Nishant Jindal

Refracitive Index of glass slab less than surrounding

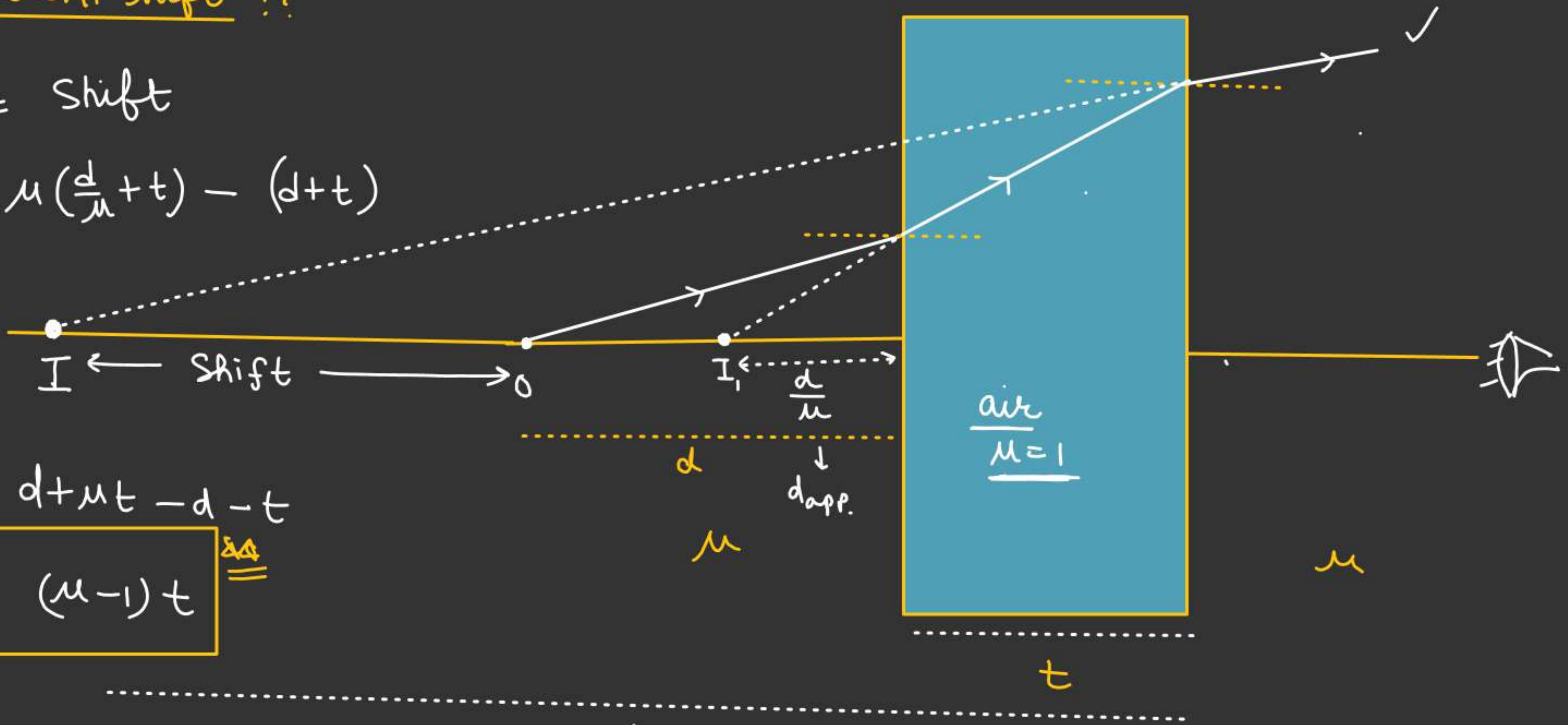
Apparent Shift ??

$OI = \text{Shift}$

$OI = \mu\left(\frac{d}{\mu}+t\right) - (d+t)$

$OI = d + \mu t - d - t$

$$\boxed{OI = (\mu - 1)t}$$



$h_{app} = \mu\left(\frac{d}{\mu}+t\right)$

Air Slab in Surrounding Medium μ

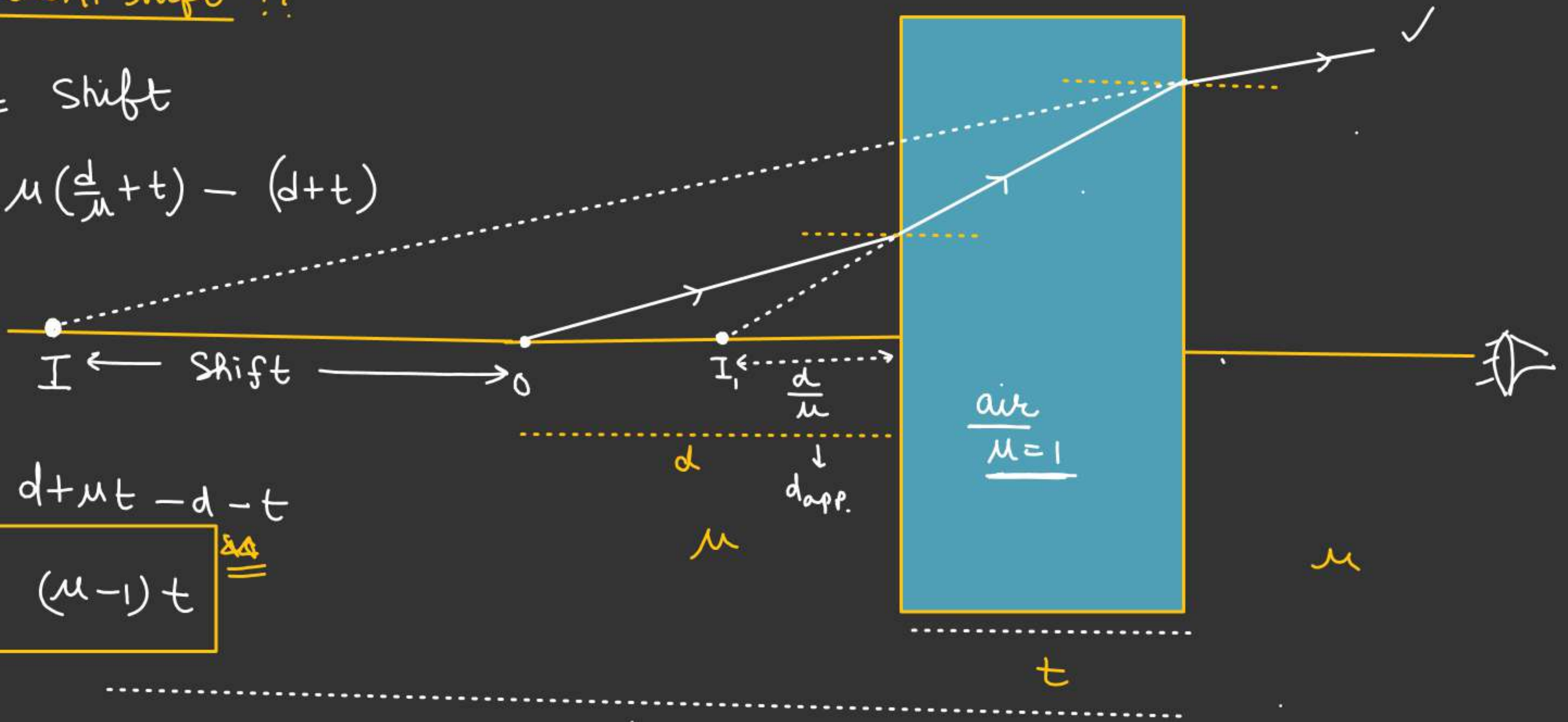
Apparent Shift ??

