

Change of Laws of Physics

اس وقت سے experiment 3000 years old
caused Scientist diff countries
to get same result by same experiment
-

3- Course cover follow Categories

a) Classical Mechanics

اس میں Motion کے discuss کیا جاتا ہے کہ
مکان، کسی چیز کی حرکت motion اس کا
مکمل - اس چیز کو دیکھا جاتا ہے۔

which deals with the Eng definition
The Motion of bodies under the
action of force. This is often
called Newtonian Mechanics as well.
مطلب کسی چیز پر کوئی force لگائی جا رہی ہے۔
چیز پر زور لگاتا اس کو push کرنا
اب اس کے action سے وہ body
مکمل ہے۔ مطلب force لگائی ہے body
Motion / Movement / action of
مکمل ہے Classical Mechanics

• Unde definition

action of force on body
classical mechanics
مکمل ہے body پر force لگائی جا رہی ہے اس کے
classical mechanics

Lecture - 1 Introduction to physics

By YOUTUBE Lecture

- Physics is a science.
- Science works a/c to scientific Method.

Scientific Method

اس میں Reason صرف Logic سے زیادہ ہے۔
accept نہیں کیا جاتا بلکہ Experiment proper سے
ہوتا ہے۔ Experiment proper کے through سے
ہوتا ہے کہ Condition / Statement Correct ہے یا نہیں۔

Physics میں Scientific اس میں proper
experiment کے method سے ہے۔
experiment correct ہے یا نہیں۔
evidence کے through سے کیا جاتا ہے کہ Correct ہے یا نہیں۔

2- Physics laws

Physics of law میں وہ ایسا قانون ہے جسے
Change نہیں ہوتا۔

Physics کے laws ان experiment سے
پائے جاتے ہیں۔ ان کو different countries میں
دیکھ کر scientist experiment کے through سے
پتہ چلتا ہے کہ law Physics میں correct ہے یا نہیں۔

b) Electromagnetism:-

بیاضی ہے electric کی بات ہے وہاں charges -ve, +ve
ہیں۔ Magnetism کی بات ہے وہاں field کی بات ہے۔

● Urdu Definition :-

”to study how charges behave under the influence of electric and magnetic fields as well as create these fields.“

● English Definition :-

How charges behave under the influence of electric and magnetic fields as well as understand how charges can create these fields.

← charges کی field کی create کی بات ہے۔
← charges کی behavior کی بات ہے field کے influence میں رکھ دیا جاتا ہے۔

c) Thermal Physics:-

Eng defina:- Studies the Nature of heat and the changes that the addition of heat brings about in matter.”

← جب مادہ / matter میں heat آتی ہے تو اس کے about دیکھا جاتا ہے کہ اس میں تبدیلی کیا آ رہی ہے۔ اور heat کی Nature کے بارے میں discuss کیا جاتا ہے۔

d) Quantum Mechanics-

"Deals with the physics of small objects such as atoms, nuclei, Quarks, etc. Quantum mechanism will be treated only briefly for lack of time."

- Nuclei, atoms are objects small enough
- & to discuss related Quarks

4- Every physical quantity can be expressed in terms of three fundamental dimensions:-

- Mass (M)
- Length (L)
- Time (T).

Some e.g.:-

	Dimension	Real formula / Unit
$s = d/t ::$ Speed	LT^{-1}	distance / time
$a = v/t ::$ Acceleration	LT^{-2}	velocity / time
$F = ma ::$ Force	MLT^{-2}	mass $\times$ acceleration
$E = W = f \cdot d ::$ Energy	ML^2T^{-2}	force $\times$ distance
$P = \frac{F}{A} ::$ Pressure	$ML^{-1}T^{-2}$	force / area

Physical quantity $\rightarrow$ Jis ko express
kiya ja sake a measure kiya
ja sakey.

rate of change of distance

③ speed: The distance cover by a body
in unit time is called speed.

$$v = \frac{d}{t} \quad \text{m/s} \rightarrow \text{m.s}^{-1}$$

④ velocity: The displacement covered by a
body in unit time is called
velocity.

rate of change of displacement

$$\vec{v} = \frac{\vec{s}}{t} \quad \text{m/s} \rightarrow \text{m.s}^{-1}$$

⑤ acceleration: The rate of change of
velocity is called acceleration. "OR"
acceleration is velocity per unit time.

$$a = \frac{v}{t} \quad \text{m/s}^2$$

⑥ Pressure: Pressure is force per unit
area is called pressure.

$$P = \frac{F}{A}$$

$a = \text{velocity} / \text{time}$

velocity = $\frac{\text{displacement}}{\text{time}}$

acceleration

velocity

displacement

T

$$\frac{\text{m}}{\text{T}} / \frac{\text{m}}{\text{T}} \Rightarrow \frac{\text{LT}^{-1}}{\text{T}}$$

$$\Rightarrow \text{LT}^{-2}$$

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

$$\times \text{time}$$

Now solve the dimensions :-

1) Dimensional formula of Speed (velocity) :-

$$\Rightarrow \text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \text{velocity} = \frac{\text{Displacement}}{\text{Time}}$$

Dimension of Distance (Length) :-
[L]

Dimension of Time (T) :-
[T]

now apply in formula :-

$$\boxed{\text{Speed} = \frac{L}{T} = LT^{-1}}$$

2) Dimension formula of Acceleration :-

formulas

Acceleration = $\frac{\text{velocity}}{\text{Time}}$

$$\text{velocity} = \frac{\text{distance}}{\text{time}} = \frac{L}{T}$$

$$a = \frac{LT^{-1}}{T} = LT^{-2}$$

we already found velocity (speed) = LT^{-1}

Now divide by Time (T) :-

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

$[L T^{-2}]$ Dimensional formula of acceleration.

