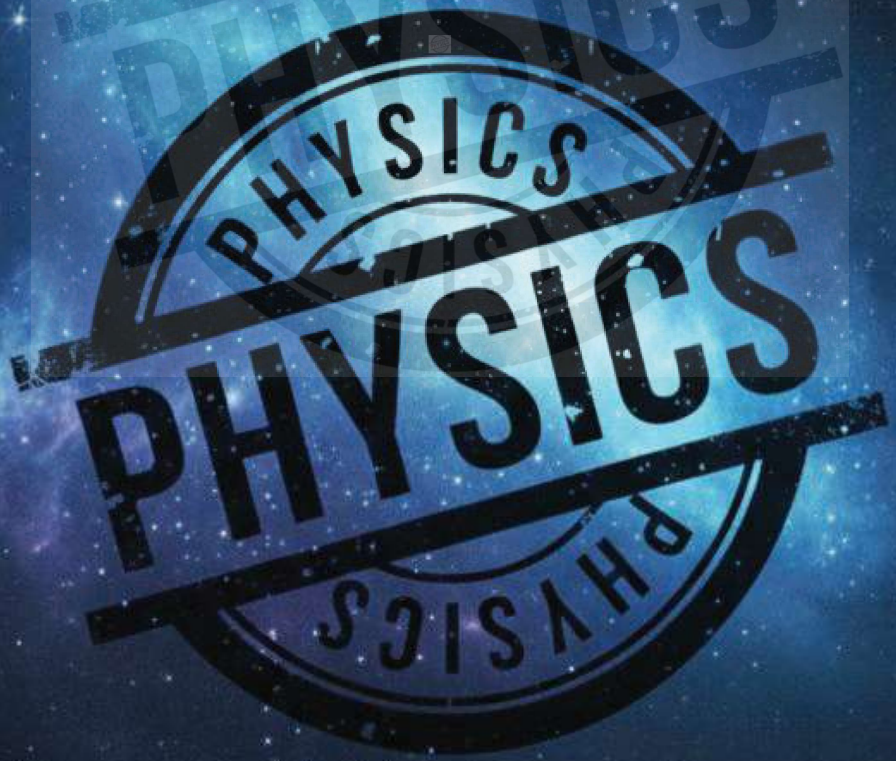
Class 12th

PHYSICS

Short Notes

JEE MAIN | JEE ADVANCED | NEET



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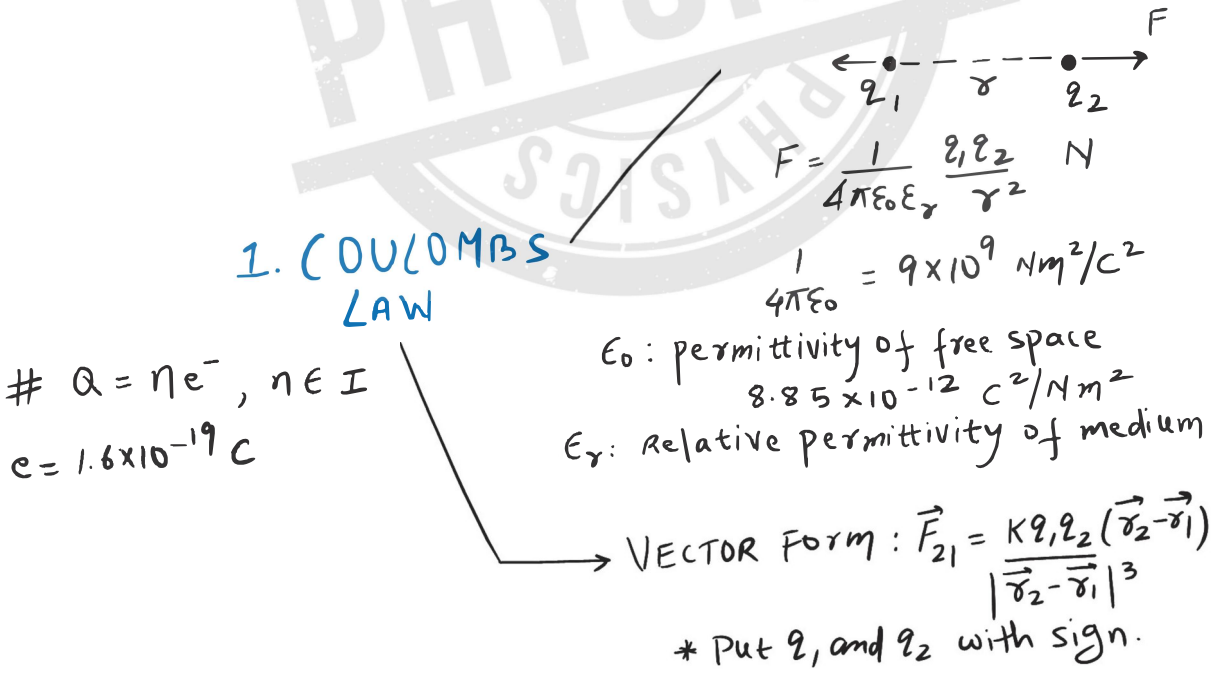
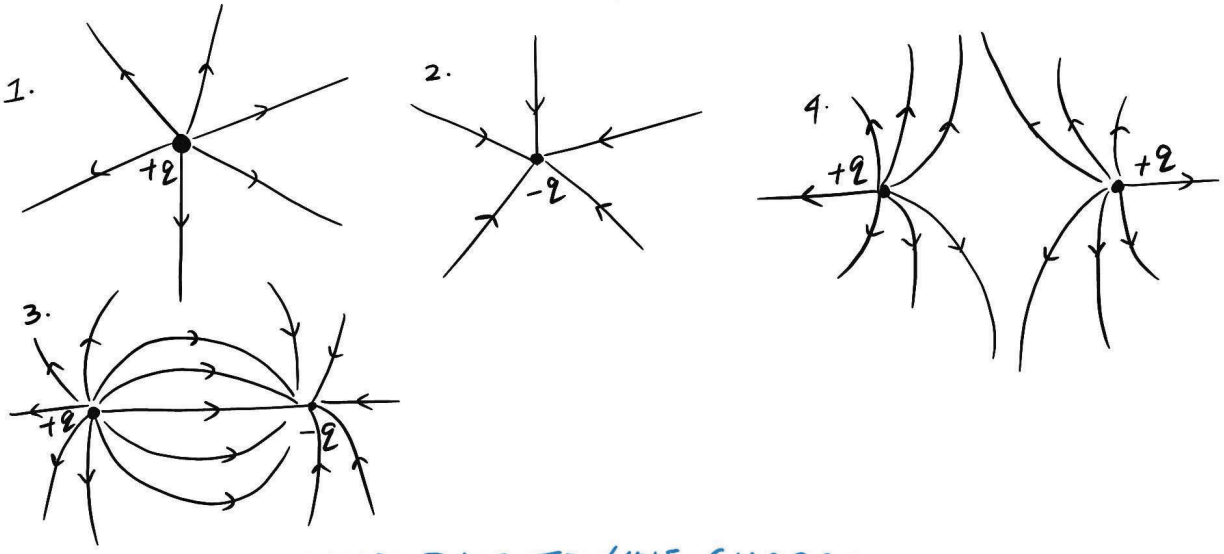
Topics to cover in ELECTROSTATICS – PART 1 (ELECTRODYNAMICS)

1. Coulomb's Law
2. Electric Field & Standard Line diagram
3. Electric Field due to line charge
4. Electric Field due to a charged ring
5. Electric Field due to a charged disc
6. Electric Field due to a charged sphere
7. Electric Field due to Non-Uniform Charge Distribution
8. Electrostatic Potential (ring & sphere)
9. Electrostatic Potential Energy (self energy)
10. Relation between E & V
11. Electric Dipole
12. Electric Flux
13. Conductors



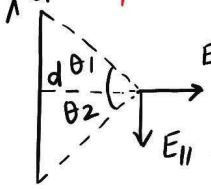
2. ELECTRIC FIELD ($E = KQ/r^2$), N/C



3. ELECTRIC FIELD DUE TO LINE CHARGE

(CHARGE IS UNIFORMLY DISTRIBUTED)