OI = Shift

$$OI = \mu\left(\frac{d}{\mu}+t\right) - (d+t)$$

$$OI = d + \mu t - d - t$$

$$\boxed{OI = (\mu - 1)t}$$



$$h_{app} = \mu\left(\frac{d}{\mu}+t\right)$$

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$$\text{Shift} = t\left(1 - \frac{1}{{}_{\text{surrounding}}\mu_{\text{slab}}}\right)$$

$$\boxed{\text{Shift} = t\left[1 - \frac{\mu_{\text{surrounding}}}{\mu_{\text{slab}}}\right]}$$

Case-1

if $\mu_{slab} = \mu$

$\mu_{surrounding} = 1.$

$\text{Shift} = t\left(1 - \frac{1}{\mu}\right)$

if $\mu_{slab} = 1$, $\mu_{surrounding} = \mu$

$\text{Shift} = t(1 - \mu)$

$= - t(\mu - 1)$

$\Downarrow$

Shift opposite to incident ray

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Distance of the final image from the Mirror after refraction and reflection

$d_{real} = 10cm.$

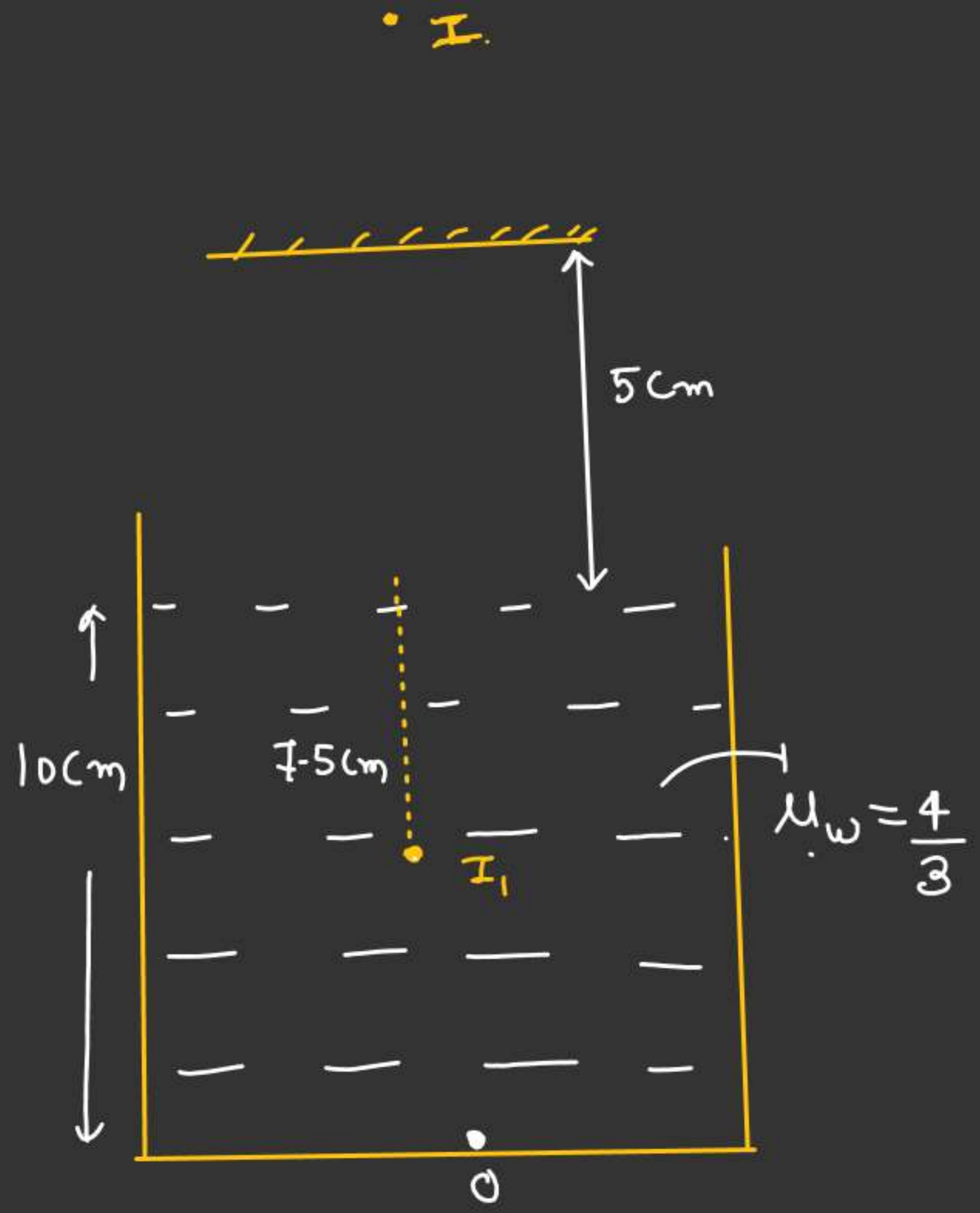
$$d_{app} = \frac{d_{real}}{\mu} = \frac{10}{4/3} = \frac{30}{4} = \frac{15}{2} = 7.5cm.$$

