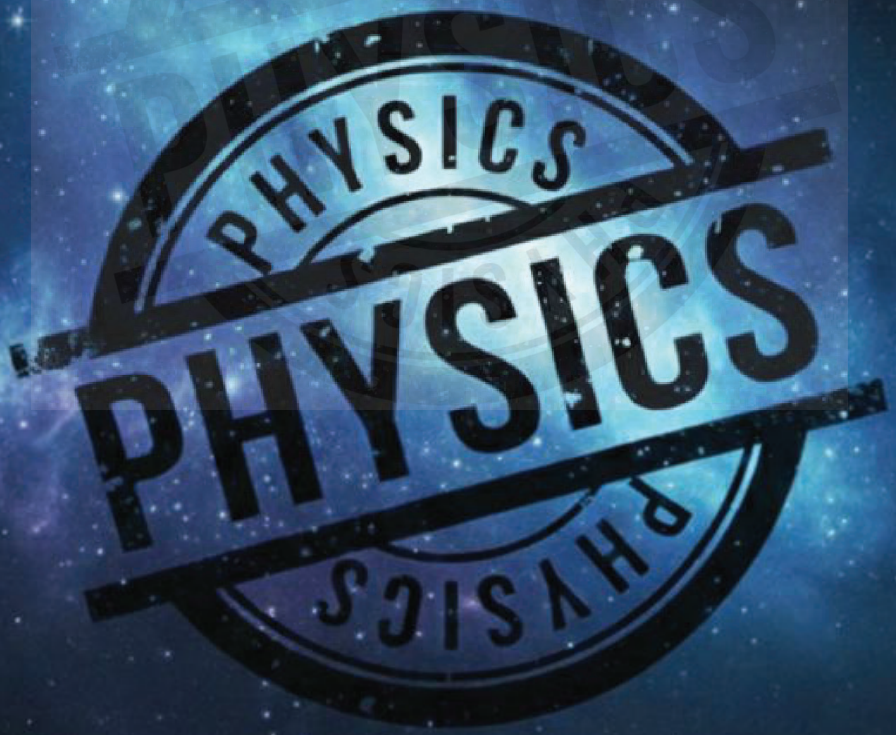
Class 11th

PHYSICS

Short Notes

JEE MAIN | JEE ADVANCED | NEET



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Topics to cover in Units & Dimensions - Part 1

1. Fundamental Units
2. Supplementary Units
3. Must Know / Practice Dimensional Formulae
4. Principle of Homogeneity
5. Conversion of Units
6. Dimension in Terms of other Physical Quantity
7. KEY Points (Dimensionless Qty)

1. FUNDAMENTAL UNITS

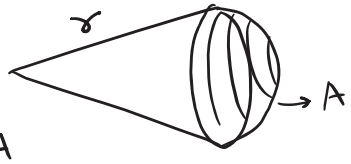
	Quantities	SI UNIT	C.G.S	SYMBOL
1.	LENGTH	m	cm	L
2.	MASS	kg	g	M
3.	TIME	s	s	T
4.	TEMP°	K		θ
5.	CURRENT	A		A
6.	INTENSITY	cd		cd
7.	AMOUNT	mol		mol

2. SUPPLEMENTARY UNITS

(i) ANGLE ⟶ Radian

$\theta = \ell / r$

(ii) SOLID ANGLE ⟶ Steradian



$\Omega = \frac{A}{r^2}$

3. MUST KNOW DIMENSIONAL FORMULAE

	Physical Qty	DIMENSIONAL FORMULAE
1	FORCE	MLT^{-2}
2	ENERGY	ML^2T^{-2}
3	ε_0	$M^{-1}L^{-3}T^4A^2$
4	μ_0	$MLT^{-2}A^{-2}$

Ex: Steffan boltzmann Const. (σ)

$\frac{dQ}{dt} = \sigma e A T^4 \Rightarrow \sigma = \frac{Q}{t \times A \times T^4}$

$[\sigma] = \frac{ML^2T^{-2}}{T \times L^2 \times \theta^4} = MT^{-3}\theta^{-4}$

↳ e is dimensionless.

