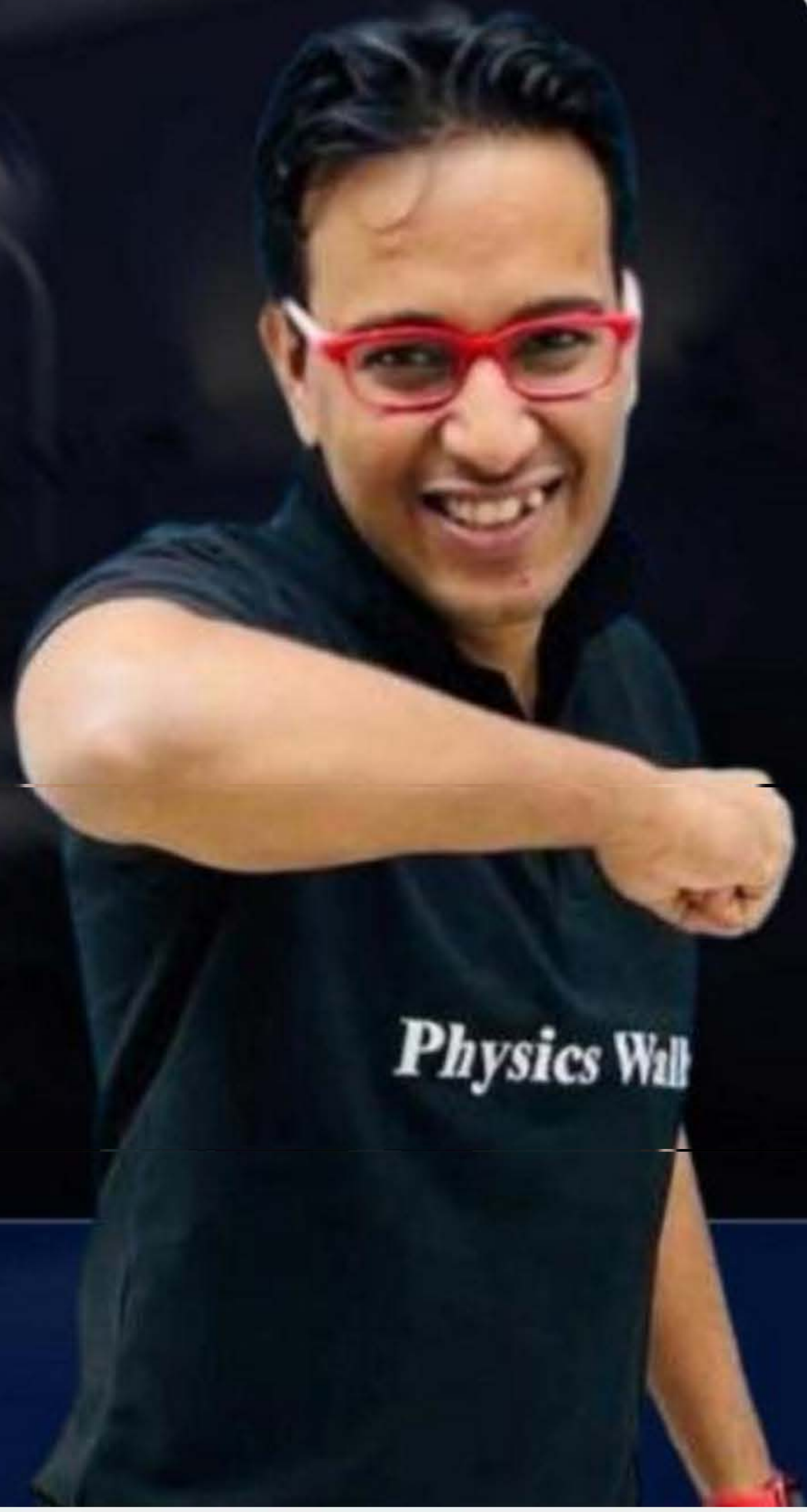
YAKEEN NEET 2.0

2026

Mechanical Properties of Fluids

PHYSICS Lecture 05

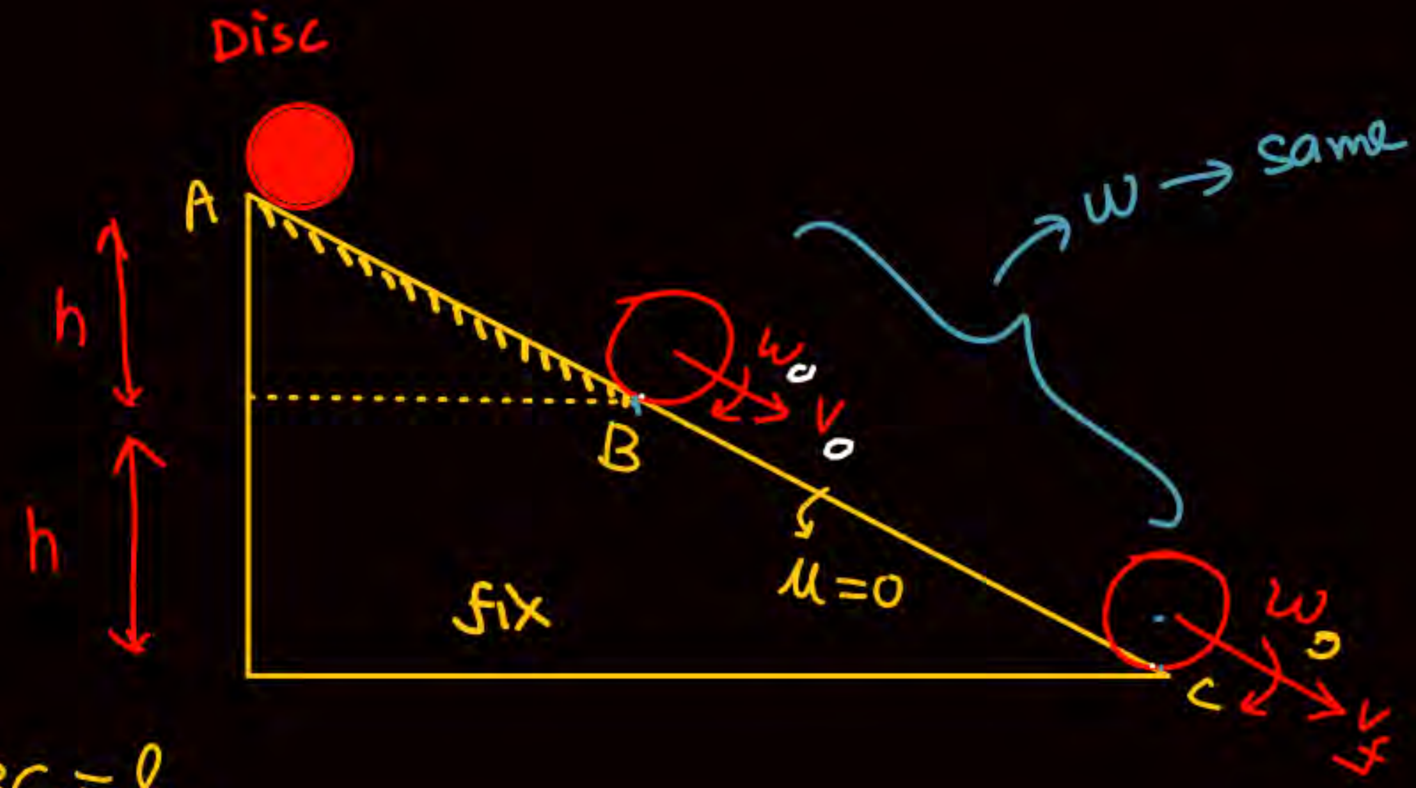
By - Saleem Ahmed Sir



Todays Goal

- velocity of efflux.
- Stokes Law.

Q



$AB = BC = l$.

AB → friction is sufficient

$$a = \frac{g\sin\theta}{1 + \frac{I}{mR^2}}$$

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WET

$(A \rightarrow B)$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\cdot\frac{mR^2}{2}\left(\frac{v}{R}\right)^2$$

$$v_B = \sqrt{\frac{4}{3}gh} = v_0, \quad \omega_0 = \frac{v_0}{R}$$

$B \rightarrow C$

$$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_B^2$$

$$\omega_B = \omega_C$$

Pani Ki Dhar (पानी की धार)

- Speedup, $V\uparrow$, $A\downarrow$, $(A_1V_1 = A_2V_2)$

$\Rightarrow$ $V_2^2 = V_1^2 + 2gh$

$\Rightarrow$ $\frac{d\,vol^n}{dt}$ = Rate of flow of fluid $= A_1V_1 = A_2V_2$

$\Rightarrow$ $\frac{dm}{dt} = \rho AV = \rho A_1V_1 = \rho A_2V_2$

ध्यान से देखो पानी की धार जैसे नीचे जाने पर पतली होती जा रही है.... अब समझ आया ऐसा क्यों हुआ.... नीचे जाने पर velocity बढ़ रही है और from eqn. of continuity $AV = \text{const} \Rightarrow$ if $V\uparrow$ then $A\downarrow \Rightarrow r\downarrow$

भाई ये ques JEE MAINS मे 2-3 times पूछा है। इसमे बस ये दो formula याद करलो जो कि बहुत आसान है..... ये बिलकुल motion under gravity मे third eqn of motion जैसा है।

$$V_2^2 = V_1^2 + 2gh$$

$$\frac{d\,vol^m}{dt} = A_1V_1 = A_2V_2$$

5. Water is flowing continuously from a tap having an internal diameter 8×10^{-3} m. The water velocity as it leaves the tap is $0.4\ ms^{-1}$. The diameter of the water stream at a distance 2×10^{-1} m below the tap is close to :- **[AIEEE-2011]**

आन्तरिक व्यास 8×10^{-3} m वाले एक टोंटी से पानी लगातार प्रवाहित हो रहा है। जैसे ही पानी टोंटी से बाहर आता है, पानी का वेग $0.4\ ms^{-1}$ है। टोंटी के नीचे 2×10^{-1} m की दूरी पर पानी की धार का व्यास इसके लगभग है :-

(1) 9.6×10^{-3} m (2*) 3.6×10^{-3} m (3) 5.0×10^{-3} m (4) 7.5×10^{-3} m

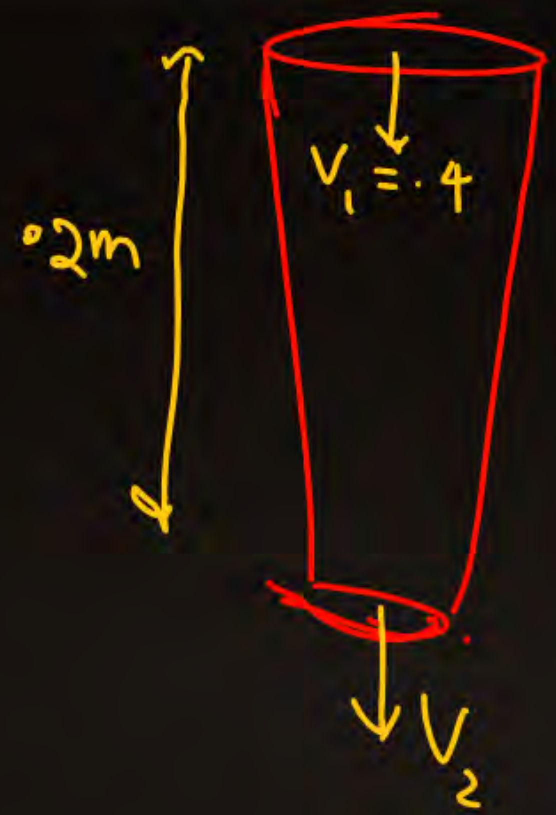
Ans. (2)

$V_1 = .4$

$V_2^2 = V_1^2 + 2gh$

$V_2^2 = \frac{16}{100} + 2 \times 10 \times .2$

$V_2 = \checkmark$



$A_1V_1 = A_2V_2$

$\pi r_1^2 V_1 = \pi r_2^2 V_2$

21. The tap in the garden was closed in appropriately resulting in the water flowing freely out of it which forms a downward narrowing beam. The beam of water has a circular cross-section, the diameter of the circle is 6 mm at one point and 3 cm below it is only 3 mm as shown in figure. If the rate of water wasted is $(x \times \pi)$ $\boxed{\text{mL/minute}}$ then find the value of x. (Neglect the effect of