I_1 acts as a object for the Mirror

Object distance from the Mirror $= 12.5cm$

Image distance from the Mirror

$= \underline{12.5cm}$ Ans



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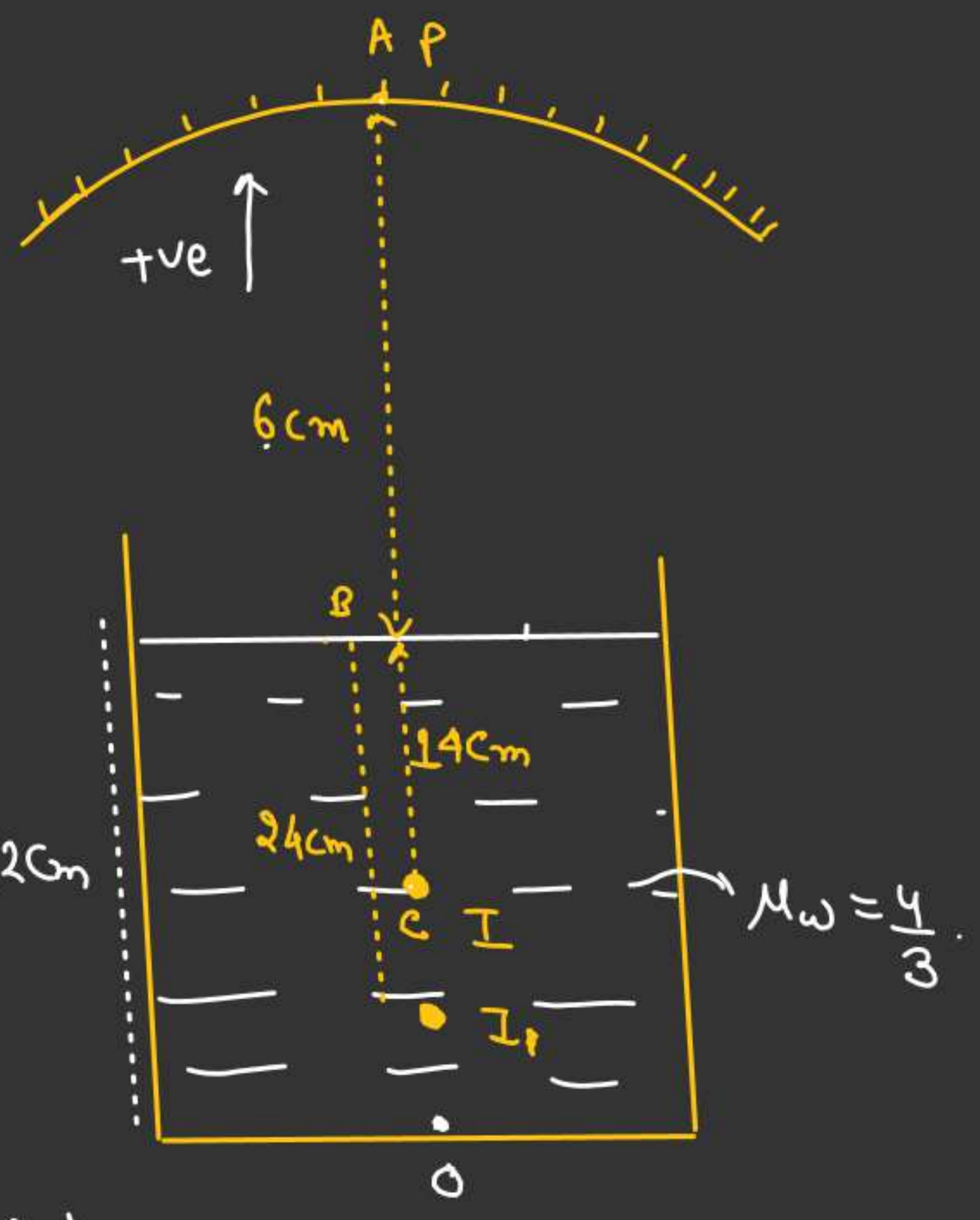
Object 'O' kept along the principal axis of the Mirror.

I = final image of object ie after refraction and reflection.

BI = 14 cm.
AB = 6 cm.

f = Focal length of the Mirror = ??



Sol^n : After refraction let, I_1 be the image.

$$d_{app} = \frac{d_{real}}{\mu} = \frac{32}{4} \times 3 = 24\,\text{cm}$$

I_1 acts as a Virtual object for mirror.

$u = -30\,\text{cm}$ $\quad \frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$v = -20\,\text{cm}$ $\quad f = \frac{uv}{u+v} = \frac{(-30)(-20)}{(-30-20)} = -\frac{60\cancel{0}}{5\cancel{0}} = \underline{-12\,\text{cm}}$