NOTE: you may practice to find Dimension of some constants Like:

(a) Gravitational Const., $G = M^{-1}L^3T^{-2}$

(b) Gas Const., $R = ML^2T^{-2}\theta^{-1}$

(c) Boltzmann's Const., $K_B = ML^2T^{-2}\theta^{-1}$

(d) Planck Const., $h = ML^2T^{-1}$

(e) Rydberg's Const., $R_y = L^{-1}$

(f) Magnetising field, $H = \frac{B}{\mu_0} = \frac{\mu_0 i/2r}{\mu_0} = \frac{i}{r} \Rightarrow AL^{-1}$

4. PRINCIPLE OF HOMOGENEITY

(i) If $a = b + c$

$\Rightarrow [a] = [b] = [c]$

Ex: $S = ut + \frac{1}{2}at^2$

$[s] = [ut] = [at^2]$

5. CONVERSION OF UNITS

$Q = nu$ → units (can be SI, CGS or Given in question)

- Q: amount of physical qty.
- n: numeric value

Ex: Find how many POISE (C.G.S unit of viscosity) is equal to 1 POISEUILLE (in SI)

Soln: $F = 6\pi\eta r v \Rightarrow [\eta] = \frac{[F]}{[r][v]} = \frac{MLT^{-2}}{L \times LT^{-1}} = ML^{-1}T^{-1}$

$n_1u_1 = n_2u_2$

$\Rightarrow n_1 \times (g\,cm^{-1}s^{-1}) = 1 \times (kg\,m^{-1}s^{-1})$

$\Rightarrow n_1 = \frac{kg\,m^{-1}s^{-1}}{g\,cm^{-1}s^{-1}} = \frac{10^3\,g \times 10^{-2}\,cm^{-1} \times s^{-1}}{g\,cm^{-1}s^{-1}}$

$= \boxed{10}$

6. DIMENSION IN TERMS OF OTHER PHYSICAL QUANTITY

#Ex: Expression for time in terms of G (Gravitational Const.), h (Planck const.) and c (speed of light) is proportional to ?

Sol^{n}: $t \propto G^a h^b c^c \Rightarrow [t] = [G]^a [h]^b [c]^c$

$\Rightarrow [M^0 L^0 T^1] = [M^{-1} L^3 T^{-2}]^a [ML^2 T^{-1}]^b [LT^{-1}]^c$

$\Rightarrow [M^0 L^0 T^1] = [M^{-a+b} \; L^{3a+2b+c} \; T^{-2a-b-c}]$

$\therefore 0 = -a+b, \; 0 = 3a+2b+c, \; 1 = -2a-b-c$

$\Rightarrow a = b = 1/2, \; c = -5/2$

$\therefore t \propto G^{1/2} h^{1/2} c^{-5/2}$ or $\boxed{t \propto \sqrt{\frac{Gh}{c^5}}}$

7. KEY POINTS (dimensionless qty)

(i) All trigonometric ratios ($\sin\theta$, $\cos\theta$ etc.)

(ii) Angle, θ ($\sin\frac{ab}{c}$, here $[ab] = [c]$)

(iii) Exponential functions, $e^x \rightarrow$ x must be dimensionless

($e^{-t/RC} \rightarrow [t] = [RC]$)

(iv) Reynolds number ($Re = \frac{\rho v D}{\eta}$), Dielectric Const. (K)

Refractive index and many more.

Topics to cover in Error Analysis - Part 2

1. Absolute Error, Relative Error & Percentage Error
2. Combination of Errors
3. Vernier caliper and Screw Gauge

1. Absolute Error, Relative Error & Percentage Error

(Error = True Value – Measured Value)

STEP 1: $R_{avg} = \frac{R_1 + R_2 + \dots + R_n}{n}$ (we take R_{avg} as True Value)

STEP 2: Absolute Error $\Delta R_1 = R_1 - R_{avg}$

$\Delta R_2 = R_2 - R_{avg}$

$\Delta R_n = R_n - R_{avg}$

(take only magnitude)

STEP 3: Mean Absolute Error

$$\Delta R_{avg} = \frac{|\Delta R_1| + |\Delta R_2| + \dots + |\Delta R_n|}{n}$$

Final Reading = $R_{avg} \pm \Delta R_{avg}$

- Rel Error: $\frac{\Delta R_{avg}}{R_{avg}}$
- % Error: $\frac{\Delta R_{avg}}{R_{avg}} \times 100$