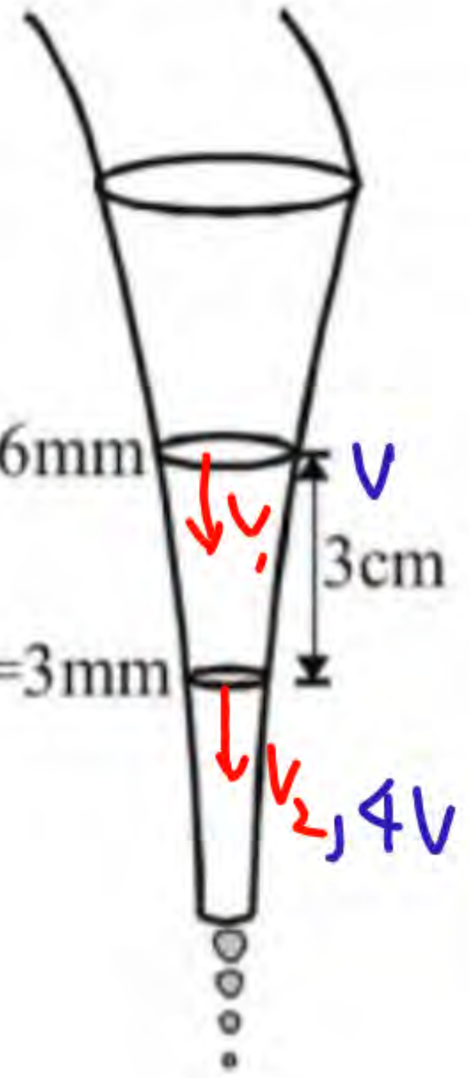
$$V_2^2 = V_1^2 + 2 \times 10 \times \frac{3}{100}$$

$$A_1 V_1 = A_2 V_2$$

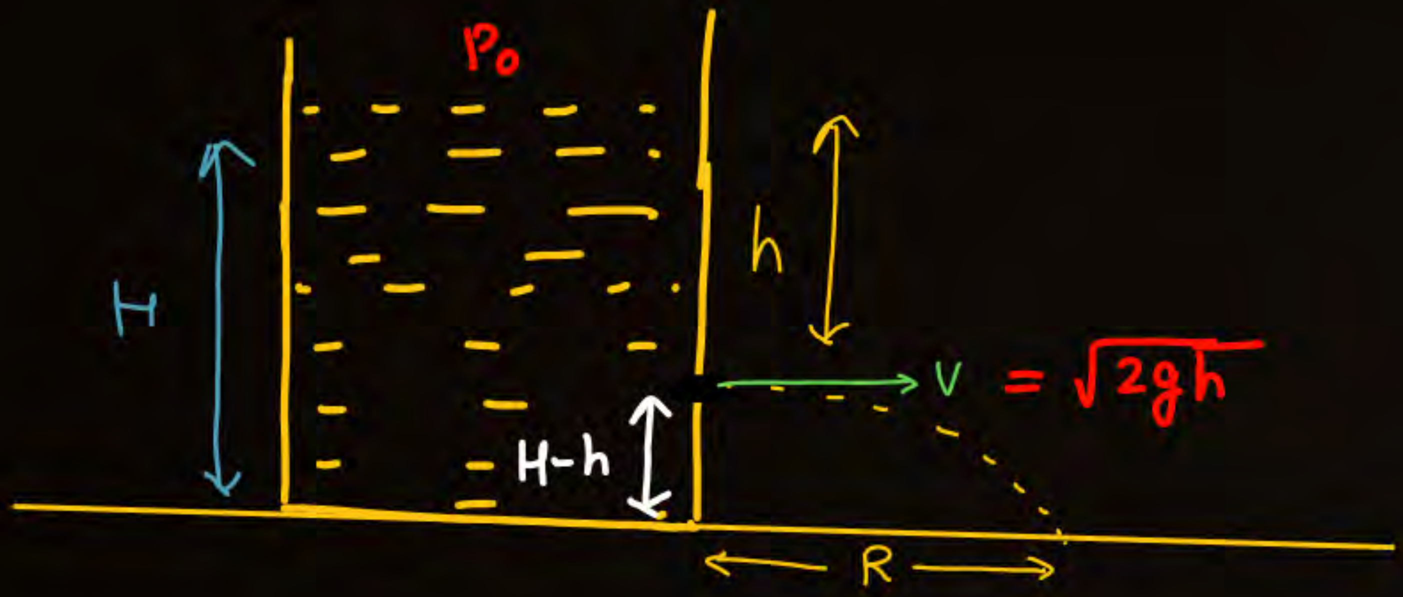
$$(4V)^2 = V^2 + \frac{2 \times 3}{10}$$

H/W

$\frac{dvol^n}{dt} = $ ✓



Ans. 108



velocity of efflux $= v = \sqrt{2gh}$

find the value of h so that $R \Rightarrow$ max $\Rightarrow R_{max} = H$

$$h = \frac{H}{2}$$

$$R = v.t$$

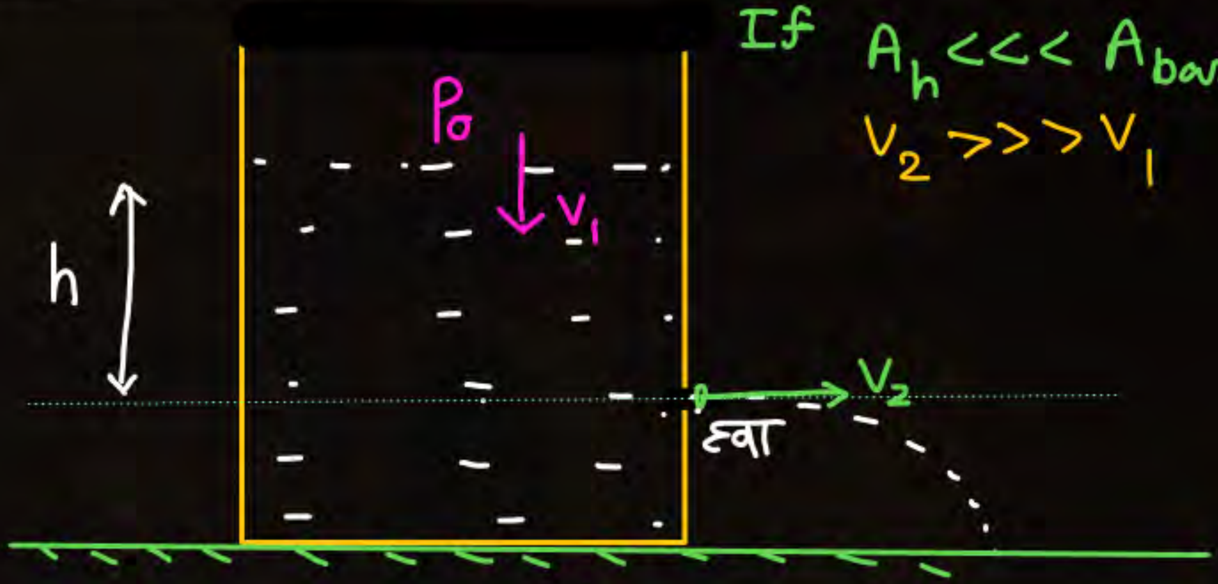
$$R = \sqrt{2gh} \times \sqrt{\frac{2(H-h)}{g}}$$

$$R = \sqrt{4(H-h)h}$$

$A_1 v_1 = A_2 v_2$

$A_{base} v_1 = A_{hole} v_2$

* Derivation



If $A_h <<< A_{base}$

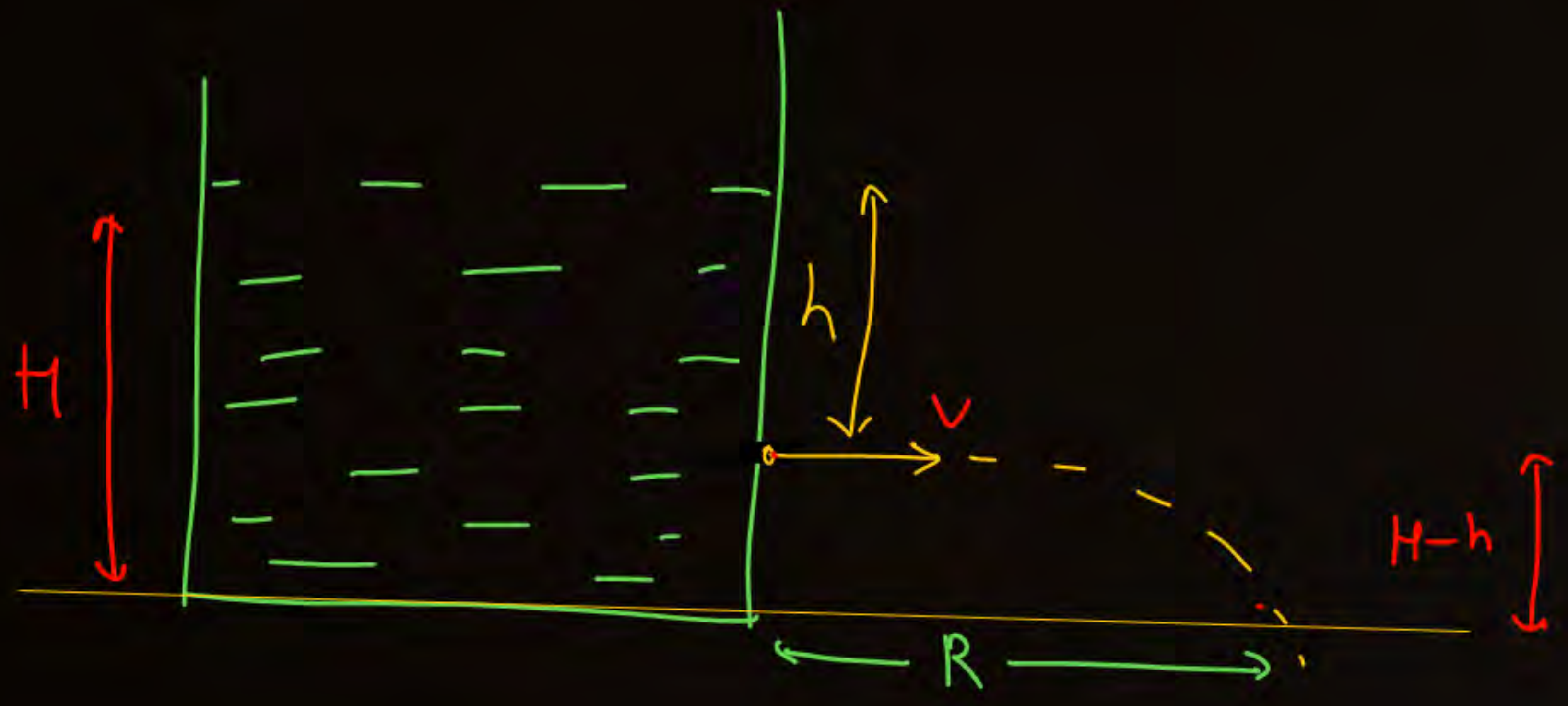
$v_2 >>> v_1$

$$\cancel{P_0} + \rho g h + \frac{1}{2}\rho \cancel{v_1^2} = \cancel{P_0} + 0 + \frac{1}{2}\rho v_2^2$$