$f = ??$

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$$d_{app} = ??$$

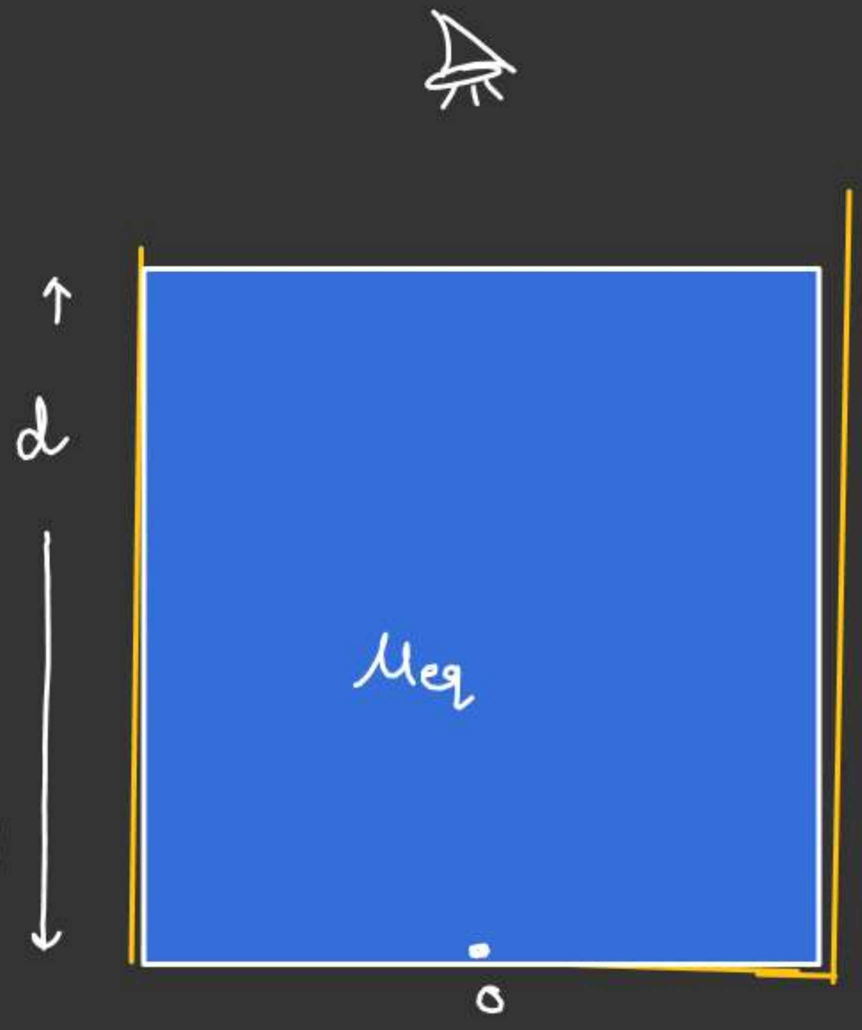
$$\text{Net Shift} = t_1\left(1-\frac{1}{\mu_1}\right) + t_2\left(1-\frac{1}{\mu_2}\right) \cdots t_n\left(1-\frac{1}{\mu_n}\right)$$

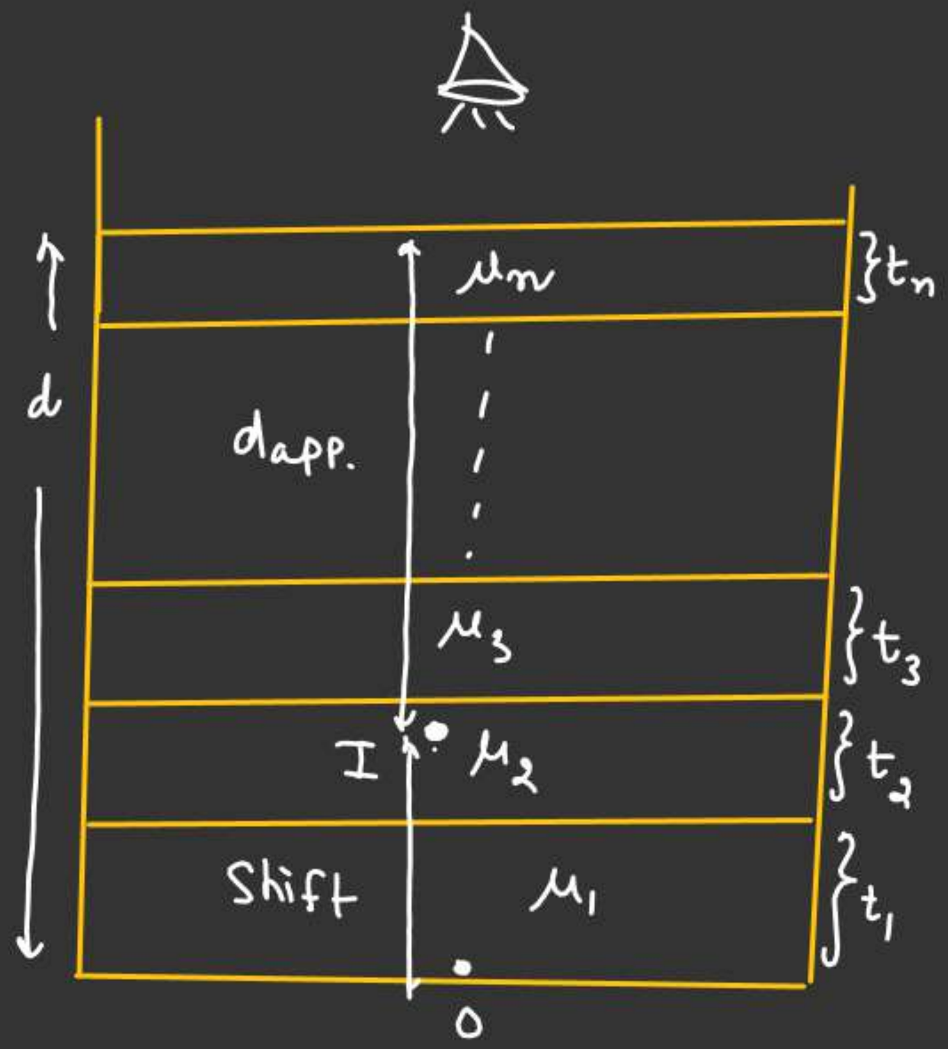
$$OI = (t_1 + t_2 \cdots + t_n) - \left(\frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} \cdots + \frac{t_n}{\mu_n}\right)$$

$$(\cancel{d} - d_{app.}) = (\cancel{t_1 + t_2 \cdots + t_n}) - \left(\frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} \cdots + \frac{t_n}{\mu_n}\right)$$

$$d = (t_1 + t_2 \cdots + t_n)$$

$$\boxed{d_{app} = \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} \cdots + \frac{t_n}{\mu_n}}$$





$$d = (t_1 + t_2 \cdots + t_n)$$

$$d_{app} = \frac{d}{\mu_{eq}} = \left[\frac{t_1 + t_2 + \cdots + t_n}{\mu_{eq}}\right]$$

