

# PRAYAS

## JEE 2025



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Lecture -10

Physics

Ray Optics



By- Saleem Ahmed Sir



# Topics *to be covered*

1 Snell's Law Continuous Form

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2

3

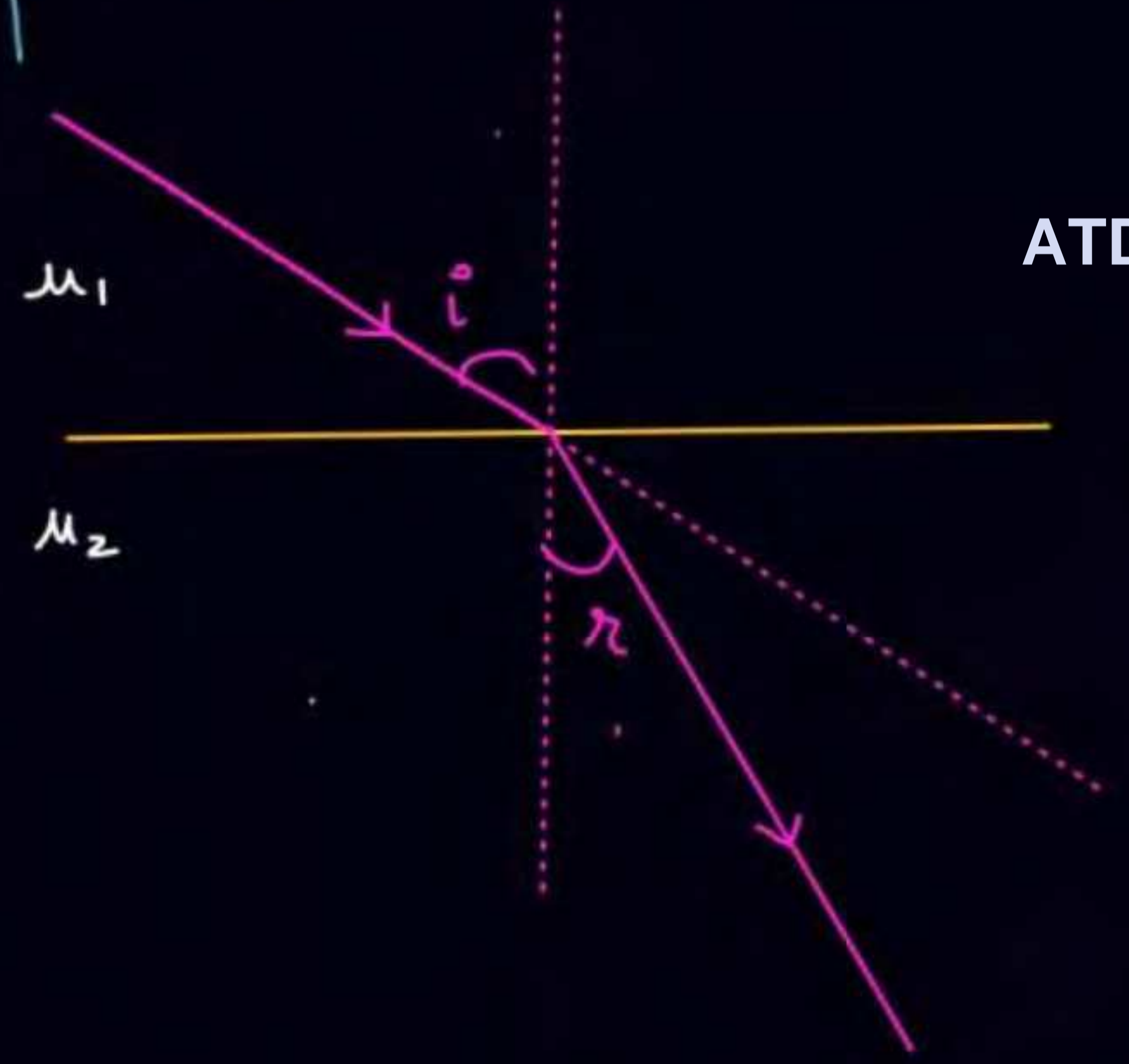
4



# Snell's Law

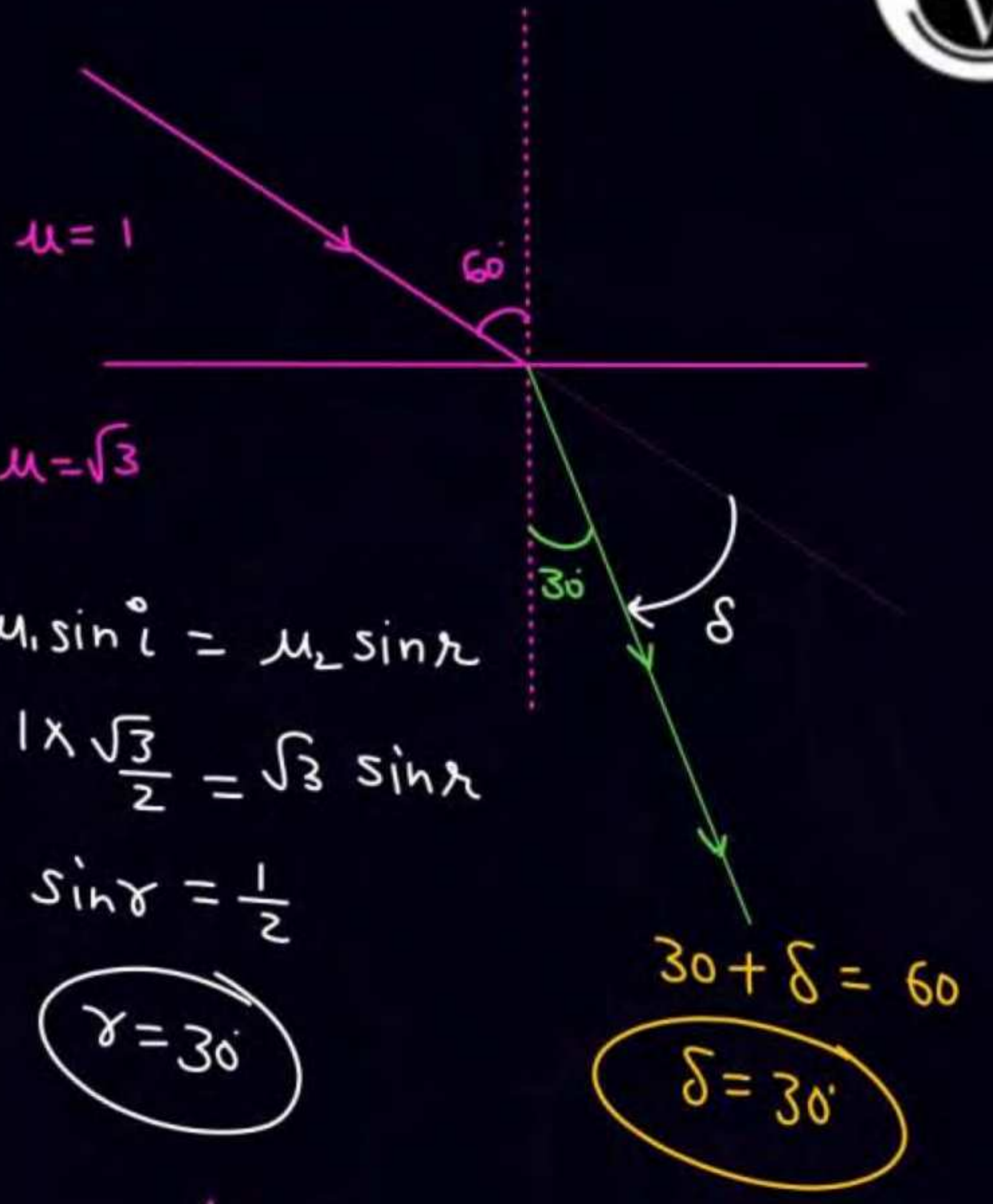
\*  $\mu_1 \sin i = \mu_2 \sin r$

\*  $\delta = |i - r|$



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$\mu = 1$

$\mu = \sqrt{3}$

$\mu_1 \sin i = \mu_2 \sin r$

$1 \times \frac{\sqrt{3}}{2} = \sqrt{3} \sin r$

$\sin r = \frac{1}{2}$

$r = 30^\circ$

$30 + \delta = 60$

$\delta = 30^\circ$



\* Continuous form of Snell's Law



$\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2$  (1<sup>st</sup> refraction)

$\mu_2 \sin \theta_2 = \mu_3 \sin \theta_3$

$\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2 = \mu_3 \sin \theta_3 = \mu_4 \sin \theta_4$

If  $\mu_4 = \mu_2$   $\mu_2 \sin \theta_2 = \mu_4 \sin \theta_4$   
 $\theta_2 = \theta_4$

$\mu \sin \theta = \text{const}$



Q

$\mu = 1$

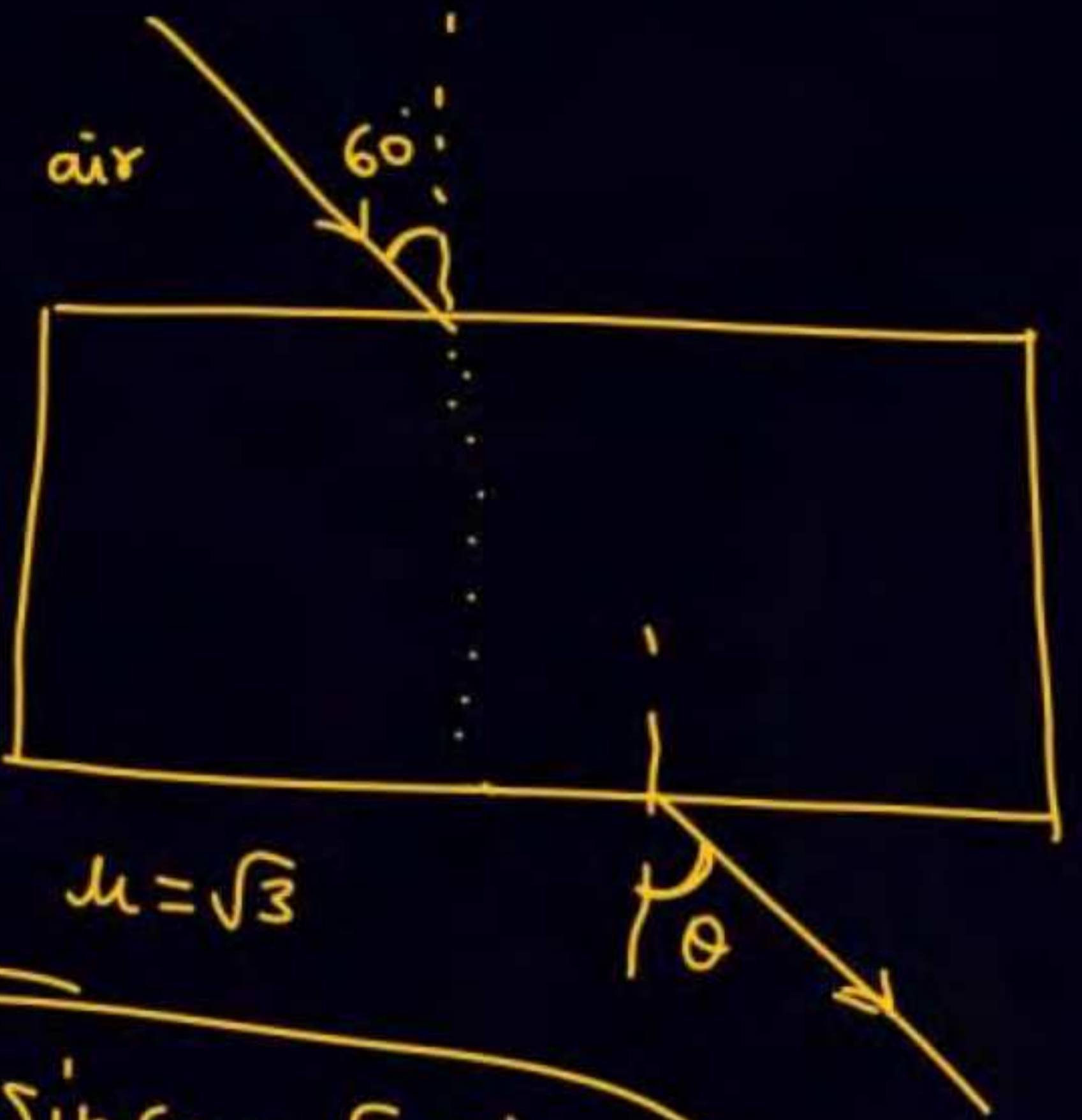


$$1 \times \sin 60 = \sqrt{3} \sin \theta_3$$

$$\theta_3 = 30^\circ$$

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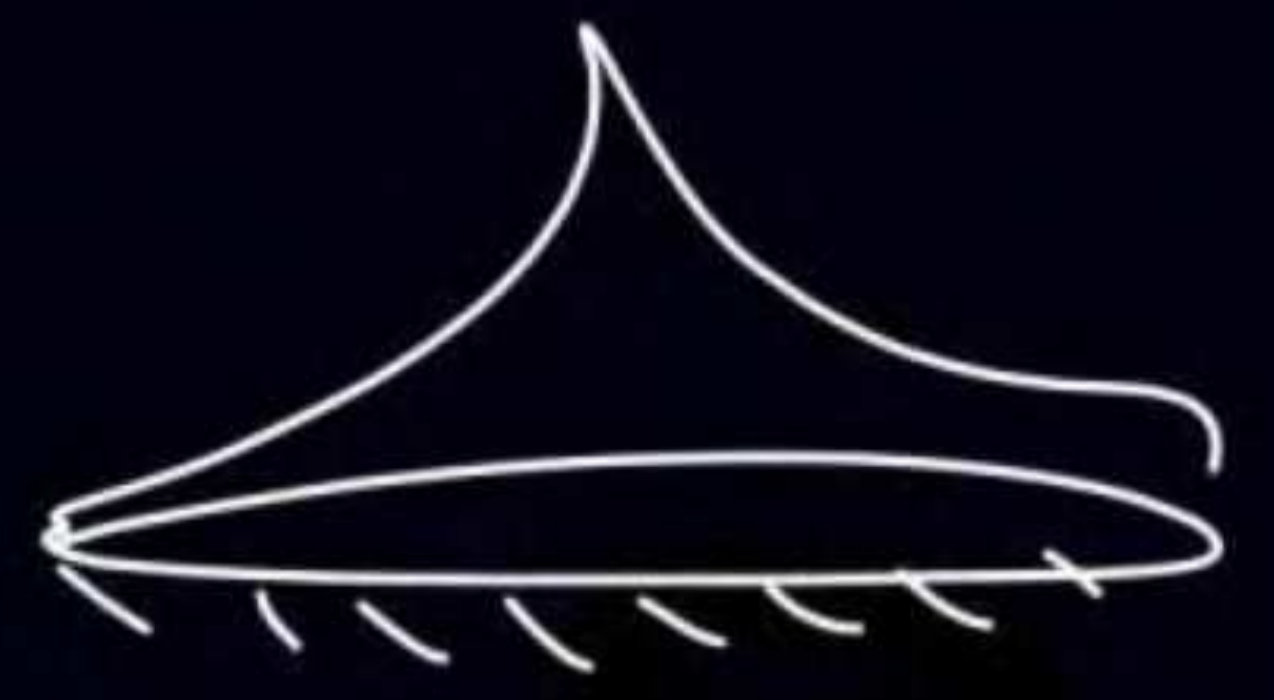
Q



$$1 \times \sin 60 = \sqrt{3} \sin \theta$$

$$\theta = 30^\circ$$

# Idea of apparent depth



$\mu_1 \sin i = \mu_2 \sin r$   
 (Paraxial rays assumption)  
 $i$  &  $r$  are very small

$\sin \theta \approx \theta \approx \tan \theta$

$\mu_1 \tan i = \mu_2 \tan r$

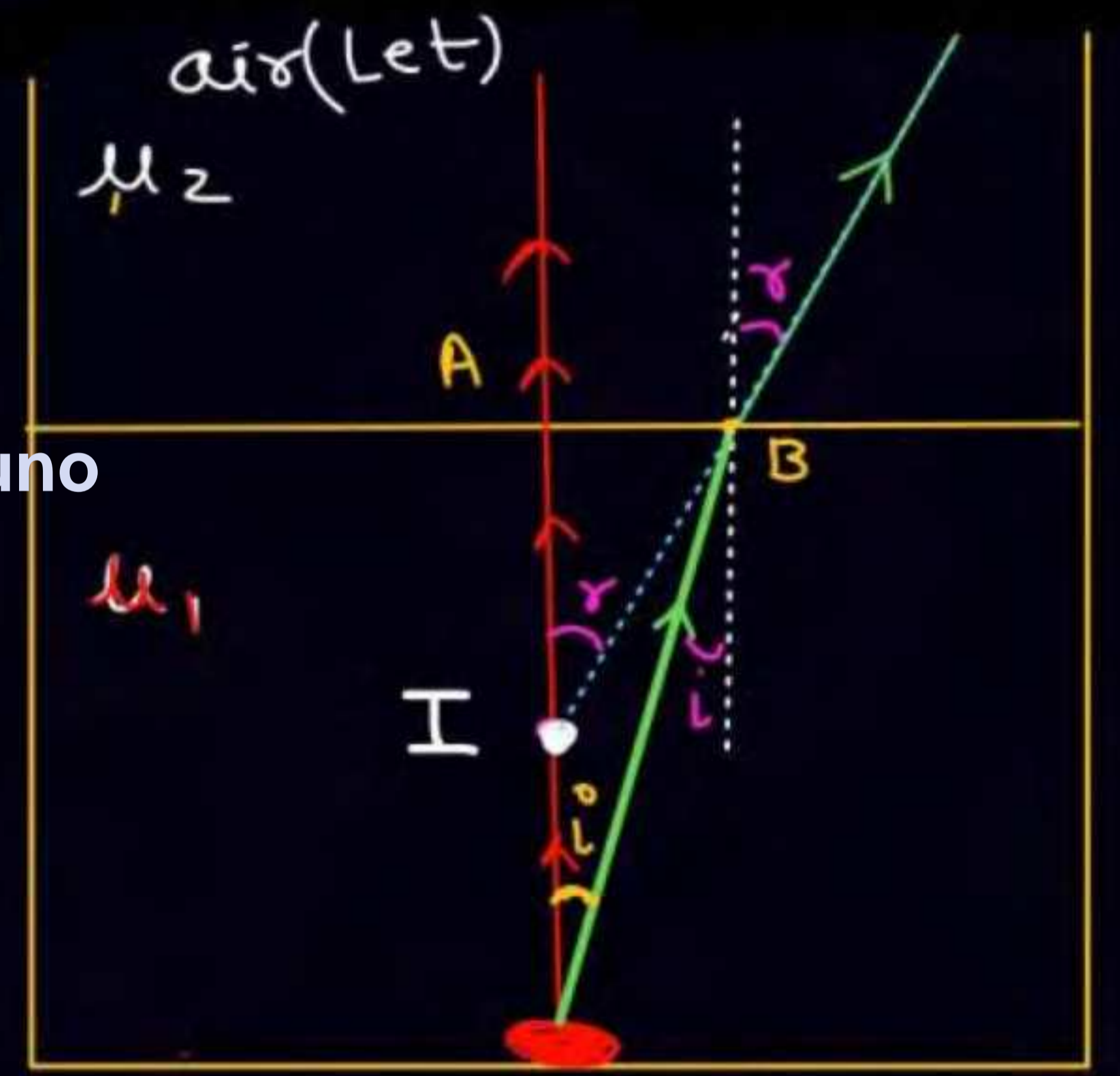
$\mu_1 \frac{AB}{h_0} = \mu_2 \frac{AB}{h_{app}}$