$v_1^2 \rightarrow 0$

$$\rho g h = \frac{1}{2}\rho v_2^2$$

$$v_2 = \sqrt{2gh}$$



$$R = vt = \sqrt{2gh} \times \sqrt{\frac{2(H-h)}{g}}$$

$$R = \sqrt{4h(H-h)}$$

find $h = ?$ so that $R \longrightarrow \text{max}$

$$\underset{\text{max}}{R} = \sqrt{4\,\underbrace{h(H-h)}_{\text{max}}}$$

$$h(H-h) \longrightarrow \text{max}$$

$$(Hh - h^2) \longrightarrow \text{max}$$

Diff. wrt h, $= 0$

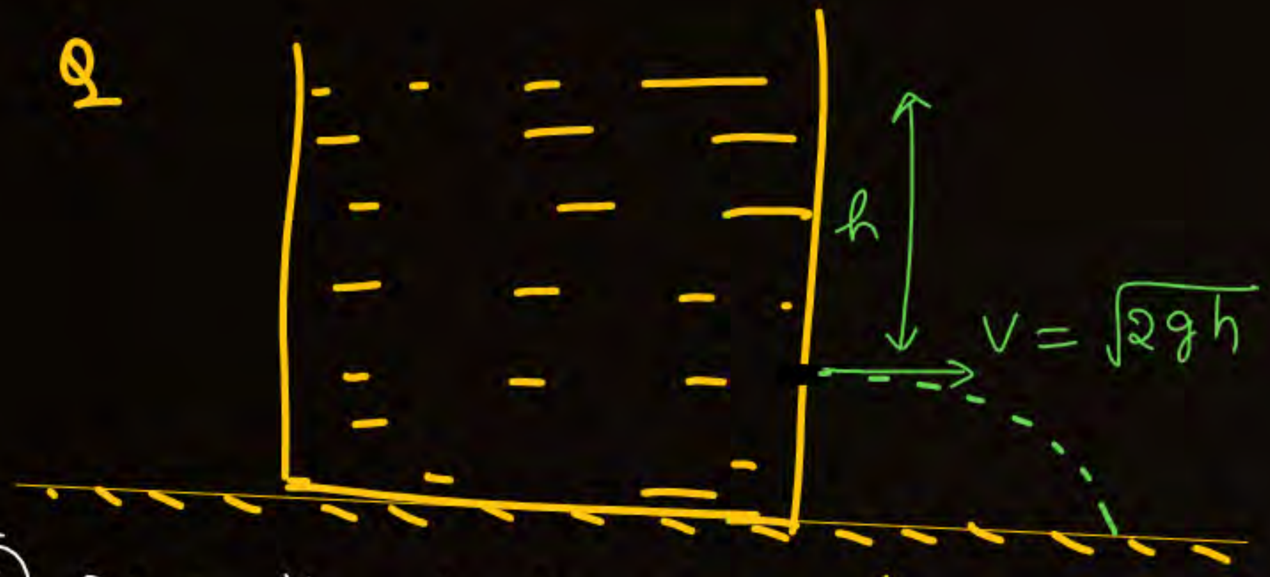
$$H \times 1 - 2h = 0$$

$$\boxed{h = H/2}$$

$$R_{max} = \sqrt{4 \times \frac{H}{2}\left(H - \frac{H}{2}\right)}$$

$$\boxed{R_{max} = H}$$

Q



(a) Find thrust force acting on beaker due to water coming out.

$$\text{Force} = \left(\frac{dm}{dt}\right) v_{rel}$$

$$= \rho A v . v = \rho A v^2 = \rho A \, 2gh$$

$A \rightarrow$ Area of hole.

(b) Find μ_{min} so that block remains at rest.

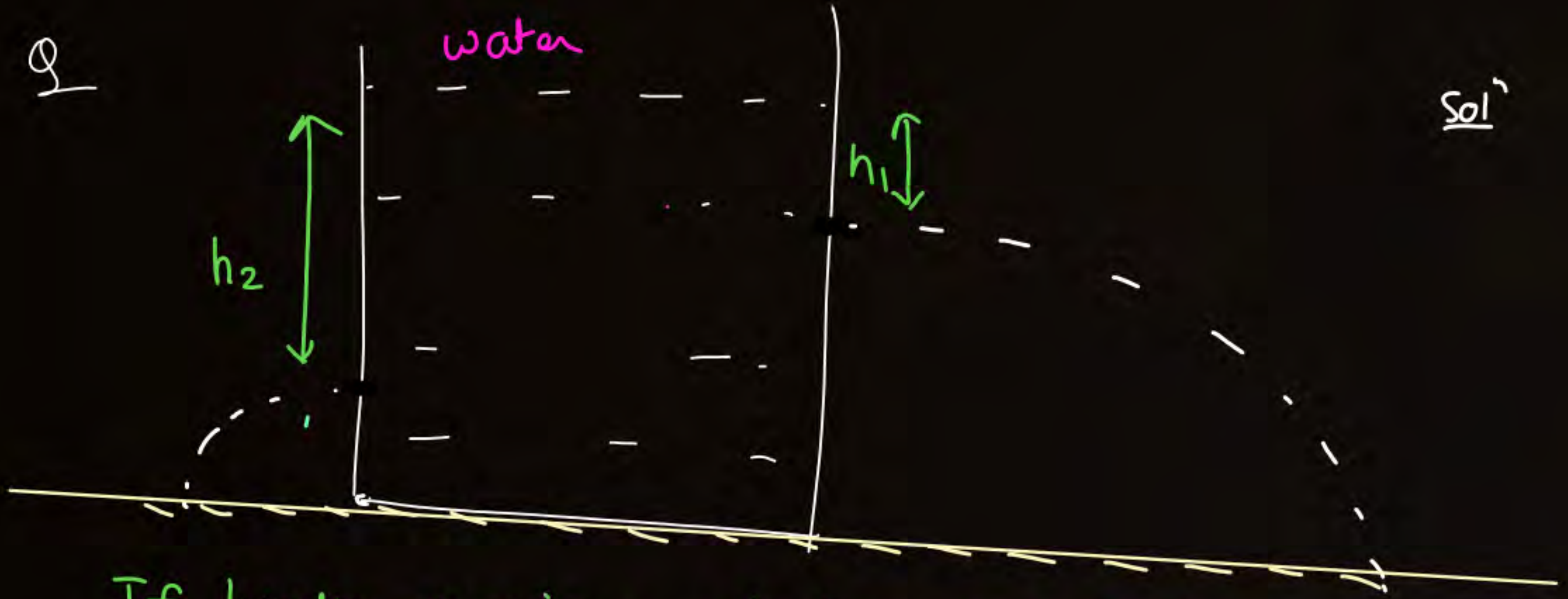
$$\rho A v^2 = \mu M g$$

$$\rho A \, 2gh = \mu m g$$

time ↑, h ↓, F ↓

F_{max} तब, $t = 0$

Q



If beaker experience net force 30N. (आगे) due to water coming out.

find $(h_2 - h_1) = ?$

$A_{hole} = 10^{-4}\,m^2$

Sol:

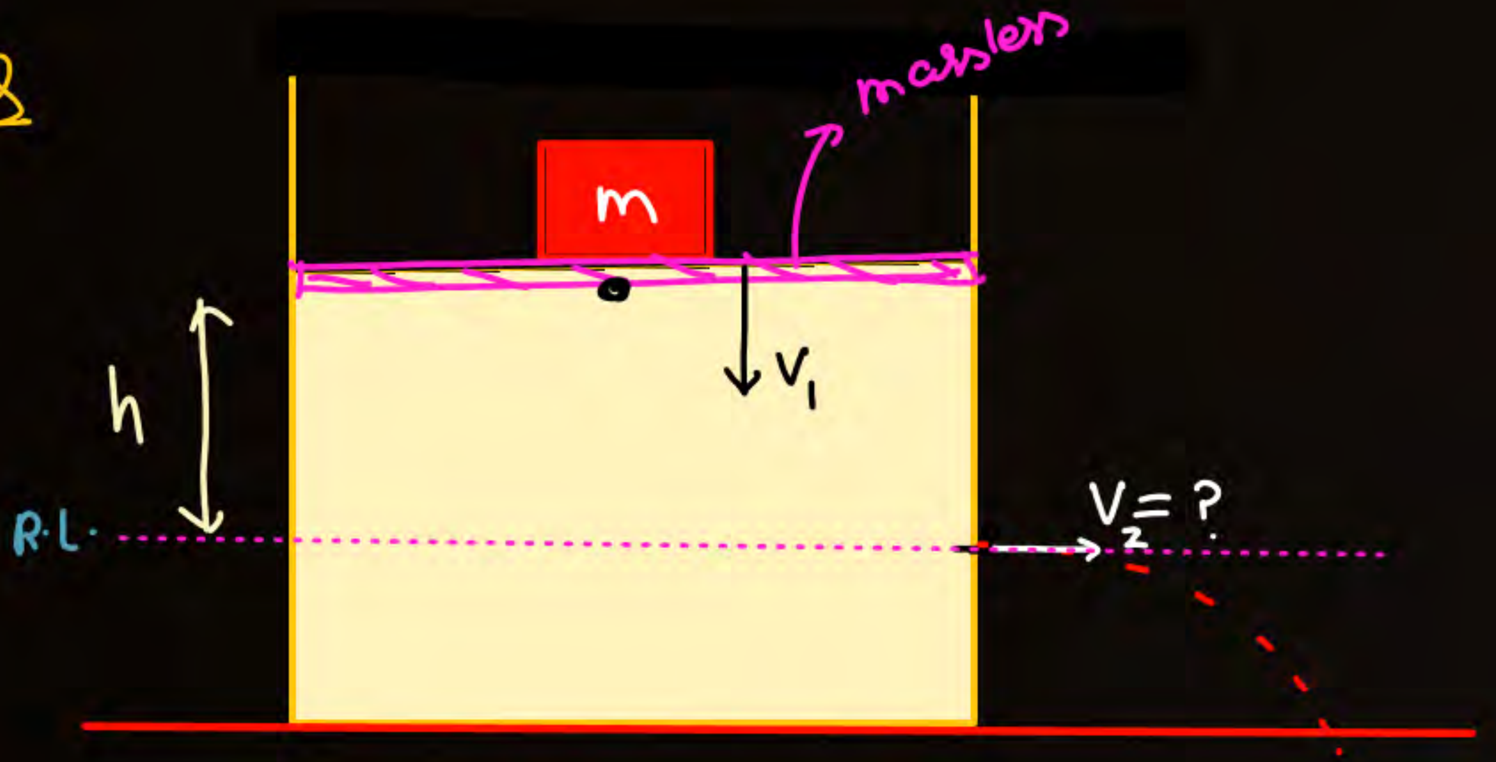
$$\rho A\, 2gh_2 - \rho A\, 2gh_1 = 30$$

$$\rho A\, 2g\,(h_2 - h_1) = 30$$

$$h_2 - h_1 = \frac{30}{\rho A\, 2g} = \frac{30}{1000 \times 10^{-4} \times 2 \times 10}$$

$$= 15$$

*Q



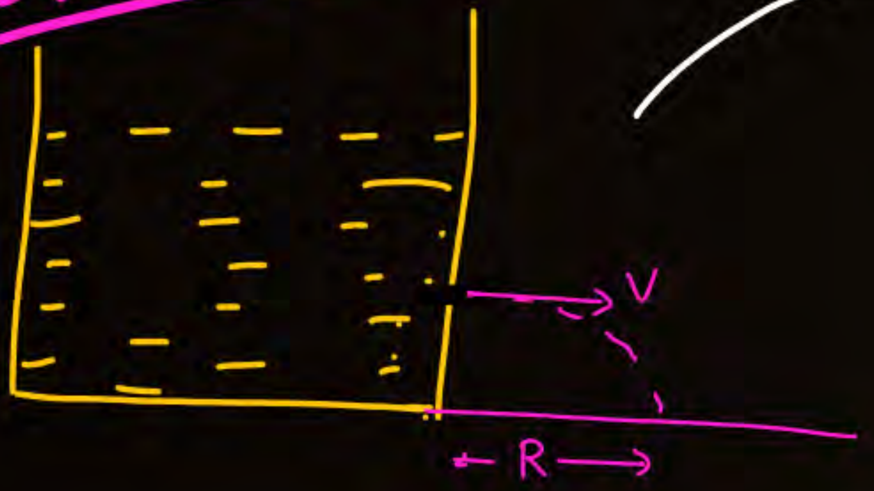
$$P_0 + \frac{mg}{A_{base}} + \rho g h + \cancel{\frac{1}{2}\rho V_1^2} = P_0 + 0 + \frac{1}{2}\rho V_2^2$$

0

$$\boxed{\frac{1}{2}\rho V_2^2 = \frac{mg}{A_{base}} + \rho g h}$$

$$V_2 = \sqrt{2gh + \frac{2mg}{\rho A_{base}}}$$

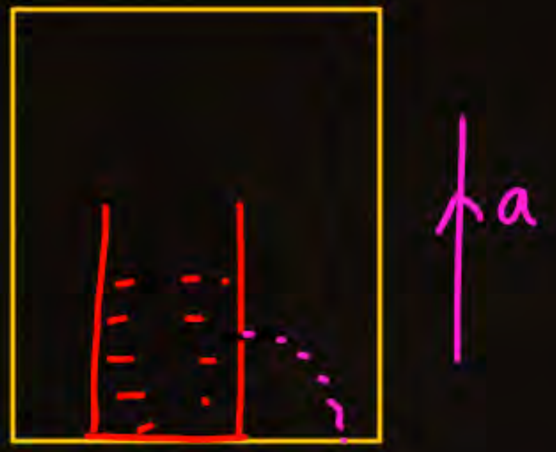
SKC box



⑥ Lift में रख दिया

$v = \sqrt{2 g_{eff} \cdot h}$

** R = same



⑦ इसे free fall lift में placed.