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$$\mu_{eq} = \left(\frac{t_1 + t_2 \cdots + t_n}{\frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} \cdots + \frac{t_n}{\mu_n}} \right)$$

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AQ

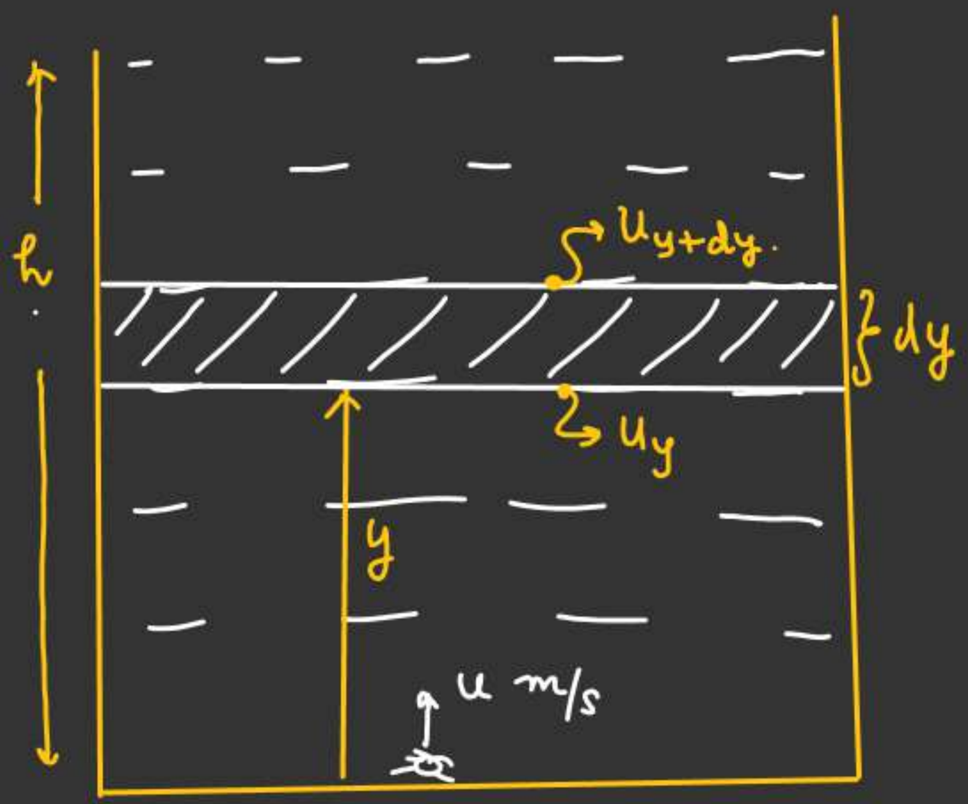
$\mu = \mu_0(1+ay)$ (μ_0 & 'a' constant)

y = distance from bottom of the liquid.

Insect Moving with Constant velocity u m/s.

Find 1) Apparent depth of the vesslel as seen by observer directly above it

2) Apparent velocity of insect seen by observer.



Since, dy is Very Small

$u_y \approx u_{y+dy}$

y_{app}

$$\int_0^{y_{app}} dy_{app} = \frac{dy}{\mu_y} = \int_0^y \frac{dy}{\mu_0(1+ay)}$$

$$y_{app} = \frac{1}{a\mu_0}\ln[1+ay]_0^y$$

$$y_{app} = \frac{1}{\mu_0 a}\ln(1+ay)$$

$$\boxed{H_{app} = \frac{1}{\mu_0 a}\ln(1+ah)}$$

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$$y_{app} = \frac{1}{\mu_0 a} \ln(1+ay)$$

$$v_{app} = \frac{dy_{app}}{dt} = \frac{1}{\mu_0 \cancel{a}} \times \frac{1}{(1+ay)} (\cancel{a}) \underbrace{\left(\frac{dy}{dt}\right)}_{u}$$