3) Dimensional formula of force :-

Formula (Newton's Second law) :-

$$F = ma.$$

We already found acceleration = $L T^{-2}$
Now mass (M) has a dimension of M.

$$F = M \times L T^{-2}$$

$$F = [M L T^{-2}]$$

Dimensional formula of force = $[M L T^{-2}]$

* Summary of Dimensional formula

Quantity	formula	Dimensional formula
Speed (velocity)	Distance / Time $L / T = L T^{-1}$	$L T^{-1}$
Acceleration	velocity / Time $\Rightarrow \frac{L / T}{T} = L T^{-2}$	$L T^{-2}$
Force	Mass $\times$ acceleration $\Rightarrow M \times \frac{L / T}{T} \Rightarrow \frac{M \times L}{T^2} = \frac{M \times \text{velocity}}{\text{Time}} = \text{acceleration}$	$M L T^{-2}$

Energy	force $\times$ displacement	ML^2T^{-2}
Pressure	$\frac{\text{Force}}{\text{Area}}$	$ML^{-1}T^{-2}$

4)

Dimensional formula of Energy
formula of Energy

Energy is given by the formula for work,

$$\text{Energy} = \text{Work} = \text{Force} \times \text{Displacement}$$

$w = F \cdot d$

Step 01 Write dimensional formula of force :-

we already found

$$\text{Force} = MLT^{-2}$$

$$\Rightarrow F = ma$$

$$\Rightarrow F = M \times LT^{-2}$$

$$F = MLT^{-2}$$

Step 02 write dimensional formula of displacement -

Energy = work = Force $\times$ displacement
F.d. $\Rightarrow$ F.m.a. $\Rightarrow$ MLT⁻² $\times$ L
Displacement is simply Length (L),
So its dimension is
[L]

Step 3 Multiply Both dimensions.

$$\Rightarrow \frac{(MLT^{-2}) \times L}{[ML^2T^{-2}]} \text{ energy/work dimension formula}$$

5) Dimensional formula of Pressure

formula :-

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Step

1- Find the dimension of force :-

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$

- Mass (M) has the dimension $[M]$
- Acceleration is the rate of change of velocity.

$$\text{Acceleration} = \frac{\text{Velocity}}{\text{Time}}$$

• velocity is "distance per unit time"

$$\text{velocity} = \frac{\text{Displacement}}{\text{Time}} \Rightarrow \frac{L}{T}$$

• So, dimension of velocity = LT^{-1}

• Acceleration is velocity per unit time:

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

• So dimension of acceleration = $[LT^{-2}]$

Therefore, dimension of force is:

$$[MLT^{-2}]$$

Step: 2 find dimension of Pressure:-

• Pressure is "force per unit area."

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

• Area is length squared $[L^2]$

$$\text{Pressure} = [M L^{-1} T^{-2}]$$

$$\text{Pressure} = \frac{[L]}{[M T^{-2}]}$$

$$[\text{Pressure} = M L^{-1} T^{-2}] \text{ dimension of Pressure!}$$

=> Now step by step solve the
 speed/velocity, acceleration, force,
 Energy, pressure. Dimensions

$$\textcircled{1} \text{ speed} = \frac{\text{Distance}}{\text{Time}}, \text{ velocity} = \frac{\text{Displacement}}{\text{Time}}$$

Both Distance/Displacement have the same dimension $[L]$. and have the same dimension formula.

$$\Rightarrow \text{speed} = \frac{L}{T} \Rightarrow L T^{-1}$$

$$[\text{speed} = L T^{-1}]$$

$$\textcircled{2} \Rightarrow \text{Acceleration} = \frac{\text{velocity}}{\text{time}}$$

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

$$[\text{Acceleration} = L T^{-2}]$$

$$\therefore f = ma \Rightarrow n = L T^{-2} \Rightarrow [M L T^{-2}]$$

(3) Force = Mass $\times$ Acceleration
 $\Rightarrow$

- Mass = $[M]$

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

[Acceleration = $L T^{-2}$]

Now force = $M \times L T^{-2}$

[force = $M L T^{-2}$]

(4) Energy = Force $\times$ displacement
 $E = W = f \cdot d$
 (Energy = work = $f \cdot d$).

- dimension of displacement = $[L]$

- force = Mass $\times$ acceleration

- force = $M \times L T^{-2}$ $\therefore f = ma$
 force = $M L T^{-2}$

Now Energy = $[M L T^{-2}] \times [L]$
 [Energy = $M L^2 T^{-2}$]

(5) Pressure = $\frac{\text{Force}}{\text{Area}}$

∴ dimension of force =

$$\rightarrow f = ma \Rightarrow M \times L T^{-2}$$
$$f = M L T^{-2}$$

∴ dimension of Area
 $(\text{length})^2 [L^2] ∴$

Now Pressure = $\frac{\text{force}}{\text{Area}}$

$$\text{Pressure} = \frac{M L T^{-2}}{L^2}$$

$$\text{Pressure} = \frac{M T^{-2}}{L}$$

$$\text{Pressure} = M L^{-1} T^{-2}$$

5- Remember that any $f(x)$ takes as input a dimensionless number x and outputs function

dimension
values of x are dimensionless
if $f(x)$ is dimensionless then x must be dimensionless
if $f(x)$ is not dimensionless then x must have the same dimension as $f(x)$
if $f(x)$ is dimensionless and x is not dimensionless then the equation is false
if $f(x)$ is not dimensionless and x is dimensionless then the equation is false

step by step explanations:-1 - Understanding dimensions:-

- In physics, each physical quantity has specific dimensions that represent its nature. for instance

• velocity (v or u): Dimensions are $[L][T]^{-1}$ length per time.

• Acceleration (a): Dimensions are $[L][T]^{-2}$ length per time square.

