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RAY OPTICS

(obstacle dimension Is very large as Comparied to wavelength of light)

Object & Image

Object → Always defined in terms of incident ray

Image → Always defined In terms of reflected or refracted rays.

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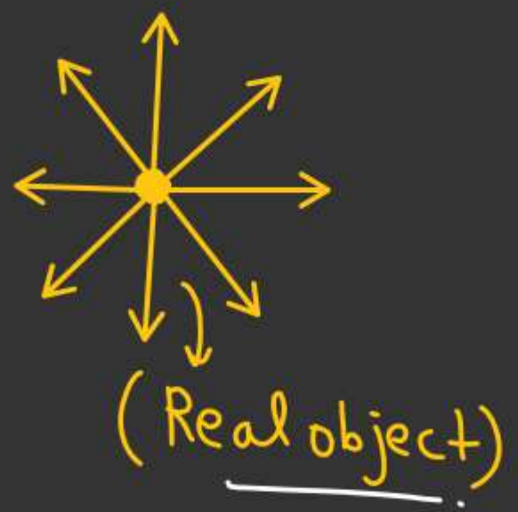
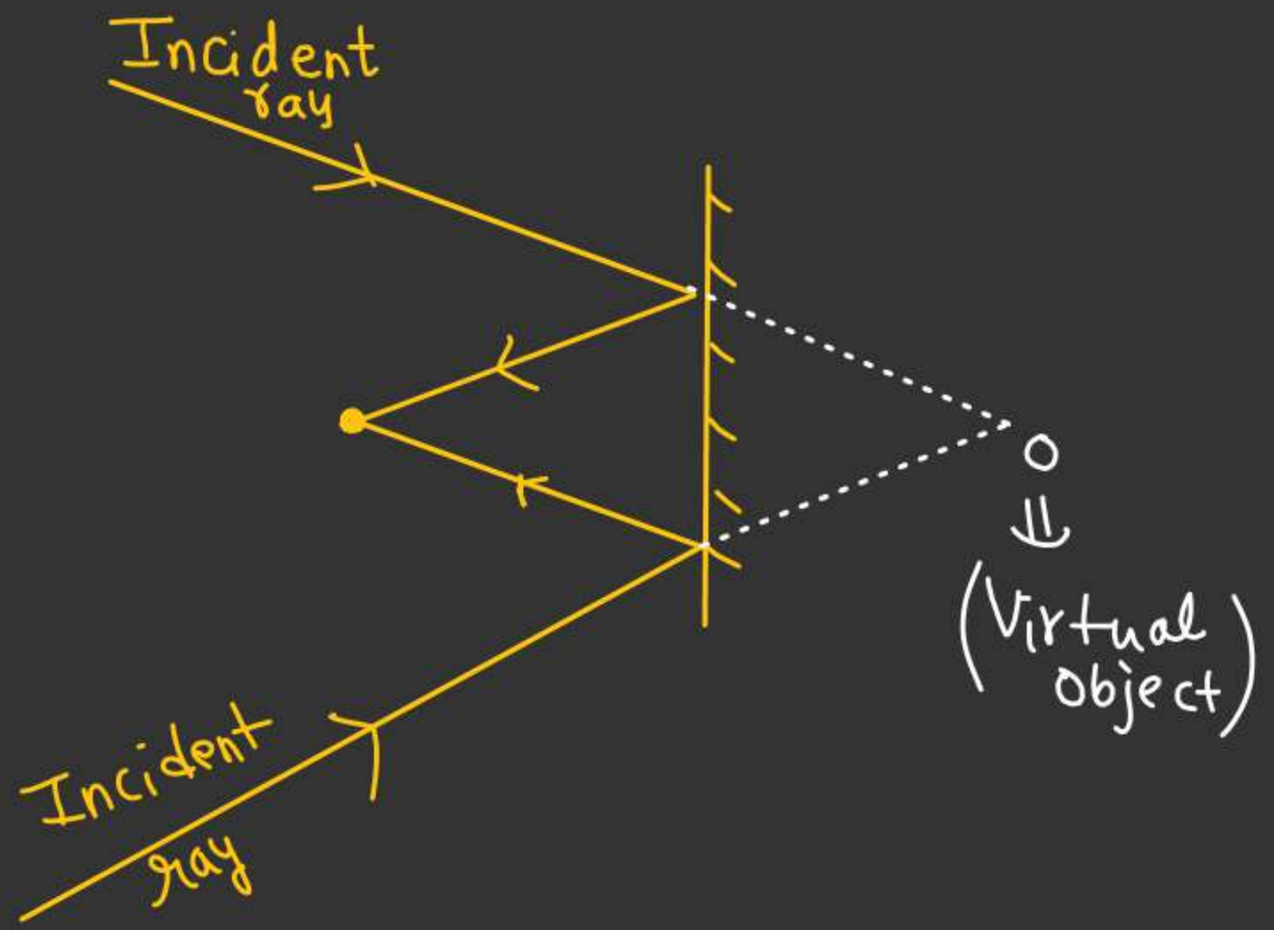
Real object

↳ When incident ray actually diverge from a point, object is said to be real.



Virtual object

When incident ray seems to converge at a point, then the point acts as a virtual object.