$$\boxed{V_{app} = \frac{u}{\mu_0 (1+ay)}}$$

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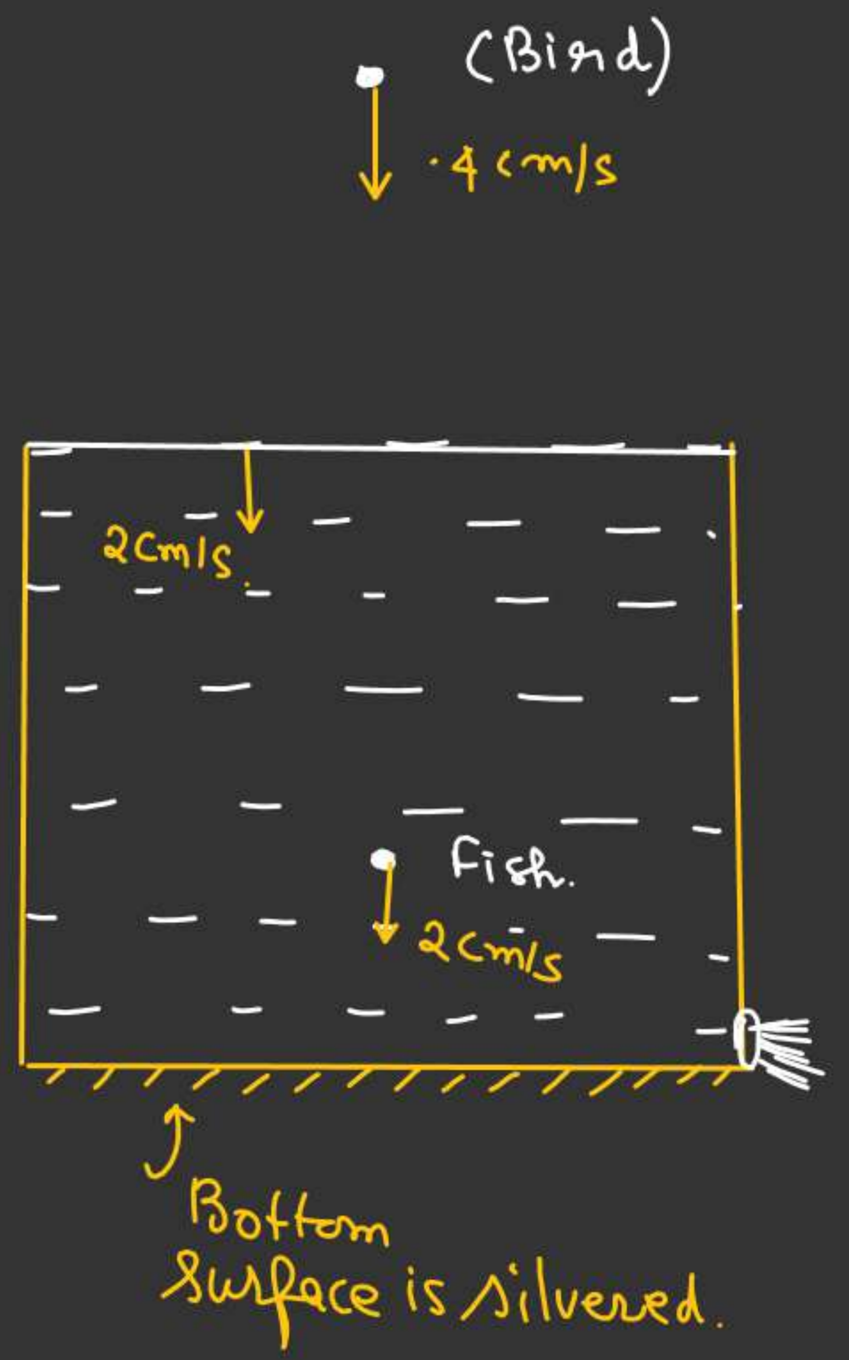
Q: Find

a) velocity of fish as seen by bird directly.

b) Velocity of image of fish as seen by bird after reflection.

c) Velocity of bird as seen by fish directly.

d) Velocity of image of bird as seen by fish.



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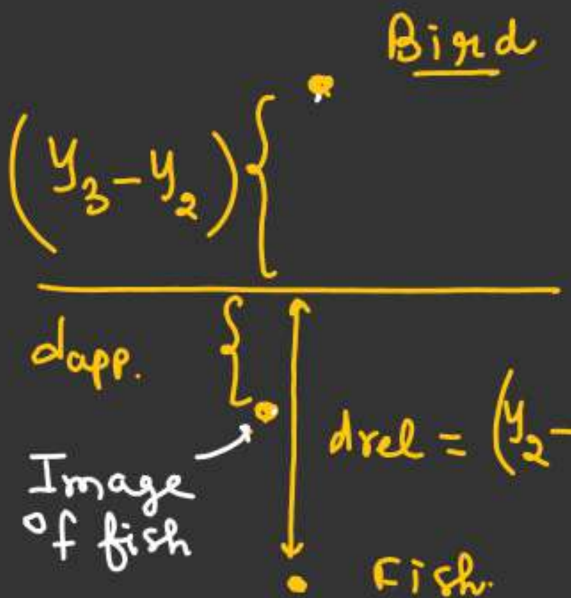
a)