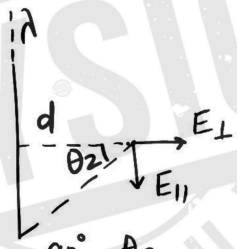
λ C/m — FINITE LENGTH



$E_\perp = \frac{K\lambda}{d}(\sin\theta_1 + \sin\theta_2)$

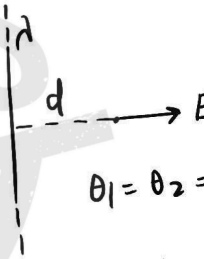
$E_{||} = \frac{K\lambda}{d}((\cos\theta_2 - (\cos\theta_1)$

SEMI-INFINITE



$\theta_1 = 90°$, θ_2

IN FINITE



$\theta_1 = \theta_2 = 90°$

$E_\perp = \frac{2K\lambda}{d} = \frac{\lambda}{2\pi\varepsilon_0 d}$

$E_{||} = 0$

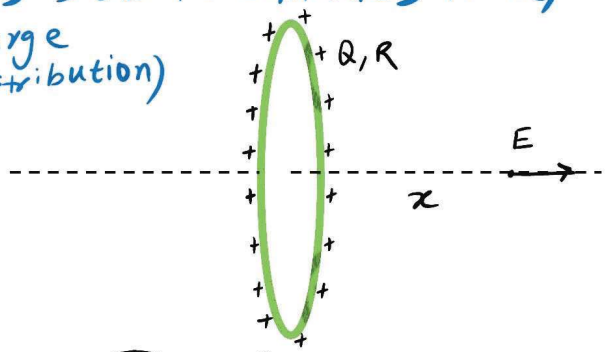
4. ELECTRIC FIELD DUE TO CHARGED RING

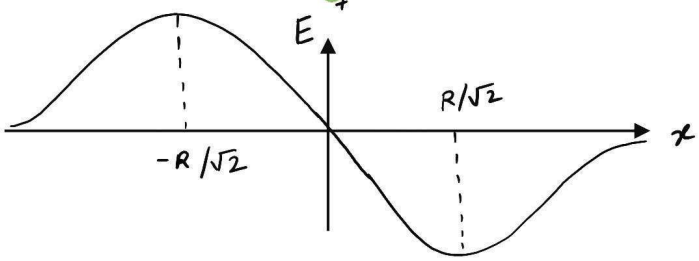
(uniform charge Distribution)

$E = \frac{KQx}{(x^2+R^2)^{3/2}}$

↳ at $x = \pm R/\sqrt{2}$, E is Max

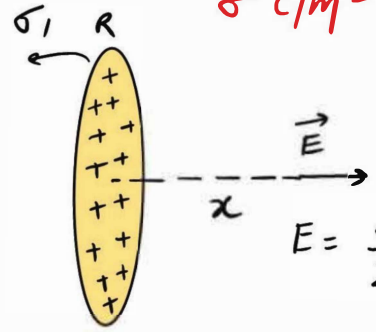
↳ at $x = 0$, $E = 0$ (center)





5. ELECTRIC FIELD DUE TO CHARGED DISC

σ C/m^2 (UNIFORM CHARGE Distribution)