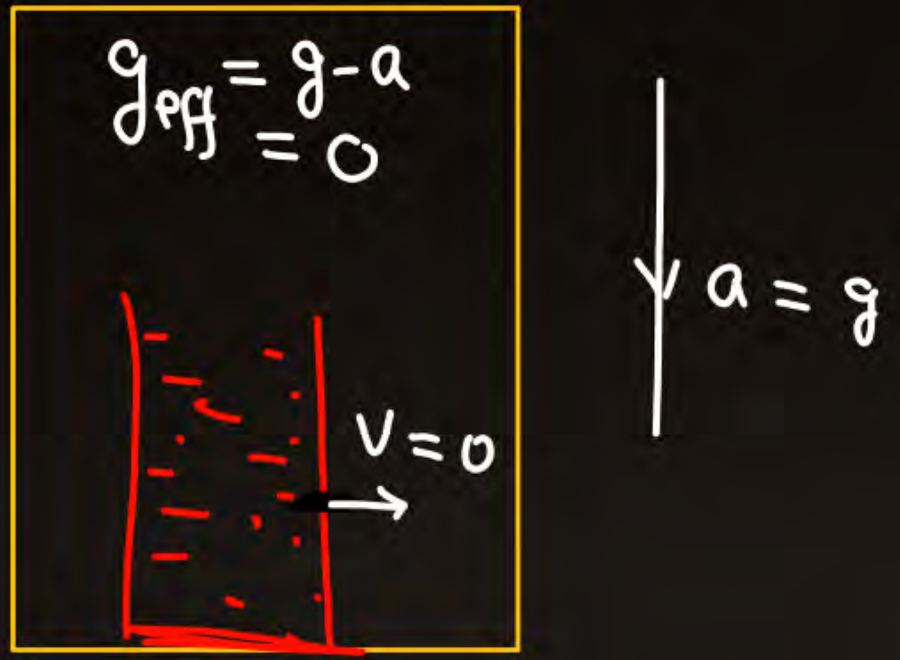
① $v = \sqrt{2gh}$

② $R = vt = \sqrt{2gh} \cdot \sqrt{\frac{2(H-h)}{g}}$

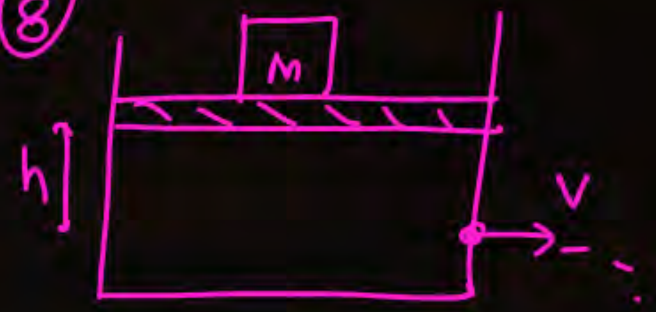
③ $R_{max} = H$ when $h = H/2$

④ $F_{thrust} = \rho A v^2 = \rho A\, 2gh$

⑤ $F_{th} = \rho A 2gh = \mu Mg$

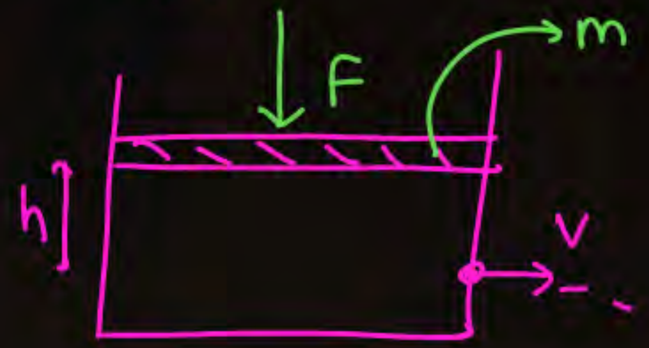


⑧



$P_0 + \frac{mg}{A_{bar}} + \rho g h = P_0 + 0 + \frac{1}{2}\rho v^2$

⑨



$P_0 + \frac{F + mg}{A_{bar}} + \rho g h = P_0 + 0 + \frac{1}{2}\rho v^2$

Stokes Law

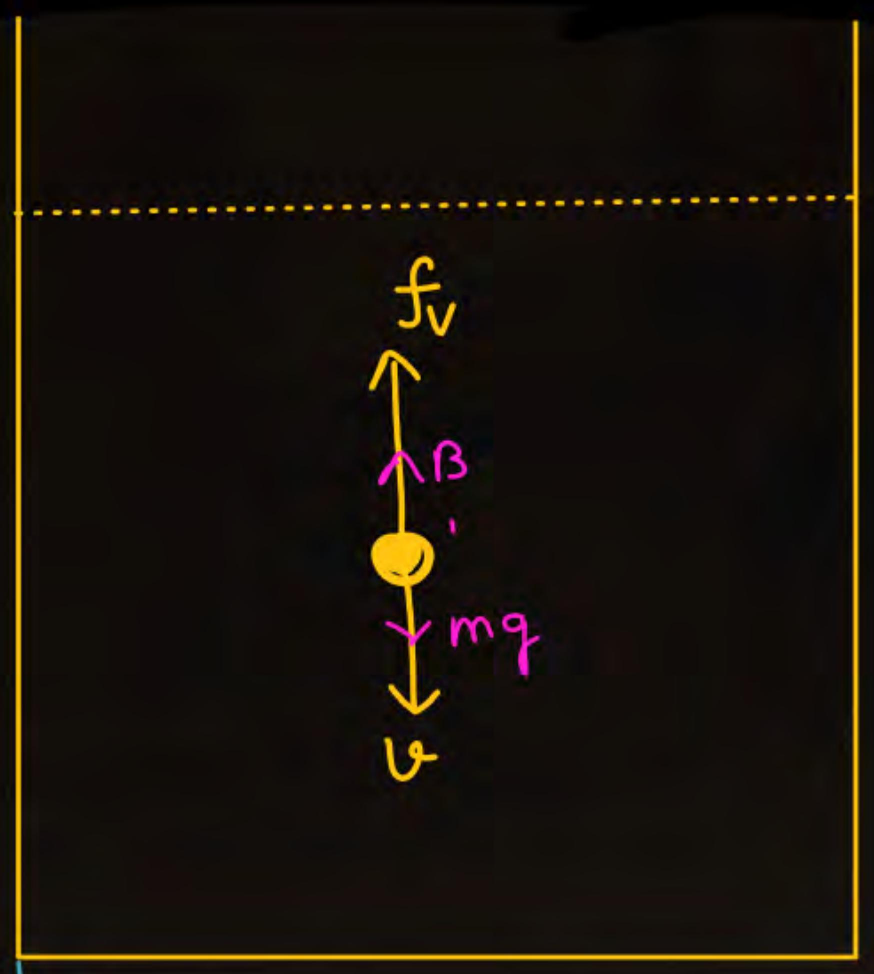
$$f_v = 6\pi r \eta v$$

If a spherical body is moving in a fluid with velocity v relative to fluid

$$f_v = 6\pi r \eta v$$

$r \longrightarrow$ radius

$\eta \longrightarrow$ Coff. of viscocity.



At terminal velocity

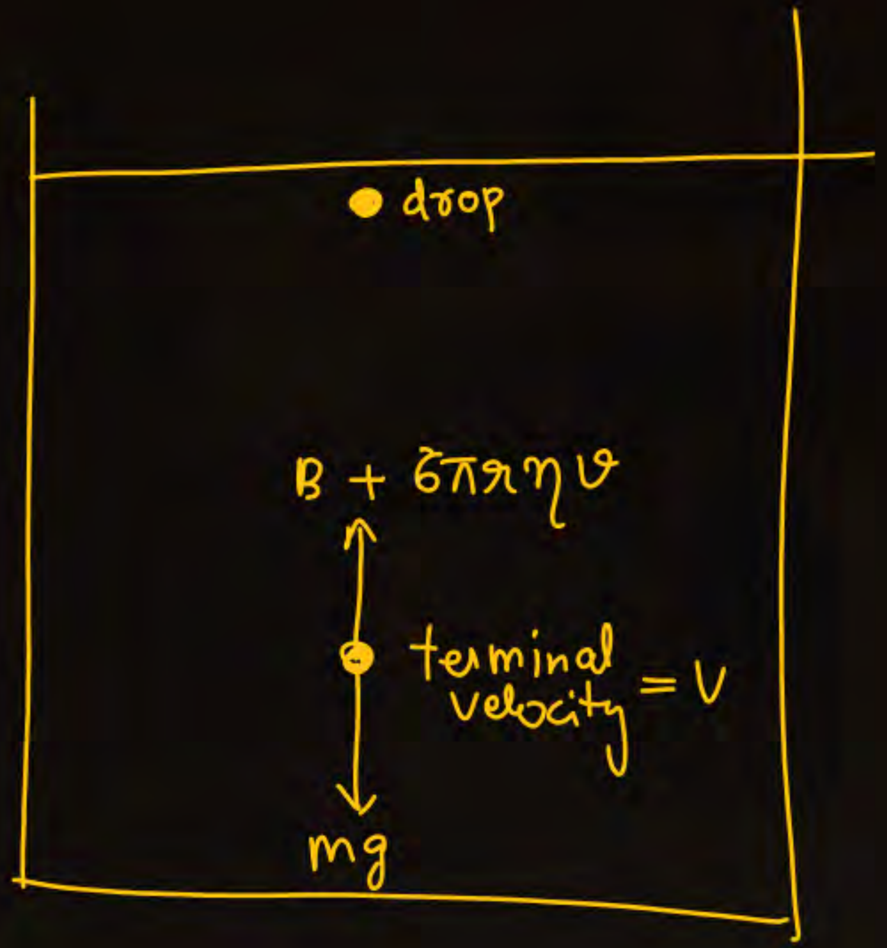
$$F_{net} = 0, \quad a = 0,$$

$$mg = B + 6\pi r \eta v$$

$$v = \frac{mg - B}{6\pi r \eta} = V_{\text{terminal velocity}}$$

After sol.

$$\boxed{V_{terminal} = \frac{2(\rho_s - \rho_l)}{9\eta} \times gR^2}$$



$$V = \frac{mg - B}{6\pi r\eta} = \frac{\rho_s \, Vol^n \, g - \rho_l \cdot (Vol^n) \cdot g}{6\pi r\eta}$$

$$= \frac{\left(\frac{4}{3}\pi R^3\right) g \left(\rho_s - \rho_l\right)}{6\pi r\eta} = \frac{2}{9}\,\frac{R^2 g\left(\rho_s - \rho_l\right)}{\eta}$$

QUESTION

Consider a water tank as shown in the figure. It's cross-sectional area is 0.4 m^2. The tank has an opening B near the bottom whose cross-section area is 1 cm^2. A load of 24 kg is applied on the water at the top when the height of the water level is 40 cm above the bottom, the velocity of water coming out the opening B is v ms^{-1}. The value of v, to the nearest integer, is.
[Take value of g to be 10 ms^{-2}].