When bird See the fish directly

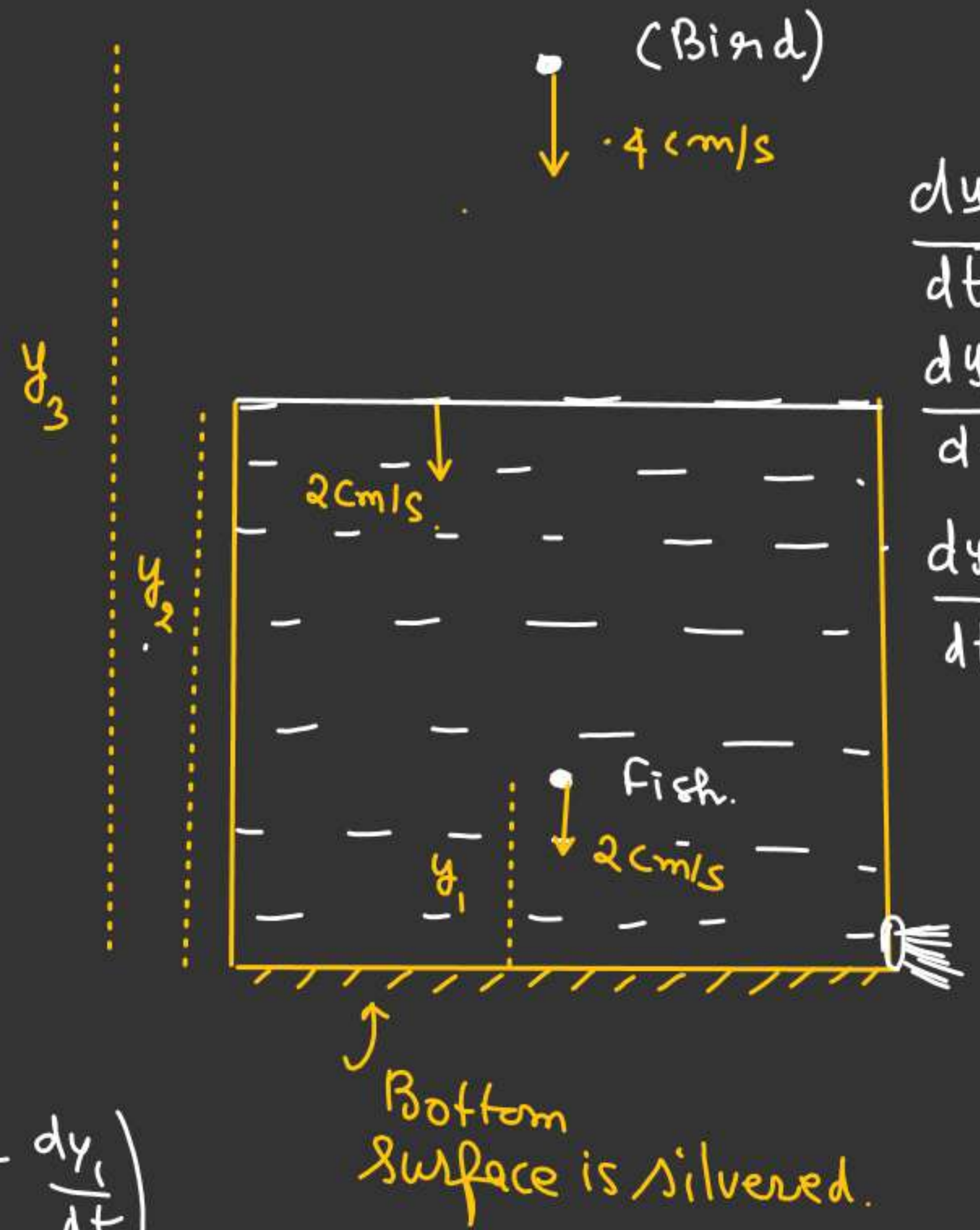
$$d_{app} = \frac{d_{rel}}{\mu}$$



$$d_{app} = \left(\frac{y_2 - y_1}{\mu}\right)$$

$$X_{fish/bird} = (y_3 - y_2) + d_{app}$$

$$X_{fish/bird} = (y_3 - y_2) + \left(\frac{y_2 - y_1}{\mu}\right)$$



$$\frac{dy_3}{dt} = -4\,cm/s$$

$$\frac{dy_2}{dt} = -2\,cm/s$$

$$\frac{dy_1}{dt} = -2\,cm/s$$

Differentiating both side w.r.t time.

$$\frac{d(X_{fish/bird})}{dt} = \left(\frac{dy_3}{dt} - \frac{dy_2}{dt}\right) + \frac{1}{\mu}\left(\frac{dy_2}{dt} - \frac{dy_1}{dt}\right)$$

$$= [-4 - (-2)] + \frac{3}{4}\left((-2) - (-2)\right) = -2\,cm/s$$

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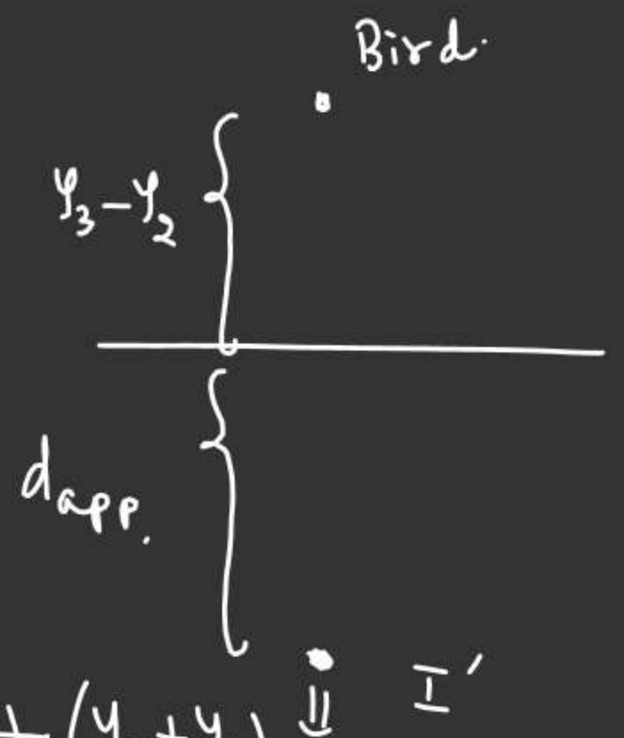
b) Velocity of image of fish as seen by bird after reflection.

