic field. In electromagnetism we can also see that how a charges can create a both fields.

Thermal Physics :

Thermal

↓

Heat حرارة

It is the study of nature of heat and also about the changes occur in matter when we heat the matter.

Quantum Physics :

Quantum

↓

atom, nuclei, quark etc

It is the study of small object.
It's related with chemistry.

Physical Quantities :

All the observable and measureable quantities are called physical quantity.
Every physical quantity can be expressed in terms of three fundamental dimensions which is ;
Mass (M), Length (L), Time (T).

Dimension :

Speed	LT^{-1}
Energy	$ML^{2}T^{-2}$
Force	MLT^{-2}

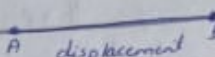
Don't Confuse In Unit / Dimension :

We can find dimension by the help of formula While every value have it's own unit.

Kinematics I

Displacement :

The shortest distance b/w two points are called displacement.



It denote the position of body at time.

If the displacement is on left side, then it is negative.	If displacement is on right side then it is positive.
←	→
	0

Displacement = $D = x_2 - x_1$

It is a vector quantity.

Speed :

Time rate of change of distance of a body.

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$v = \frac{d}{t}$$

It is a scalar quantity and It's SI unit is ms^{-1}.

Velocity :

The rate of change of displacement of a body at time Δt.

$$v = \frac{\Delta x}{\Delta t}$$

$$v = \frac{x_2 - x_1}{t_2 - t_1}$$

Acceleration :

The rate of change of distance of a body at time Δt.

$$a = \frac{\Delta v}{\Delta t}$$

$$a = \frac{v_f - v_i}{\Delta t}$$

Negative acceleration is called deceleration and the speed of decelerating body decrease with time.

Constant Acceleration :

If a body move in a same sequence, speed, acceleration then the body is in constant acceleration

$v = at + v_0$ → speed

↙ velocity

Constant speed

$$x = x_0 + vt$$

As, there is a direct relation ship between $v \propto t$.

Vectors :

A quantity that has a size, direction as well as magnitude

A vector has a three component
x - component
y - component
xy - axes component

→ $x = r\cos\theta$

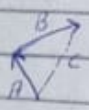
$y = r\sin\theta$

$x^2 + y^2 = r^2$

Also, $\tan\theta = y/x$

- Two vectors can be added geometrically We can add two vectors with the help of resultant vector.

$$C = A + B$$



Two vector's can be added algebraically.

$$(x, y) + (a + b)$$

Lecture # 03

Kinematics II

Kinematics :

Kinematic

motion — In [redacted] mass

- $\text{Slope} = \tan\theta = \frac{dx}{dt}$

In the above eq it is show that how a function [redacted] changes within it's arguments changed.

- Function $f(x)$ can also be written as $x(t)$ or any variable (a ··· to ··· z).

- $$\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$
$$= \lim_{\Delta t \to 0} \frac{x(t+\Delta t) - x(t)}{\Delta t}$$

- We can calculate the derivative of a simple function

As $\Delta x = (t+\Delta t)^2 - t^2$

By applying a squave formula

$\Delta x = t^2 + \Delta t^2 + 2t\Delta t - t^2$

$$\Delta x = \Delta t^2 + 2t\,\Delta t$$
$$\Delta x = \Delta t\,(\Delta t + 2t)$$
$$\frac{\Delta x}{\Delta t} = \Delta t + 2t$$

Now,
$$\lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{d\,\Delta t}{dt} + \frac{d\,2t}{dt}$$
$$\frac{dx}{dt} = 2$$

- We can also take derivative of a power function
$$\frac{d}{dx} = x^3$$

Taking derivation
$$\frac{d}{dx} = 3x^2$$

- For a constant acceleration.
$$x(t) = x_0 + v_0 t + \frac{1}{2} a t^2$$

Taking derivation w.r.t 't'
$$\frac{dx}{dt} = \frac{d}{dt} x_0 + \frac{d}{dt} v_0 t + \frac{d}{dt} \frac{1}{2} a t^2$$
$$\frac{dx}{dt} = 0 + v_0 + \frac{1}{2} a\,(2t)$$
$$\frac{dx}{dt} = v_0 + \frac{1}{2}(2at)$$
$$\frac{dx}{dt} = v_0 + at$$

Now, take derivation w.r.t 'v'

$$\frac{dv}{dt} = \frac{d}{dt} v_0 + \frac{d}{dt} at$$

$$\frac{dv}{dt} = 0 + a$$

$$\frac{dv}{dt} = a$$

So, acceleration (a) is constant.

- We can also take a double derivative of function.

- Scalar Product:

$$A \cdot B = AB \cos\theta$$

It can also be written as

$$A \cdot B = (A)(B \cos\theta)$$

Here,

A = Length of A

B = Projection of B on A.

We can also write as

$$A \cdot B = (B)(A \cos\theta).$$

Lecture # 04

Force And Newton

- **Force:**
  The effect or influence that produces a change in a body is called force.
- **Inertia:**
  A tendency of a body to maintain it's state of rest or a uniform motion unless using any external force

Newton's First Law of Motion:
It states that if a body is at rest or moving with a constant speed in a straight line, It will remain at rest or moving in a straight line unless acted upon by external force.

1st Law of motion is also called law of inertia.