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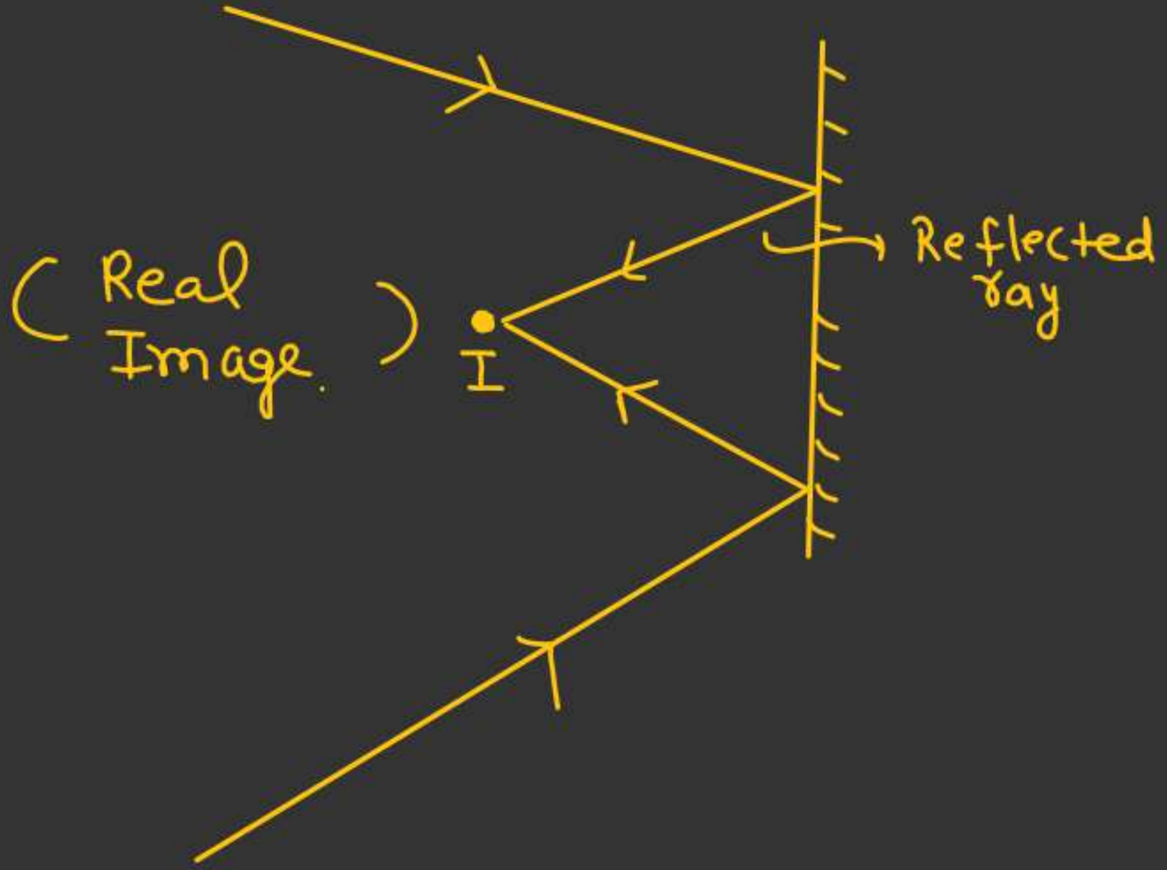
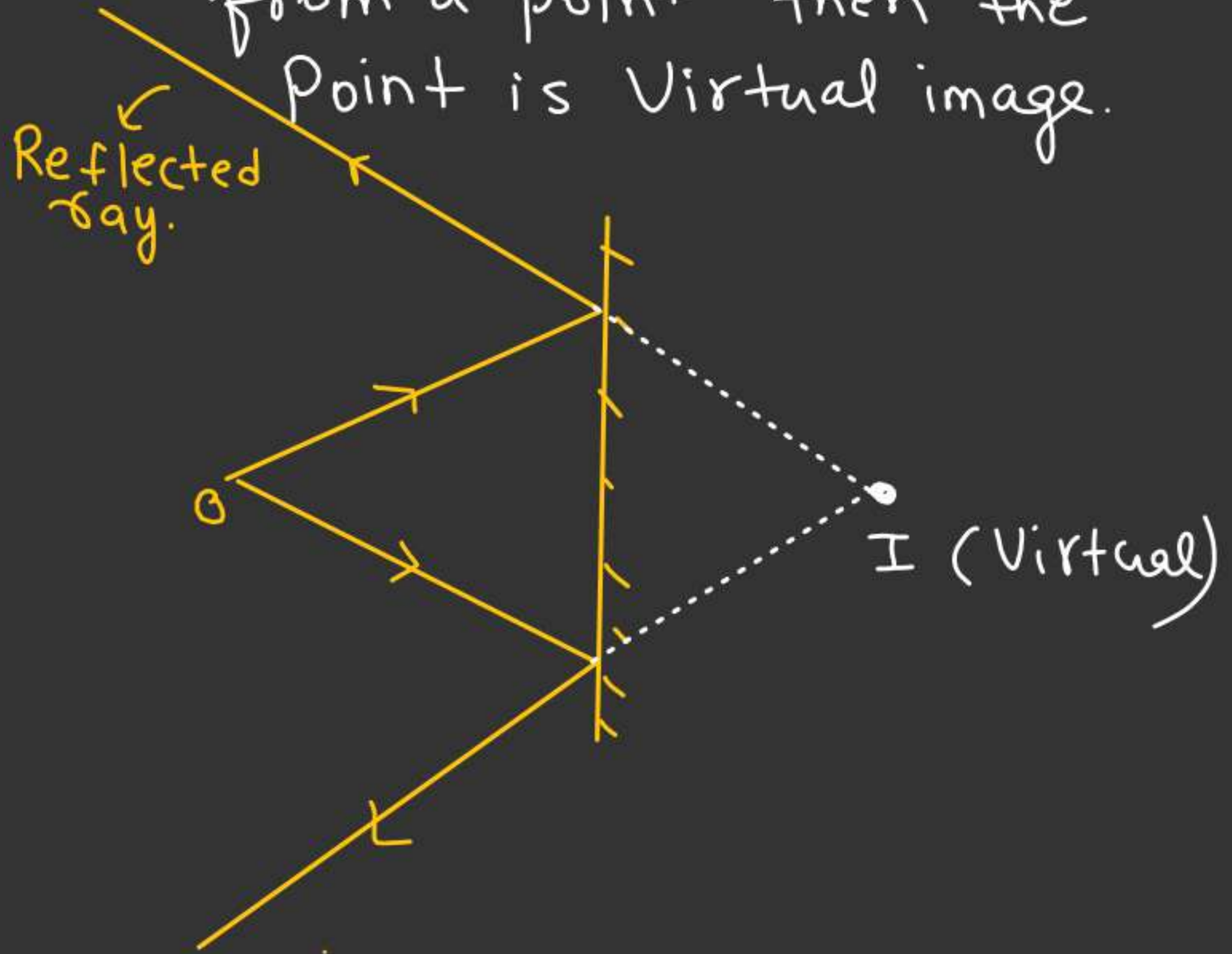
Real Image