• time: Dimensions are $[T]$

2) Dimension analysis for 1st equation :- $(v^2 = u^2 + 2at)$

• Left side (v^2):

• Dimensions of v are $[L][T]^{-1}$

• Squaring v : $([L][T]^{-1})^2 = [L]^2[T]^{-2}$
 $\Rightarrow L^2 T^{-2}$

• Right side (u^2): $(u^2 + 2at)$

• Dimensions of u^2 : same as v^2 , which is $[L]^2[T]^{-2}$

$\Rightarrow [T]^{-1}]^2 \Rightarrow L^2 T^{-2}$

Dimensions of λ at:

- λ is a dimensionless constant.
- Dimensions of $a = [L][T]^{-2}$
- Dimension of $t = [T]$
- product of a and t :

$$LT^{-2} \times T = LT^{-1}$$

Comparison :-

- left side: $L^2 T^{-2}$
- Right side: u^2 has dimensions $L^2 T^{-2}$, but λat has dimensions LT^{-1} .
- Since $L^2 T^{-2} \neq LT^{-1}$, the equation is dimensionally inconsistent and thus incorrect.

3) Dimension analysis of the second equation $v^2 = u^2 + 13a^2 t^2$

- left side: (v^2)
as before $[L^2][T]^{-2}$
- Right side: $(u^2 + 13a^2 t^2)$
 - Dimensions of $u^2 = [L]^2 [T]^{-2}$
 - Dimensions of $13a^2 t^2$:

- 13 is a dimensionless constant.
- Dimensions of $a^2 = ([L][T]^{-2})^2$
 $\Rightarrow L^2 T^{-4}$

- Dimensions of $t^2 = ([T])^2 = [T]^2$

- Product of a^2 and $t^2 = L^2 T^{-4} \times T^2$
 $\Rightarrow L^2 T^{-2}$

Comparisons-

- Both v^2 and $13a^2t^2$ have dimensions $L^2 T^{-2}$ OR $[L]^2 [T]^{-2}$ matching the left side.

- Since both sides have identical dimensions, the equation is dimensionally consistent & could be correct. but dimensional consistency doesn't guarantee the equation's physical correctness, it only indicates that the form is plausible.

→ An equation must have the same ~~side~~ dimensions on both sides to be potentially correct.

Q17] Distance/Displacement dimension: "L".

Step 3 of a^2 and t^2 multiplication
Understanding:-

To find the dimensions of the product $a^2 \times t^2$, we multiply their respective dimensions.

- $[a^2 \times t^2] = [a^2] \times [t^2] = ([L]^2 [T]^{-4}) \times [T]^2$

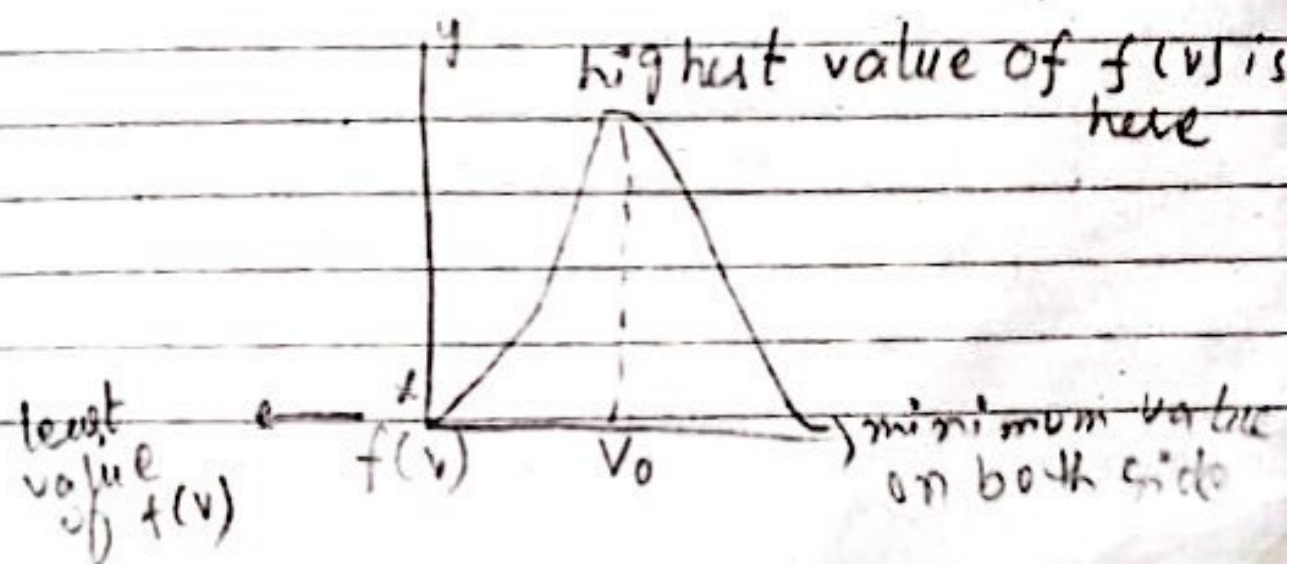
- When Multiplying, we add the exponents of like dimensions

$\Rightarrow$ for length $[L]$, Exponent is 2 (from $[L]^2$)
 $\Rightarrow$ for time $[T]$, Exponents are -4 (from $[T]^{-4}$)
and +2 (from $[T]^2$).

Adding these gives $-4 + 2 = -2$.

- Thus the resulting dimensions are:
• $[L]^2 [T]^{-2}$

Continue to YT lecture of



by AQ

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PHY101 Handout Lecture:

- The law of physics do not change from place to place.
 - we can use diff units to measure the same physical quantity.
 - we can measure the mass in units of kilograms, pounds,
- MKS → Metre - kilogram - second system

Lecture NO: 02

'Summary of Lecture 2' Kinematics I

displacement:

→ $x(t)$ is called displacement
it denotes the position
of a body at time.