Mathematically:

$F_{net} = 0$ then $a = 0$

Newton Second Law Of Motion:

"The acceleration of a body is directly proportional to the net force and inversly proportional to mass of a body"

Mathematically:

$$a \propto F \quad \text{---(1)}$$

$$a \propto \frac{1}{m} \quad \text{---(2)}$$

Combining (1) and (2)

$$a \propto \frac{F}{m}$$

$$a = K \frac{F}{m}$$

As, K = constant = 1

$$a = \frac{F}{m}$$

$$F = ma$$

Dimension:

As we know that

Force = F

Mass = M

$$\text{Acceleration} = \frac{L}{T^2} = L^1T^{-2}$$

Now,

$$F = ma$$

$$F = M^1L^1T^{-2}$$

- Forces are vector, so they can be added vertically
  $F = F_1 + F_2 + \dots$
- Galileo had established the concept of gravity.
- The weight and mass are two different quantities

Newton Third Law Of Motion:

"Every action has a reaction in a same magnitude but in a opposite direction"

OR

"When two bodies interact they apply forces to one another that are equal in magnitude but opposite in direction.

Third law is also known as law of action and reaction.

Mathematically:

$$F_{AB} = -F_{BA}$$

Lecture # 05

Applications Of Newton Law-I

- As we know that

$$F = ma$$

If $F = 0$

Then,

$$\frac{F}{m} = a$$

$$\frac{0}{m} = a$$

$$\Rightarrow a = 0$$

Equilibrium:

Equilibrium means a stable situation in which forces cancel the effect of one another.

Example of In-equilibrium:

* a stone resting on the ground
* a pencil balanced on finger
* a ladder placed against wall

Example Of Out-equilibrium:

* a stone thrown upwards that is its highest point
* a plane diving downward

etc —

- We can find the force of a body if we know the acceleration of body.

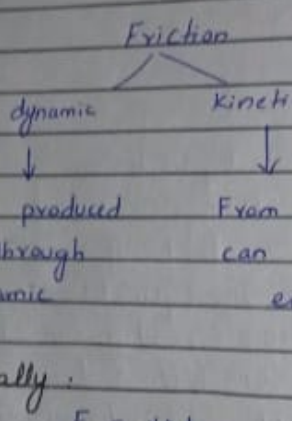
Tension:

It is a streess that produces an elongation of elastic physical body

It is denoted by T.

Friction:

When a two bodies rub against each other than a friction is produced & opposite to the its direction of motion.



Mathematically:

$$F = \mu N$$

Friction — Force.

The sign μ is called the co-efficient of friction.

Friction is large for rough surface and small for smooth surface.

- If we want to find tension and acceleration then.

$$T = \frac{m_2 F}{m_1 + m_2}$$

and

$$a = \frac{F}{m_1 + m_2}$$

- The sum of all the forces in a equilibrium is equal to zero.

$$F = F_1 + F_2 + F_3 + \cdots$$

$$F = 0$$

and we can also write as.

$$F_x = F_y = F_z = 0$$

Lecture # 06

Applications of Newton's Law II

- As we know that acceleration is directly proportional to Force and inversly proportional to mass.

$$a \propto F$$

$$a \propto \frac{1}{m}$$

$$a \propto \frac{F}{m}$$

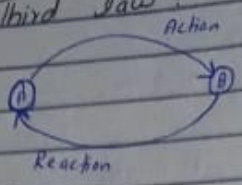
$F \propto ma$

$F = kma$

If $k = 1$

$F = ma$

Newton's Third law:



Every action has a reaction equal in magnitude but opposite in direction

- The direction of fluid resistance on a body is always opposite to the direction of the body's velocity.
- The magnitude of fluid resistance usually increase within the speed of the body through fluid.

As,

$f = kv$

when

$mg = kv$

$v = mg/k$

- $T\cos\theta = mg$

  $T\sin\theta = ma$

  $\tan\theta = a/g \Longrightarrow \tan\theta = \frac{\sin\theta}{\cos\theta}$

  $\tan\theta = a/g$

- Friction force always act in the opposite direction.

e.g.

Imagine a block, if we push it forward, friction will act backward.

Lecture # 07

WORK AND ENERGY

Work

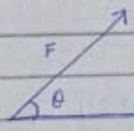
The dot product of force and displacement is called work.

Mathematically:

$$W = F \cdot d$$

Work is a scalar quantity.

Force must be in the direction of displacement.



Here,

$$W = Fd\cos\theta$$

Maximum Work:

If the angle b/w work and displacement is 0°, then the work is maximum

Minimum Work:

If the angle b/w work and displacement is 90°, then a minimum work will be done

Dimension:

$$W = Fd$$
$$F = ma = MLT^{-2}$$
$$d = L$$

So,

$$W = MLT^{-2} \cdot L$$
$$W = ML^2T^{-2}$$

Unit:

The unit of work is Joule.

- The sum of all the work is,

$$W = \Delta W_1 + \Delta W_2 + \cdots + \Delta W_3$$
$$W = F_1\Delta x + F_2\Delta x + \cdots + F_n\Delta x$$

So,

$$\sum F_n \Delta x = W$$

Energy:

The ability of a body to do work is called energy.

Types:

mechanical
electrical
nuclier
sound
etc.

- Energy can be stored and convert from one place to another.
- Energy neither be created nor be destroyed

$$W = F \cdot d \quad \text{— (A)}$$

As,

$$F = ma \quad \text{— (1)}$$

$$2ad = v^2 \quad \text{— (2)}$$

Put (1) and (2) in (A)

$$W = (ma) \cdot d$$

$$W = \frac{mv^2}{2d} \cdot d$$

$$W = \frac{mv^2}{2}$$

$$W = \frac{1}{2} mv^2$$

$2ad = v^2$
$a = \frac{v^2}{2d}$

This work done is converted into a kinetic energy.

Power :

The Workdone by a body in a unit time is called power.

Mathematically :

$$P = \frac{W}{t} \Rightarrow P = \frac{F \Delta x}{\Delta t}$$

As, $\frac{\Delta x}{\Delta t} = v$, so $P = Fv$