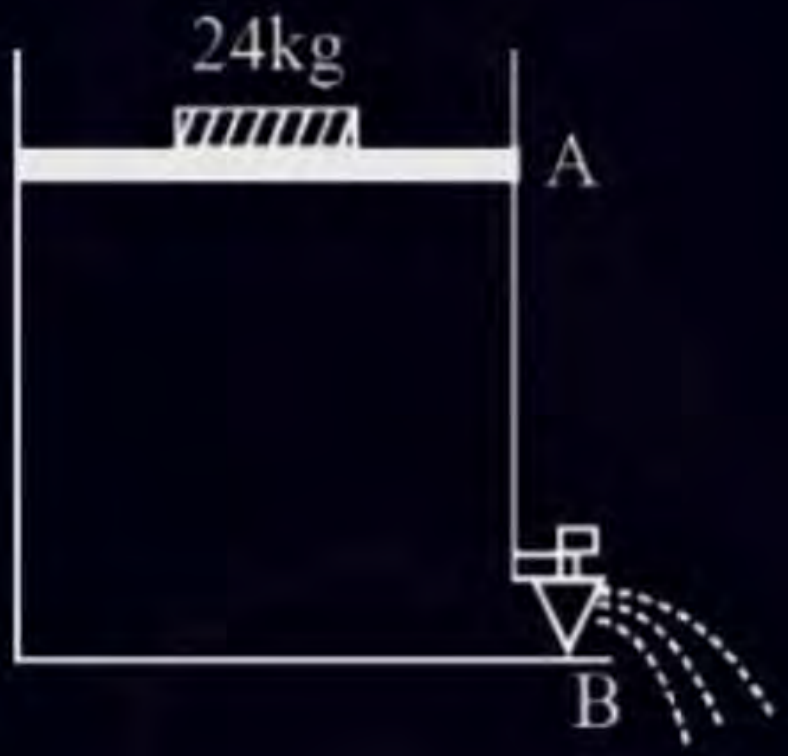
(JEE Mains 2021)

$$\rho g h + P_0 + \frac{mg}{A_{bar}} + \frac{1}{2}\rho \cancel{v_1^2} = P_0 + 0 + \frac{1}{2}\rho v_2^2$$

$$\frac{240}{.4} + 1000 \times 10 \times \frac{40}{100} = \frac{1}{2} \times 1000\, v_2^2$$

$$600 + 4000 = 500 v_2^2$$

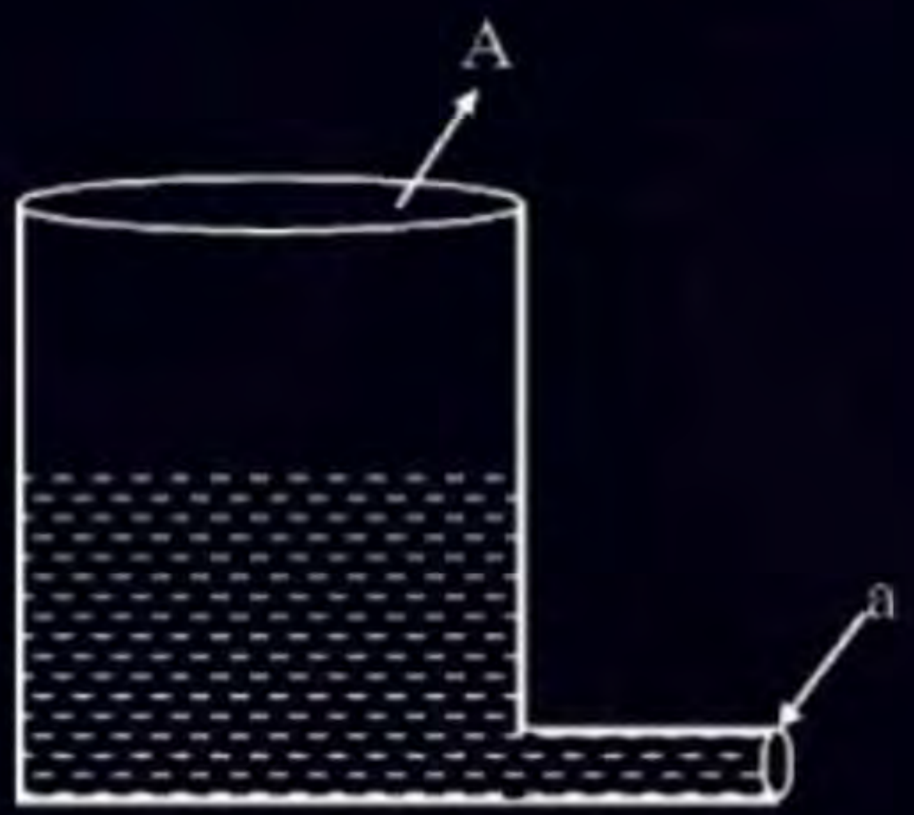
$$v_2 = \sqrt{\frac{46}{5}} = \sqrt{9.\ldots} = 3$$



Ans. 3

QUESTION

A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is ($a << A$): **(JEE Mains 2021)**



1. $\frac{A}{2a}$
2. None of these
3. $\frac{2a}{A}$
4. $\frac{a}{A}$

Ans. (3)

QUESTION

The water is filled upto height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth 'h' below the water level. The value of 'h' for which the emerging stream of water strikes the ground at the maximum range is ______ m.

(JEE Mains 2021)

$$h = \frac{H}{2} = \frac{12}{2} = 6$$

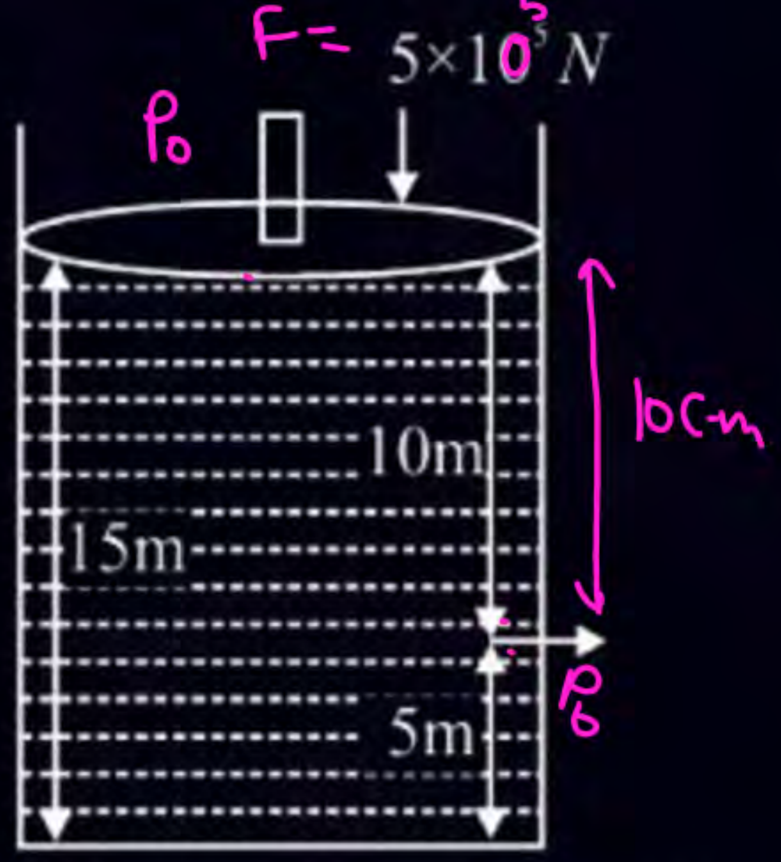
Ans. 6

QUESTION

H/w

Consider a cylindrical tank of radius 1 m is filled with water. The top surface of water is at 15 m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5 m from the bottom. A force of 5×10^5 N is applied an the top surface of water using a piston. The speed of efflux from the hole will be: (given: atmospheric pressure $P_A = 1.01 \times 10^5$ Pa, density of water $\rho_W = 1000\ kg/m^3$ and gravitational acceleration $g = 10\ m/s^2$). **(JEE Mains 2022)**

1. 11.6 m/s
2. 10.8 m/s
3. 17.8 m/s
4. 14.4 m/s



Ans. (3)

5. Water is flowing continuously from a tap having an internal diameter 8×10^{-3} m. The water velocity as it leaves the tap is 0.4 ms^{-1}. The diameter of the water stream at a distance 2×10^{-1} m below the tap is close to :- **[AIEEE-2011]**

आन्तरिक व्यास 8×10^{-3} m वाले एक टोंटी से पानी लगातार प्रवाहित हो रहा है। जैसे ही पानी टोंटी से बाहर आता है, पानी का वेग 0.4 ms^{-1} है। टोंटी के नीचे 2×10^{-1} m की दूरी पर पानी की धार का व्यास इसके लगभग है :-

(1) 9.6×10^{-3} m (2*) 3.6×10^{-3} m (3) 5.0×10^{-3} m (4) 7.5×10^{-3} m

Ans. (2)

Sol

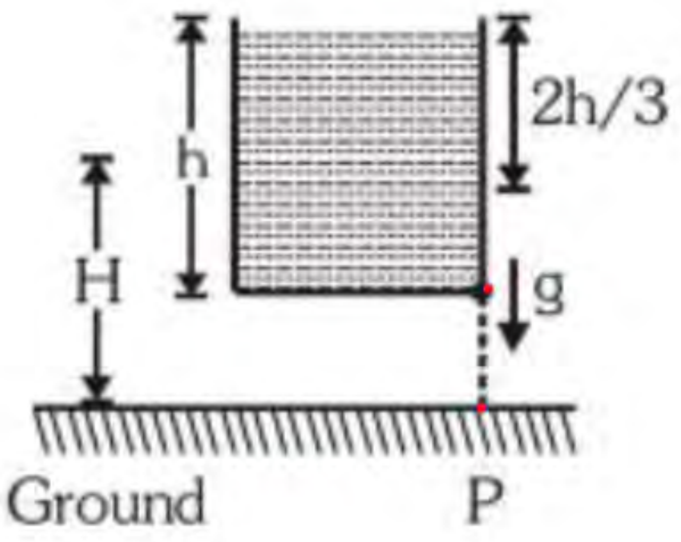
22. An open vessel full of water is falling freely under gravity. There is a small hole in one face of the vessel, as shown in the figure. The water which comes out from the hole at the instant when hole is at height H above the ground, strikes the ground at a distance of x from P. Which of the following is correct for the situation described ?

(A) The value of x is $2\sqrt{\frac{2hH}{3}}$

(B) The value of x is $\sqrt{\frac{4hH}{3}}$

(C) The value of x can't be computed from information provided.

(D) The question is irrevalent as no water comes out from the hole.

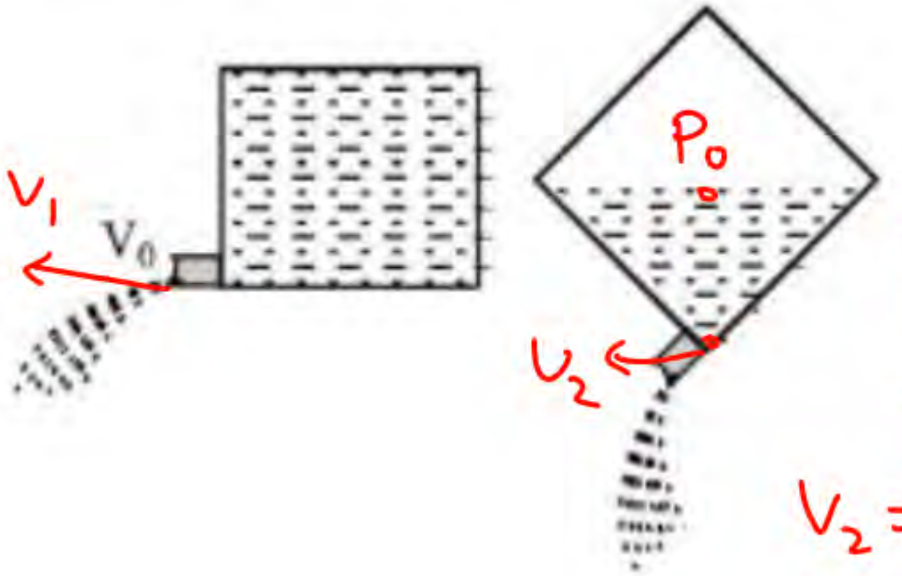


14. H/W A cubical box of wine has a small spout located in one of the bottom corners. When the box is full and placed on a level surface, opening the spout results in a flow of wine with a initial speed of v_0 (see figure). When the box is half empty, someone tilts it at 45° so that the spout is at the lowest point (see figure). When the spout is opened the wine will flow out with a speed of

जल से भरे घनाकार बॉक्स में निचले कोने पर एक छोटा छिद्र स्थित है। जब बॉक्स पूर्ण भरा है व समतल सतह पर रखा है तो छिद्र को पूरा खोलने पर जल v_0 चाल से बाहर निकलता है। चित्र(1) के अनुसार जब बॉक्स अभी भी आधा खाली है, यह 45° कोण से झुका दिया जाता है ताकि छिद्र सबसे निचले बिन्दु पर रहे। अब जल किस चाल से बहेगा :-