2. Combination of Errors

↳ error in measurement is very small

(a) Sum or difference

$l = 4.1 \pm 0.1$ cm, $b = 3.3 \pm 0.1$ cm

- $S = l + b = 7.4 \pm 0.2$ cm
- $S = l - b = 0.8 \pm 0.2$ cm

(b) Product or Division

$P = d\frac{x^a y^b}{z^c}$ { error is Δx, Δy & Δz. Find Error in P

$\Rightarrow \ln P = a\ln x + b\ln y - c\ln z + \ln d$

$\Rightarrow \frac{dP}{P} = a\frac{dx}{x} + b\frac{dy}{y} - c\frac{dz}{z} + 0$

To find Max error in P

$$\boxed{\frac{\Delta P}{P} = a\frac{\Delta x}{x} + b\frac{\Delta y}{y} + c\frac{\Delta z}{z}}$$

($\frac{\Delta x}{x}$ is rel error in x)

3. Vernier Caliper & Screw Gauge

↳ Must refer video for this from our youtube channel "EDUNITI".

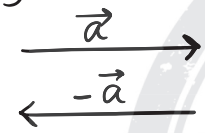
Space to add concepts learnt from PYQs if any

Topics to cover in Vectors - Part 3

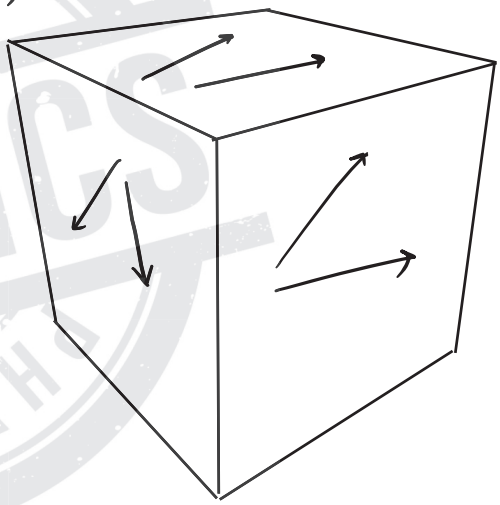
1. Basic properties of vectors
2. Addition of vectors
3. Subtraction of vectors
4. Resolution of vectors in 2-D & 3-D
5. Dot product (scalar product)
6. Cross product (vector product)

1. Basic Properties of Vectors

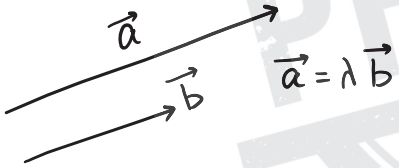
(a) Negative Vectors



(b) Coplanar Vectors

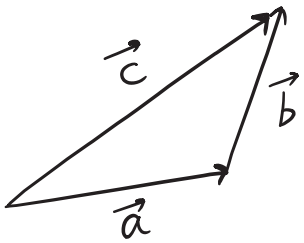


(c) Collinear Vectors



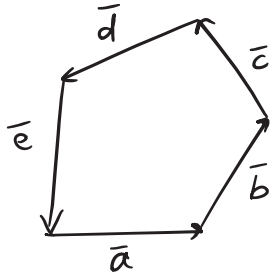
2. Addition of Vectors

Triangle Law



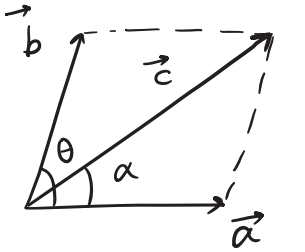
$\vec{a} + \vec{b} = \vec{c}$

Polygon Law (an extension of triangle law)



$\bar{a} + \bar{b} + \bar{c} + \bar{d} + \bar{e} = 0$

Parallelogram law

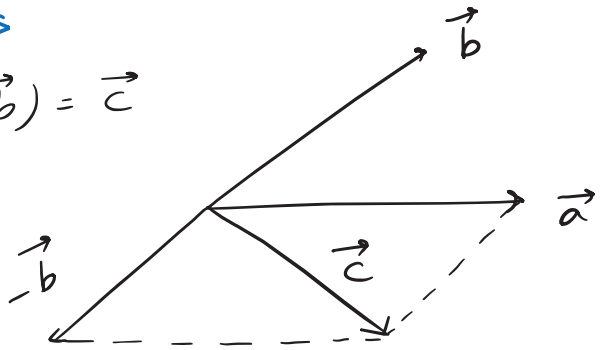


$c = \sqrt{a^2 + b^2 + 2ab\cos\theta}$

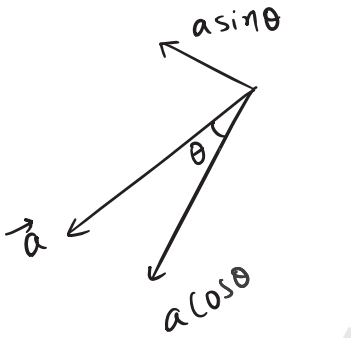
$\tan\alpha = \dfrac{b\sin\theta}{a + b\cos\theta}$