$d_{real} = (y_2 + y_1)$

$d_{app} = \left(\frac{y_2 + y_1}{\mu}\right)$

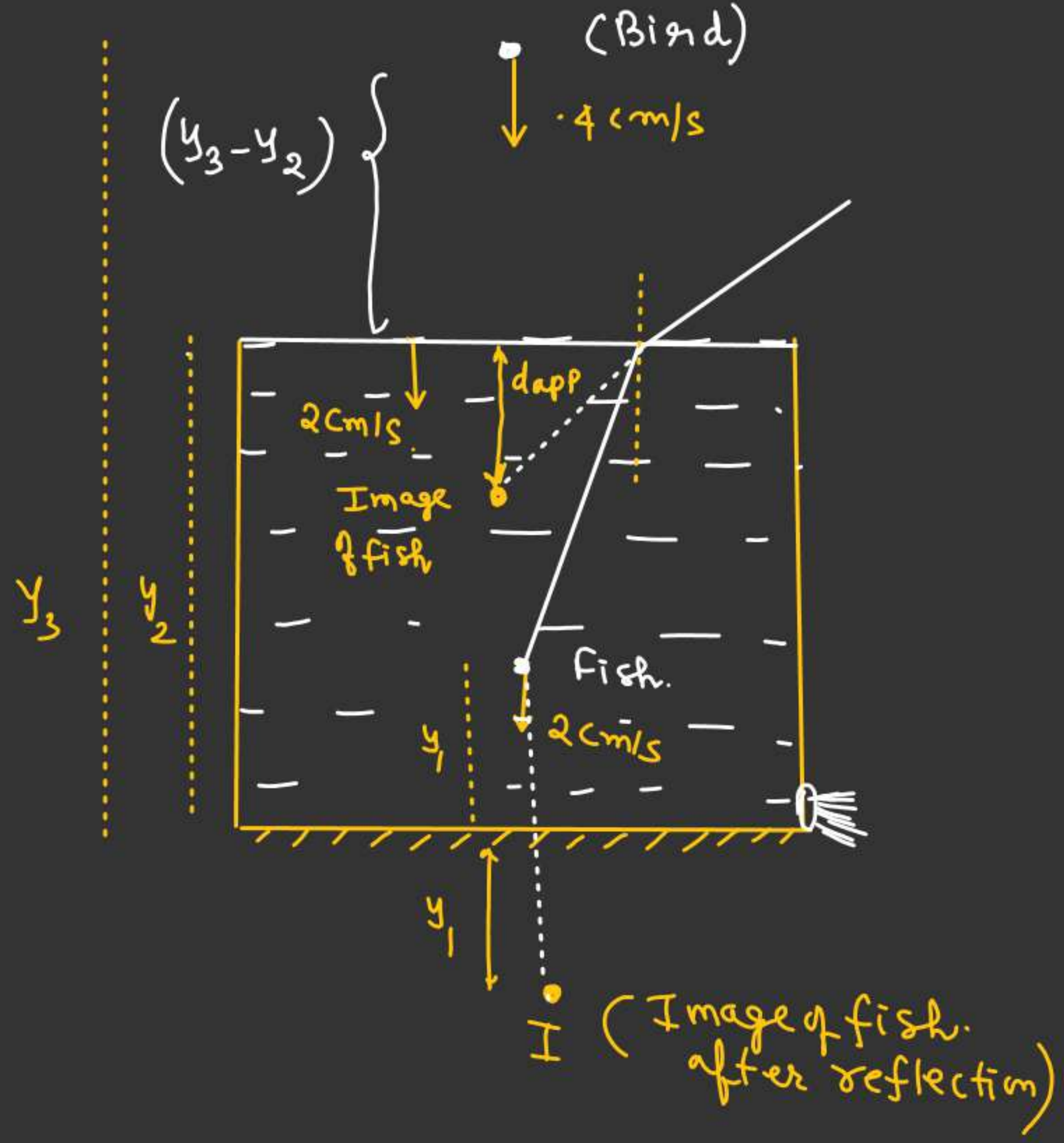
⇓

From water Surface



✓ $X_{\text{image of fish/Bird}} = (y_3 - y_2) + \left(\frac{y_2 + y_1}{\mu}\right)$

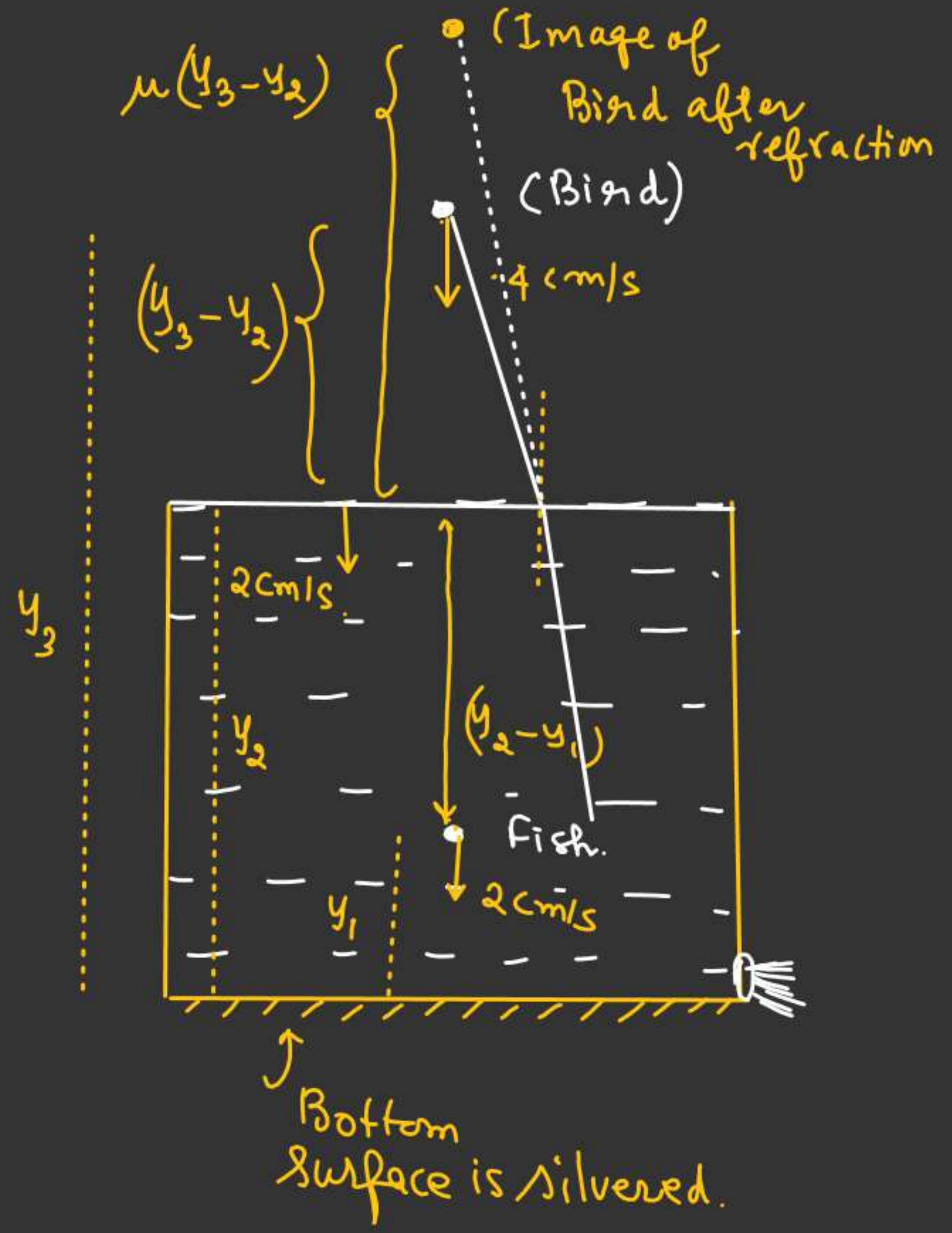
$V_{\text{image of fish/Bird}} = \frac{d}{dt}\left(X_{\text{image of fish/Bird}}\right)$ ✓



c) Velocity of bird as seen by fish directly.

$$X_{bird/fish} = \mu(y_3 - y_2) + (y_2 - y_1)$$

$\Rightarrow$



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d) Velocity of image of bird as seen by fish.

$$X_{bird/fish} = (y_3-y_2)\mu + (y_2+y_1)$$