$h_{app} = h_0 \frac{\mu_2}{\mu_1}$

If  $\mu_2 = \text{air}$   
 $\mu_1 = \mu$   
 $h_{app} = \frac{h_0}{\mu}$

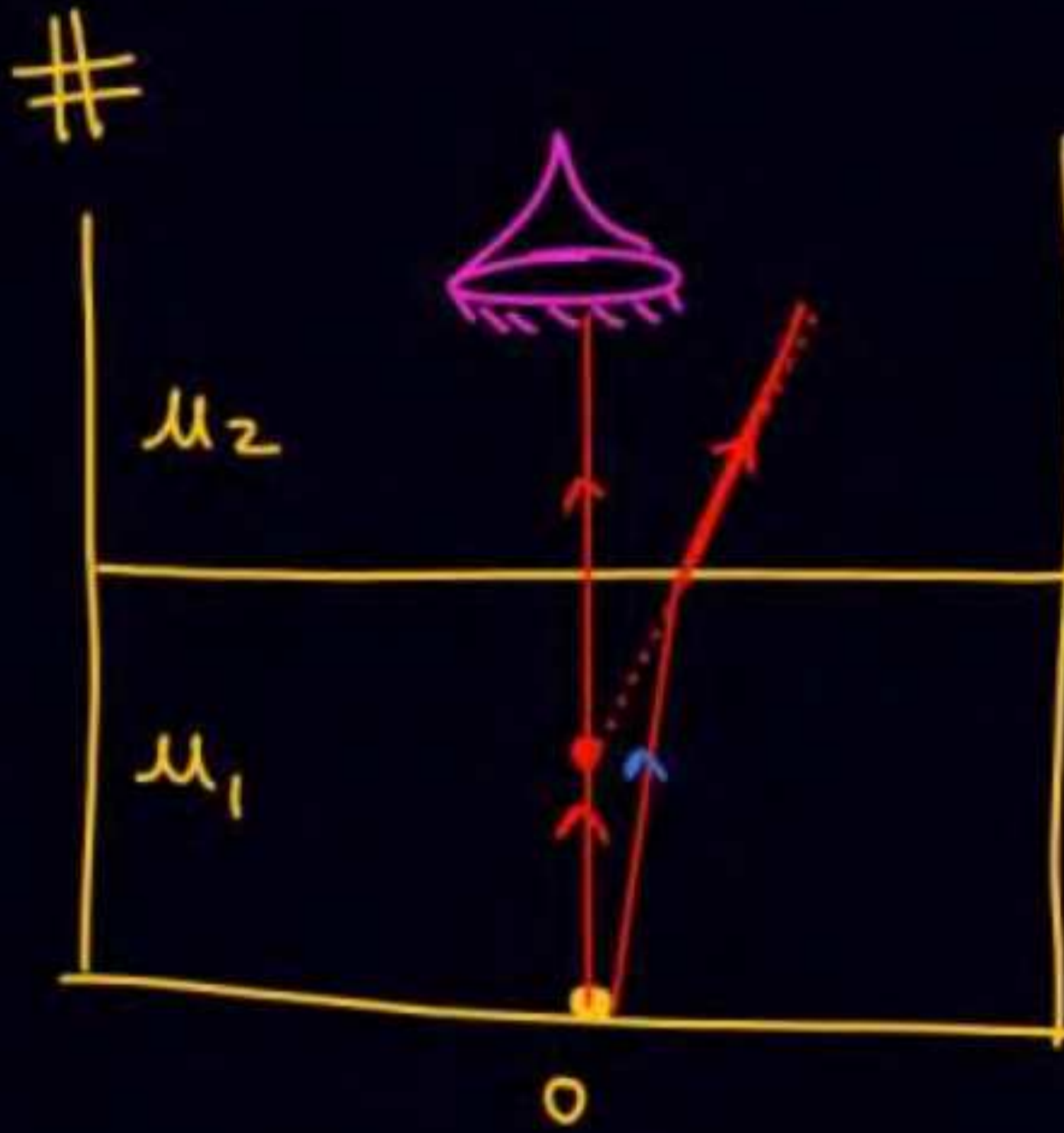
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$h_0$



$h_{app}$

O coin

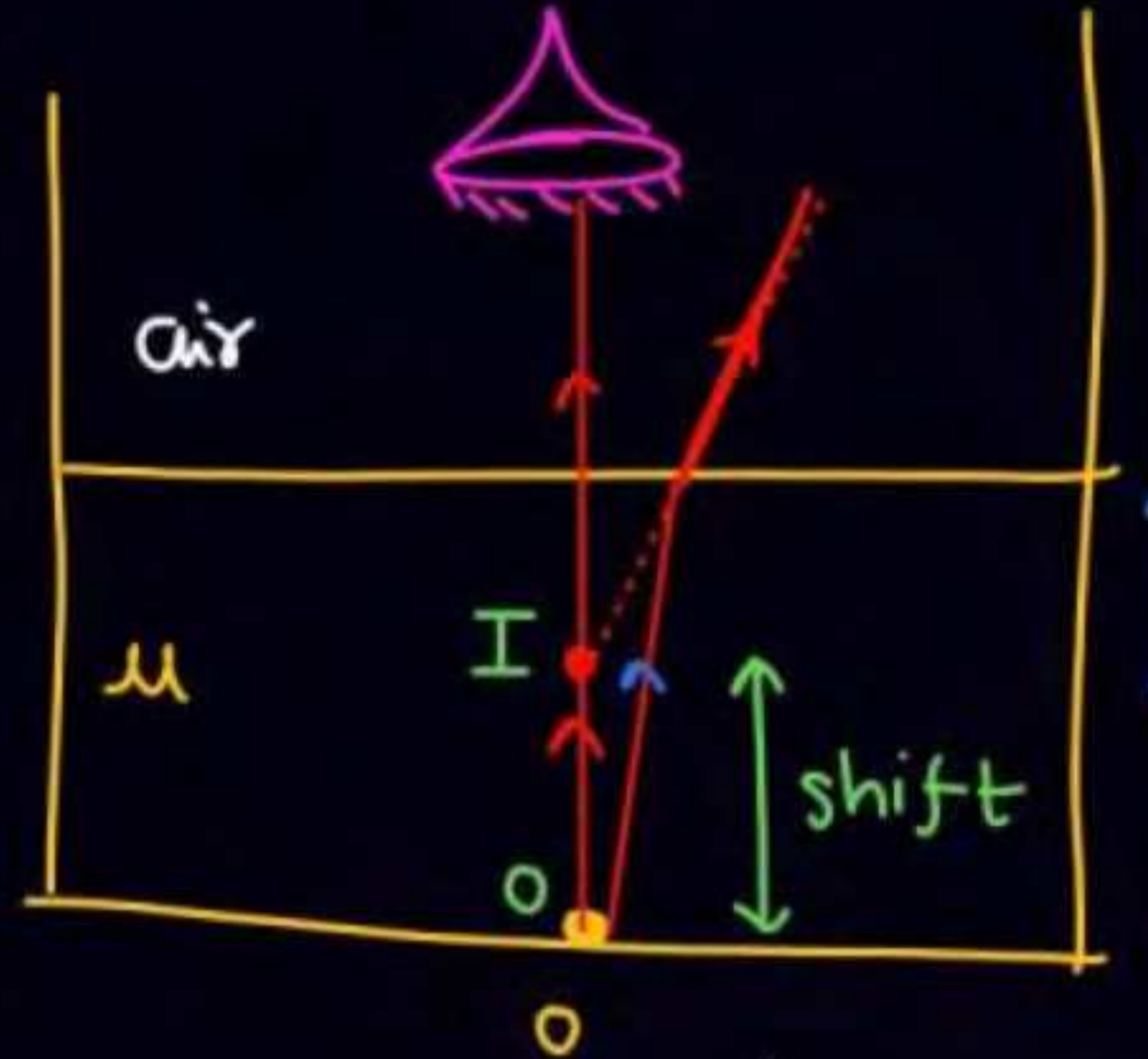


$$h_{app} = h_0 \frac{\mu_2}{\mu_1}$$

$$h_{app} = h_0 \frac{\mu_{\text{जाने वाली}}}{\mu_{\text{आने वाली}}}$$

(SKC)

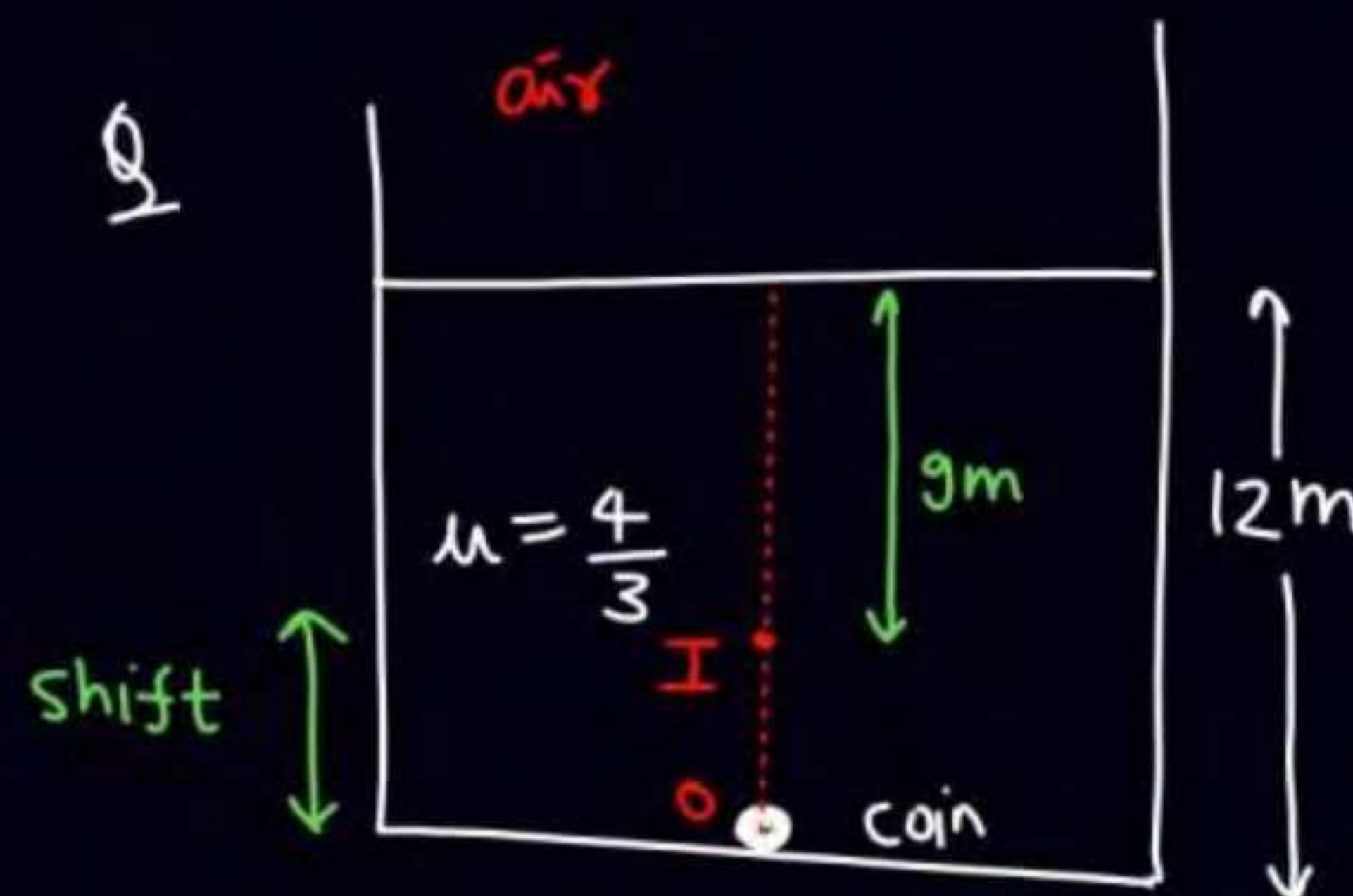
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$$h_{app} = h_0 \frac{\mu_2}{\mu_1}$$