time t Position of body $x(t)$ denote $x(t)$

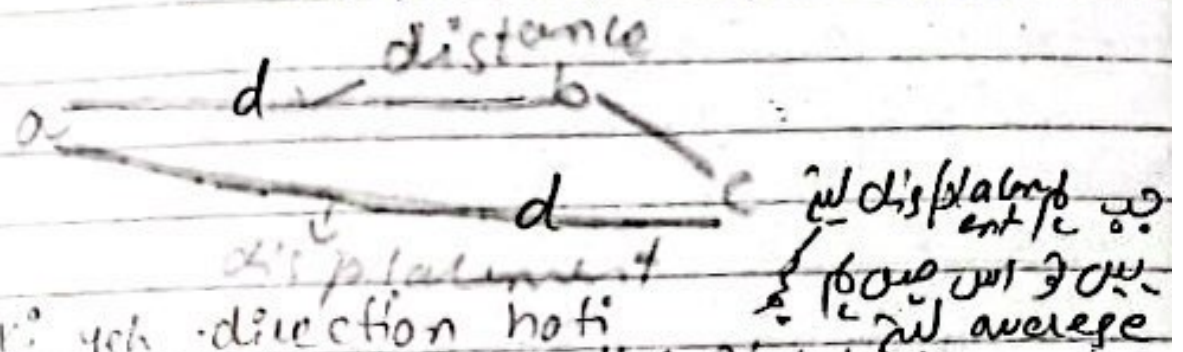
$$\text{Displacement } r = r_2 - r_1$$

→ find value

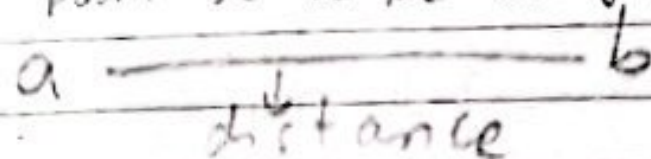
Kie formula

Tab aap starting
or ending point
subtract karega
to aple pass dist

R. w $\rightarrow$ shortest distance $\rightarrow$ displacement
 the shortest distance is
 known as displacement.



or use: yeh direction hoti
 starting point se le ke ending point tak.



displacement: the change in the
 position of the body from initial
 position to the final position
 is called displacement.

Δ mean w b change Δ change
 $\Delta \rightarrow$ change in means $\rightarrow$ shortest distance
 hota hai wo

$d = vt$ if a body is moving with
 average speed v then in time t it
 will cover a distance $d = vt$.

(xt) Displacement denotes the position
 of a body at time.

amant aagay

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formula of distance

Distance = Speed $\times$ Time

= $v \times t$ here 'v' is speed.

Distance = vt $\therefore d = vt$

Distance measure in metres or km

Defination:-

Distance is the total path traveled by an obj.

→ It's a scalar quantity, meaning it has only (magnitude) no direction.
e.g. if you walk 3 km north & then 2 km south, your total distance is $3 + 2 = 5$ km

Displacement:-

Displacement is the shortest straight-line distance from the starting point to the ending point with direction.

→ vector Quantity, has both magnitude & direction.

e.g. from the example above (3 km north, 2 km south), the

Displacement is 1 km north ($3 - 2 = 1$)

($3 - 2 = 1$ km in the Original direction)
displacement = final position - initial position

$$S = x_f - x_i$$

byig

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Diff b/w distance & displacement

	Distance	Displacement
Quantity type	Scalar (no direction)	Vector (with direction)
Value	always +ve	can be +ve, negative or zero
Path	Total path covered	straight line path
Example	5 km	1 km north

Average Speed:-

Average Speed = Total distance / Total Time

• It tells how fast something is moving on average during a journey.

• Scalar Quantity (so direction doesn't matter)

• Units (m/s or km/h)

e.g. If a car travels 100 km in 2 hours

$$\text{Average Speed} = 100 \text{ km} \div 2 \text{ h} = 50 \text{ km/h}$$

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$$\text{average speed} = \frac{\text{distance travelled in time}}{\Delta t}$$

For more accurately, one defines an average speed over the small time interval Δt as $\uparrow$

velocity - $v = \frac{d}{dt}$

$\rightarrow$ displacement over time.

we define instantaneous velocity

formula of instantaneous velocity: $v = \frac{ds}{dt}$ or $\frac{\Delta s}{\Delta t}$

we define instantaneous velocity at any time 't' as:

$$= \frac{x(t_2) - x(t_1)}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$

here $\Delta t \rightarrow$ change in time.

$\Delta x \rightarrow$ change in displacement

$x(t)$ is called displacement.

Displacement : $x(t) = s = x_f - x_i$
Displacement : $x(t) = s = x_2 - x_1$
displacement : $x(t) = s = \Delta x$

$\therefore \text{velocity} = \vec{v} = \frac{\text{displacement}}{\text{time}} \Rightarrow \frac{d}{t}$

$\therefore \text{Speed} = v = \frac{\text{distance}}{\text{time}} \Rightarrow \frac{d}{t}$

$\therefore \text{distance} = d = \text{Speed} \times \text{Time} \Rightarrow$
 $d = vt$

average speed:-

avg speed = distance travelled in time Δt

avg speed = $\Delta v = \frac{\Delta d}{\Delta t}$

Δ this sign used for very small & average values.

1 average speed nikalne ke liye time ke hisab se sb chalti hai na wo time bi us se divide karta hai

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$$\Delta v = \Delta d / \Delta t$$

اب بیاں پڑو وہ ang میں ڈرا گیا ہے یہ کہنا کہ اس کے ساتھ ہ کا جوئی لگا دیا ہے کہوتیہ اس کی جھولی جھرتی بند ہے <http://www.dailymotion.com/video/x3p3p3> اور یہ جھولے جھولے time کیسا ہے اس کو نہ کہہ رہا ہے۔

But in fact the speed of a car changes from time to time $\therefore$ so we should limit the use of this formula to small time differences only.

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

lim's apply karte

Instantaneous velocity:-

Q3) Change in $\vec{v}$ and $\vec{v}$ velocity of

We define instantaneous velocity at any time t

$$v_{\text{ins}} = \lim_{\Delta t \rightarrow 0} \frac{\Delta d}{\Delta t}$$

نیمے 3. Δt کا sign لے کر
اس N apply limit
نہ لے کر، بلکہ

use limits as $\Delta t \rightarrow 0$ sign Δt is

2. If a body is moving with average speed v then in time t it will cover a distance $d = vt$.

But in fact, the speed of a car changes from time to time $\therefore$ so one should limit the use of this formula to small differences only.