$V_0 = \sqrt{2gl} = V_0$

$V_2 = \sqrt{2g \frac{l}{\sqrt{2}}}$



$h = l/\sqrt{2}$

$V_2 = \sqrt{2gh}$

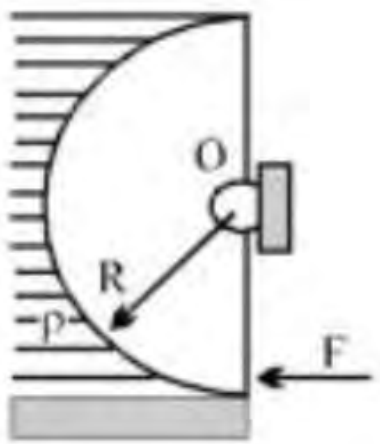
(A) v_0 (B) $v_0/2$ (C) $v_0/\sqrt{2}$ (D) $v_0/\sqrt[4]{2}$

Ans. (D)

2. A light semi cylindrical gate of radius R is pivoted at its mid point O, of the diameter as shown in the figure holding liquid of density ρ. The force F required to prevent the rotation of the gate is equal to

H|W

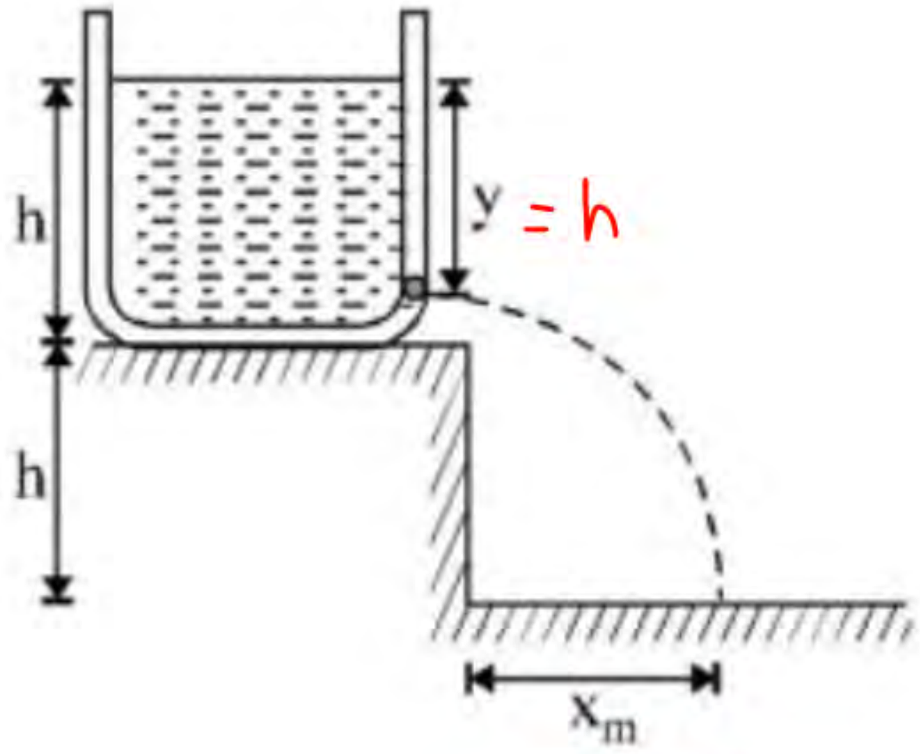
त्रिज्या R वाले एक हल्के अर्द्धबेलनाकार द्वार को इसके व्यास के मध्य बिन्दु O पर कीलकीत किया गया है। यह ρ घनत्व वाले द्रव को रोककर रखता है। द्वार को घूर्णन करने से रोकने के लिये आवश्यक बल F का मान होगा :-



(A) $2\pi R^3 \rho g$ (B) $2\rho g R^3 l$ (C) $\frac{2R^2 l\rho g}{3}$ (D) none of these

51. A tank is filled upto a height h with a liquid and is placed on a platform of height h from the ground. To get maximum range x_m a small hole is punched at a distance of y from the free surface of the liquid. Then

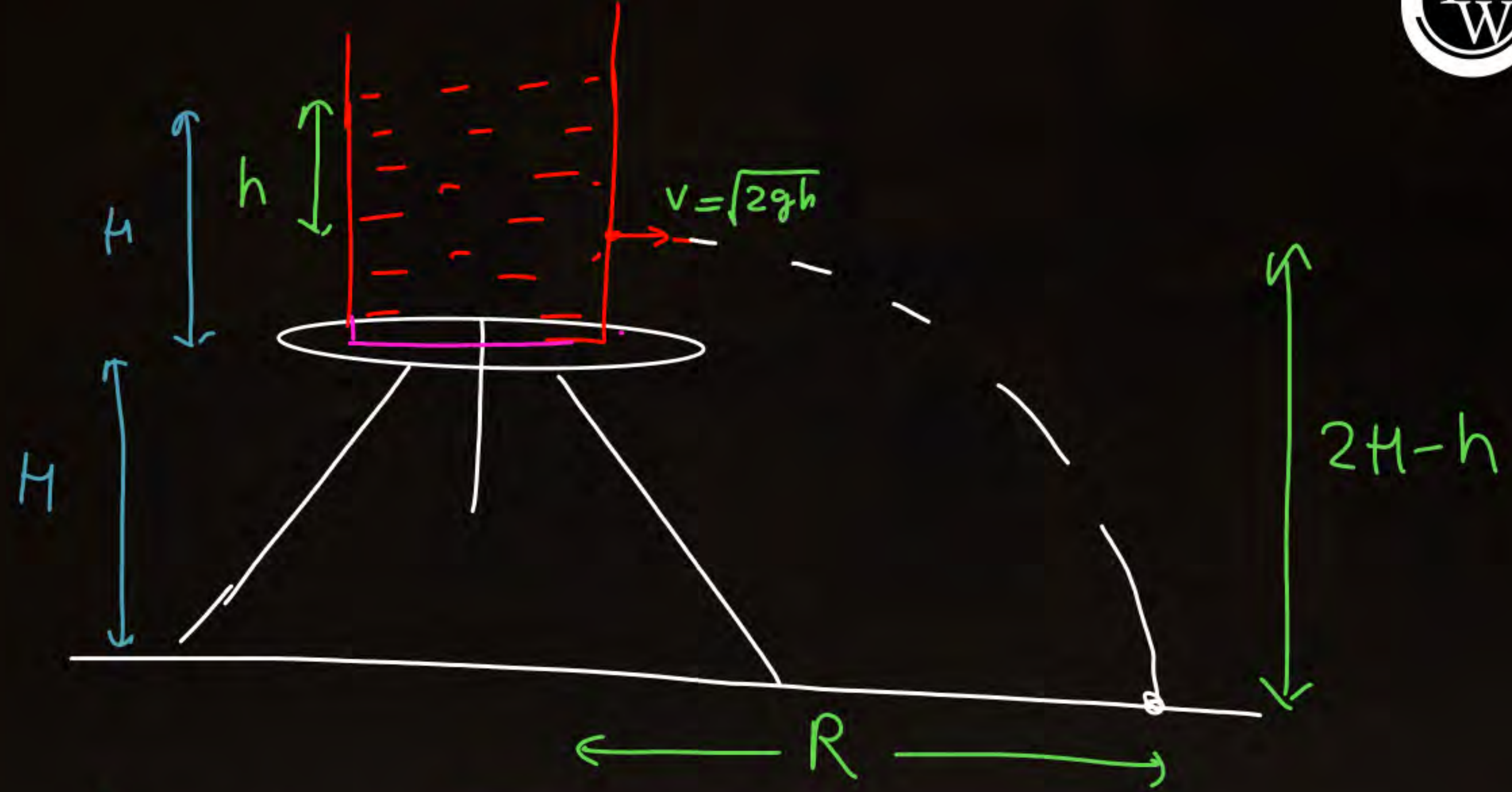
एक पात्र में h ऊँचाई तक द्रव भर कर इसे धरातल से h ऊँचाई पर रखे एक प्लेटफॉर्म पर रख दिया जाता है। अधिकतम परास x_m प्राप्त करने के लिये द्रव की मुक्त सतह से y दूरी पर एक छोटा छिद्र कर देते है। तब



(A*) $x_m = 2h$ (B) $x_m = 1.5\,h$ (C*) $y = h$ (D) $y = 0.75\,h$

Ans. **(A,C)**

note



R_{max} will be = ?

$h(2H-h) \longrightarrow max$

$2Hh-h^2 \longrightarrow max$

$2H-2h=0$

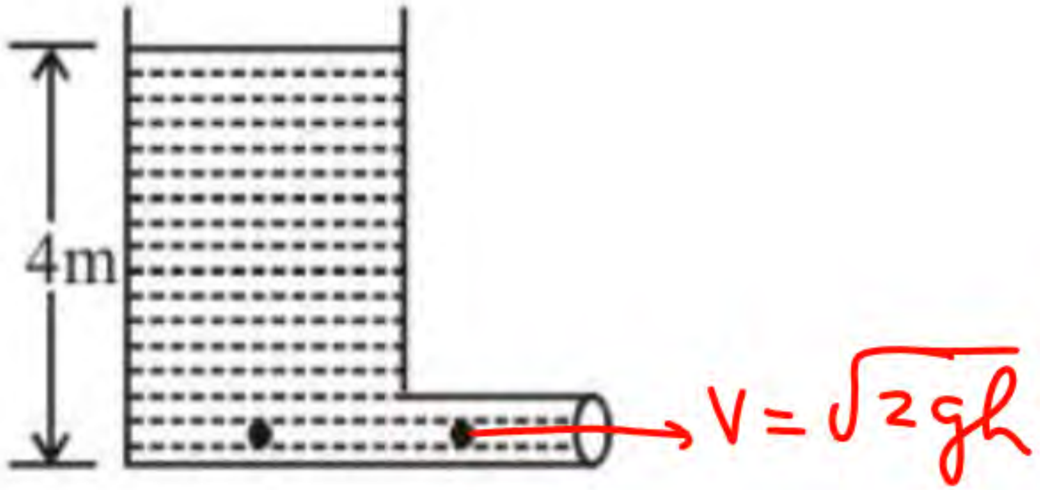
$\boxed{h=H}$

$$R = vt = \sqrt{2gh} \times \sqrt{\frac{2\times(2H-h)}{g}} = \sqrt{4h(2H-h)}$$

$$R_{max} = \sqrt{4\times H(2H-H)} = 2H$$

24. A vent tank of large cross-sectional area has a horizontal pipe 0.12 m in diameter at the bottom. This holds a liquid whose density is 1500 kg/m^3 to a height of 4.0 m. Assume the liquid is an ideal fluid in laminar flow. In figure, the velocity with which fluid flows out is :-

एक छिद्रयुक्त अधिक अनुप्रस्थ काट क्षेत्रफल वाले टैंक के पैंदे पर 0.12 m व्यास वाला एक क्षैतिज पाइप लगा हुआ है। इसमें 4m की ऊँचाई तक 1500 kg/m^3 घनत्व वाला द्रव भरा है। माना यह द्रव एक आदर्श द्रव है, जिसका धारारेखीय (laminar) प्रवाह होता है। इस चित्र में द्रव किस वेग से बाहर निकलता है।



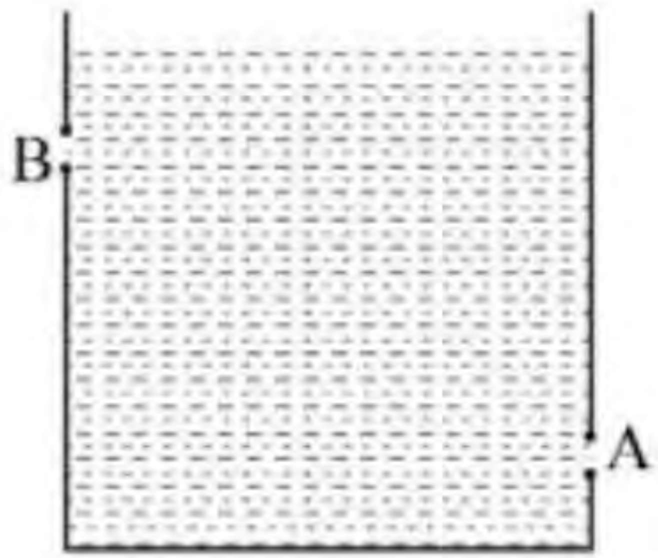
(A) $2\sqrt{5}$ m/s (B) $\sqrt{5}$ m/s (C) $4\sqrt{5}$ m/s (D) $\sqrt{10}$ m/s

Ans. (C)

23. Two identical holes each of cross-sectional area 10^{-3} m^2 are made on the opposite sides of a tank containing water as shown in the figure. As the water comes out of the holes, the tank will experience a net horizontal force of 20 N. The difference in height between the holes A and B is.