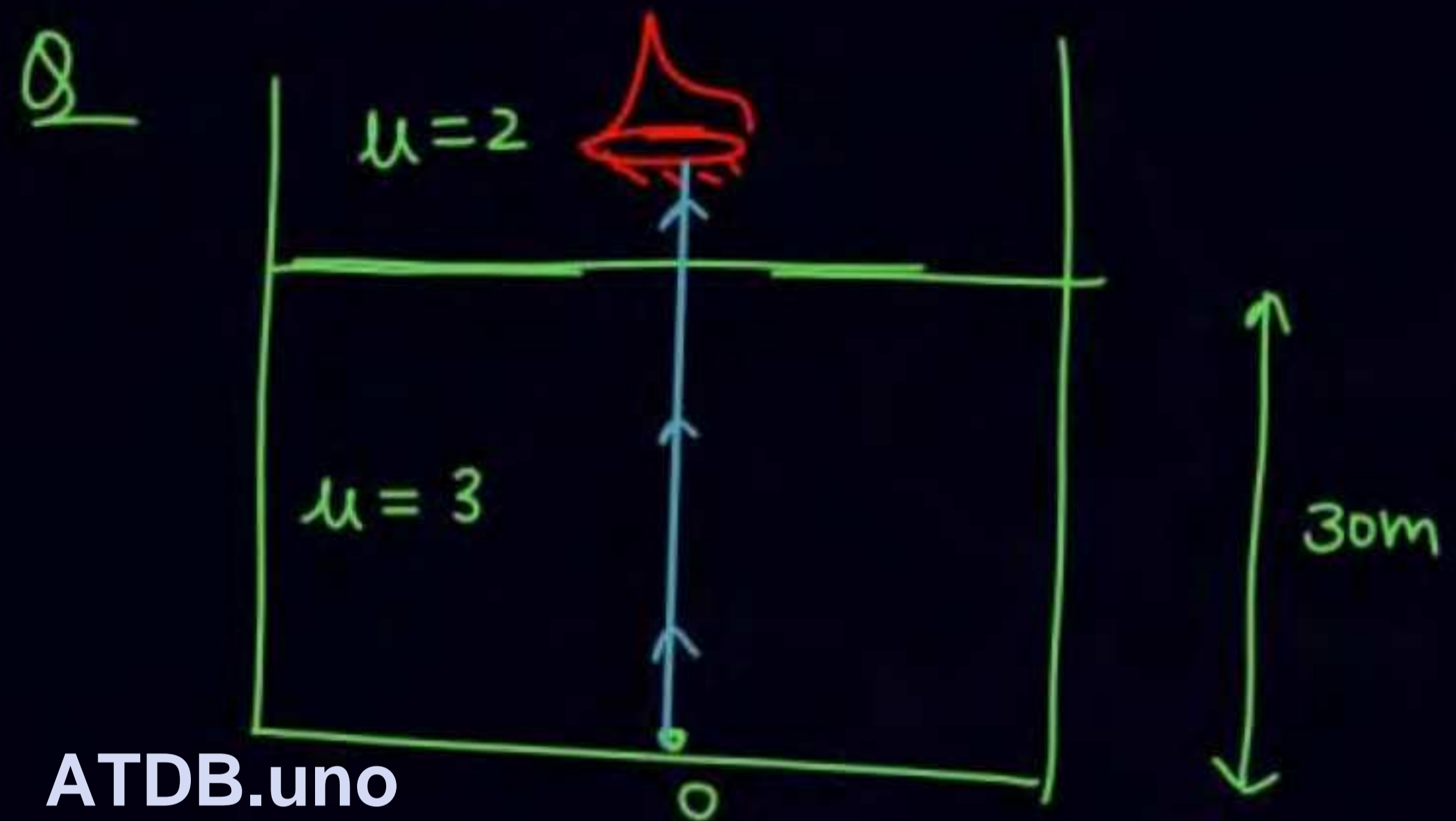
$$h_{app} = \frac{h}{\mu}$$

$$shift = h - \frac{h}{\mu} = h \left( 1 - \frac{1}{\mu} \right)$$

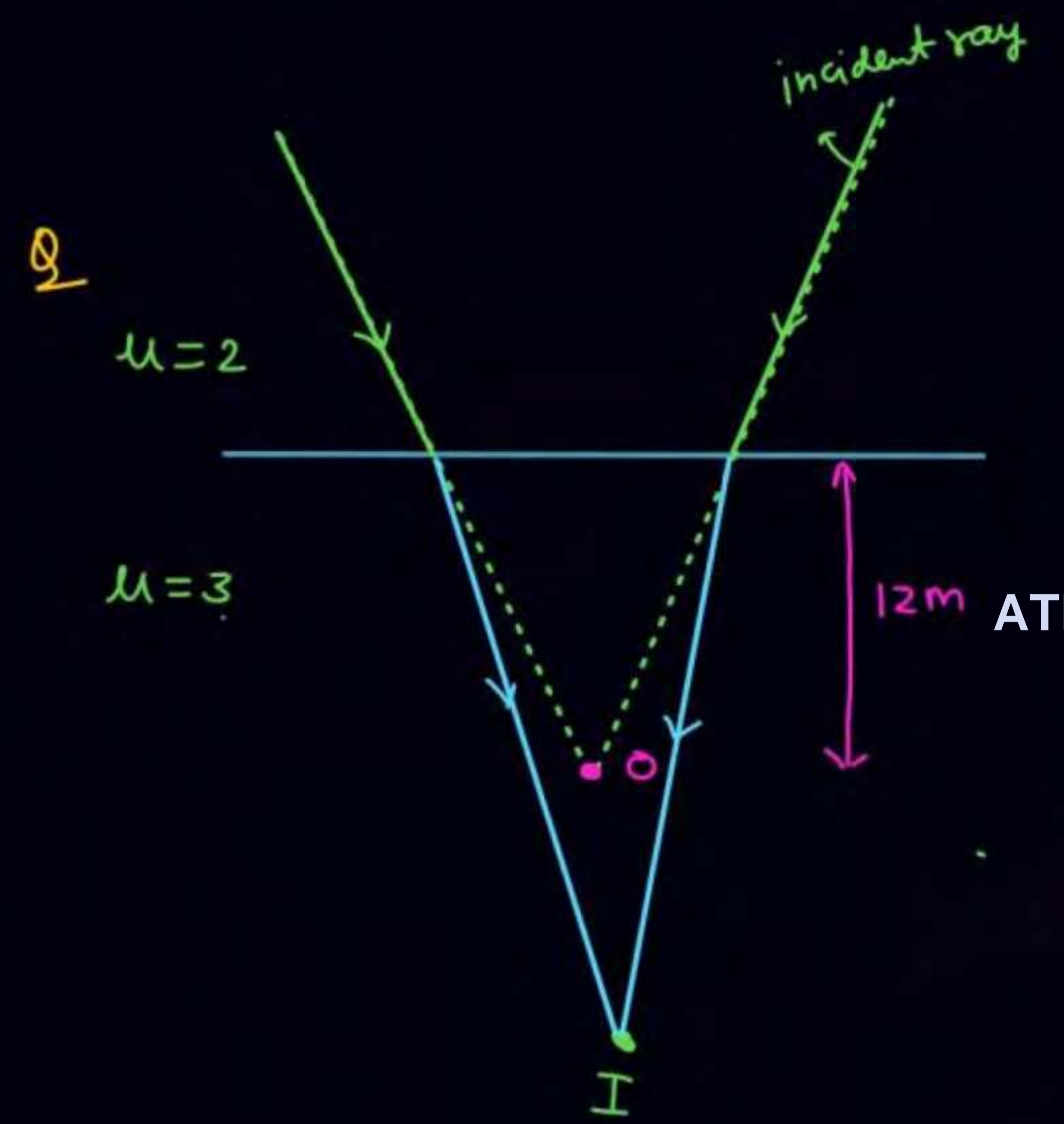


$$h_{app} = \frac{h}{\mu} = \frac{12}{\frac{4}{3}} = 9m$$

$$\text{shift} = 12 - 9 = 3$$



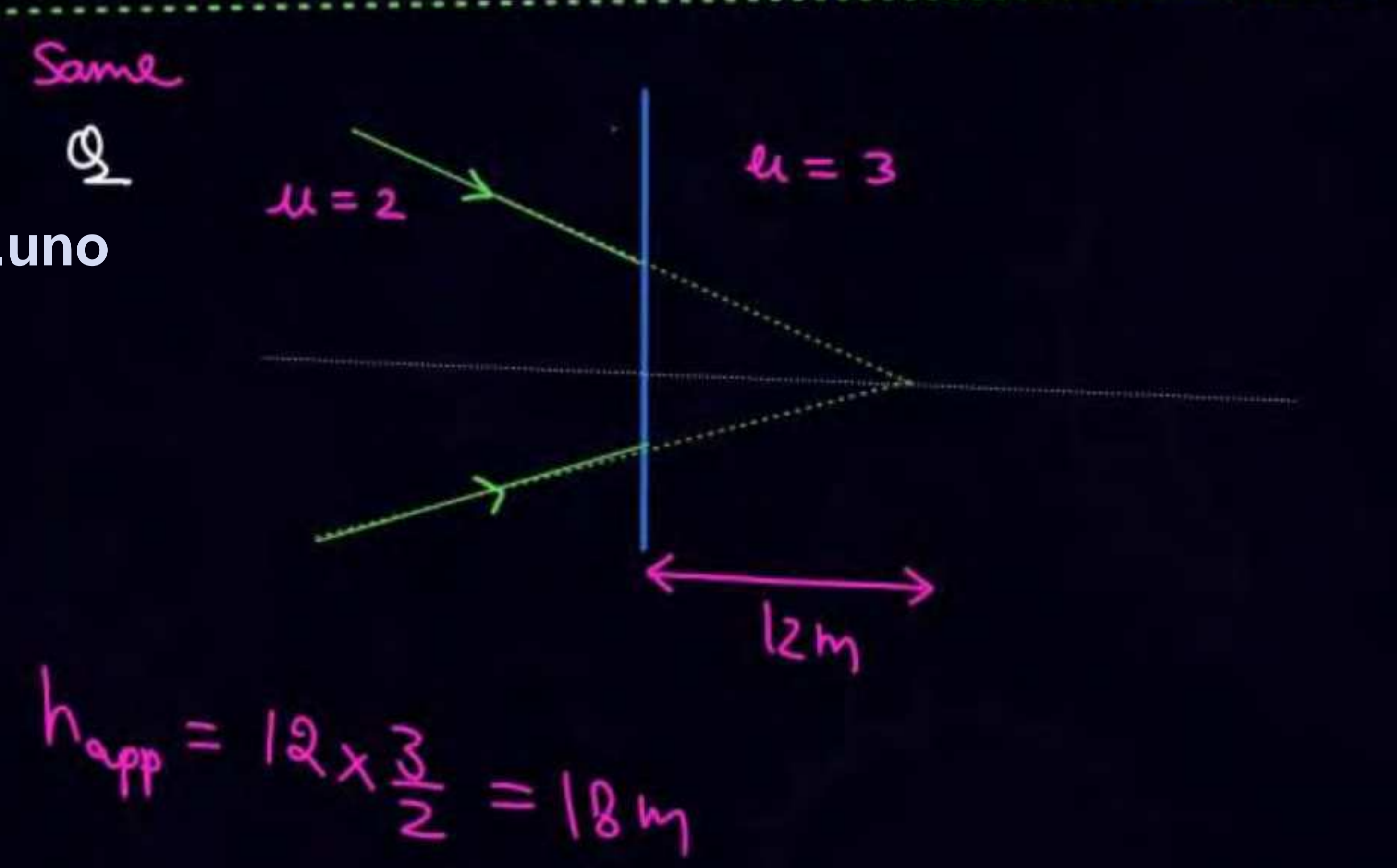
$$h_{app} = h_0 \frac{\mu_{\text{जामे}}}{\mu_{\text{आने}}} = 30 \times \frac{2}{3} = 20m$$



$$h_{app} = h_o \frac{\mu_{जाने}}{\mu_{माने}}$$

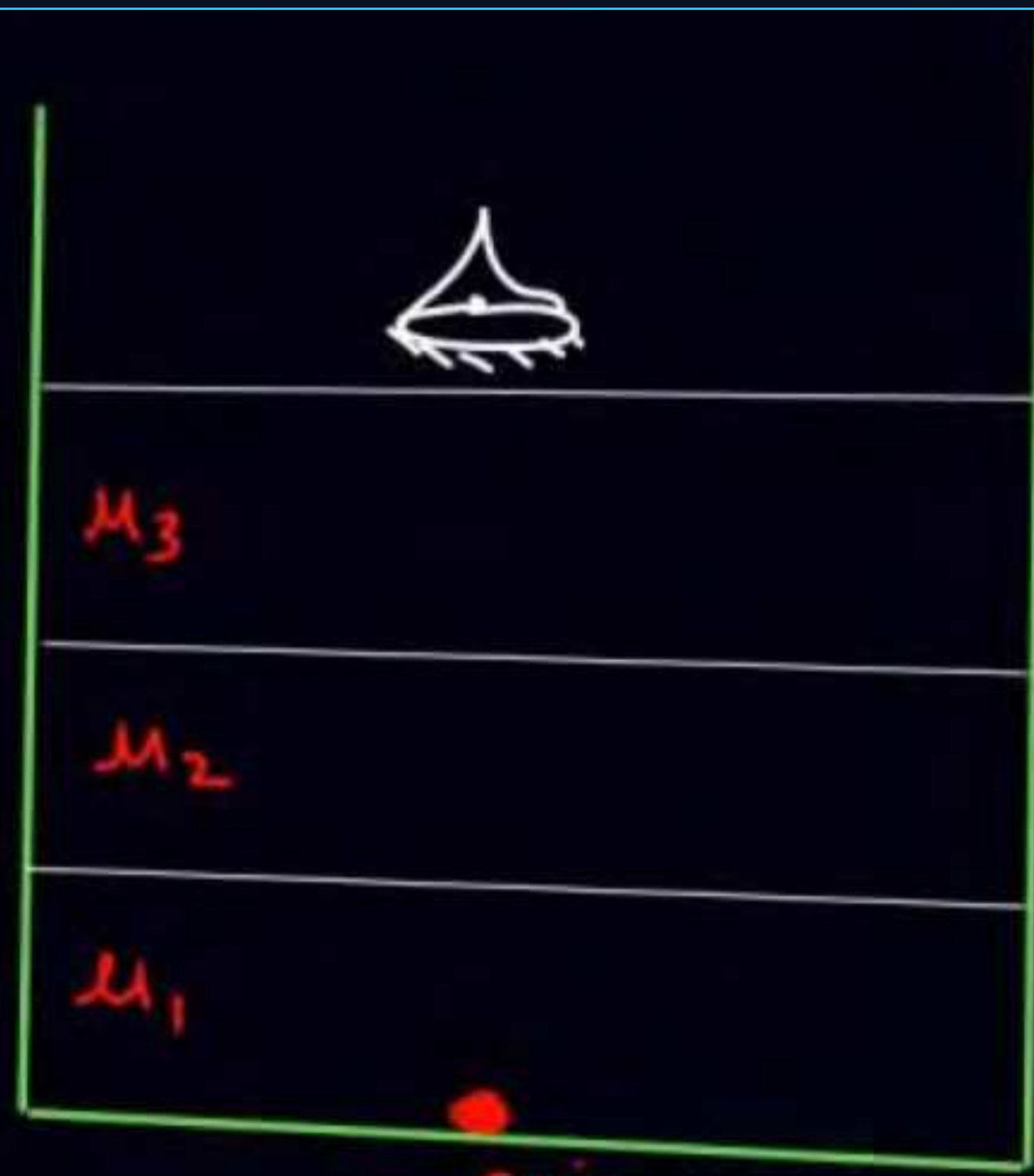
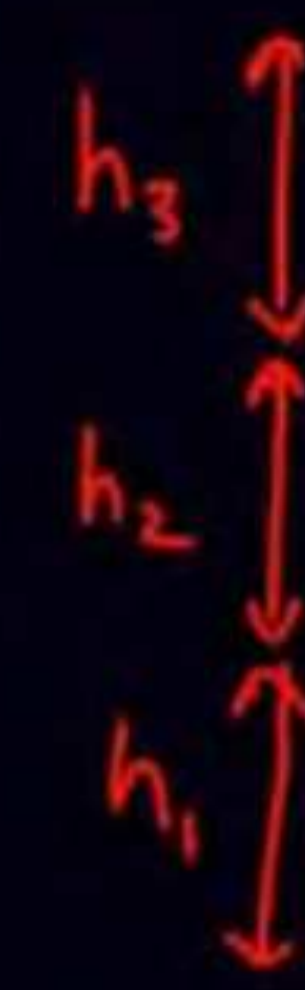
$$h_{app} = 12 \times \frac{3}{2} = 18 \text{ m}$$

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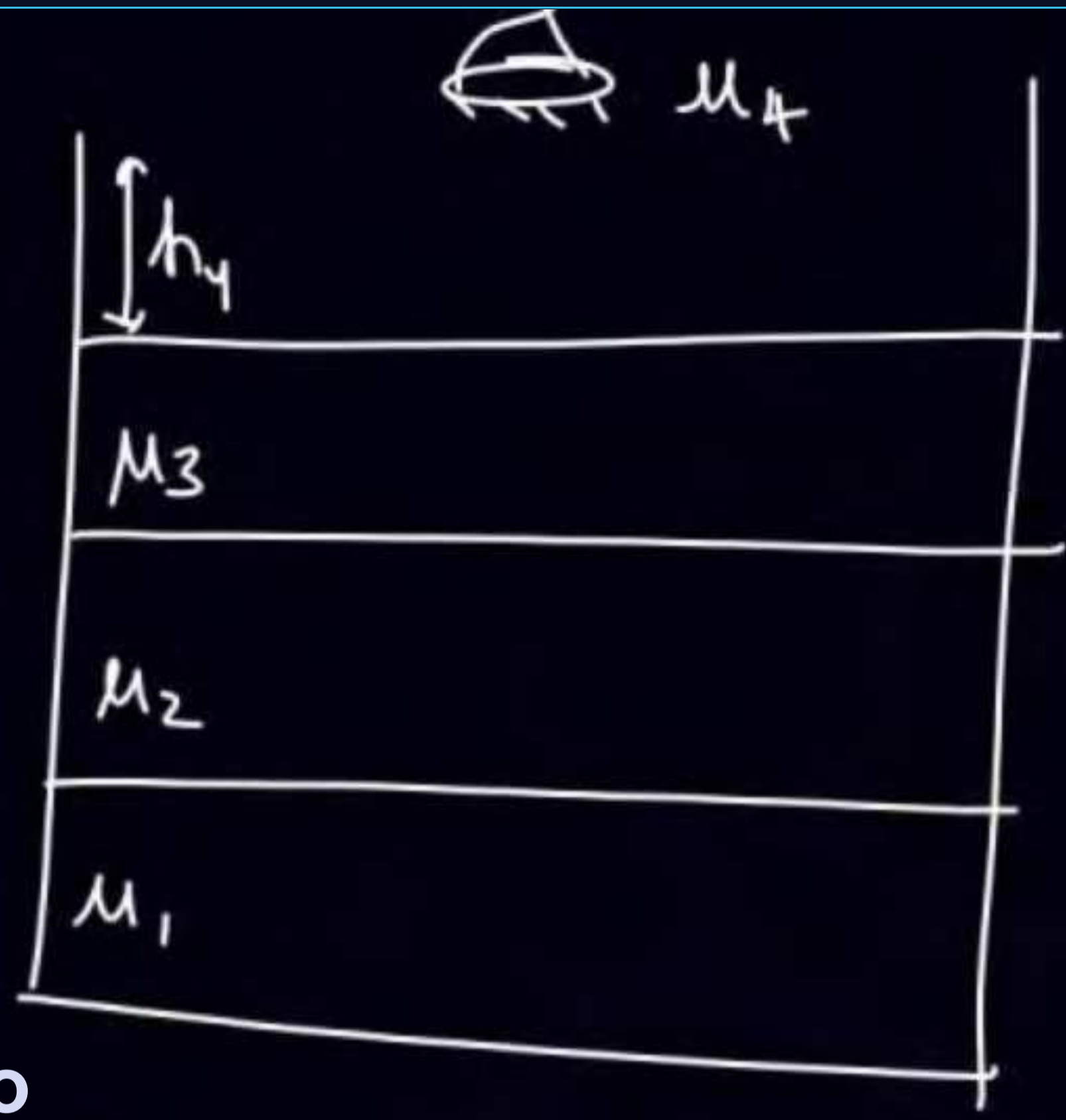
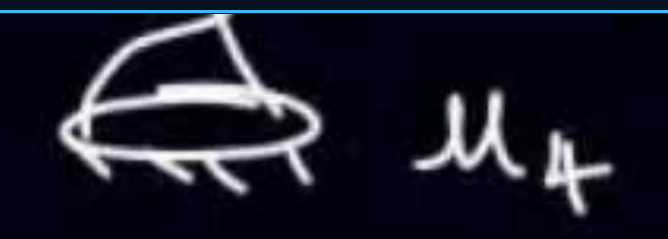


$$h_{app} = 12 \times \frac{3}{2} = 18 \text{ m}$$

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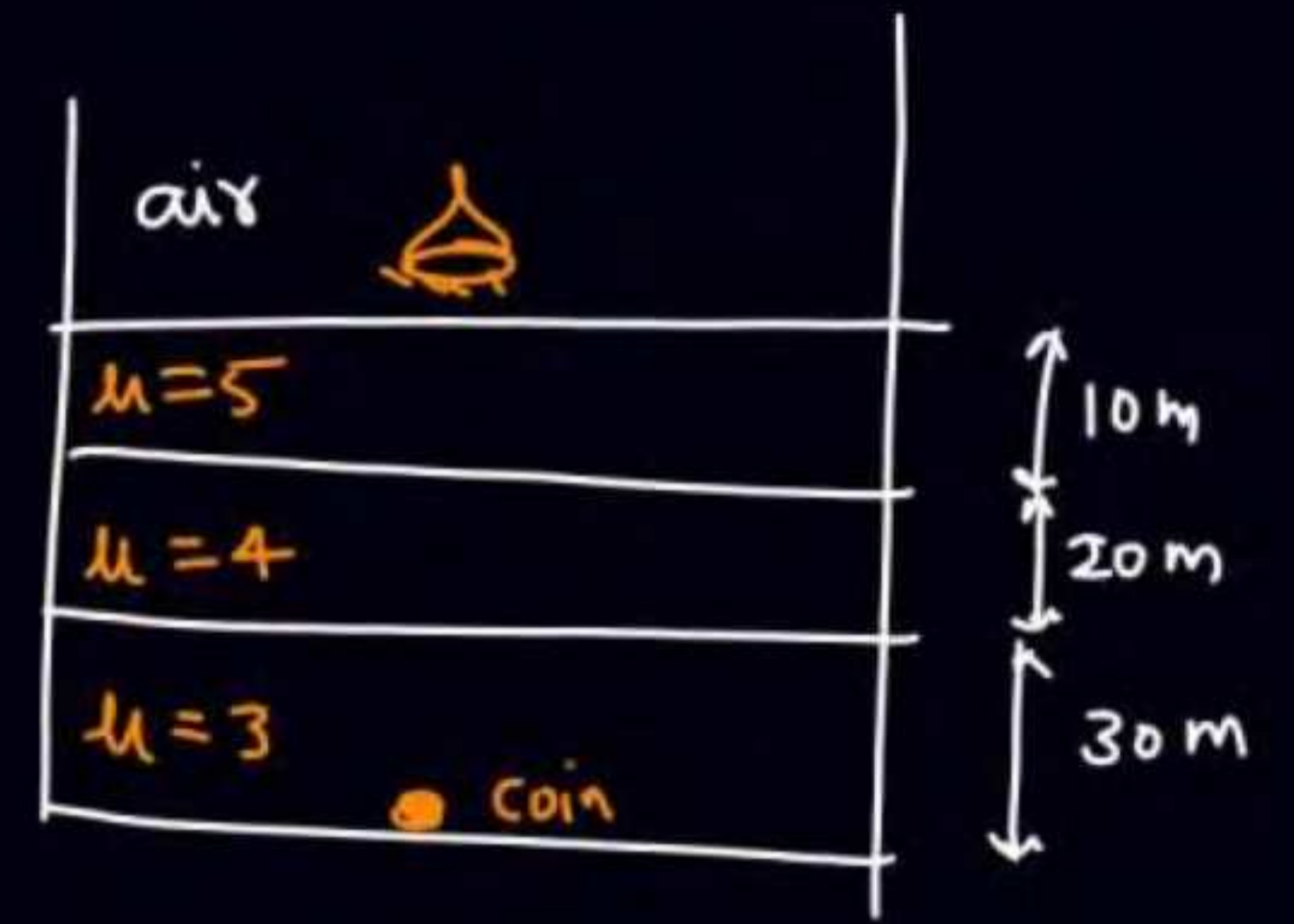


$$h_{app} = \mu_{\text{observer}} \left( \frac{h_1}{\mu_1} + \frac{h_2}{\mu_2} + \frac{h_3}{\mu_3} \right)$$

Shift = ✓

$$h_{app} = \mu_4 \left[ \frac{h_1}{\mu_1} + \frac{h_2}{\mu_2} + \frac{h_3}{\mu_3} + \frac{h_4}{\mu_4} \right]$$