So, more accurately, one defines an average speed over the small time interval Δt as:

$$\therefore \text{average speed} = \frac{\text{distance travelled in time } \Delta t}{\Delta t}$$

3- we define instantaneous velocity at any time t as:

$$v = \frac{x(t_2) - x(t_1)}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$

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Here Δx and Δt are both very small quantities that tend to zero but their ratio c_v does not.



Acceleration

measures how the velocity changes with time.

→ velocity $\vec{v}$ $\vec{v}$ 191 barhi ha.

→ aise velocity 1 (constant time) value $\frac{1}{2}$ for nahi badh rhi.

Average

Acceleration =

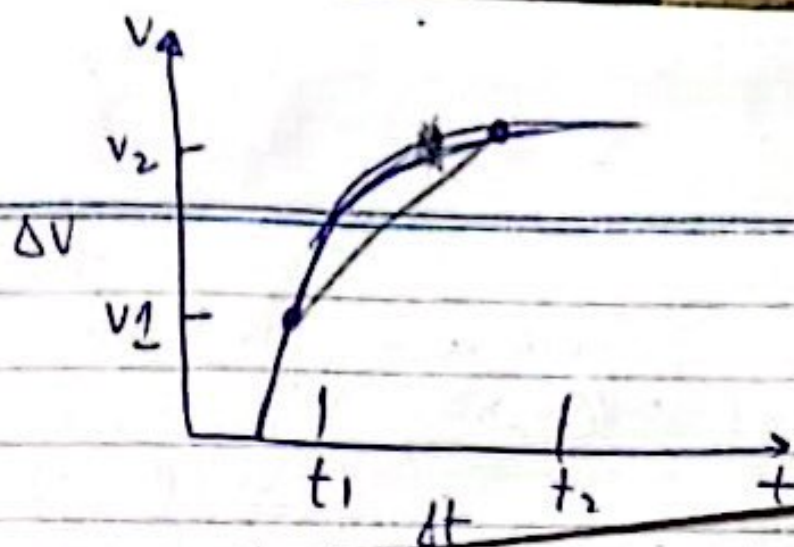
$$= \frac{V_2 - V_1}{t_2 - t_1} = \frac{\Delta V}{\Delta t}$$

formula for a $\uparrow$ slope

average acceleration is the change in velocity $\div$ by time taken for the change in vel.

acceleration mathematical definition:-

acceleration is equal to the limit as $(\Delta t \rightarrow 0)$ Δt into 0 of the ratio $\frac{\Delta V}{\Delta t}$.



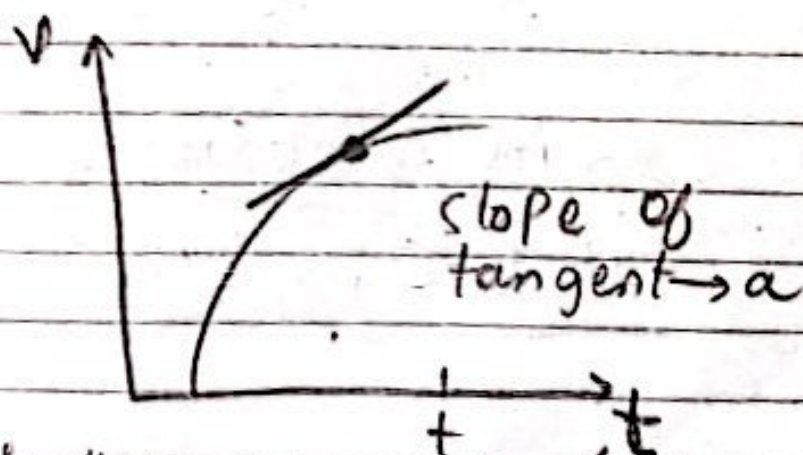
(28)

→ time t_1 pe velocity ki value v_1 hai or time t_2 pe velocity ki value v_2 hai;

→ Jese time badhega uske p badhe se velocity me koi change aayega to a, wo acceleration hoga.

اب جسے t_1 اور t_2 اب دوسرے کے قریب آتے جاتی ہیں تو v_1 اور v_2 اب دوسرے کے قریب آتے ہیں اور اب آپ اب line لیں گے اس کے لیے آپ tangent کا لگا دیتے ہیں

→ The slope of the tangent is equal to "a".



→ آپ Δt کو exactly zero نہیں کر سکتے
→ آپ اسے approach کر سکتے ہیں "0" towards "0"

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Definition of average -

$$V_{av} = \frac{1}{2} (v_0 + v) \rightarrow \frac{v_0 + v}{2}$$
 add of Quantities 2 by 2.
 It is the avg of v_0 and v divided by "2".

average speed: $\frac{\Delta x}{\Delta t}$

$$V_{av} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$x = x_0 + V_{av} t$$

avg speed
avg velocity

$$\frac{x - x_0}{t - 0} = \frac{v + v_0}{2}$$

$$= \frac{v_0 + at + v_0}{2}$$

$$= v_0 + \frac{1}{2} at$$

$$\Rightarrow x = x_0 + v_0 t + \frac{1}{2} at^2$$

→ yeh 'x' as a function
define krta ha. x as a function
of time. tou ap 't' ki
value der. tou uske
sath 'x' milega.

$x = x_0 + v_0 t + \frac{1}{2} a t^2$
 (x) 0, 210
 it is x_0 value ki
 so, $t=0$, $x = x_0$ which is the
 initial position from you
 were started.

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2 main equations :-

$$\therefore x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$(?) \therefore v = v_0 + a t$$

as (0) & (t) are equation 2nd
 so, $v = v_0$.