↳ When reflected or refracted ray actually meet at a point then form real image.



Virtual Image

↳ Reflected or refracted ray when seems to diverge from a point then the point is Virtual image.



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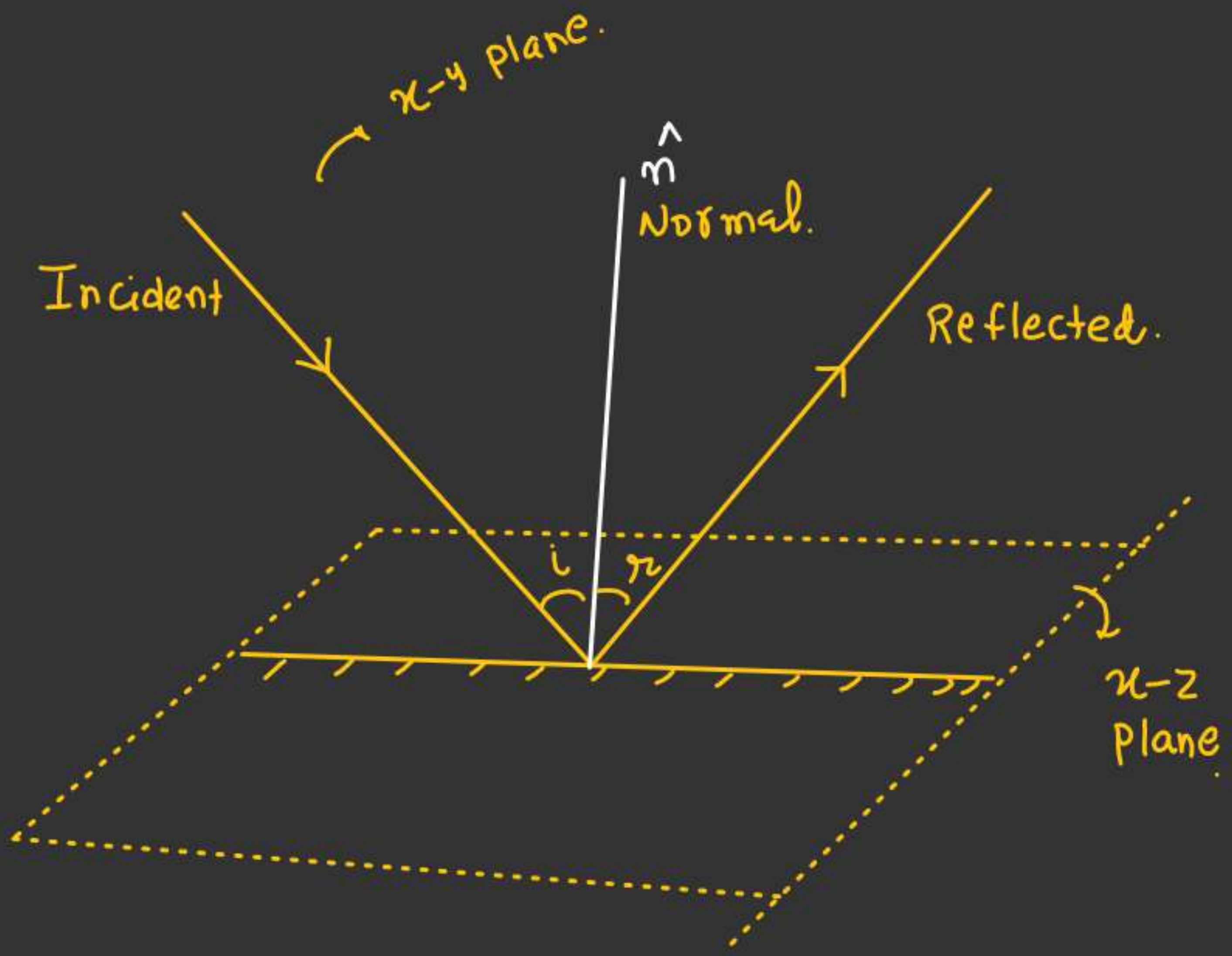
LAW OF REFLECTION

- Incident ray, Normal & Reflected ray are on the same plane. & is Perpendicular to the Mirror plane.