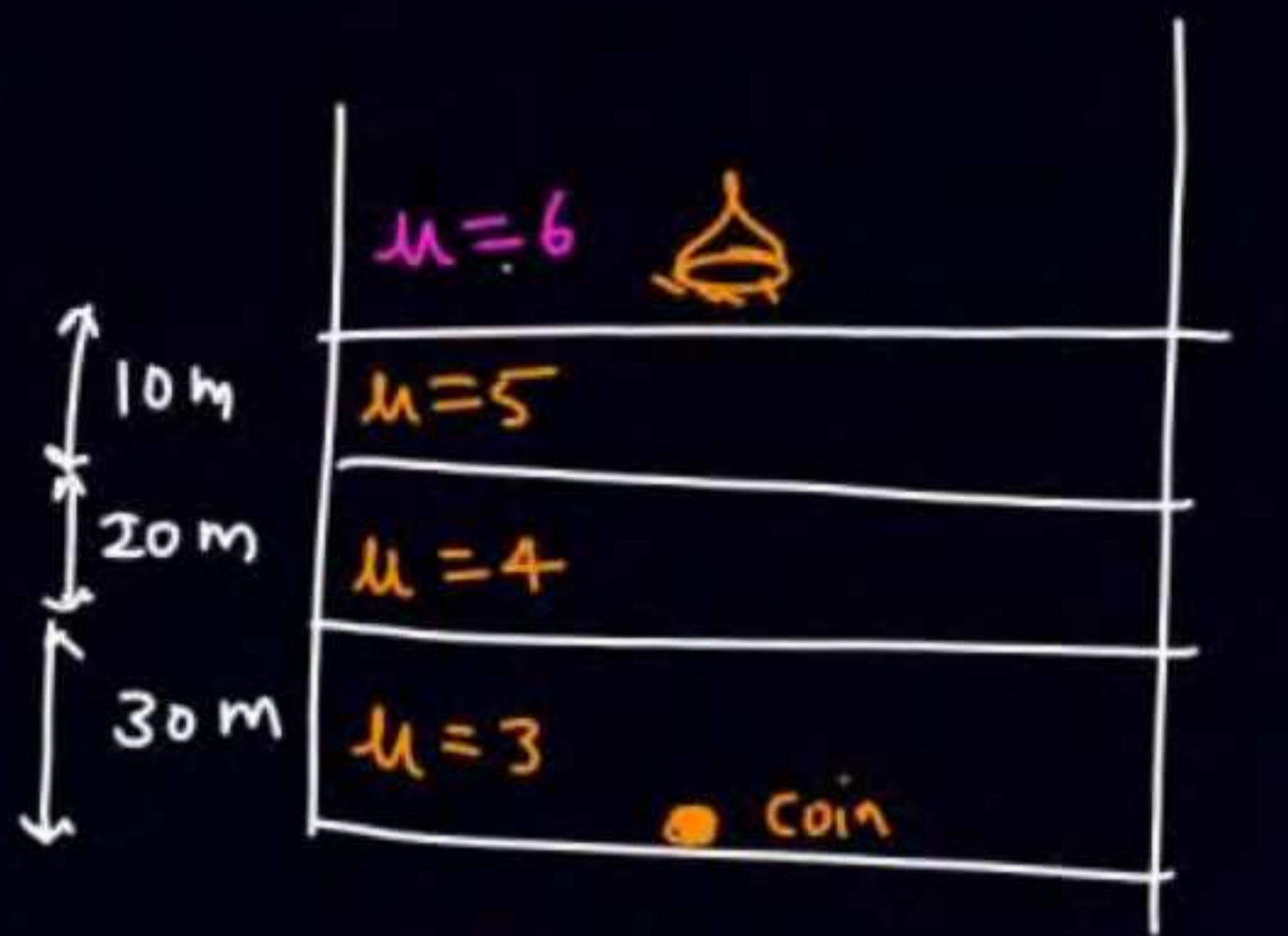
Q



$$h_{app} = 1 \left( \frac{30}{3} + \frac{20}{4} + \frac{10}{5} \right) = 17$$

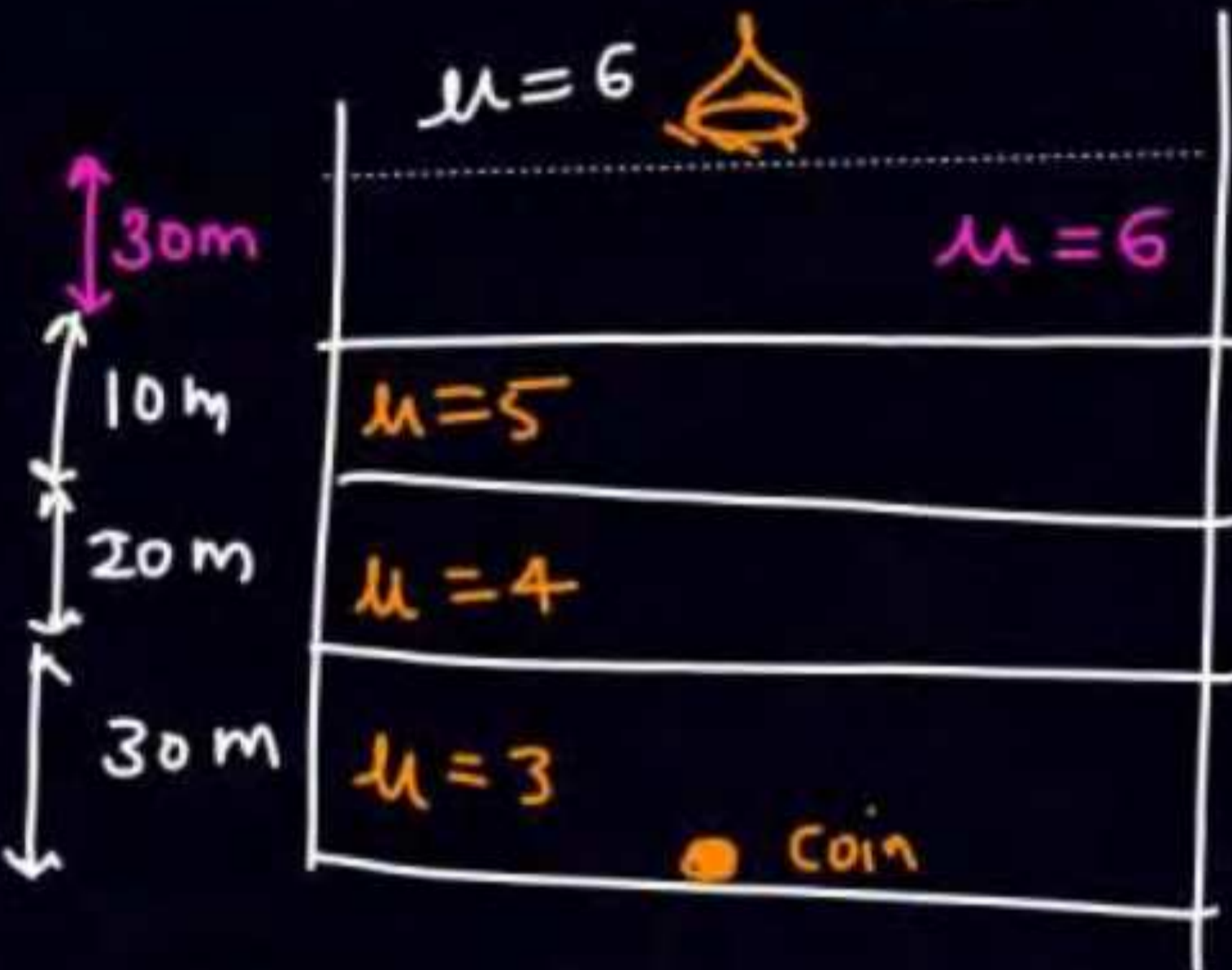
$$\text{Shift} = (10 + 20 + 30) - (17)$$

$$\begin{aligned} \text{Shift} &= 30 \left( 1 - \frac{1}{3} \right) + 20 \left( 1 - \frac{1}{4} \right) + 10 \left( 1 - \frac{1}{5} \right) \\ &= (30 + 20 + 10) - \left( \frac{30}{3} + \frac{20}{4} + \frac{10}{5} \right) \end{aligned}$$



$$h_{app} = 6 \left[ \frac{30}{3} + \frac{20}{4} + \frac{10}{5} \right]$$

$$h_{app} = 102$$

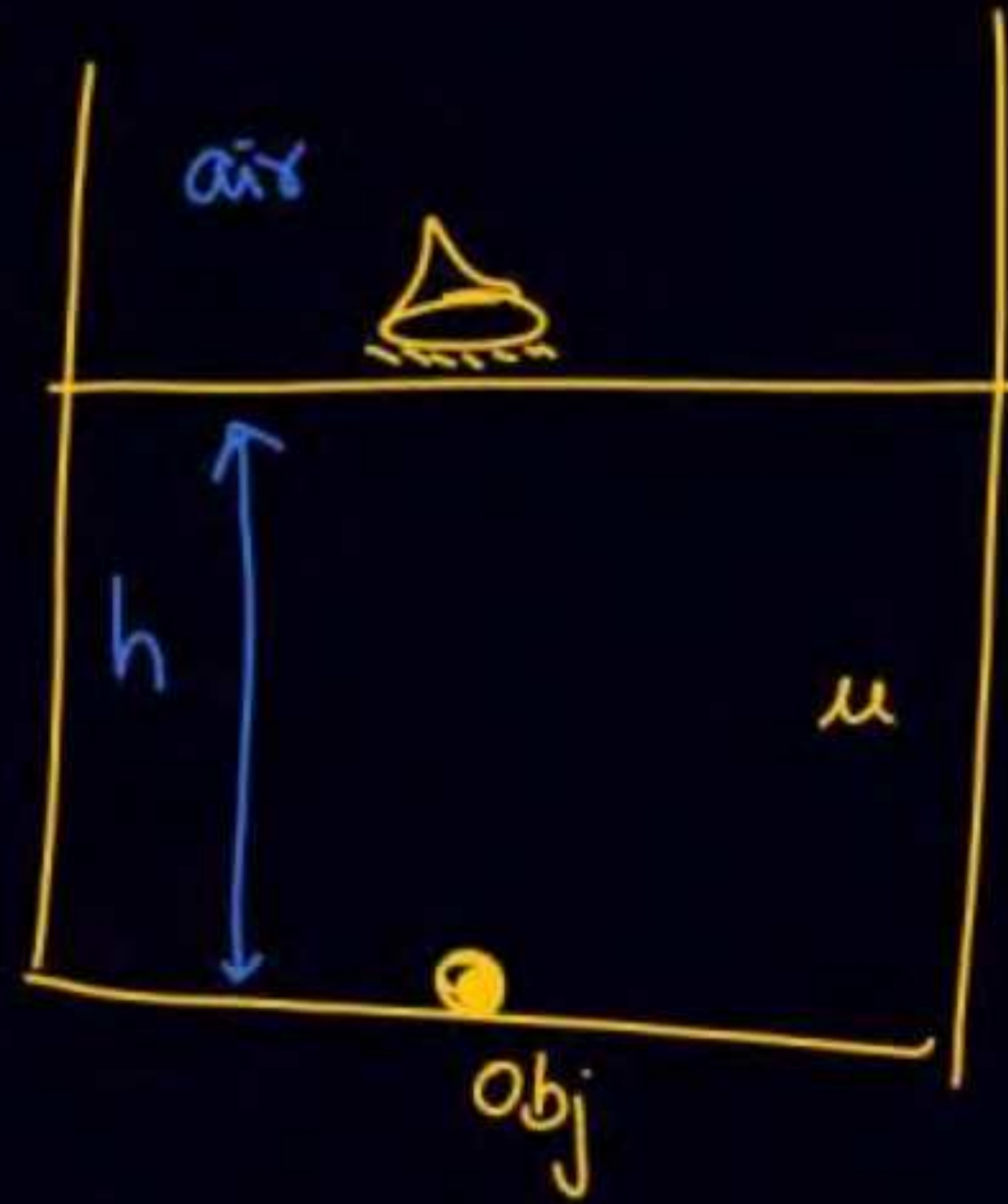


Ans (1)  $\Rightarrow 102 + 30 = 132$

(m-2)

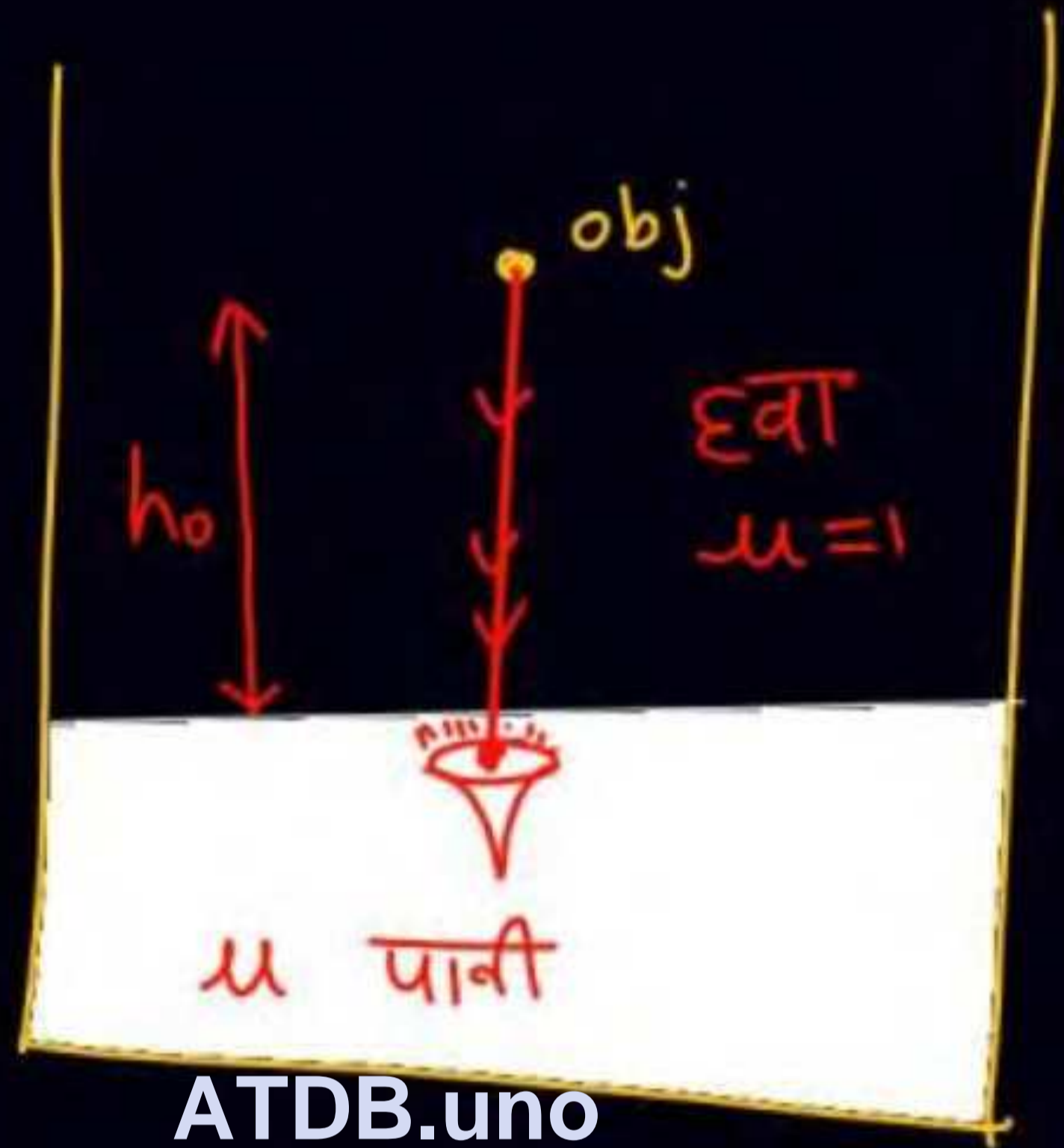
$$\begin{aligned} h_{app} &= 6 \left[ \frac{30}{3} + \frac{20}{4} + \frac{10}{5} + \frac{30}{6} \right] \\ &= 6 [10 + 5 + 2 + 5] = 132 \end{aligned}$$

#



$$h_{app} = \frac{h}{\mu}$$

#

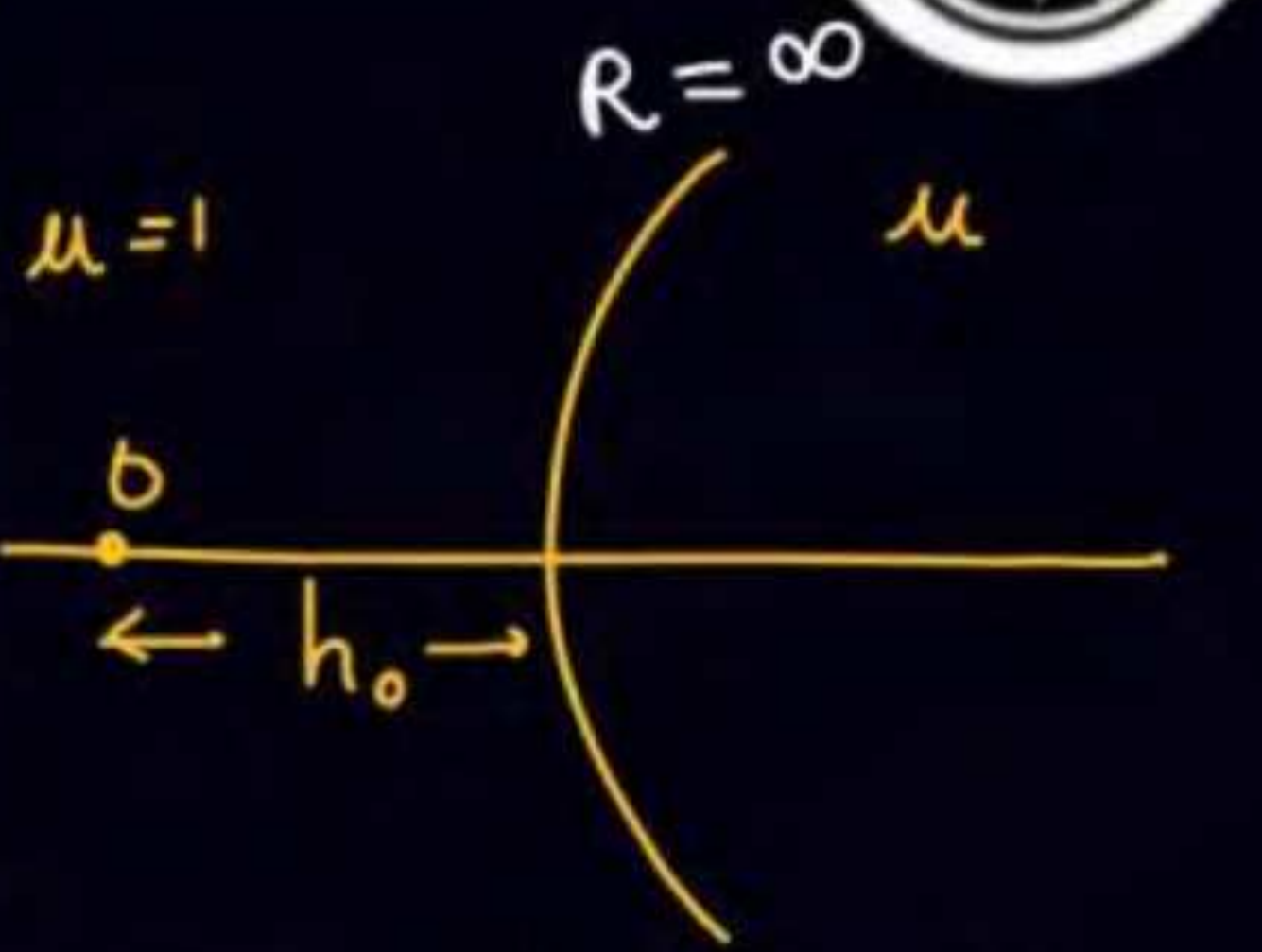


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$$h_{app} = h_0 \frac{\mu_{जाने}}{\mu_{आने}} = h_0 \frac{\mu}{1}$$

$$h_{app} = h_0 \mu$$

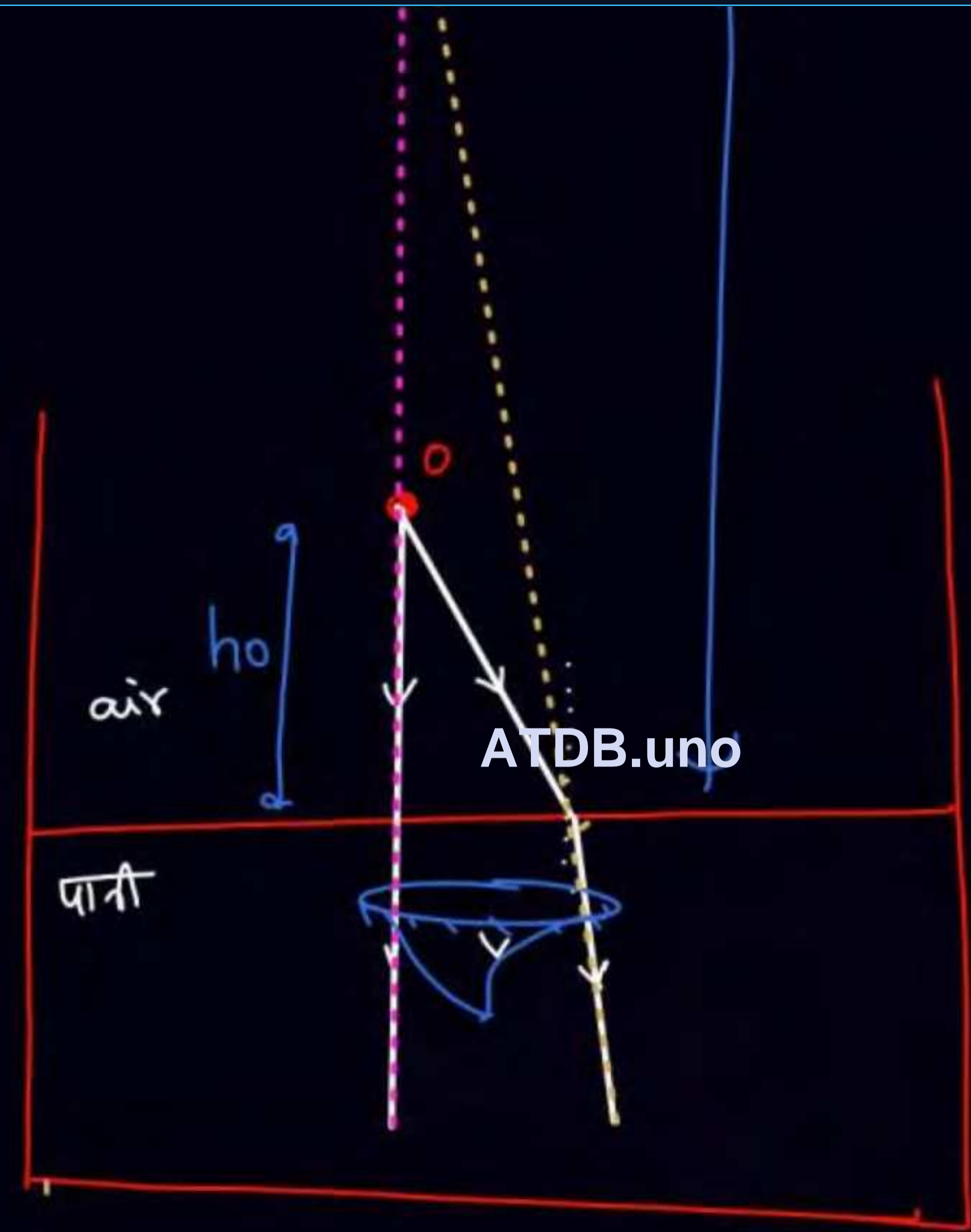
$$h_{app} = \mu \left( \frac{h_0}{1} \right)$$