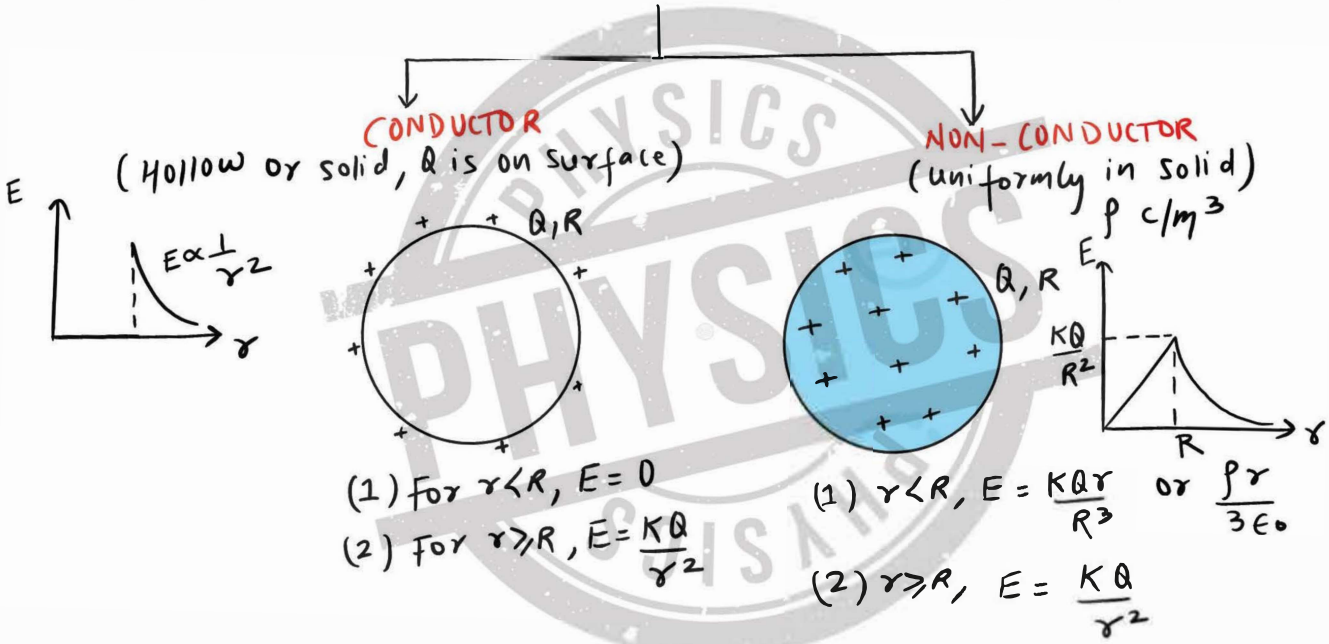
$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right)$$

Case If Disc is very large ($x << R$)

$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$

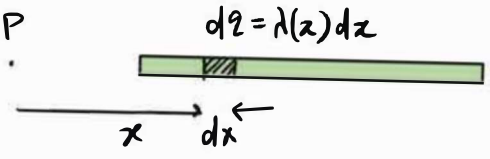
↳ for infinite sheet

6. ELECTRIC FIELD DUE TO CHARGED SPHERE



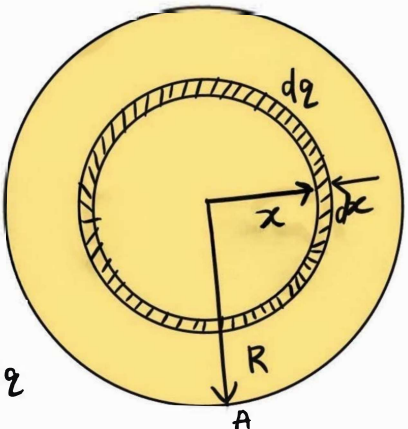
7. ELECTRIC FIELD (NON-UNIFORM CHARGE Distribution)

1.



$$E = \int_a^b \frac{K\lambda(x)\,dx}{x^2}$$

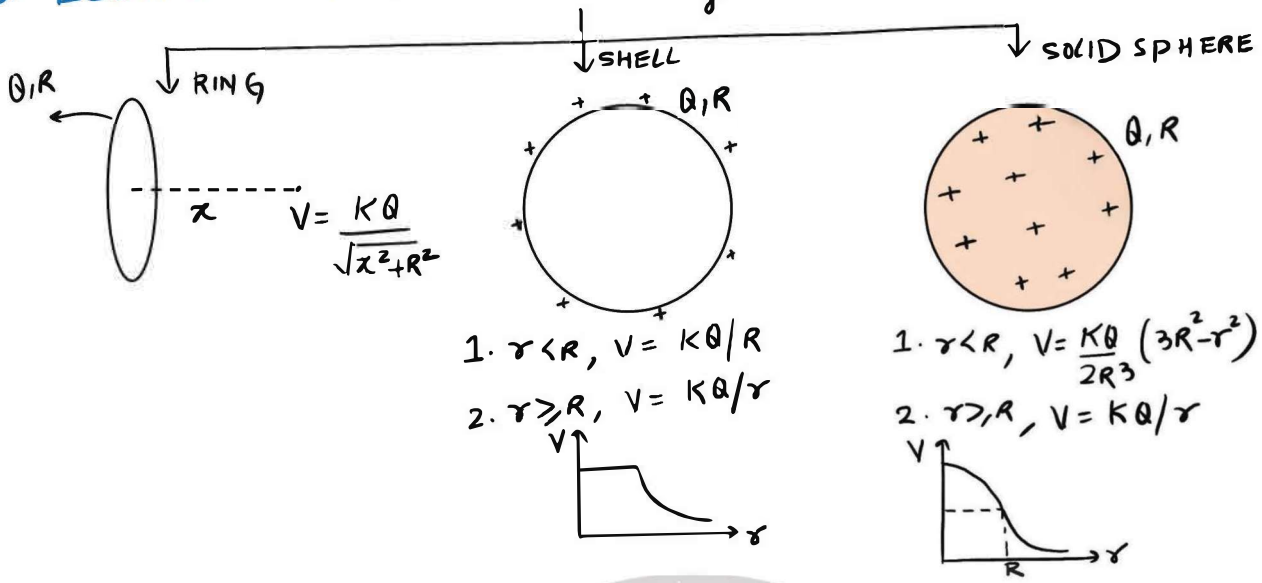
2.