- Angle of Incidence is equal to angle of reflection.

$$\angle i = \angle r$$

Angle $\angle i$ & $\angle r$ from the Normal.



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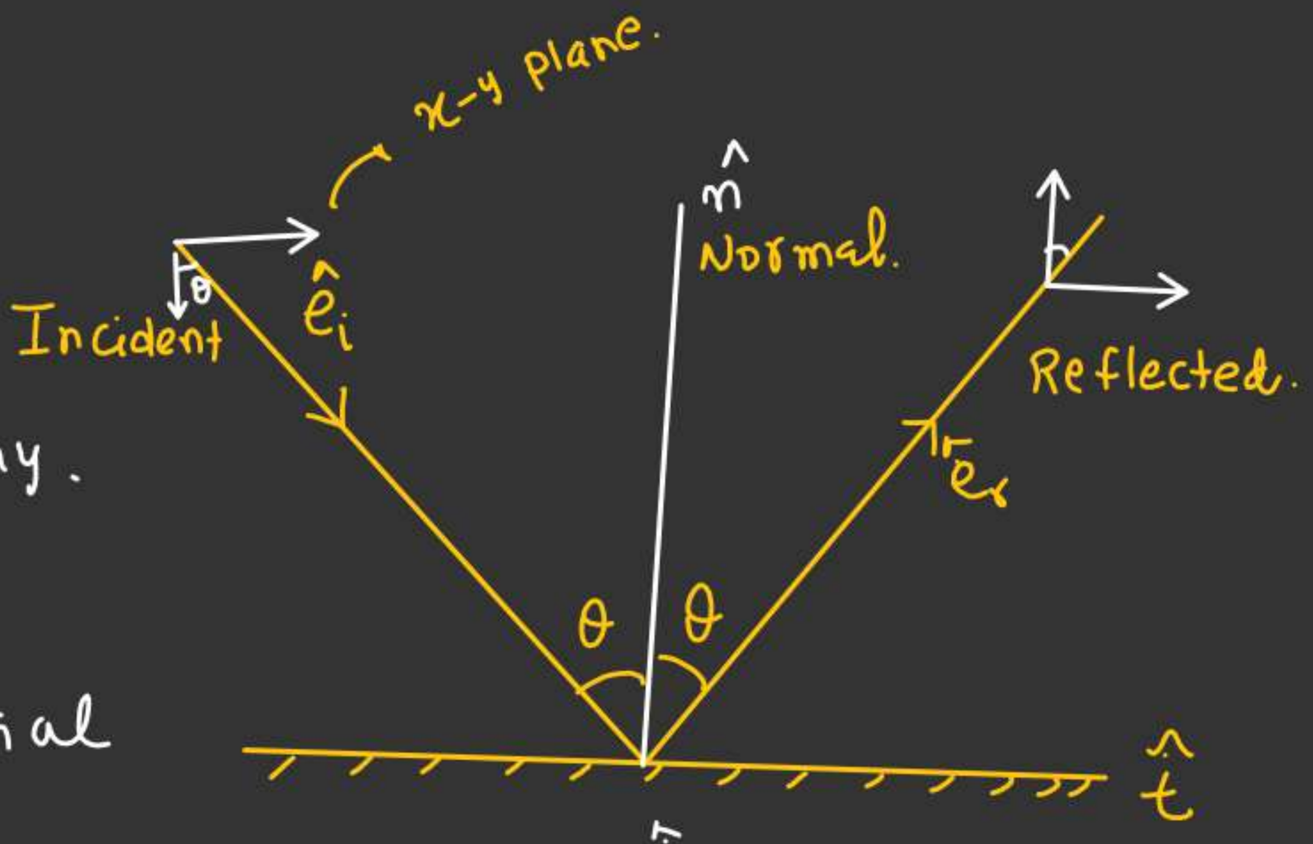
Unit vector along reflected ray



$\hat{e}_i$ = Unit vector along incident ray

$\hat{e}_r$ = Unit vector along reflected ray.

$\hat{n}$ = unit vector along normal.