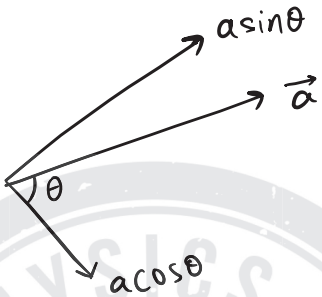
3. Subtraction of Vectors

$\vec{a} - \vec{b} = c \Rightarrow \vec{a} + (-\vec{b}) = \vec{c}$

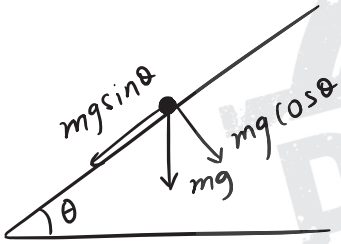


4. Resolution of Vectors (why resolve and how decide axis)

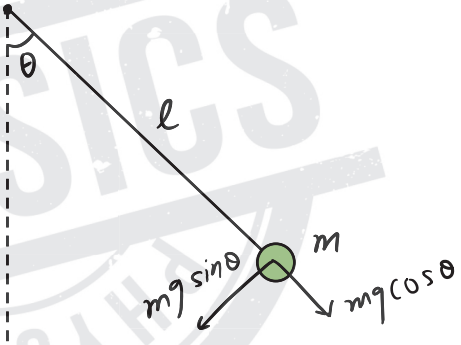




(i)

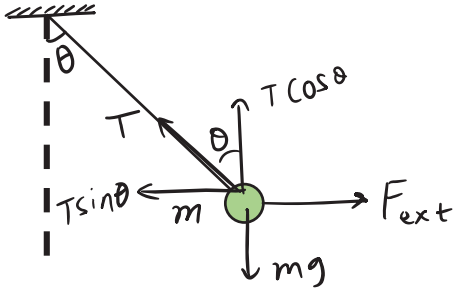


(ii)



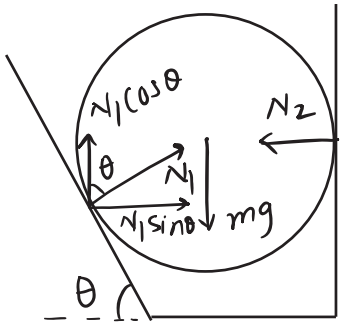
If Particle is in accelerated state or tends to move.

(iii)



NOTE: These forces makes closed polygon.

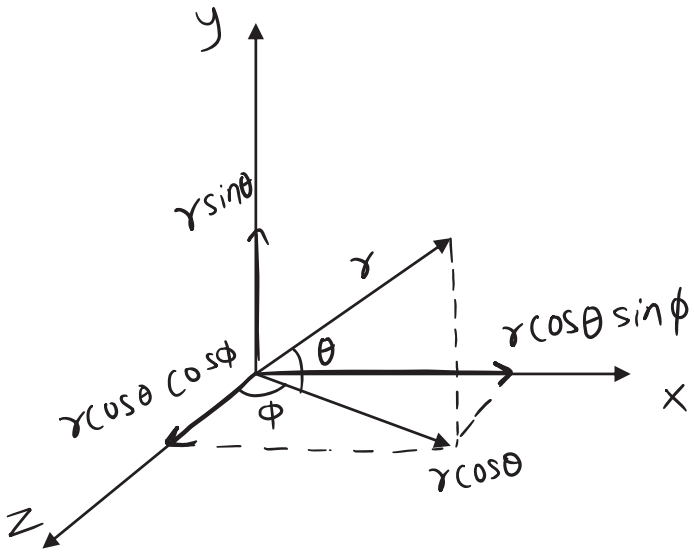
(iv)



If Particle is in Equilibrium

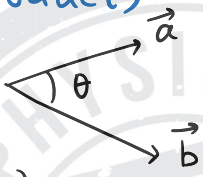
Resolution of vectors (3 dimension)

$$\vec{r} = r\cos\theta\sin\phi\,\hat{i} + r\sin\theta\,\hat{j} + r\cos\theta\cos\phi\,\hat{k}$$