$$\frac{\mu}{v} - \frac{1}{h_0} = \frac{\mu - 1}{R = \infty}$$

$$\frac{\mu}{v} - \frac{1}{h_0} = 0$$

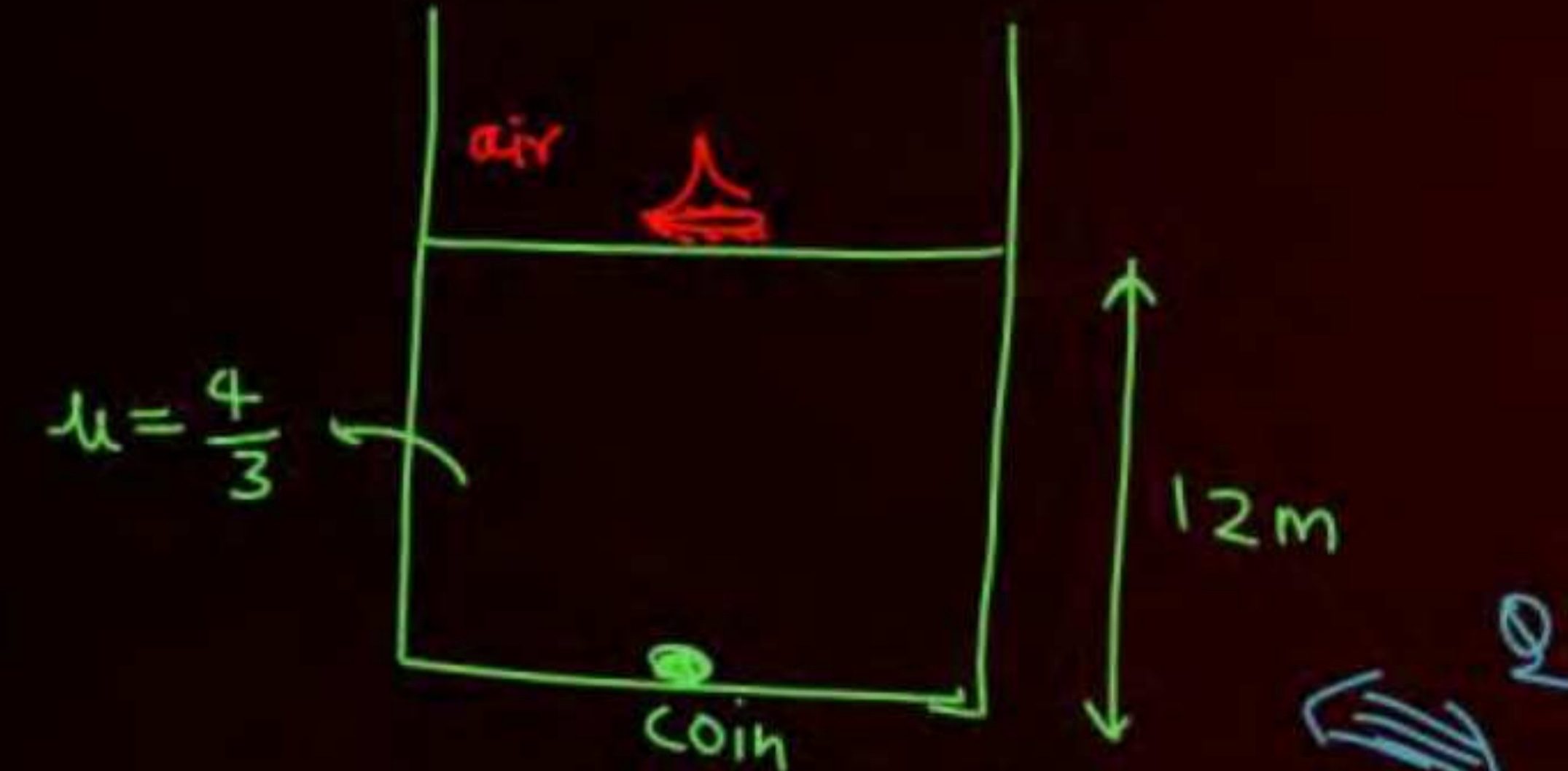
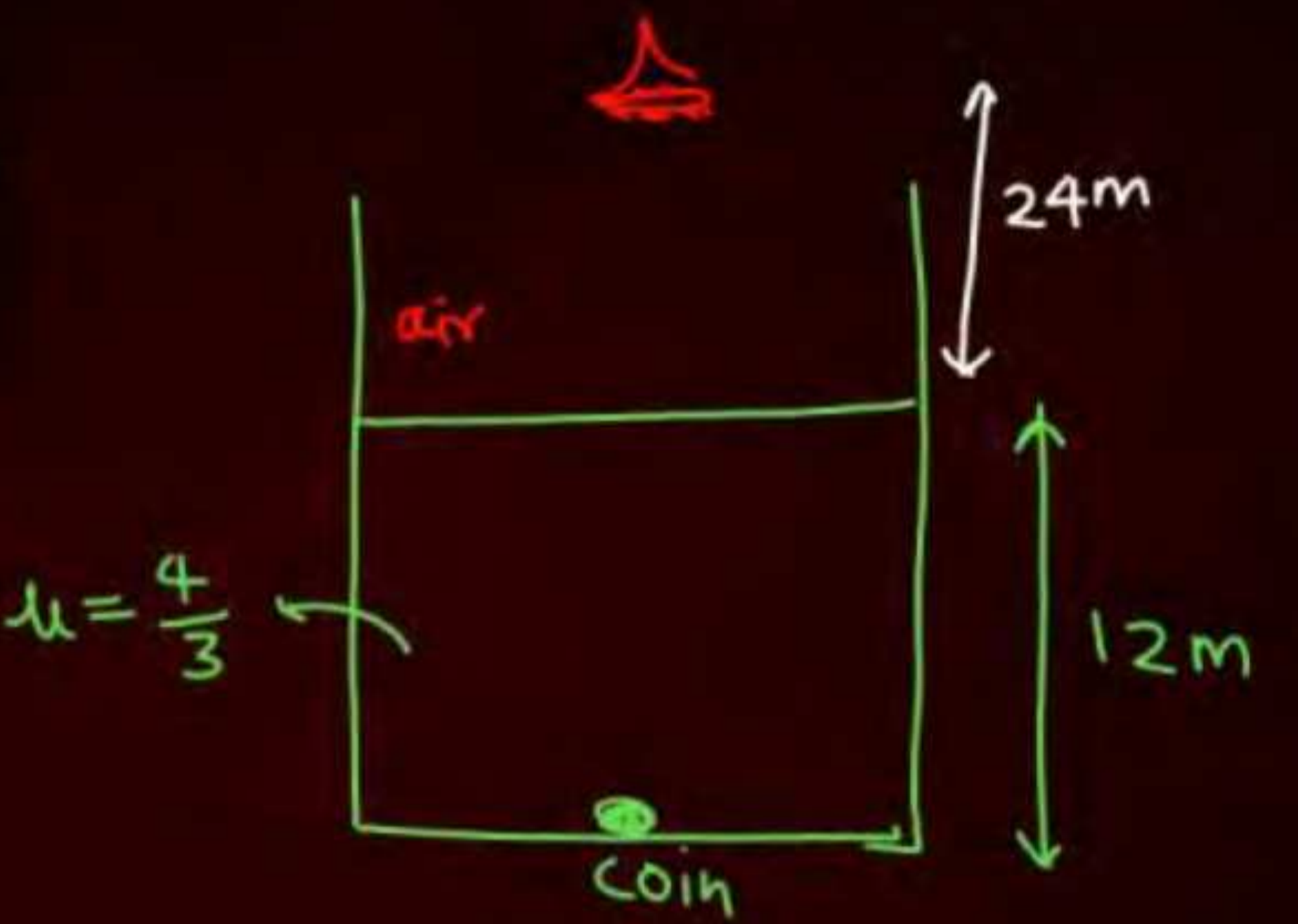
$$v = \mu h_0$$





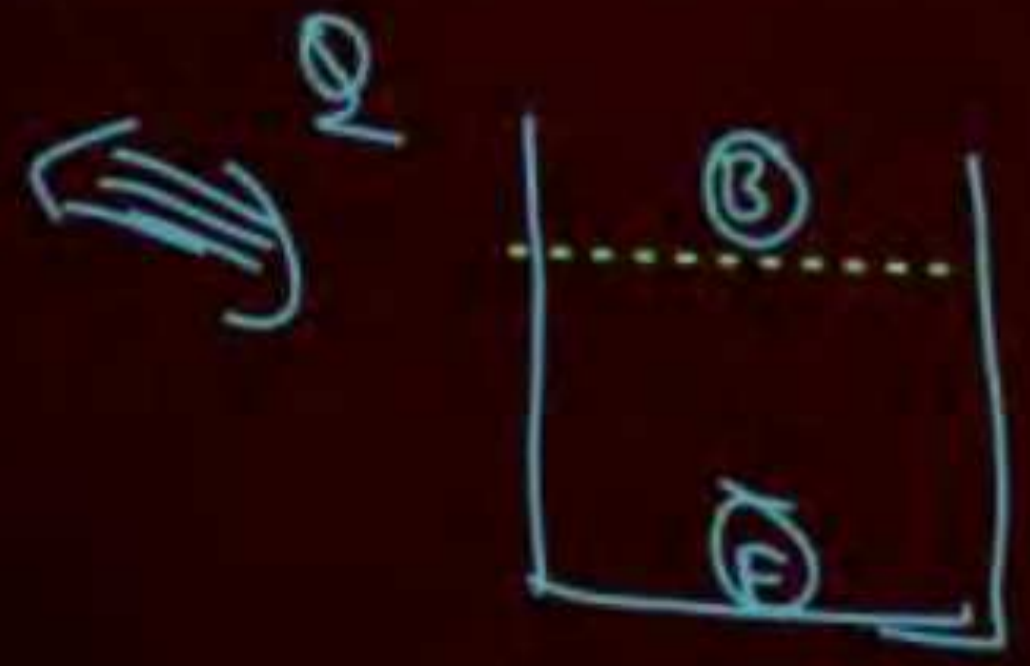
चिड़िया मछली वाले Ques  
Bird fish problem

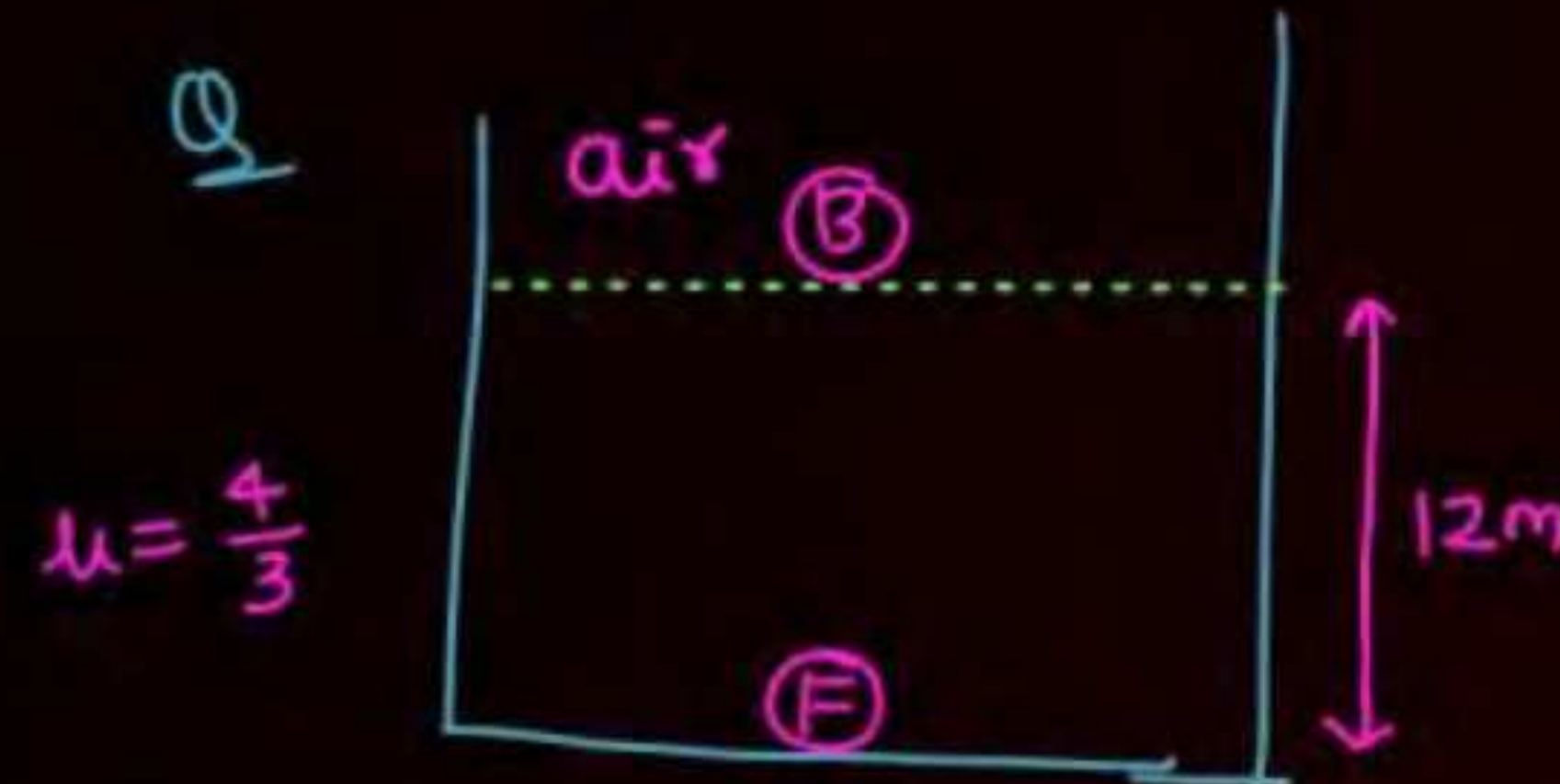
Q



ATDB.uno Apparent depth of coin observed by eye  
 $= 24 + \frac{12}{\mu} = 24 + \frac{12}{4/3}$   
 $= 24 + 9 = 33$

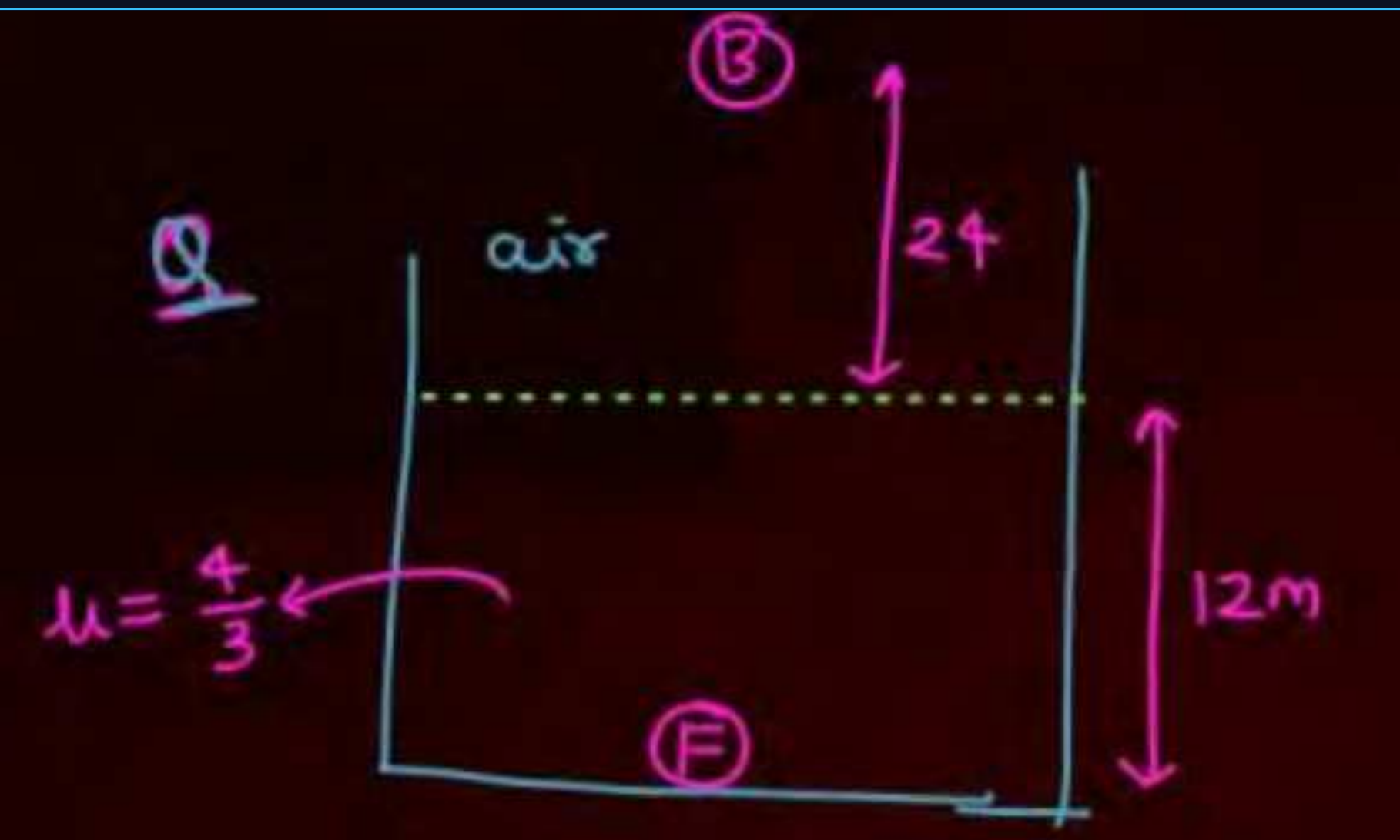
$h_{app} = \frac{h}{\mu} = \frac{12}{4/3}$   
 $h_{app} = 9m$