$\hat{t}$ = Unit vector along tangential direction.

$$\hat{e}_i = \sin\theta\,\hat{t} - \cos\theta\,\hat{n}$$

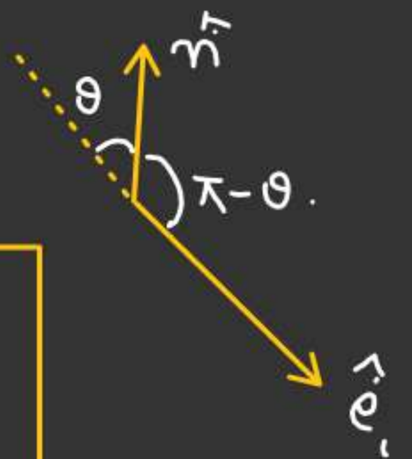
$$\hat{e}_r = \sin\theta\,\hat{t} + \cos\theta\,\hat{n}$$

$$\hat{e}_i - \hat{e}_r = -2\cos\theta\cdot\hat{n} \quad -(1)$$

$$\hat{e}_i - \hat{e}_r = 2(\hat{e}_i\cdot\hat{n})\,\hat{n}$$

$$\hat{e}_i\cdot\hat{n} = (-\cos\theta) \quad -(2)$$

$$\boxed{\hat{e}_r = \hat{e}_i - 2(\hat{e}_i\cdot\hat{n})\,\hat{n}}$$



$$\hat{e}_i\cdot\hat{n} = |\hat{e}_i||\hat{n}|\cos(\pi-\theta) = -\cos\theta$$

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* A ray of light incident on a Mirror along the vector $a\hat{i}+b\hat{j}-c\hat{k}$ and normal along the unit vector $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$. Find Unit vector along reflected ray.

$$\left[\hat{e}_r = \hat{e}_i - 2(\hat{e}_i\cdot\hat{n})\hat{n}\right]$$

$$\hat{e}_i = \left(\frac{a\hat{i}+b\hat{j}-c\hat{k}}{\sqrt{a^2+b^2+c^2}}\right)$$

$$\hat{e}_r = \left(\frac{a\hat{i}+b\hat{j}-c\hat{k}}{\sqrt{a^2+b^2+c^2}}\right) - 2\left[\frac{a\hat{i}+b\hat{j}-c\hat{k}}{\sqrt{a^2+b^2+c^2}}\cdot\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)\right]\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$$

$$\hat{e}_r = -\frac{(a\hat{i}+b\hat{j}+c\hat{k})}{\sqrt{a^2+b^2+c^2}}$$

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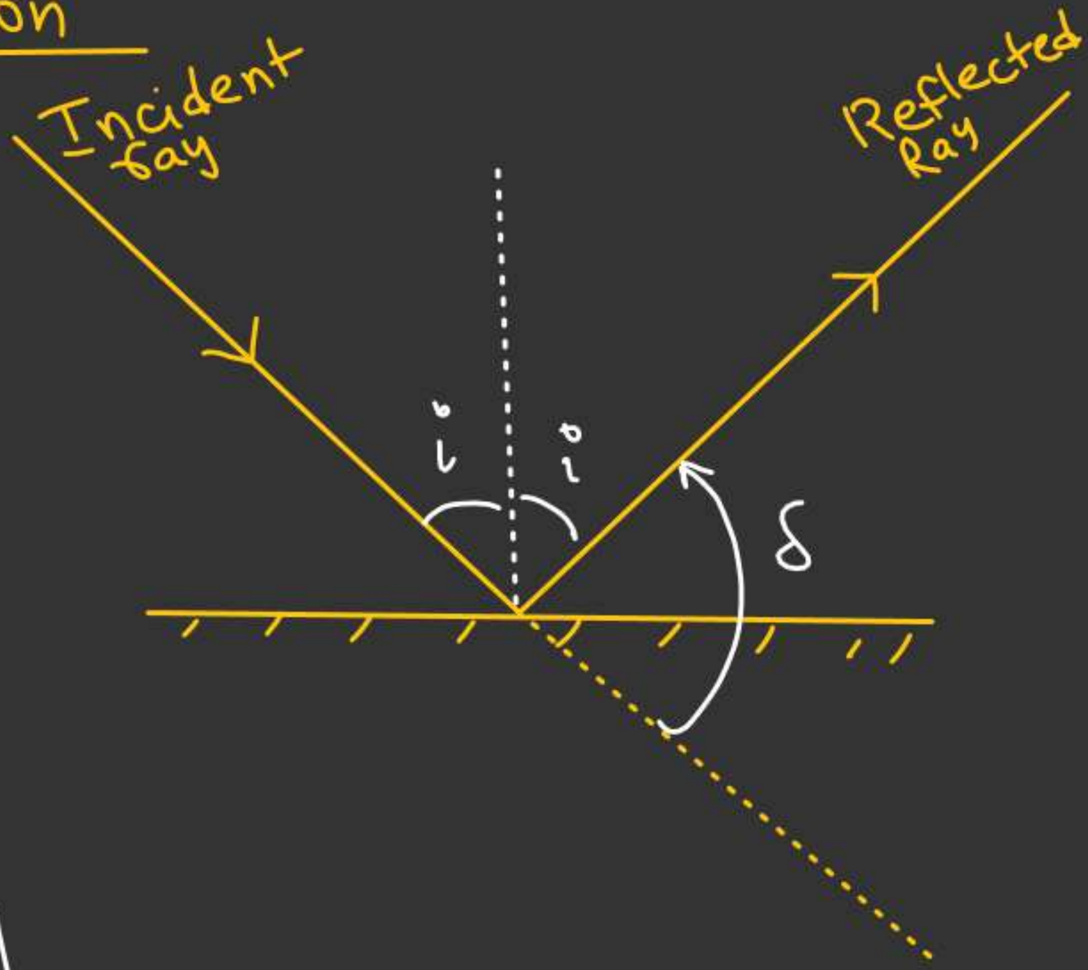
Reflection from plane Mirror

Angle of deviation in Case of Reflection from plane Mirror

$$\delta = (\pi - 2i^\circ)$$

(Angle of deviation)



For Multiple reflection

$$\delta_{net} = \left(\sum_{i=1}^{n} \delta_i\right)$$

[if deviation in anticlockwise ↺ +ve
if deviation in clockwise ↻ −ve.]