जल से भरे एक टेंक की दोनों दीवारो पर 10^{-3} m^2 अनुप्रस्थकाट क्षेत्रफल वाले दो एक जैसे छिद्र चित्रानुसार बना दिये जाते है। जब इन छिद्रो से जल बाहर निकलता है तो टेंक पर 20 N का परिणामी क्षैतिज बल लगता है। छिद्र A व B की ऊँचाई में अंतर है।

H/W



(A*) 1 m (B) 0.5 m (C) 2 m (D) 0.25 m

Ans. (A)

20. In the case of a fluid, Bernoulli's theorem expresses the application of the principle of conservation of :-

H/W

(A) linear momentum (B) energy (C) mass (D) angular momentum

तरल के संदर्भ में बर्नोली प्रमेय किस संरक्षण सिद्धान्त के अनुप्रयोग को व्यक्त करती है :-

(A) रेखीय संवेग (B) ऊर्जा (C) द्रव्यमान (D) कोणीय संवेग

Ans. (B)

21. Two water pipes P and Q having diameters 2×10^{-2} m and 4×10^{-2}m, respectively, are joined in series with the main supply line of water. The velocity of water flowing in pipe P is :-

H/W

(A) 4 times that of Q (B) 2 times that of Q

(C) 1/2 times of that of Q (D) 1/4 times that of Q

पानी के दो पाइपों P व Q के व्यास क्रमशः 2×10^{-2} m व 4×10^{-2}m हैं। इन्हें पानी की मुख्य आपूर्ति लाइन के साथ श्रेणीक्रम में जोड़ा गया है। पाइप P में प्रवाहित पानी का वेग होगा

(A) Q की तुलना में चार गुना (B) Q की तुलना में दो गुना

(C) Q की तुलना में 1/2 गुना (D) Q की तुलना में 1/4 गुना

Ans. (A)

Bernoulli

19. Water is flowing steadily through a horizontal tube of non uniform cross-section. If the pressure of water is 4×10^4 N/m^2 at a point where cross-section is 0.02 m^2 and velocity of flow is 2 m/s, what is pressure at a point where cross-section reduces to 0.01 m^2.

H/W

असमान अनुप्रस्थ काट वाली क्षैतिज नली से पानी लगातार प्रवाहित हो रहा है। यदि उस बिन्दु पर जहां अनुप्रस्थ काट क्षेत्रफल 0.02 m^2 है, पानी का दाब 4×10^4 N/m^2 है तथा प्रवाह वेग 2 m/s है तो उस बिन्दु पर जहां अनुप्रस्थ काट क्षेत्रफल घटकर 0.01 m^2 हो जाता है, दाब क्या होगा ?

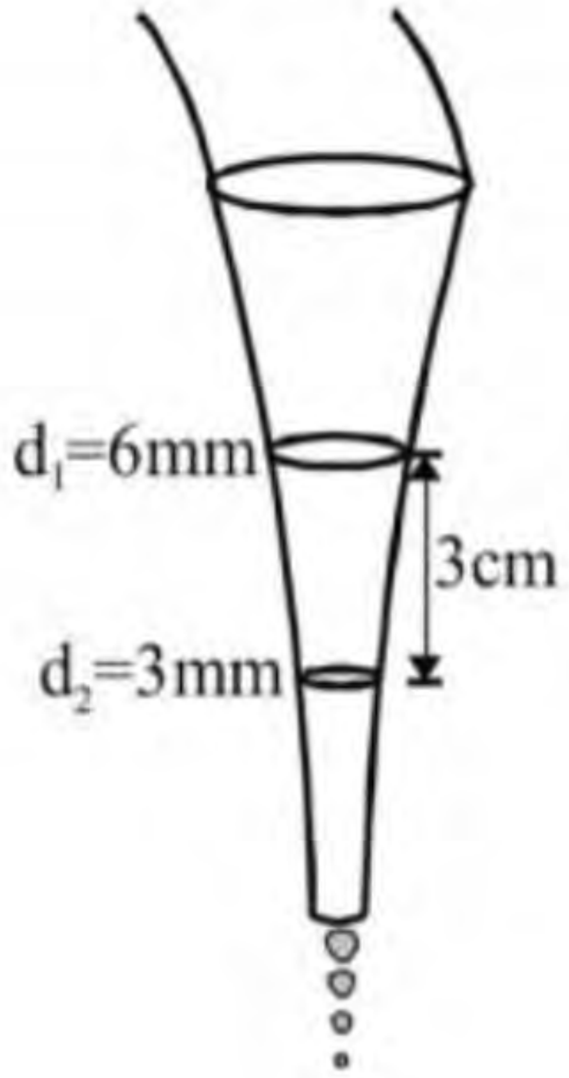
(A) 1.4×10^4 N/m^2 (B) 3.4×10^4 N/m^2 (C) 2.4×10^{-4} N/m^2 (D) none of these

Ans. (B)

21. The tap in the garden was closed in appropriately resulting in the water flowing freely out of it which forms a downward narrowing beam. The beam of water has a circular cross-section, the diameter of the circle is 6 mm at one point and 3 cm below it is only 3 mm as shown in figure. If the rate of water wasted is $(x \times \pi)$ mL/minute then find the value of x. (Neglect the effect of

H/W

Sol^n →

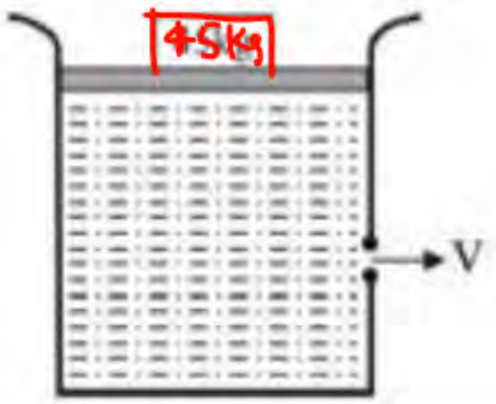


Ans. 108

19. A large cylindrical tank of cross-sectional area $1 m^2$ is filled with water. It has a small hole at a height of 1m from the bottom. A movable piston of mass 5 kg is fitted on the top of the tank such that it can slide in the tank freely. A load of 45 kg is applied on the top of water by piston, as shown in figure. Find the value of v when piston is 7m above the bottom $(g = 10 \text{ m/s}^2)$

H/W

अनुप्रस्थ काट क्षेत्रफल $1 m^2$ वाले एक बड़े बेलनाकार टेंक को पानी से भरा गया है। इसके पैंदे से 1m की ऊंचाई पर एक छिद्र है। एक 5 kg द्रव्यमान के चलायमान पिस्टन को टेंक के शीर्ष पर इस प्रकार से कसा गया है कि यह टेंक में मुक्त रूप से गति कर सकता है। पिस्टन द्वारा पानी के शीर्ष पर एक 45 kg का भार चित्रानुसार लगाया जाता है। जब पिस्टन पैंदे से 7m ऊपर है तो v का मान ज्ञात कीजिए $(g = 10 \text{ m/s}^2)$ Ans 11



17. Calculate the rate of flow of glycerine of density 1.25×10^3 kg/m^3 through the conical section of a pipe if the radii of its ends are 0.1m & 0.04m and the pressure drop across its length is 10N/m^2.

HW

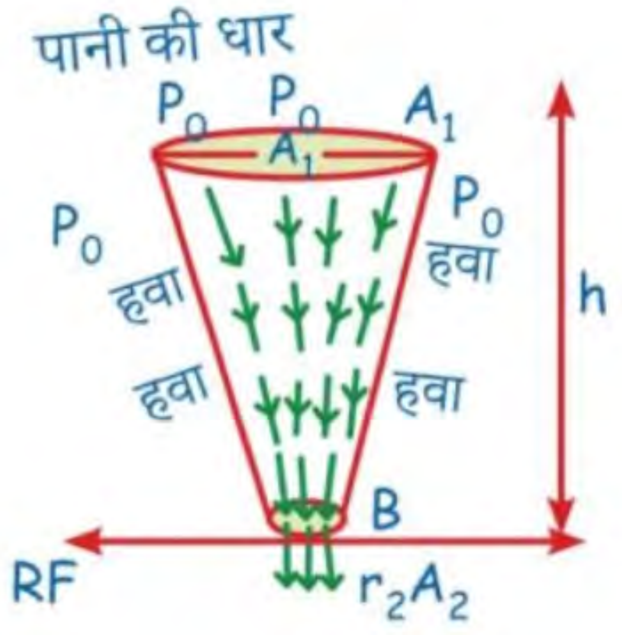
एक पाइप के दोनों सिरों की त्रिज्याएें 0.1m व 0.04m है तथा इसकी लम्बाई के अनुदिश दाब में अन्तर 10N/m^2 है। इस पाइप के शंक्वाकार भाग से 1.25×10^3 kg/m^3 घनत्व वाले ग्लिसरीन के प्रवाह की दर ज्ञात कीजिये।

Ans. 6.43×10^{-4} m^3/s

Tap Water पानी की धार वाला Question

Q. Find the radius of पानी की धार at a depth 'h' below point A & speed & volume rate flow

$\Rightarrow$



Derivation

Sol. $A_1V_1 = A_2V_2$

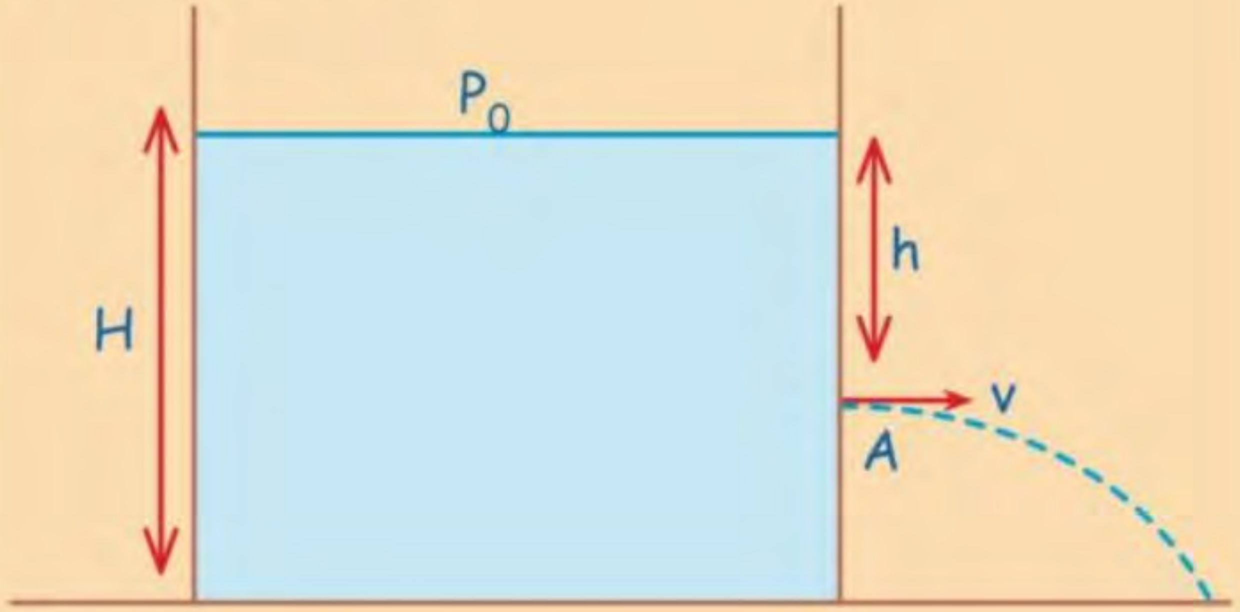
$\underline{P_A = P_0 ; P_B = P_0} \Rightarrow P_A = P_B$

Apply Bernoulli theorem between A & B.