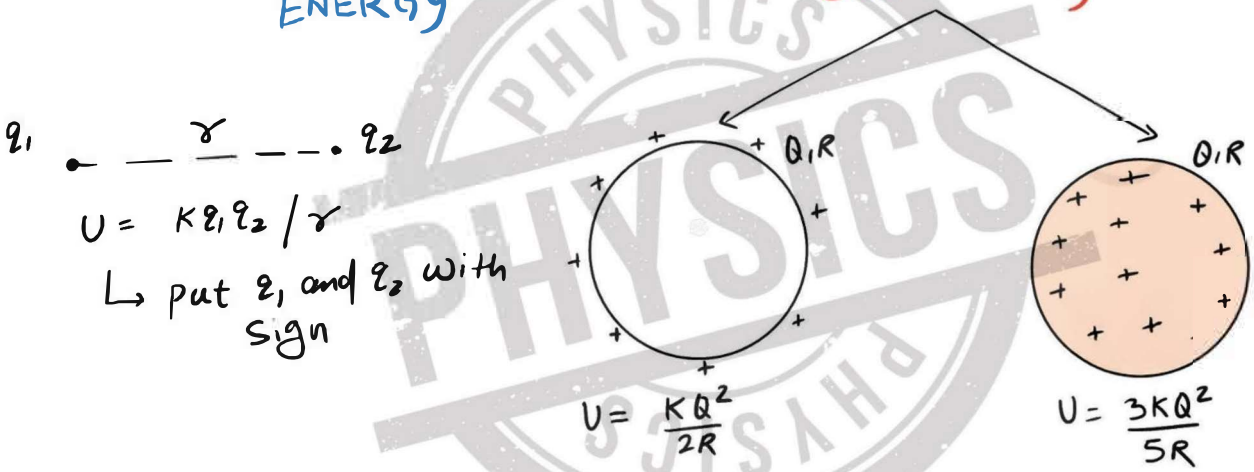
$$E_A = \frac{K Q_{in}}{R^2}$$

$$Q_{in} = \int dq = \int_0^R \rho(x) \times 4\pi x^2\,dx$$

8. ELECTROSTATIC POTENTIAL $V = \frac{Kq}{r}$, Put q with sign.



9. ELECTROSTATIC POTENTIAL ENERGY



10. RELATION BETWEEN E and V

(1.) $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

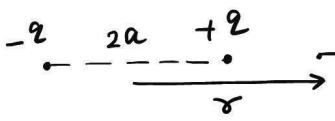
(2.) $\Delta V = -\int \vec{E} \cdot d\vec{r}$

Here $\frac{\partial V}{\partial x}$ means differentiate V w.o.t x keeping y and z constant.