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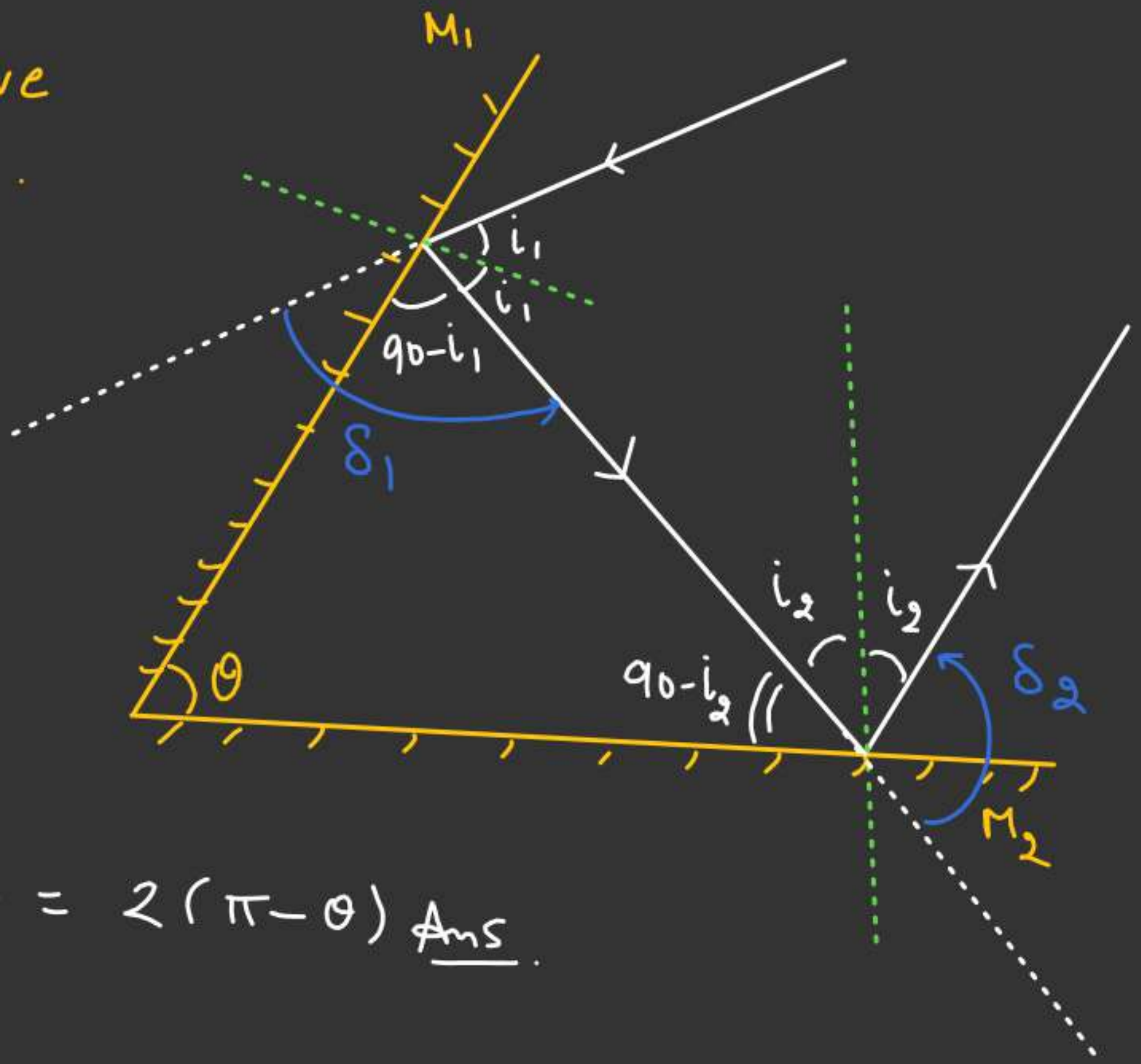
Q:

Find angle of deviation of the incident ray after 2- Successive reflection from M_1 & M_2.



$\theta + 90 - i_1 + 90 - i_2 = 180°$

$\theta = (i_1 + i_2)$.

$\delta_1 = \pi - 2i_1$

$\delta_2 = \pi - 2i_2$

$\delta_{net} = (\delta_1 + \delta_2)$

$= 2\pi - 2(i_1 + i_2)$

$= 2\pi - 2\theta$

$\delta_{net} = 2(\pi - \theta)$ Ans.

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Find total angle of deviation after 3-Successive reflection.