5. Dot Product (Scalar Product)

↳ $\vec{a}\cdot\vec{b} = ab\cos\theta$



↳ $\vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{a}$ (commutative law)

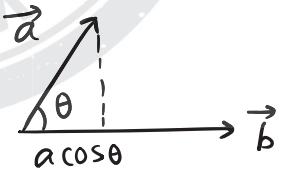
↳ $\vec{a}\cdot\vec{a} = a^2$

It's application:

(i) If $\vec{a}\cdot\vec{b} = 0 \Rightarrow$ Vectors are orthogonal (90°)

(ii) Find angle bet^n two Vectors, $\cos\theta = \frac{\vec{a}\cdot\vec{b}}{ab}$

(iii) Finding Projection of one Vector on another:



$\vec{a}\cdot\vec{b} = ab\cos\theta$

$\therefore a\cos\theta = \frac{\vec{a}\cdot\vec{b}}{b}$

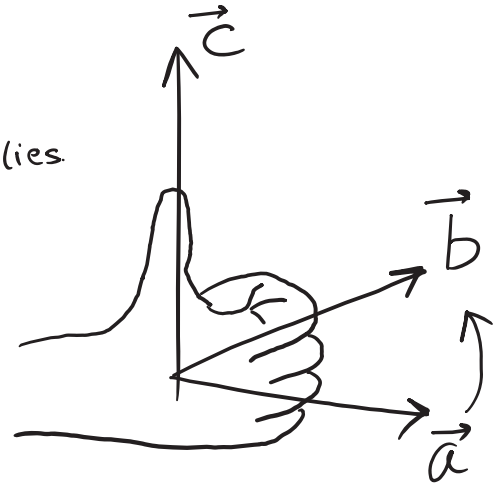
6. Cross Product (Vector Product)

↳ $\vec{a}\times\vec{b} = \vec{c}$, $\vec{c} = ab\sin\theta\,\hat{n}$

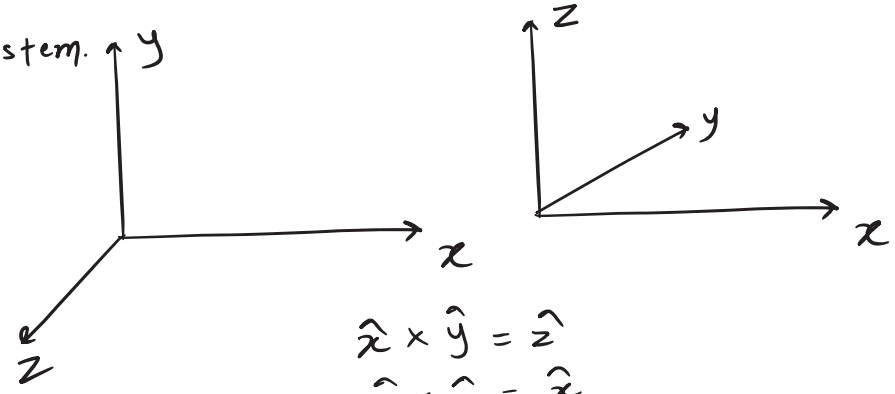
(i) $\vec{c}$ is ⊥ to plane in which $\vec{a}$ & $\vec{b}$ lies.

(ii) $\vec{a}\times\vec{b} \neq \vec{b}\times\vec{a}$ $(\vec{a}\times\vec{b} = -\vec{b}\times\vec{a})$

(iii) $\vec{a}\times\vec{a} = 0$



Co-ordinate system.



$\hat{x} \times \hat{y} = \hat{z}$

$\hat{y} \times \hat{z} = \hat{x}$

$\hat{z} \times \hat{x} = \hat{y}$

Cross Product (Vector Product)

Ex: $\vec{a} = 2\hat{i} + 3\hat{j} + 5\hat{k}$

$\vec{b} = \hat{i} - 3\hat{j} + 4\hat{k}$

find $\vec{c}$

$$\vec{c} = \begin{vmatrix} +\hat{i} & -\hat{j} & +\hat{k} \\ 2 & 3 & 5 \\ 1 & -3 & 4 \end{vmatrix}$$

$$\vec{c} = \hat{i}(12+15) - \hat{j}(8-5) + \hat{k}(-6-3)$$

$$= 17\hat{i} - 3\hat{j} - 9\hat{k}$$

Space to add concepts learnt from PYQs if any