Apparent depth observed by bird =  $\frac{h}{\mu} = \frac{12}{4/3} = 9\text{m}$

$$h_{app} = 12 \times \frac{1}{4/3} = 9$$



Apparent depth observed by

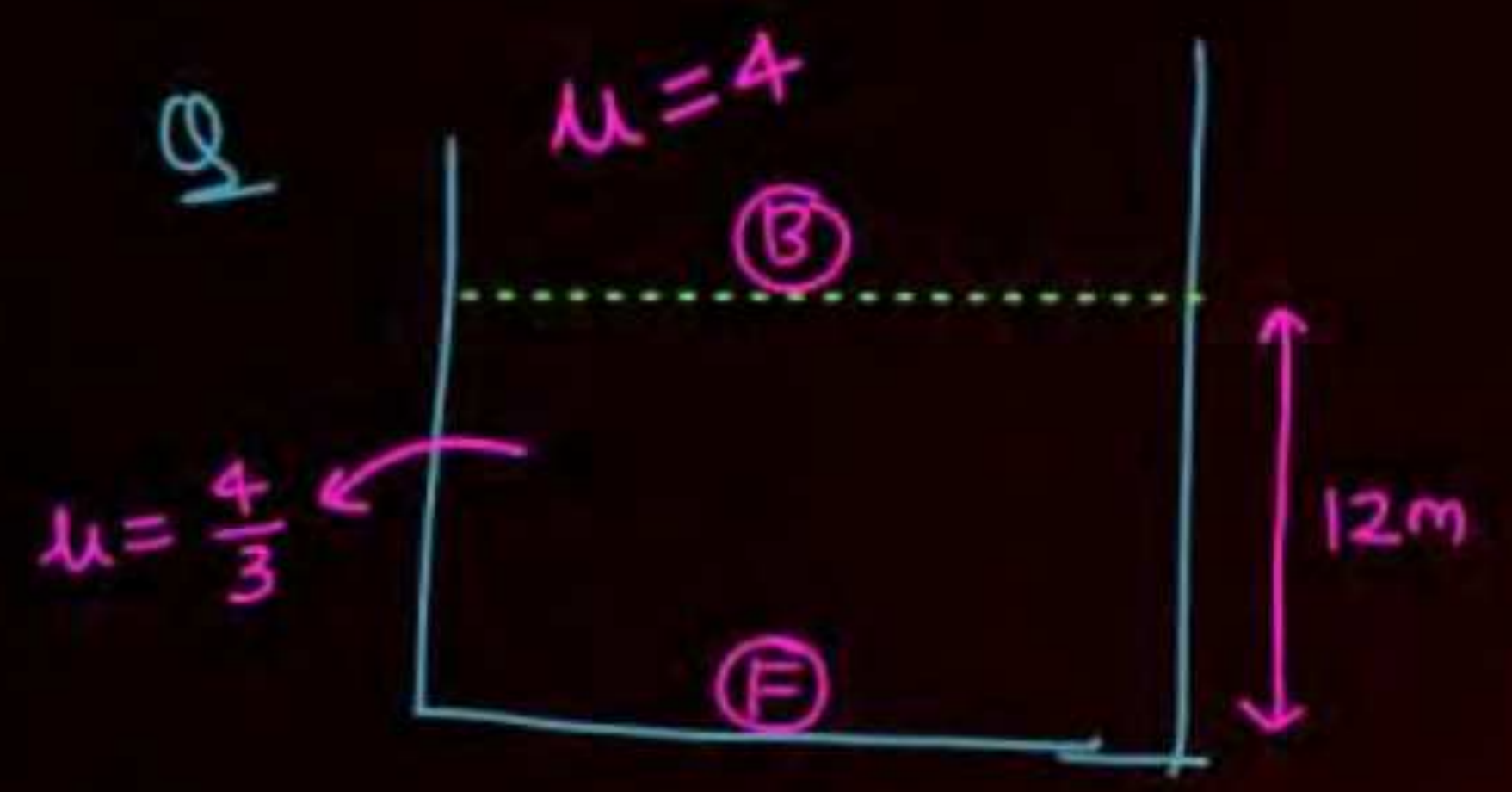
$$\text{bird} = 24 + \frac{12}{4/3} = 24 + 9 = 33$$

$$= 24 + 12 \times \frac{1}{4/3} = 24 + 9 = \underline{\underline{33}}$$

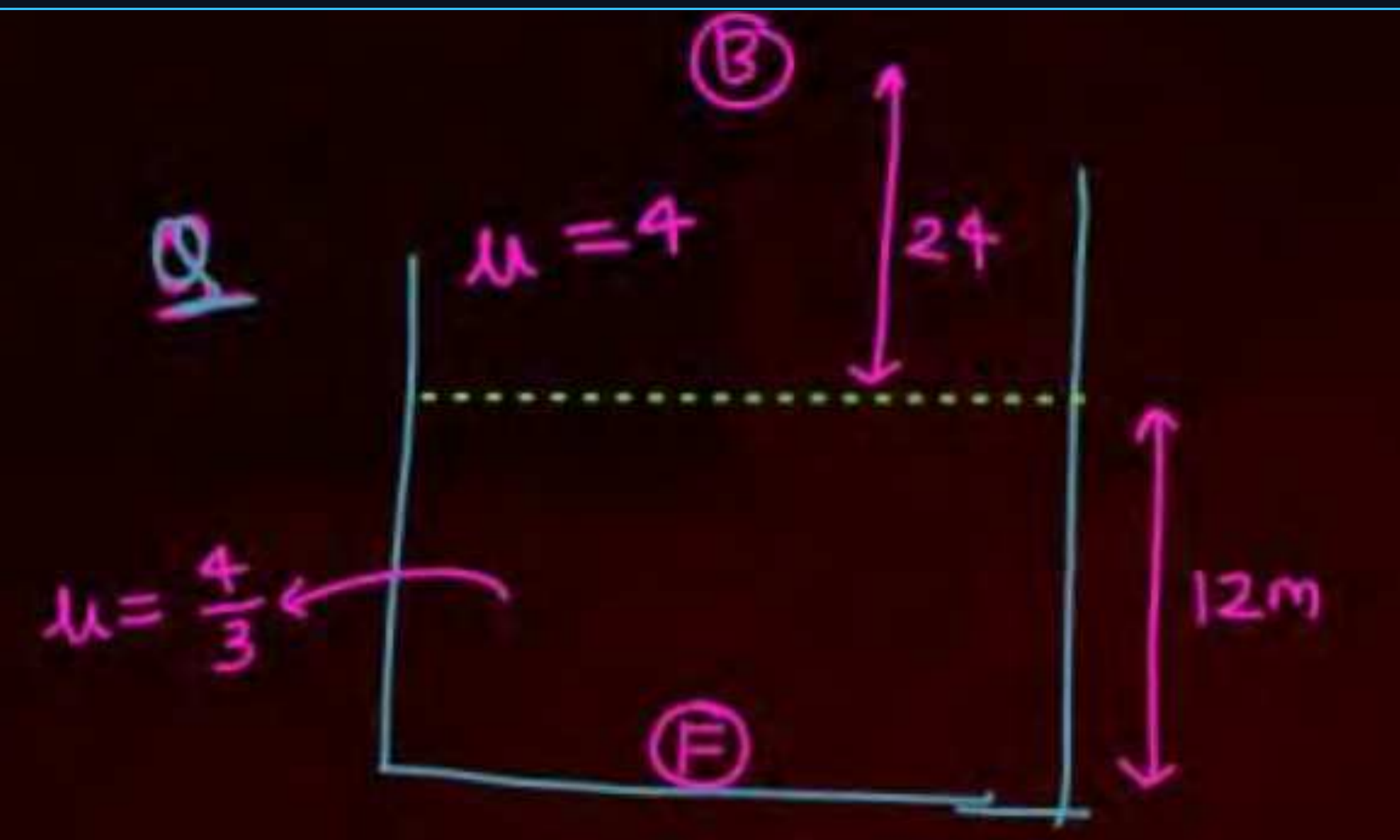
SKC

$$h_{app} = h_o \frac{\mu_{\text{जाने वाली}}}{\mu_{\text{आने वाली}}}$$

- \* देख कौन रहा है
- \* जो देख रहा है उसकी आंखों में rays जाती हैं



Apparent depth observed by bird =  $12 \times \frac{4}{4/3} = 36 \text{ m}$



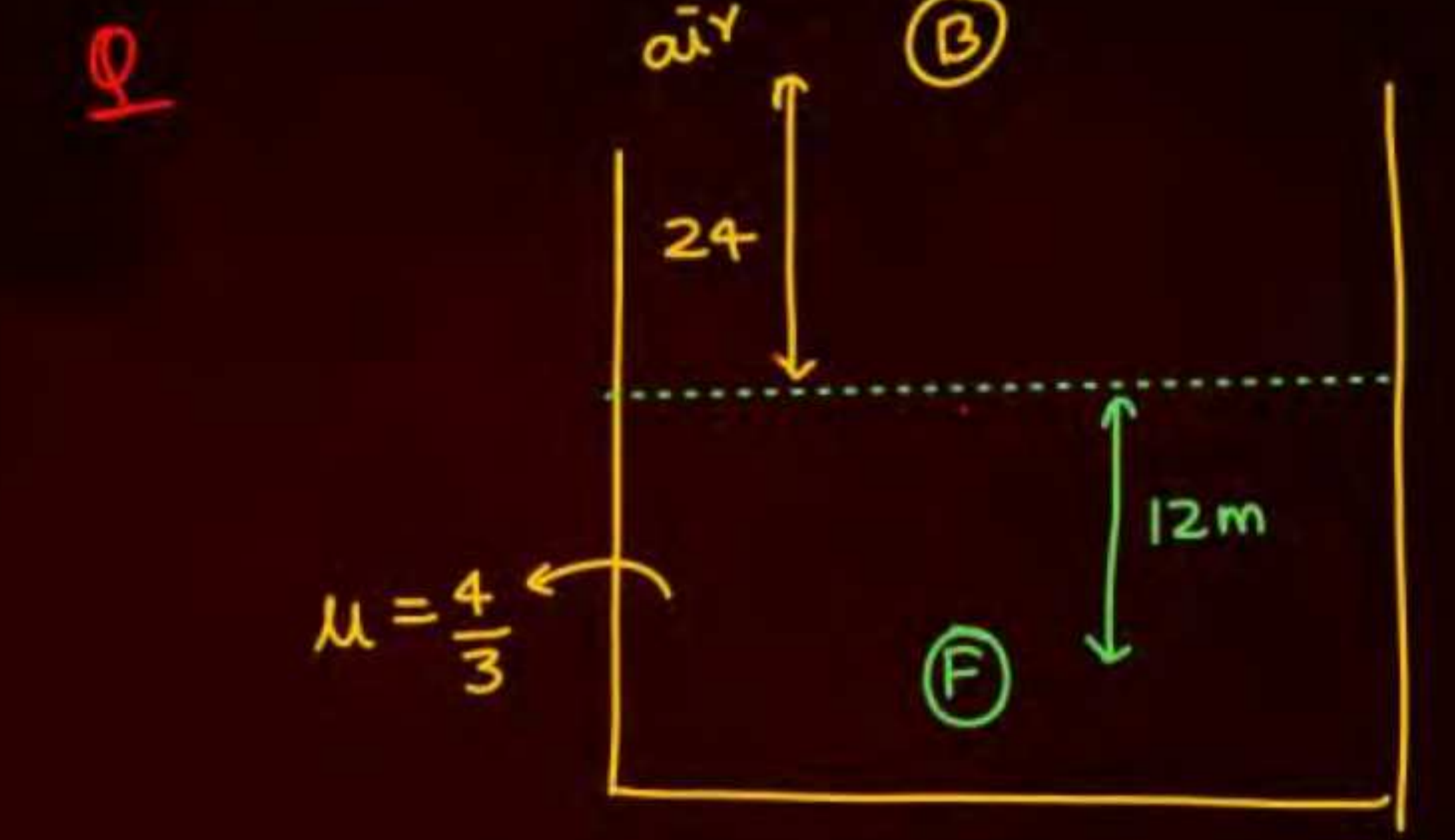
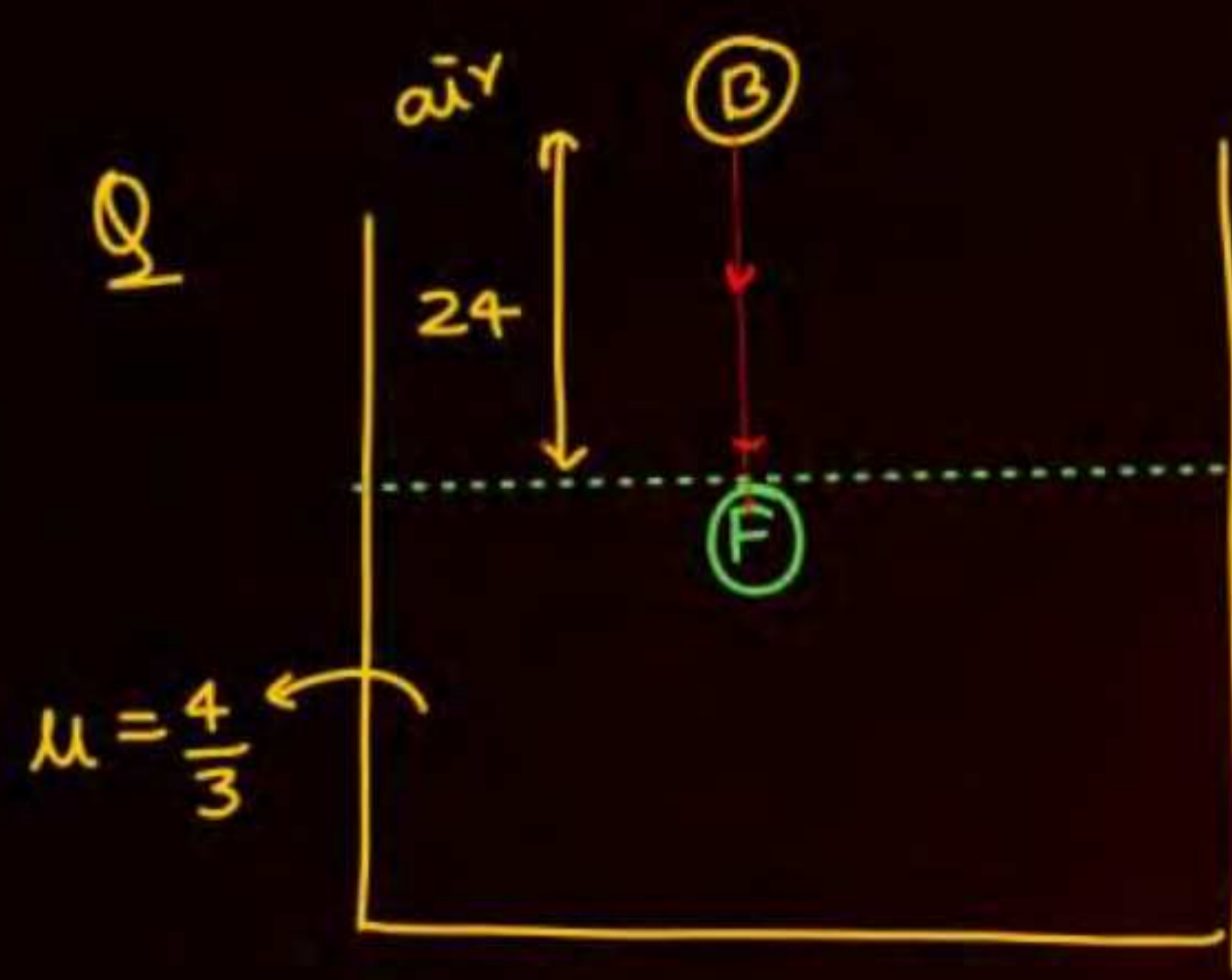
Apparent depth observed by bird =  $12 \times \frac{4}{4/3}$

SKC

$$h_{app} = h_o \frac{\mu_{\text{जाने वाली}}}{\mu_{\text{आने वाली}}}$$

- \* देख कौन रहा है
- \* जो देख रहा है उसकी आंख में rays जाती हैं

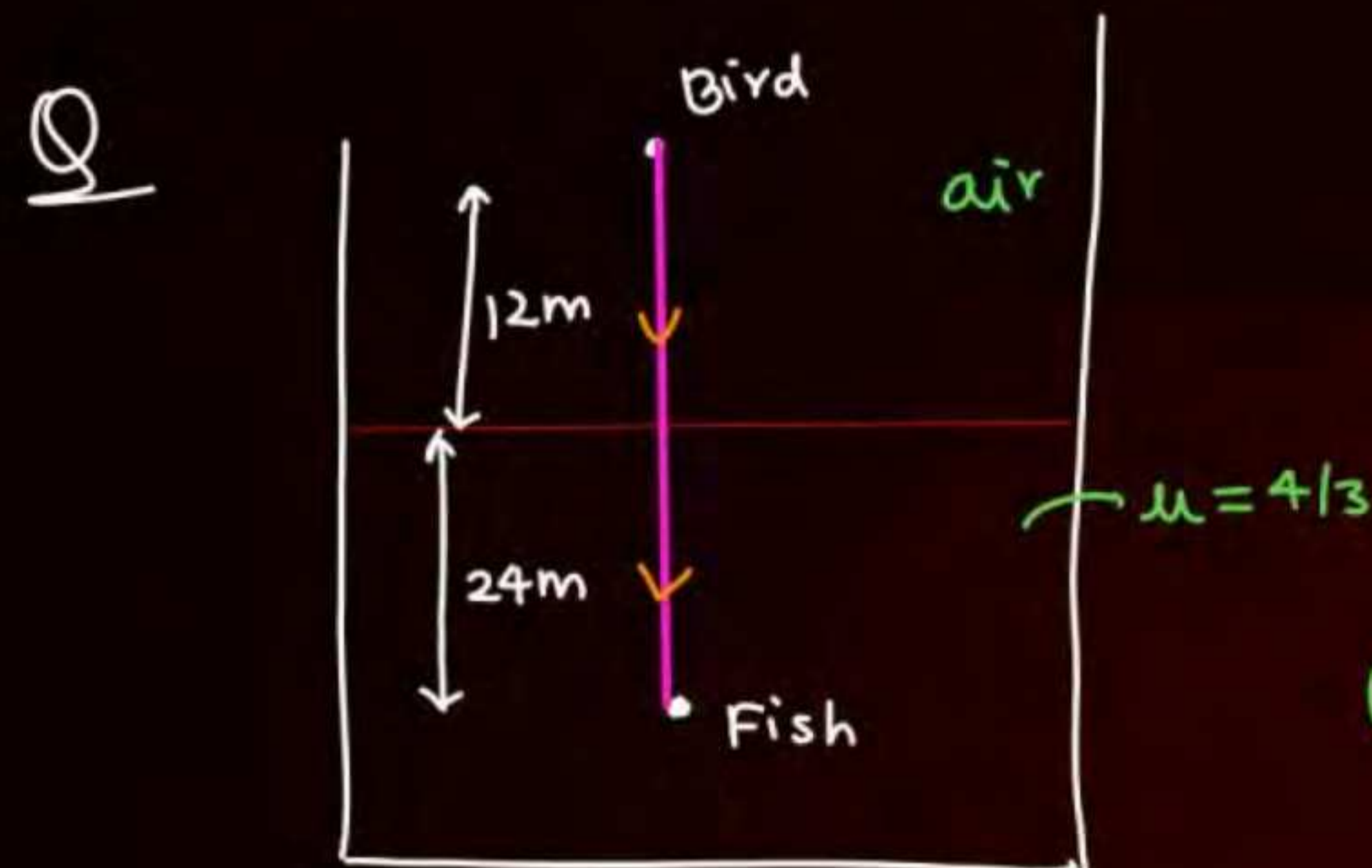
$$V_{app} = V_o \frac{\mu_{\text{जाने}}}{\mu_{\text{आने}}}$$



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Apparent distance of bird observed by fish =  $h_{\text{act}} \frac{\mu_{\text{जाने}}}{\mu_{\text{आने}}} = 24 \times \frac{4/3}{1} = 32\text{m}$

Apparent distance of bird observed by fish by fish =  $12 + 24 \times \frac{4/3}{1} = 12 + 32 = 44$