$\delta_1 = \pi - 2(50^\circ)$

$= 80^\circ$

$\delta_2 = \pi - 2(20^\circ)$

$= 140^\circ$

or

$2\pi - 220^\circ$

$360^\circ - 220^\circ$

140°

$\delta_3 = \pi - 2(10^\circ)$

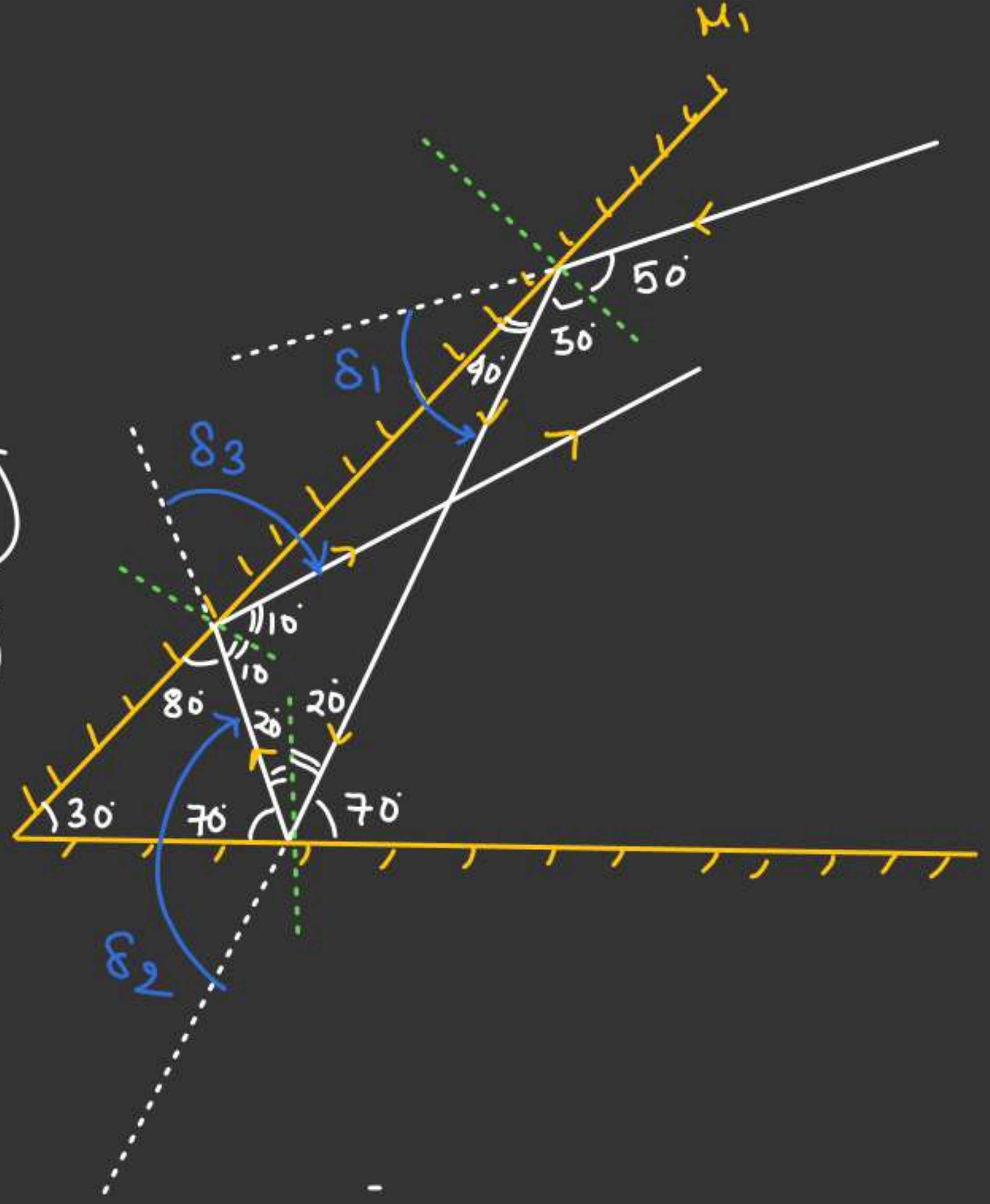
$= 160$

$\delta_{net} = \delta_1 + \delta_2 + \delta_3$

$= (+80 - 140 - 160)$

$= 80 - 300$

$= -220^\circ$



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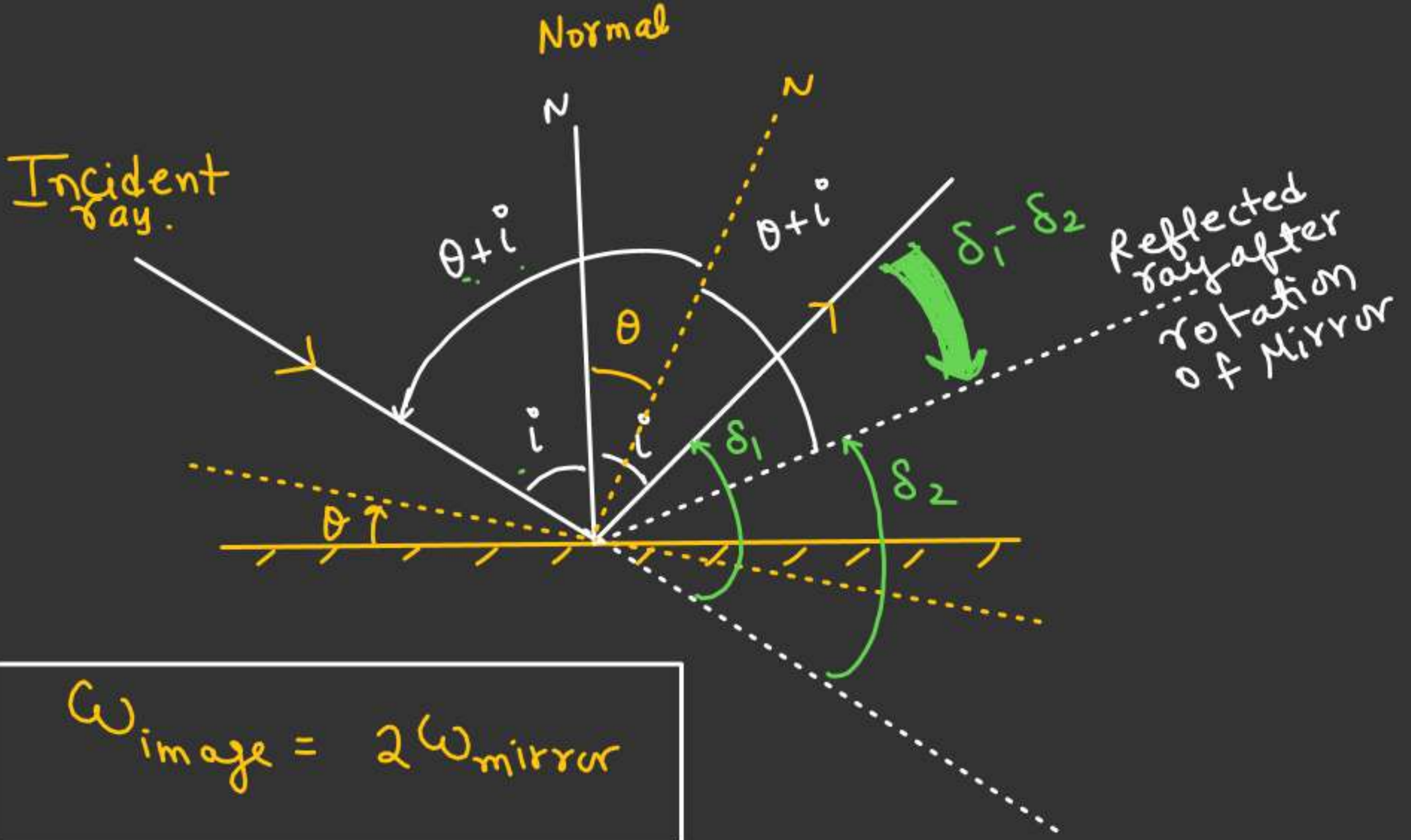