11. ELECTRIC DIPOLE ($-q$ ---- $+q$, $P = 2qd$, direction from -VE to +VE)

(a) ELECTRIC FIELD

AXIAL POINT



$$E = \frac{2PKr}{(r^2-a^2)^2}$$

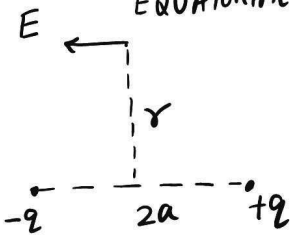
* SHORT DIPOLE ($r >> a$)

$$E_{axial} = 2PK/r^3$$

Direction : Along $\vec{P}$

$P = 2aq$

EQUATORIAL POINT



$$E = \frac{PK}{(r^2+a^2)^{3/2}}$$

* SHORT DIPOLE ($r >> a$)

$$E_{eq} = PK/r^3$$

Dirn : OPP $\vec{P}$

(b) POTENTIAL

AXIAL POINT

$$V = \frac{PK}{r^2-a^2}$$

SHORT DIPOLE ($r >> a$)

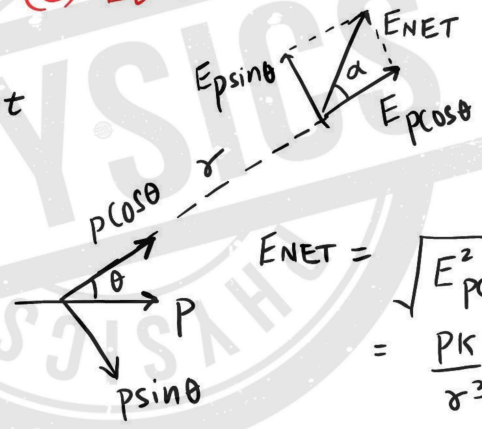
$$V = \frac{PK}{r^2}$$

$P = 2aq$

Equatorial Point

$V = 0$

(c) ELECTRIC FIELD AT GENERAL POINT



$$E_{P\cos\theta} = \frac{2P\cos\theta\, K}{r^3}$$

$$E_{P\sin\theta} = \frac{P\sin\theta\, K}{r^3}$$

$$E_{NET} = \sqrt{E^2_{P\cos\theta} + E^2_{P\sin\theta}}$$

$$= \frac{PK}{r^3}\sqrt{1+3\cos^2\theta}$$

$$\boxed{\tan\alpha = \frac{\tan\theta}{2}}$$

(d) DIPOLE IN E (uniform)

TORQUE

$\vec{\tau} = \vec{P} \times \vec{E}$

↳ SHM based Question

Potential Energy

$U = -\vec{P}.\vec{E}$

STABLE ↳ $\theta = 0^\circ$, $U_{min} = -PE$

UNSTABLE ↳ $\theta = 180^\circ$, $U_{max} = PE$

↳ $\theta = 90^\circ$, $U = 0$

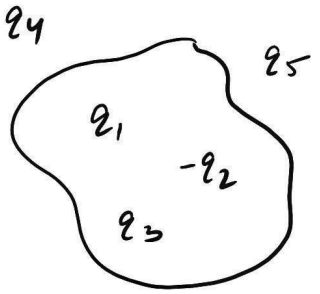
12. ELECTRIC FLUX ($\phi = \vec{E} \cdot \vec{A}$)

GAUSS's LAW

↳ $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

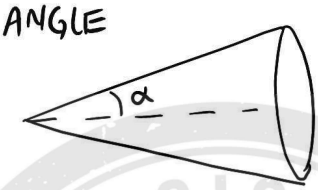
① q_{in} : charge enclosed

② E : Electric field is due to all the charges.



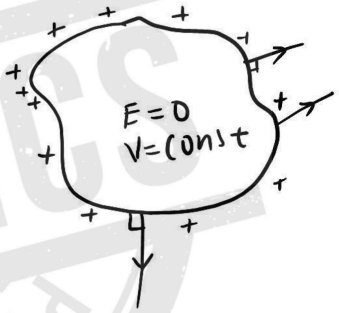
$\phi = \frac{q_1 - q_2 + q_3}{\varepsilon_0}$

Solid ANGLE



$\Omega = 2\pi(1 - \cos\alpha)$

13. CONDUCTOR



(1.) charge remains on surface

(2.) Electric field inside is zero

(3.) V is constant

(4.) Field Lines are ⊥ to surface

(5.) CONNECTING TWO CONDUCTORS
↳ They share charge untill V of both bodies are same.

(6.) EARTHING:

V of body will always be zero

Space to add concepts learnt from PYQs if any