→ is same bat same aati hai,
 v_0 is the initial velocity, the
 velocity time $t=0$.

aur apko yahan se 't' find
karna hai.

$$v = at + v_0$$

$$v - v_0 = at$$

a

$$\Rightarrow t = \frac{v - v_0}{a}$$

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7) we know in (6) above how far a body moving at constant speed moves in time t . But what if the body is changing its speed? if the speed is increasing linearly (i.e. constant acceleration) then the answer is particularly simple: just the same formula as in (6) but use the average speed: $\frac{(v_0 + v_0 + at)}{2}$ so we get

$$x = x_0 + \frac{(v_0 + v_0 + at)t}{2} = x_0 + v_0 t + \frac{1}{2} at^2.$$

this formula tells u how far a body moves in time t if it moves with constant acceleration a , and if started at position x_0 at $t = 0$

with speed v_0 .

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$$\Rightarrow \frac{x - x_0}{t - 0} = \frac{v + v_0}{2}$$

Solve this eq by using these

$$\therefore x = x_0 + vt$$

$$\therefore v = v_0 + at$$

now put the values of x
and v :-

$$\Rightarrow \frac{x - x_0}{t - 0} = \frac{v + v_0}{2} \quad v = v_0 + at$$

ab is = $\frac{v_0 + at + v_0}{2}$
put to
solve kadiya $\Rightarrow v_0 + \frac{1}{2} at$

$$\Rightarrow x = x_0 + v_0 t + \frac{1}{2} at^2$$

(by I Q)

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$$x = x_0 + (v_0 + v_0 + at) \frac{t}{2}$$

$$\Rightarrow x = x_0 + v_0 t + \frac{1}{2} at^2$$

speed + direction = velocity

vectors :-

A Quantity that has a size as well as direction is called a vector.

has Magnitude, size and direction.

10- vectors in 3 dimensions
not in 1D.

In one dimension, a vector
a vector has only one

Component (call it x-component)

In 2 dimension $\rightarrow$ x and y Component

In 3 dimension $\rightarrow$ the

Components
are along

x, y, z axes.

(24)

→ If we denote a vector $\vec{r} = (x, y)$

then $r_x = x = r \cos \theta$

and $r_y = y = r \sin \theta$

$\therefore \text{vector } x = \text{vector } r \cos \theta$

$\therefore \text{vector } y = \text{vector } r \sin \theta$

Note that: $r^2 = x^2 + y^2$

$\Rightarrow \tan \theta = y/x$

$\therefore \vec{r} = (x, y), r^2 = x^2 + y^2$

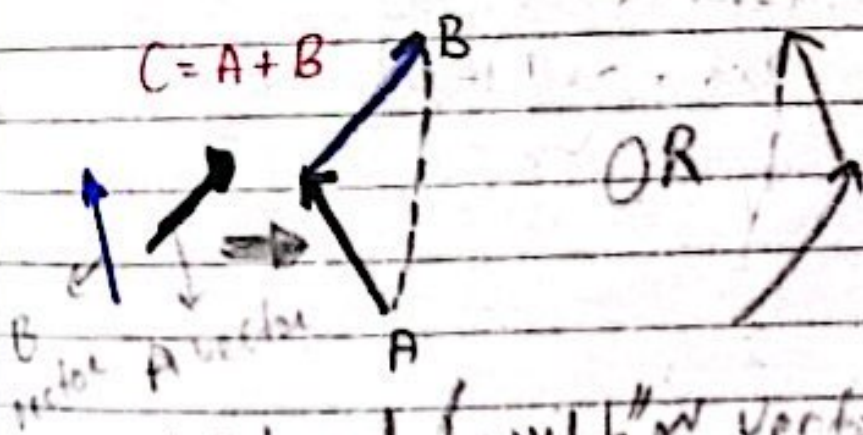
$\therefore r_x = x = r \cos \theta$

$\therefore r_y = y = r \sin \theta$

$\therefore \tan \theta = y/x$

13- 2 vectors can be added together geometrically. Resultant vector is through add k: ya Ta sakta.

We take any one vector, move it without changing its direction so that both vectors start from the same point.



geometrically
aise
add karna

2. head of 1st vector first 3. &
4. join p. w. tail of vector 2nd of
5. 1st vector 2. next 3. 1st

اس کی ابتدا نیچے والی 2 head کو
 کہلاتی ہے

→ head-to-tail rule is use (35)
 here.

find 3 vectors third ab
 کرنے کے لئے 2 vectors ان کے
 3rd vector کو add

e.g. $\vec{C} = \vec{A} + \vec{B}$
 resultant vector

14- 2 vectors can also be
 added algebraically.

e.g. $(x, y) + (a, b)$
 variable x, y, a, b
 $\boxed{xa + yb}$
 2 vector کے sum
 2 vector

for e.g. 2 vectors can be put
 together as $(1.5, 2.4) + (1, -1)$

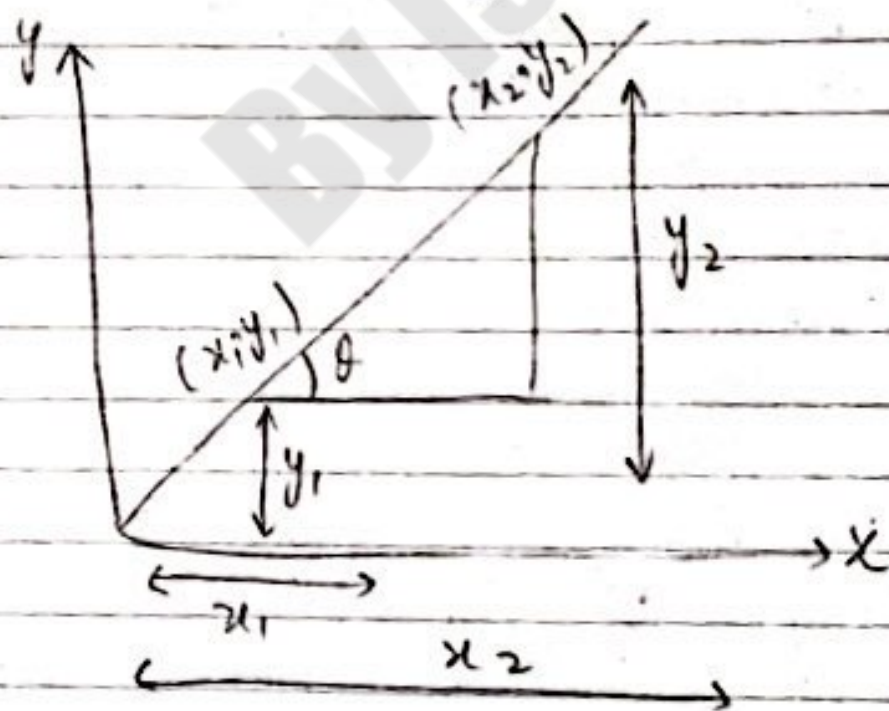
$\Rightarrow (2.5, 1.4)$

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Lecture 3 Kinematics II :-

1) derivative shows how fast a function changes when its argument is changed.