If Mirror is rotated by θ, then image will rotate by 2θ. keeping Incident ray fixed.

$$\delta_1 = (\pi - 2i)$$

$$\delta_2 = \pi - 2(\theta + i)$$

$$\boxed{\delta_1 - \delta_2 = 2\theta}$$



$$\boxed{\omega_{image} = 2\omega_{mirror}}$$

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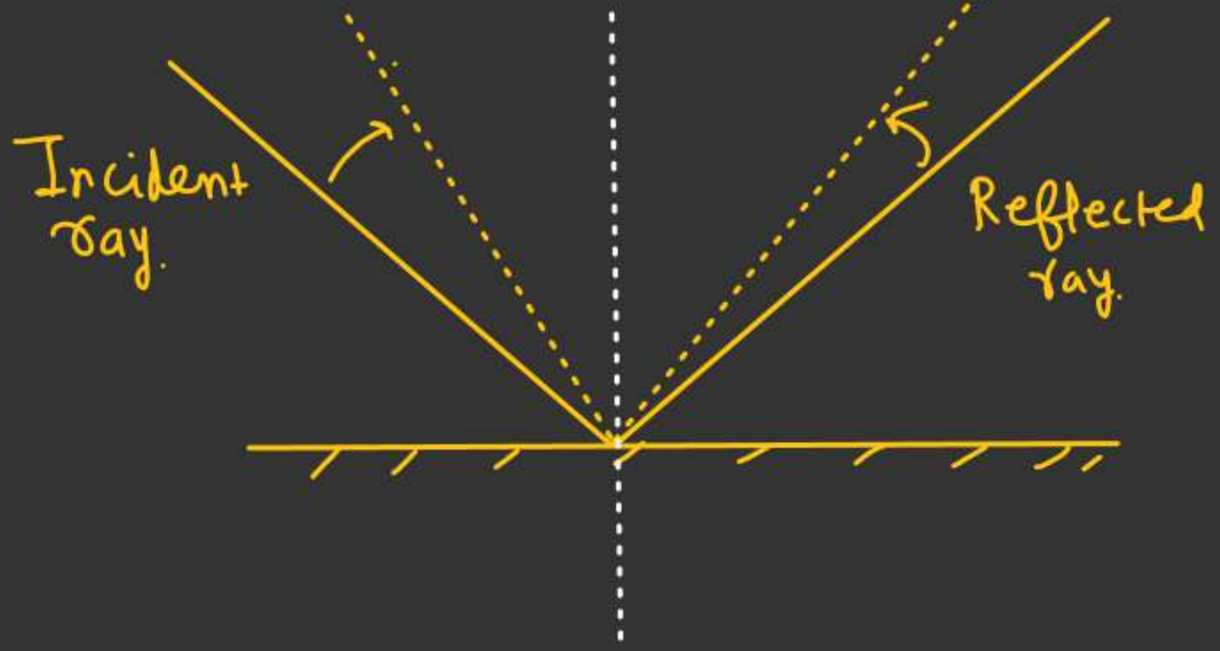
If Mirror is fixed and incident ray rotating



$$\boxed{\omega_i = -\omega_r}$$