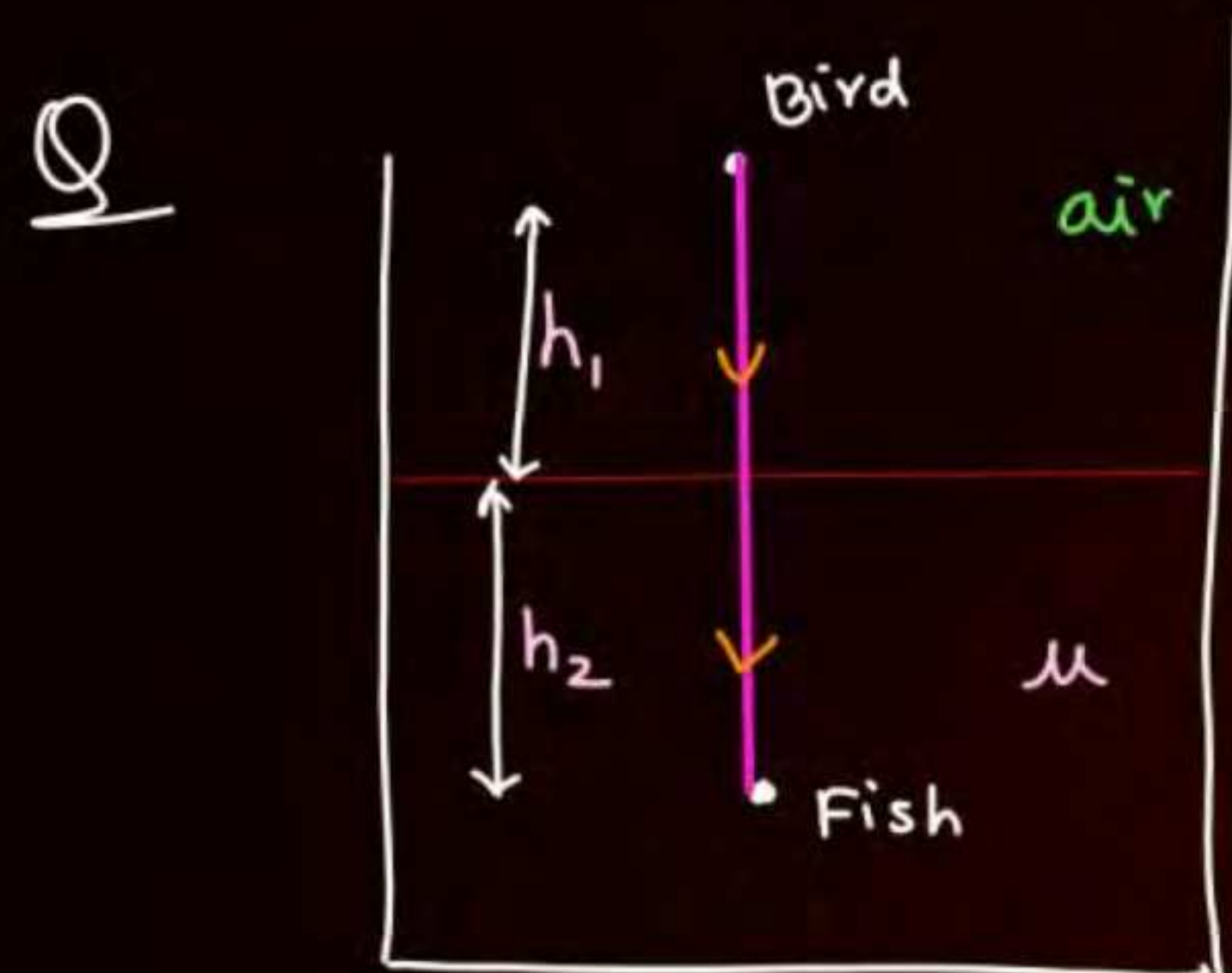
① Apparent depth of fish observed by Bird

$$= 12 + 24 \times \frac{1}{4/3} = 12 + 18 = 30\text{m}$$

② Apparent height of bird observed by fish

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$$= 24 + 12 \times \frac{4/3}{1} = 24 + 16 = 40$$

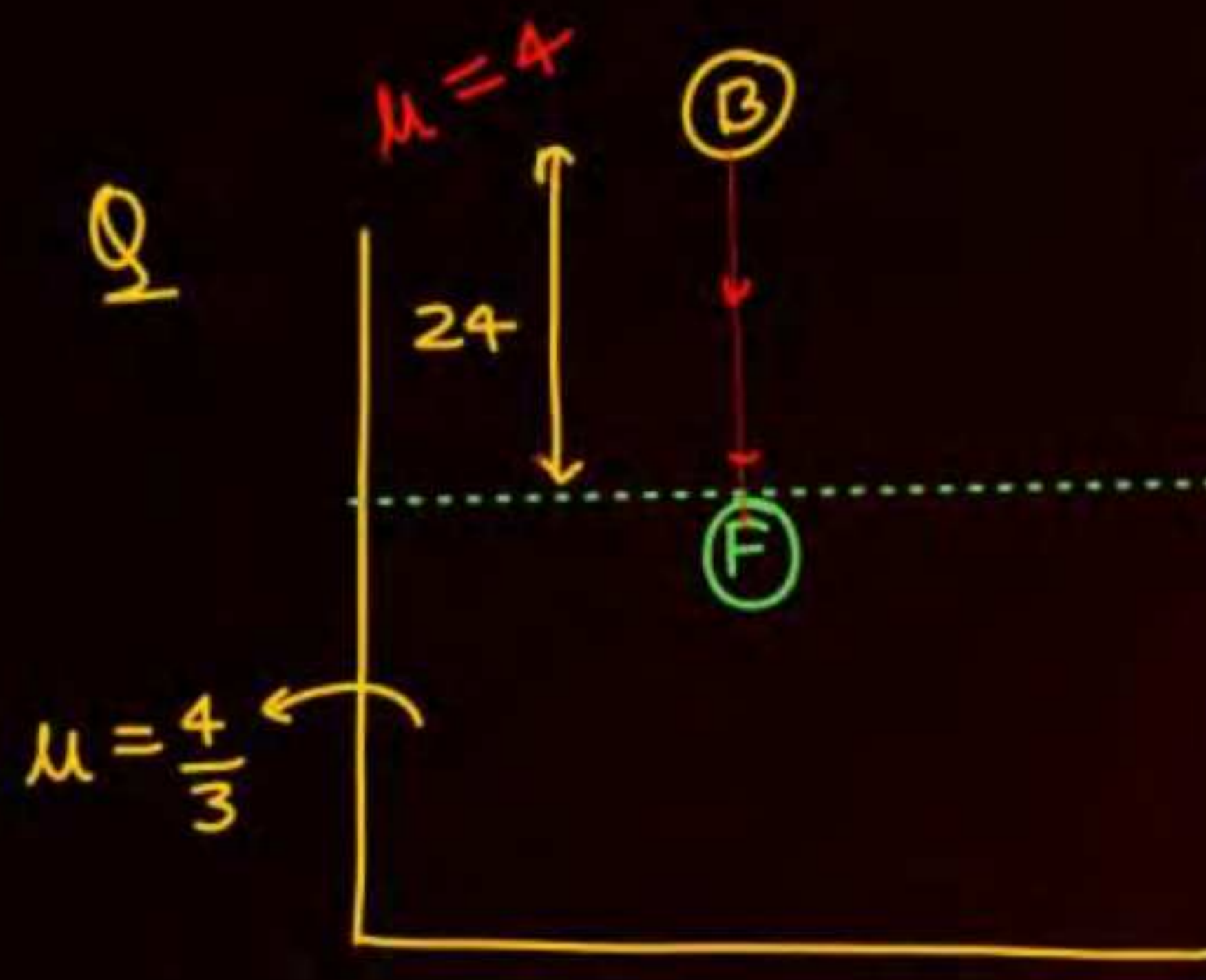


① Apparent depth of fish observed by Bird  

$$= h_1 + \frac{h_2}{\mu}$$

② Apparent height of bird observed by fish

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$$= h_2 + \mu h_1$$



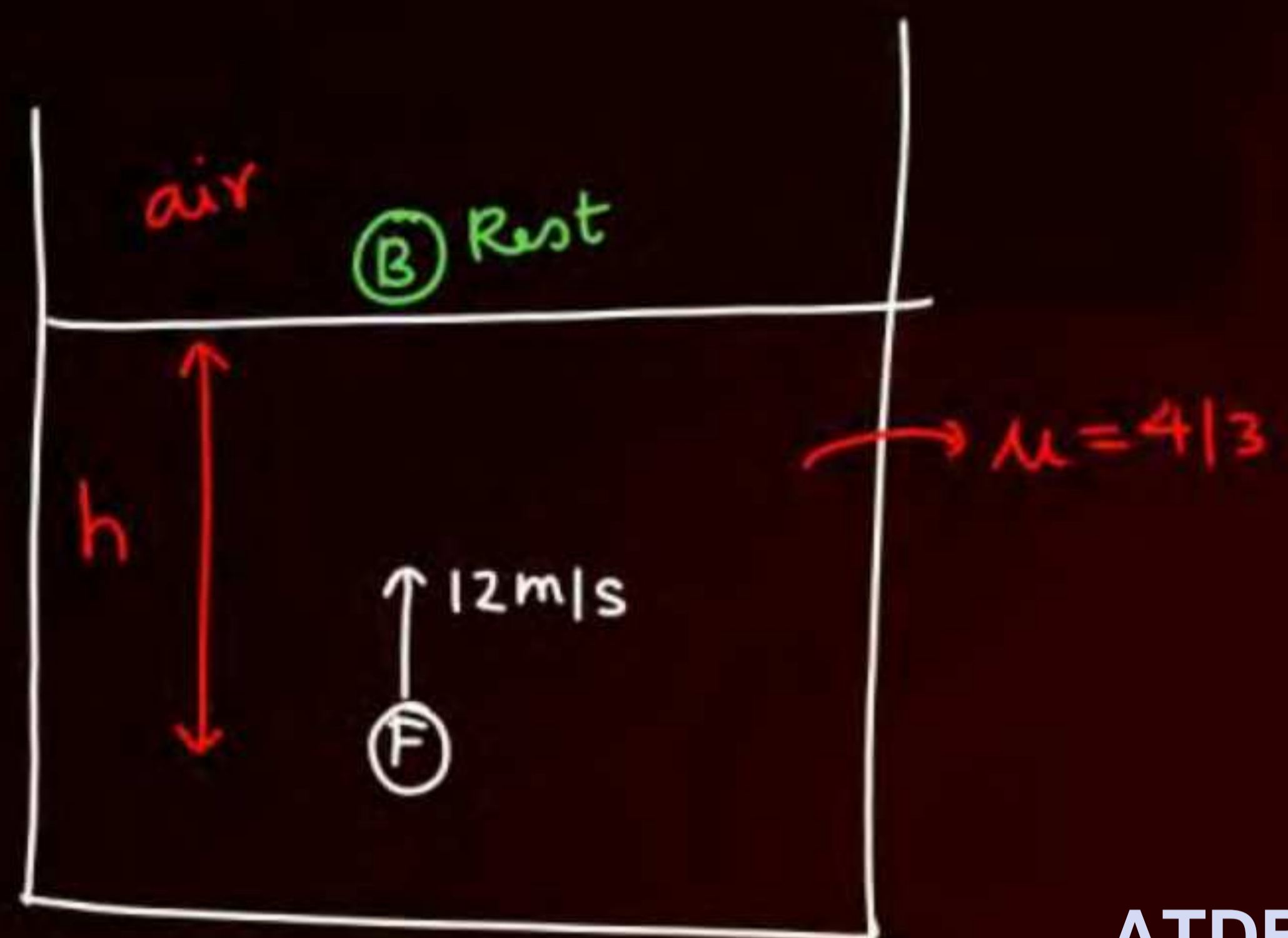
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Apparent distance of bird observed

$$\text{by fish} = h_{\text{act}} \frac{\mu_{\text{जाने}}}{\mu_{\text{आने}}} = 24 \times \frac{4/3}{4} = 8$$



Q  
 $h = 12\text{m}$

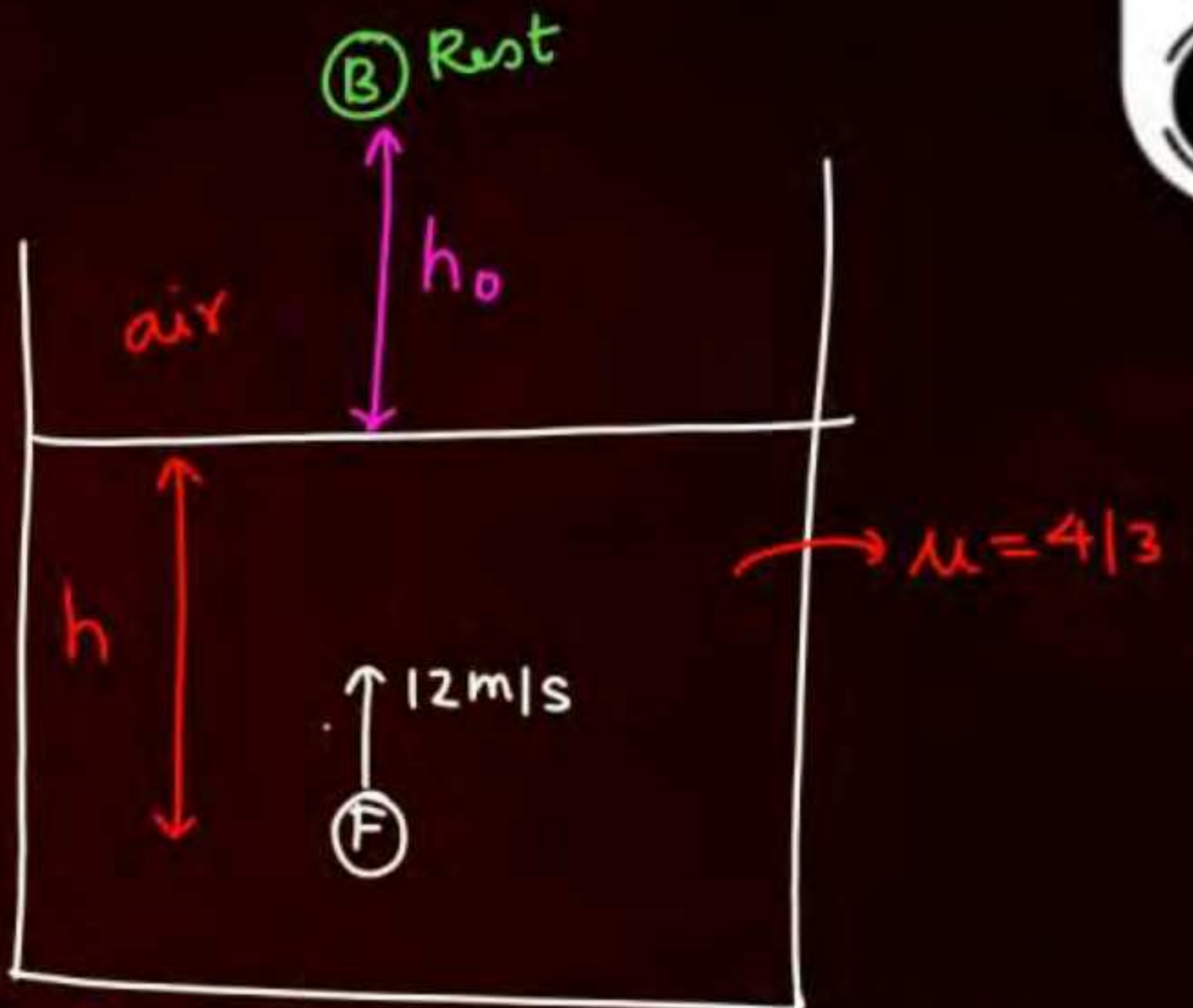


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Velocity of fish observed by Bird =

$$= V_{app} = V_o \frac{\mu_{\text{जाने}}}{\mu_{\text{आने}}} = 12 \times \frac{1}{4/3} = 9\text{m/s}$$