derivates $\rightarrow$ Kiya show karke aik function mein changes ko show kar hai. Iske jab unke arguments change kar rahi hoti hai tou dikha jata ke unke function kiya effect pa raha hai. wo kis tarhan se change ho raha hai.



Constant slope

$\rightarrow$ because jaha pe koi point change nahi ho raha, balki straight aurahi, bilkul tou yeh hamara constant

$\Rightarrow$ It means derivative shows how a function changes when its argument changes
 $\left(\frac{y_2 - y_1}{x_2 - x_1} \right)$

(37)

When function we changes ko find karte hain to uske liye derivative ko use kr pdtge

$\Rightarrow f(x)$ can be written as $x(t)$ or any variable (a---z)

2- Functions do not always have to be written as $f(x)$. $x(t)$ is also a function.

It tells us where a body is at different times t .
 $\therefore f(x) = x(t)$

3- derivative of $x(t)$ at time t is defined as

$$\therefore \frac{dx}{dt} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$

apply limit $\approx$ (cutting)

(cutting)

$\Rightarrow \Delta$ shows changing ho r hi hain x mein or time t me.

by Ishah

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(4) $\frac{d}{dx} x^2 = 2x$

value of x find power
derivative of x^2 solve

start power of derivative
 $\frac{d}{dx} x^2 = 2x$

power of derivative of x^2 find value

here,

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

derivative of x^2 find value
solve value power

$2t\Delta t$ ke se aaya.

$$(t + \Delta t)^2 = (a + b)^2 \text{ formula ban raha}$$

$$\Rightarrow (a + b)^2 = a^2 + b^2 + 2ab$$

ye apply kia wahan pe.

Answer

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

$$= (\cancel{t^2} + \Delta t^2 + 2t\Delta t) - \cancel{t^2}$$

$$\Rightarrow \Delta t^2 + 2t\Delta t = 0$$

$$\Rightarrow \Delta t(\Delta t + 2t) = 0$$

Δt common
le liya

$$\Rightarrow \Delta t + 2t$$

Now,

$$\frac{\Delta x}{\Delta t} = \Delta t + 2t$$

ab bolte Lim $\frac{\Delta x}{\Delta t} = \lim_{\Delta t \rightarrow 0} \Delta t + 2t$

side, $\Delta t \rightarrow 0$ limit
apply $\frac{dx}{dt} = 0 + 2 \Rightarrow \boxed{2}$
deta hain

$$\left[\frac{\Delta x}{\Delta t} = \Delta t + 2t \Rightarrow \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} = 2 \right]$$

again likha
Just

7. A Stone dropped from rest increases its speed in the downward direction a/c to $\frac{dv}{dt} = g = 9.8 \text{ m/sec}$.

اگر آپ کوئی stone آپ جب پھینکتے ہیں تو وہ
نیچے کی طرف چلتی ہے اور اس کی direction
نیچے کی طرف ہے اس لیے اس کی acceleration
کی value +ve کی وجہ سے -

→ The value of 'g' decreases as we go further away from the earth.

اگر ہم earth سے قریب ہوں تو 'g' کی
value increase ہوتی ہے۔ اس کی speed
'g' کی value 9.8 m/sec ہوتی ہے۔
اگر ہم earth سے دور ہوتے جائیں تو 'g' کی
value decrease ہوتی ہے۔
(I) اگر آپ اوپر کی طرف کسی چیز کو پھینک
دیں تو وہ نیچے کی طرف 'g' کی value -ve ہو جائے
گی۔ اور acceleration بھی -ve ہو جائے گی۔
(II) اگر آپ نیچے کی طرف کسی چیز کو پھینک
دیں تو وہ نیچے کی طرف 'g' کی value +ve ہو جائے
گی۔ اور acceleration بھی +ve ہو جائے گی۔

→ Also note that if we measured distances from the ground up, then acceleration would be negative.

(10)
(41)

Scalar Product $\rightarrow$ also called dot product
 $\vec{A} \cdot \vec{B} = AB \cos \theta$

Q U Can think of it as $\rightarrow$ the law cosines $\rightarrow$ change in position $\rightarrow$ distance

$$\Rightarrow \vec{A} \cdot \vec{B} = (A)(B \cos \theta) \\ = (\text{length of } \vec{A}) \times (\text{projection of } \vec{B} \text{ on } \vec{A})$$

OR $\rightarrow$

$$\Rightarrow \vec{A} \cdot \vec{B} = (B)(A \cos \theta) \\ = (\text{length of } \vec{B}) \times (\text{projection of } \vec{A} \text{ on } \vec{B})$$

$\therefore$ Remember that for unit vectors

$$\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} = 1 \quad \hat{k} \cdot \hat{k} = 1 \\ \text{and } \hat{i} \cdot \hat{j} = 0$$

Q If value 1 $\rightarrow$ are same unit vectors $\in$ (parallel vectors) vector

Q If value 0 $\rightarrow$ are perpendicular vectors $\in$ (perpendicular vectors) vector
Q If value 2 $\rightarrow$ answer $\rightarrow$ unit vectors $\rightarrow$ 2 unit vectors diff

Summary of lec(4)

(42)

Force and Newton's Laws

→ Force is required to keep something moving.