Q

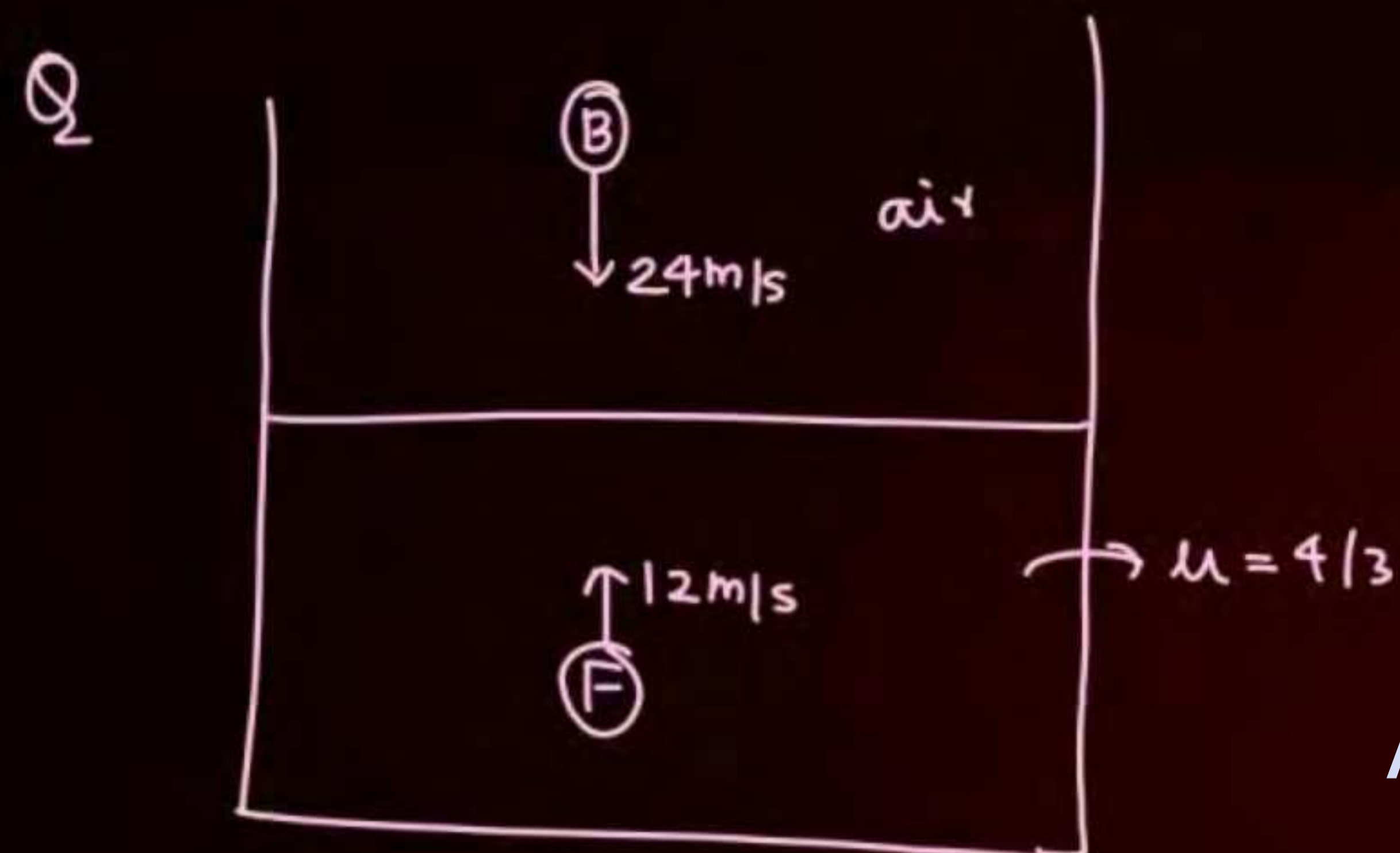


Velocity of fish observed by Bird =

Ans  $\equiv$  Same - 9m/s

$$h_{app} = h_0 + \frac{h}{\mu}$$

$$\frac{dh_{app}}{dt} = V_{app} = 0 + \frac{1}{\mu} V_o$$

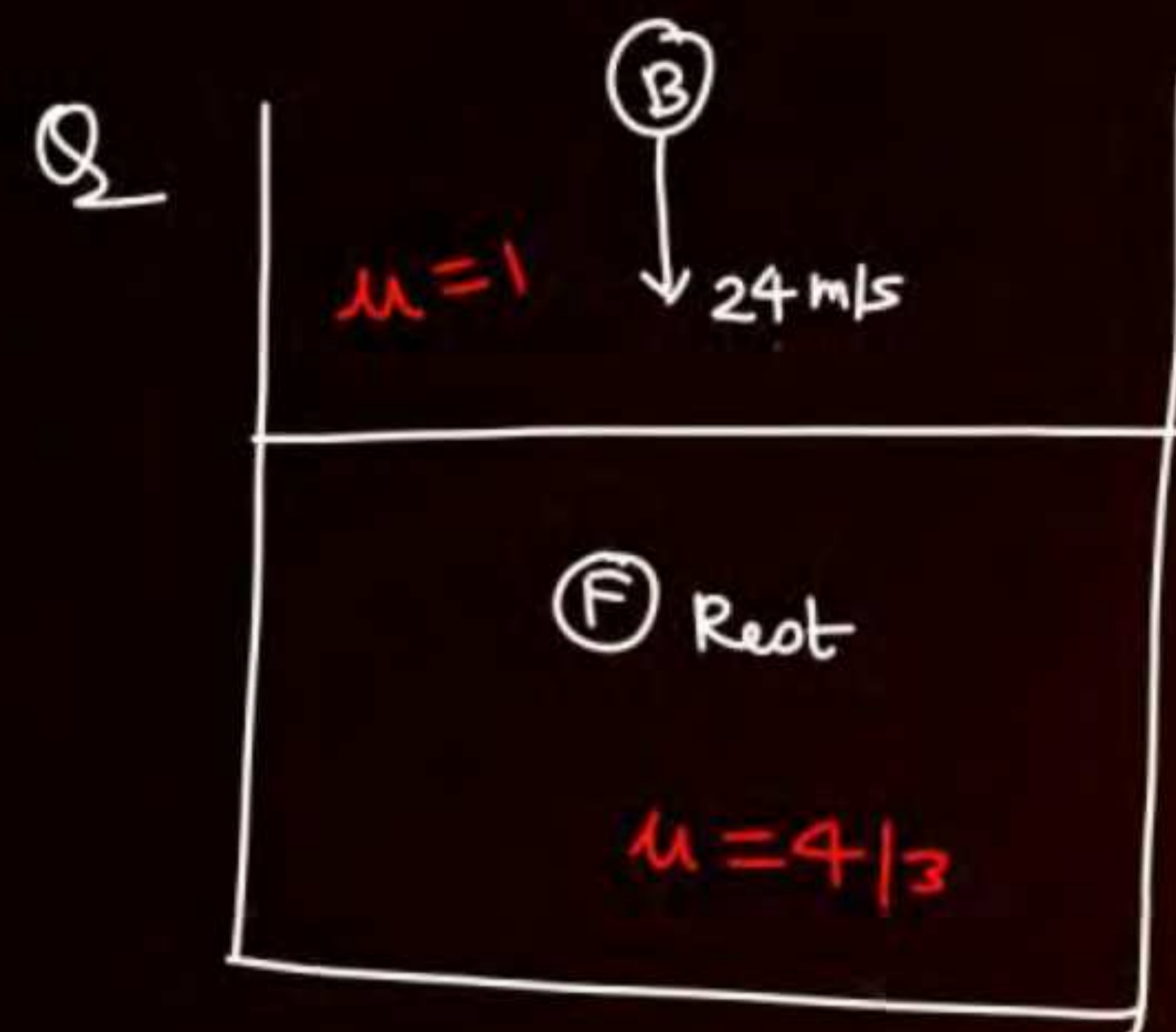


velocity of fish observed by bird

$$= 24 + 12 \times \frac{1}{4/3}$$

→ पहले Bird रोक दी

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(a) find velocity of bird observed by fish

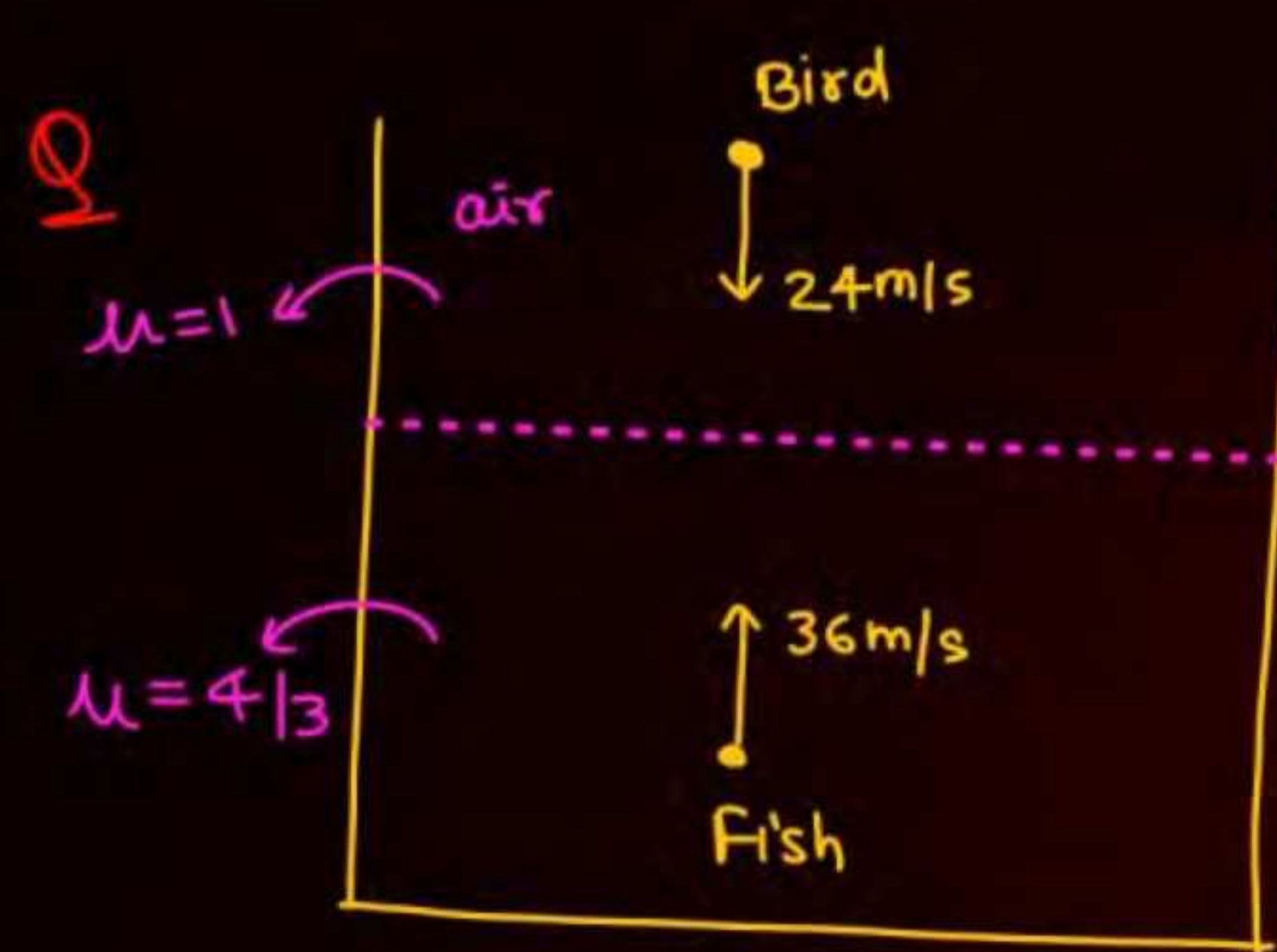
$$= 24 \times \frac{4/3}{1} = 32 \text{ m/s}$$

→ रोक दो

(b) if fish start moving upward with speed 10 m/s  
find velocity of bird observed by fish

$$= 10 + 32$$

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① Velocity of fish observed by bird

$$= 24 + 36 \times \frac{1}{\frac{4}{3}}$$

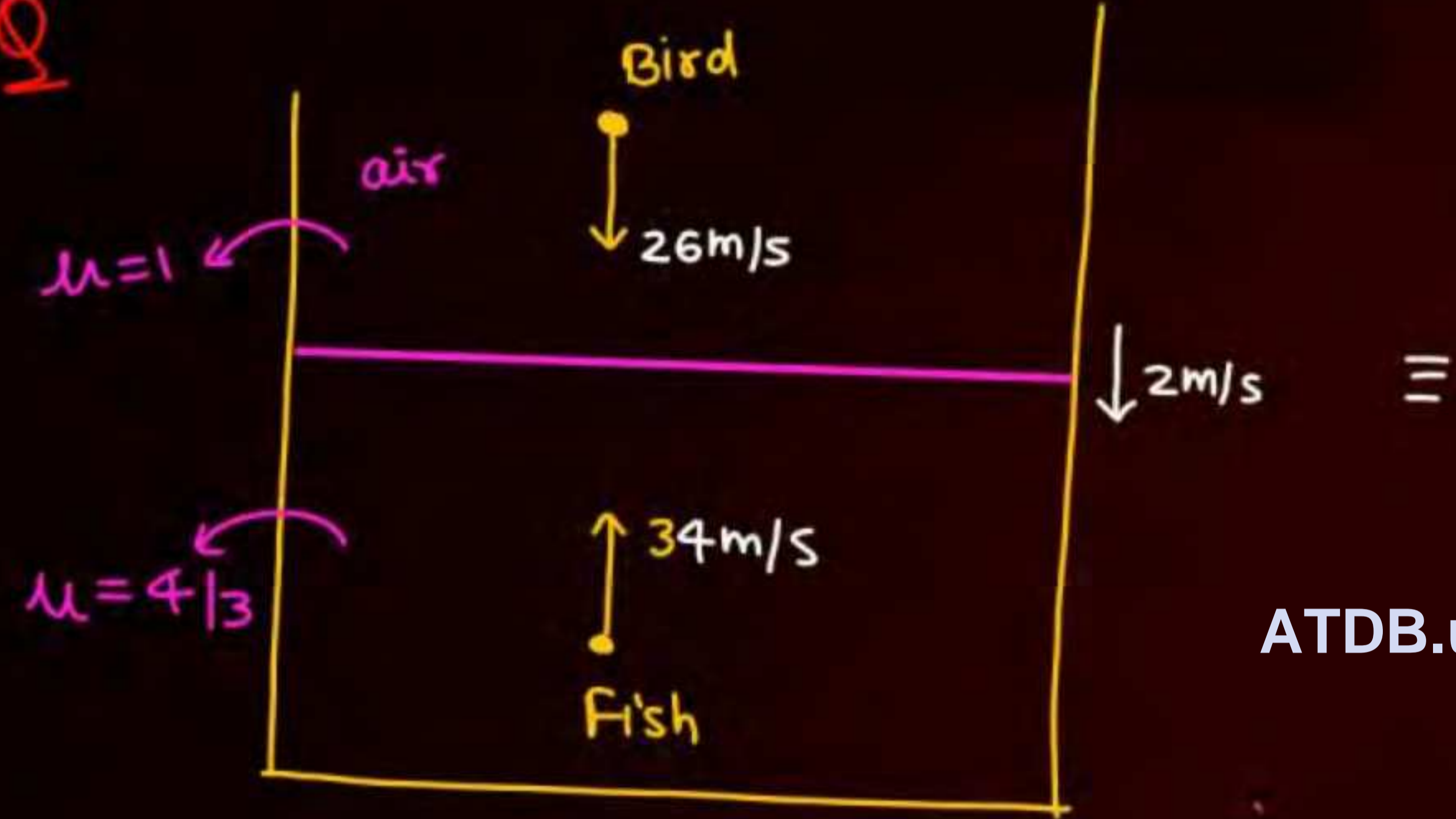
② Velocity of bird observed by fish.

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$$= 36 + 24 \times \frac{\frac{4}{3}}{1}$$

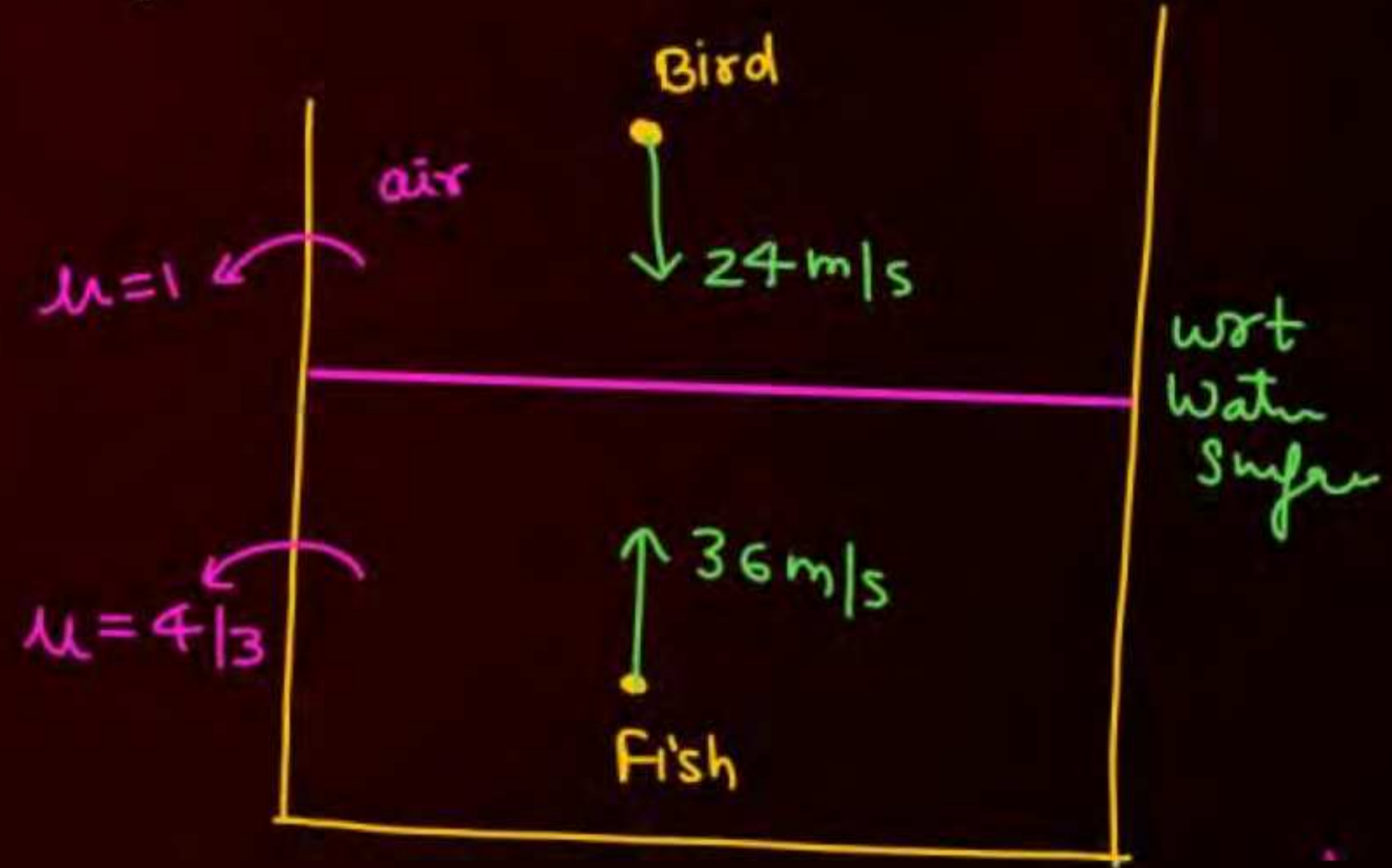


Q



Water surface की रोकती उसके respect में Velocity निकाल लो

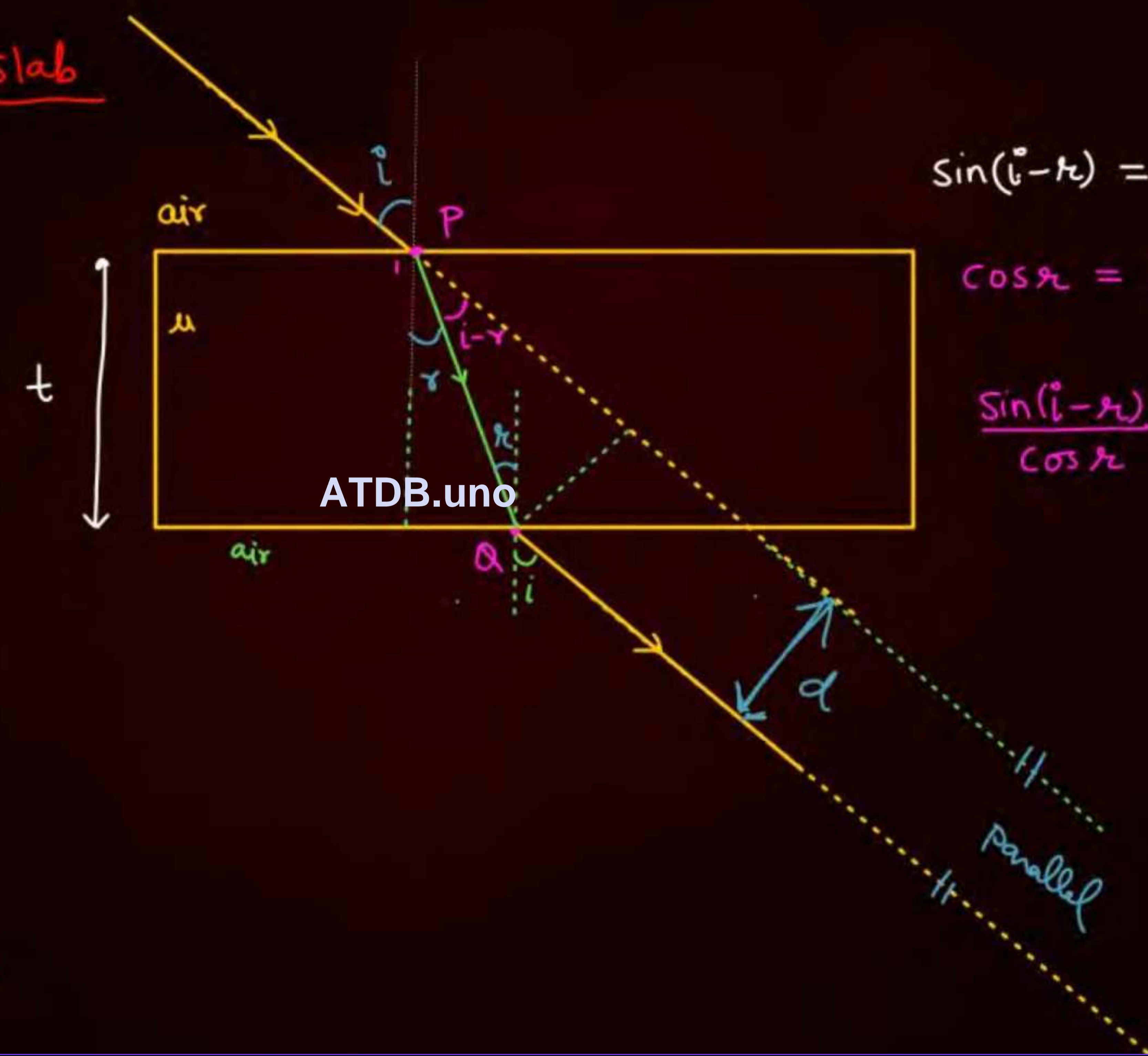
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# Lateral shift by slab

$$d = \frac{t \sin(i - r)}{\cos r}$$



$$\sin(i - r) = \frac{d}{PA}$$

$$\cos r = \frac{t}{PA}$$

$$\frac{\sin(i - r)}{\cos r} = \frac{d}{t}$$

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parallel



# THANK YOU

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