→ force is required to change motion.

396/ → Resistance to changes in motion is called 'inertia'.

→ More inertia means it is harder to make a body accelerate or decelerate.

→ Newton's First Law

An obj will remain at rest or move with constant velocity unless acted upon by a net external force.

(non-accelerating frame is called an inertial frame)

(43) Phy 101

→ Newton 1st law → hold only in inertial frame.

→ more force leads to more acceleration.
 $\Rightarrow a \propto F$ — (i)

→ Law of inertia → Newton First Law
mass

→ more mass means more inertia. In other words, more mass leads to less acceleration.

(ii) — $\Rightarrow a \propto \frac{1}{m}$ → Jab mass
hadd hogi,
acceleration

Combine both
observation (i) & (ii)

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

Kam hogi.
Or Jab,
acceleration
hadd hogi
to mass
Kam hoga
acceleration.
Inertia also
inversely
proportional

→ Newton's Second Law

(44)

$$\therefore a = \frac{F}{m} \quad (\text{Or if u prefer, write as } F = ma)$$

→ $F = ma$ is one relation b/w three independent quantities (m, a, f).

⇒ Force has dimensions of $[mass] \times [acceleration] = MLT^{-2}$

$$\therefore F = ma$$

$$\left(\begin{array}{l} m = \text{Kg} \\ \text{S.I. unit} \end{array} , \begin{array}{l} a = \text{m/s}^2 \\ \text{S.I. unit} \end{array} \right)$$

we will find dimension of 'f' by ' $F = ma$ ' formula.

$m = \text{mass} = M \rightarrow \text{dimension}$

$a = \text{acceleration} = LT^{-2} \rightarrow \text{dimension}$

$$\therefore a = \frac{\text{velocity}}{\text{time}} \Rightarrow \frac{L/T}{T} \Rightarrow LT^{-2}$$

$$\therefore \left(\begin{array}{l} v = \frac{\text{distance}}{\text{time}} \rightarrow L \text{ dimension} \\ \text{time} \rightarrow T \text{ dimension} \end{array} \right)$$

12 The weight of a body " W " is the force which gravity exerts upon it.

means we say that W is equal to F .
Weight is equal to force.

$$W = F \text{ , } F = W$$

$$\text{So, } \rightarrow F = mg \Rightarrow W = mg.$$

$\rightarrow$ Mass & weight are two completely diff quantities.

$\rightarrow$ weight is basically a force.
but mass is amount of matter.

13 Newton's 3rd Law:-

for every action, there is an equal but opposite reaction.

$\rightarrow$ means agar ap ¹ force laga dake hai'n point A se B ~~ka~~ ki taraf agar wo wapis 'B' se 'A' taraf aayahi ha tou sath mein minus bhi aayega.

(46)

$\therefore F_{AB} = -F_{BA}$ where F_{AB} is the force exerted by body B upon A whereas F_{BA} is the force exerted by body A upon B.

also $F_{AB} + F_{BA} \neq 0$. $\rightarrow$ net force acting upon both bodies would be (zero ke equal nahi hogi)

$\rightarrow$ equal & opposite forces in Newton's 3rd law act on diff objects, not the same one. That's why then don't cancel out each other.

• small mass $\rightarrow$ same force big acceleration $\leftarrow$

• very big mass $\rightarrow$ same tiny acceleration $\leftarrow$ force

in short:-

• $F = ma$: General formula for force

• $F = mg$: Special case of force due to gravity

• $W = mg$: definition of weight

$\checkmark W = F = mg$

~~max~~

$\Rightarrow$ mass is inversely proportional to acceleration. $a \propto \frac{1}{m}$

$\Rightarrow$ force is directly proportional to

Application of Newton Law:-

uses in which we apply it in
- Ques

3 points to 1 Kaidiya :- handout ka

1) a/c to Newton's second law:-
as,
 $\therefore F = ma$

→ a/c to physics, "If there is no acceleration,
(means agar body move nahi kar rahi) there will be net force zero."
(we know that $a \propto F$)

2) Equilibrium
body kab equilibrium me hoti hai or kab nahi hoti.

→ equilibrium ke liye body rest mein bhi ho sakti hai or body ~~rest~~ ^{movement} bhi ho sakti hai.

BY Isbah Qayam

→ equilibrium ke liye body ka rest mein hona ~~blisko~~ nahi ha or motion me bhi hona zaroor nahi ha.

↳ "Zaroor yeh hai ke uski ^{for} forces ham wo balanced honi."

Equilibrium :- (when forces are balanced & equal)

- Stone at rest
- pencil balanced at finger.

No equilibrium :-

- Stone falling from height

Point no 4 U Can skip it

5 ⇒ as $F = ma$
 $a = \frac{F}{m}$

(second law of Newton)

(48)

by IQ

$$\Rightarrow a = F/m$$

$$\Rightarrow \frac{dv}{dt} = F/m$$

$$\Rightarrow \frac{d \cdot (dx)}{dt(dt)} = F/m$$

→ we put $\frac{dx}{dt}$ in place of velocity v .

$$\boxed{\frac{d^2 x}{dt^2} = F/m}$$

→ you can find acceleration by this method.

→ Jis mein double derivative le len.

→ acceleration Jo hota ha wo double derivate hota hai displacement ka.

acceleration is

time rate of change of velocity hota hai.

or change ko hum, derivative se rsk hain tou

phir acceleration ka formula w ho jayega $\frac{dv}{dt}$

∴ $d \rightarrow$ shows derivative, 'OR' change?

$\frac{dv}{dt} \rightarrow$ is rate of change of velocity over time.

→ isi tarhan velocity kiya hota ha,

"Rate of change of displacement"

tou velocity ka formula khol jayega. $\frac{dx}{dt} \rightarrow$ velocity here,

$d \rightarrow$ change in
 $x \rightarrow$ displacement
 $t \rightarrow$ time. ↓