$\cancel{P_B} + 0 + 1/2\, \rho V_2^2 = \cancel{P_A} + \rho g h + 1/2\, \rho V_1^2$

$V_2^2 = V_1^2 + 2gh$

काम का डब्बा

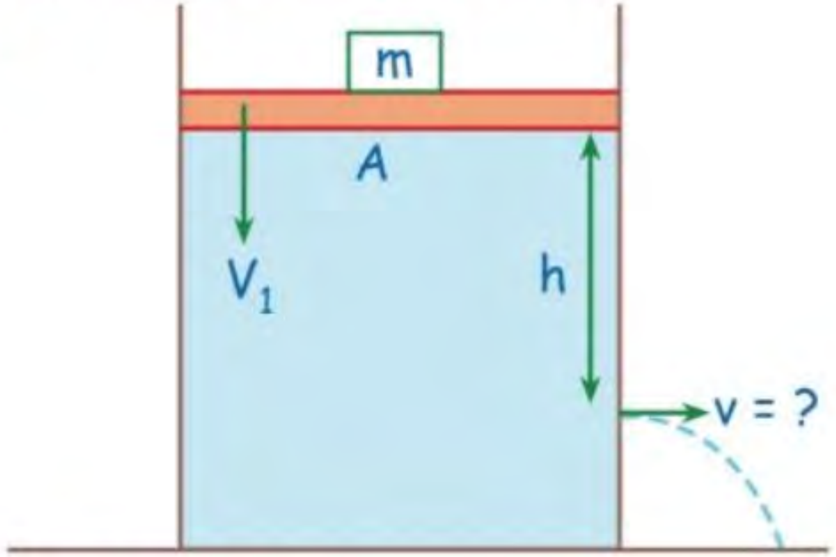


1. $V = \sqrt{2gh}$
2. $R = 2\sqrt{h(H-h)}$
3. $R_{max} = H$ when $h = H/2$
4. Free fall = $v = 0$
5. Thrust force = $\rho A 2gh$
6. $\left[\dfrac{d(vol)^n}{dt}\right]_{out} = A\sqrt{2gh}$

Q. Consider the given diagram and solve the following questions:

H/w

(a) Find velocity of efflux



$A_{hole} \ll A_{base}$

Solution

$$P_0 + \frac{mg}{A_{base}} + \rho gh + \frac{1}{2}\rho v_1^2 = P_0 + 0 + \frac{1}{2}\rho v_2^2$$

neglect

$$\boxed{\frac{1}{2}\rho v_2^2 = \frac{mg}{A_{base}} + \rho gh}$$

(b) If $\rho = 1000\ kg/m^3$, $m = 50\ kg$ $A_{base} = 1\ m^2$, $A_{hole} = 1\ cm$, $h = 2m$ then find V^2.

$$\frac{1}{2} \times 1000\, v_2^2 = \frac{500}{1} + 1000 \times 10 \times 2$$

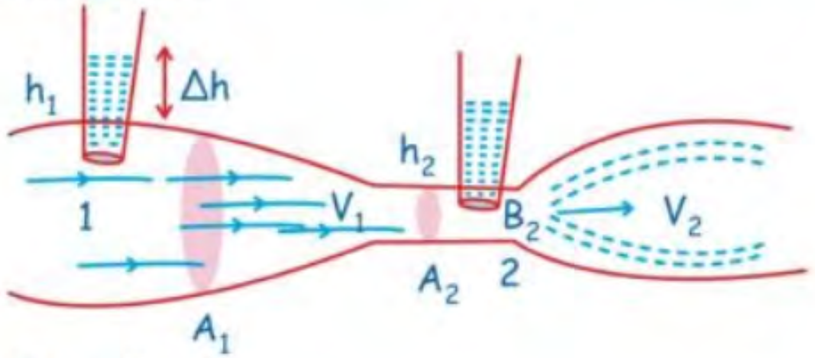
$$500\, v_2^2 = 20500$$

$$v_2 = \sqrt{41}\ m/s.$$

next class Article.

VENTURI METER

It is used to find the rate of flow of fluid or velocity of flowing fluid.



$P_1 = P_0 + \rho g h_1$

$P_2 = P_0 + \rho g h_2$

$P_1 - P_2 = \rho g(h_1 - h_2) = \rho g \Delta h$ ...(i)

Applying Bernoull's theorem between 1 and 2:

$$P_1 + 0 + \frac{1}{2}\rho V_1^2 = P_2 + 0 + \frac{1}{2}\rho V_2^2$$

$$P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2) \quad ..(ii)$$

from (i) and (ii)

$$\frac{1}{2}\rho(V_2^2 - V_1^2) = \rho g \Delta h$$

$\because A_1V_1 = A_2V_2$

$$\therefore \frac{1}{2}\rho V_2^2 - \left(\frac{A_2}{A_1}V_2\right)^2 = \rho g \Delta h$$

$$\frac{\rho V_2^2}{2}\left(1 - \frac{A_2^2}{A_1^2}\right) = \rho g \Delta h$$

$$\boxed{V_2 = \sqrt{\frac{2g\Delta h}{\left(1 - \frac{A_2^2}{A_1^2}\right)}}}$$

$$V_T = \frac{2}{9}\frac{r^2 g}{\eta}(\rho_S - \rho_l)$$

This is very very important formula जिस पर बहुत सारे question Mains और Advance मे पूछे गए है Mains मे तो हर साल question आ ही जाता है।

VISCOSITY

★ When a layer of a fluid slips or tends to slip on another layer in contact, the two layers exert tangential forces on each other. The directions are such that the relative motion between the layers is opposed, this property of a fluid to oppose relative motion between its layers is called viscosity. The forces between the layers opposing relative motion between them are known as the forces of viscosity.

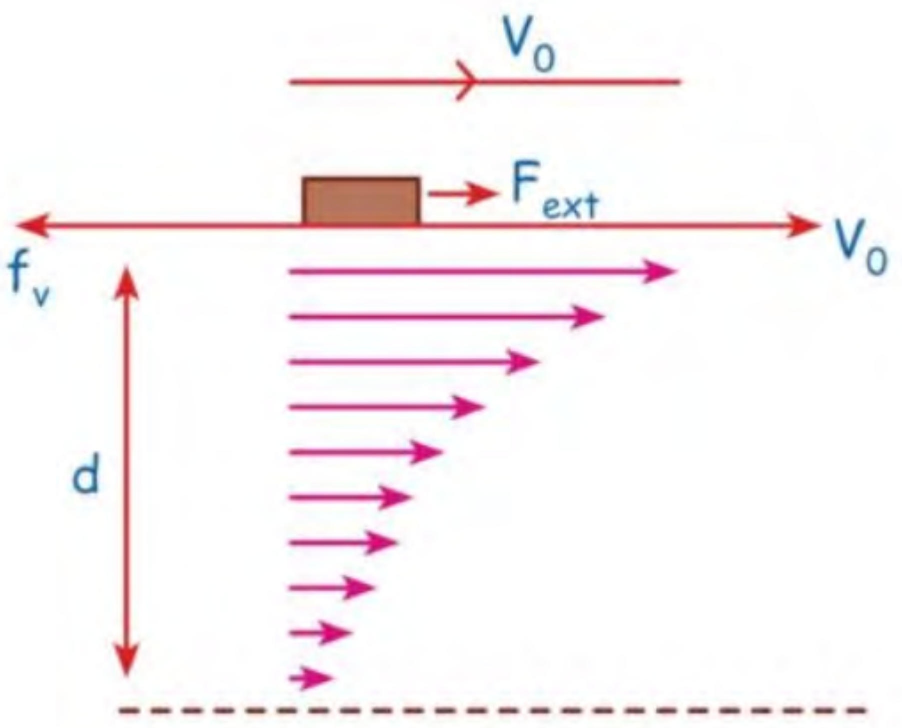
★ Velocities of different layers are different.

★ The force of viscosity between two layers of a fluid is proportional to the velocity gradient in the direction perpendicular to the layers. Also the force is proportional to the area of the layer.

$F_v \propto A$ (contact area)

$F_v \propto \frac{dv}{dx}$ (velocity gradient)

$\frac{dv}{dx} = \frac{V-0}{d}$

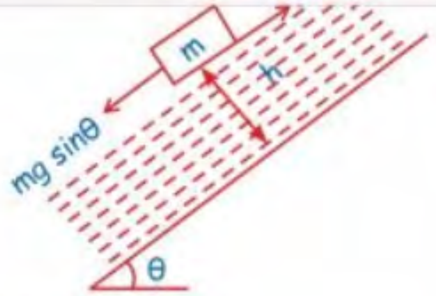


$F_v = \eta A \frac{V_0 - 0}{d}$ coeff of viscosity

भाई ये friction जैसा force है बस इस बार ये area of contact पर भी depend कर रहा है इसका formula गलती से भी मत भुलना।

$$f_v = \eta A \frac{dv}{dx}$$

$$\frac{f_v}{A} = \eta \frac{dv}{dx} = \text{shear stress}$$



Sol. $mg\sin\theta = f_v$

$$mg\sin\theta = \eta A\left(\frac{v-0}{h}\right)$$

Q. When two drop each of radius r with terminal velocity V_0 combined to form another spherical drop. Find new terminal velocity.

Sol. $(Vol^n)_i = (Vol^n)_f$

$$\frac{4}{3}\pi r^3 \times 2 = \frac{4}{3}\pi r_f^3 \Rightarrow r_f = 2^{1/3} r$$

$$Vt = \frac{2gr^2(\rho_s - \rho_l)}{9\eta} \qquad \frac{V_0}{V_f} = \frac{r_1^2}{r_f^2}$$

$$V_t \propto r^2 \qquad \frac{V_0}{V_f} = \frac{r^2}{2^{2/3} r^2}$$

$$\boxed{V_f = 2^{2/3} V_0 = 4^{1/3} V_0}$$

Q. n identical drop with terminal velocity V_0 combined to form a bigger size drop. Find the new terminal velocity.

Sol. $\frac{4}{3}\pi r^3 \times n = \frac{4}{3}\pi r_f^3$

$$\boxed{r_f = n^{1/3} r} \qquad \boxed{V_f = n^{2/3} V_0}$$

SURFACE TENSION

Q. n identical drop with terminal velocity V_0 combined to form a bigger size drop. Find the new terminal velocity.

Sol. $\frac{4}{3}\pi r^3 \times n = \frac{4}{3}\pi r_f^{\,3}$

$$\boxed{r_f = n^{1/3}\, r}$$

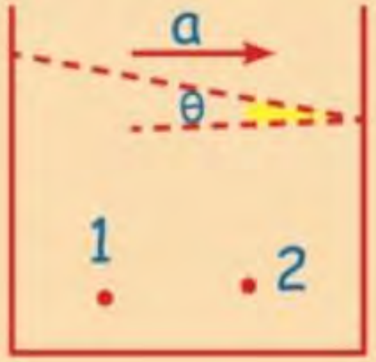
$$\boxed{V_f = n^{2/3}\, V_0}$$

काम का डब्बा

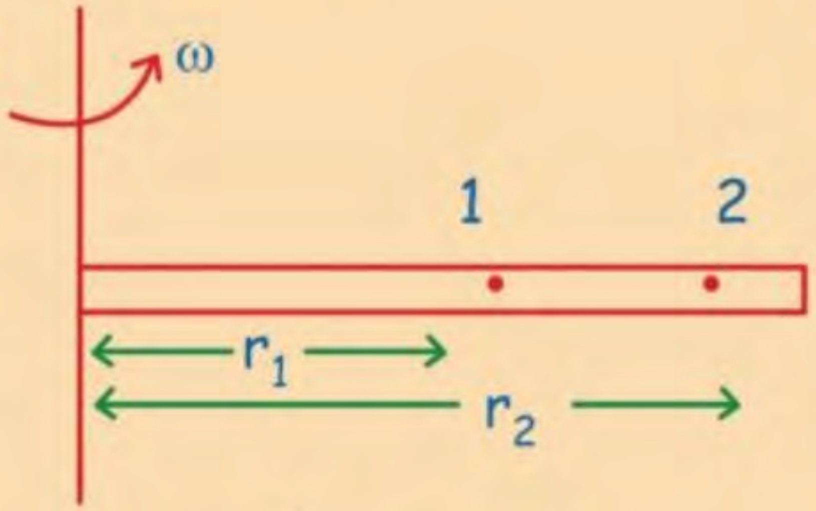
भाई इस chapter के सबसे ज्यादा use होने वाले सारे formula मै यहाँ एक साथ लिख दे रहा हुँ.... rough copy पर लिख-लिख कर अच्छे से practice कर लेना

★ $P_1 - P_2 = \rho a \ell$

$\tan\theta = a/g$



★



$$P_2 - P_1 = \frac{1}{2}\rho\omega^2(r_2^2 - r_1^2)$$

★ $B = \rho V_d g$

★ $mg = B = \rho_L V_d g$ (floating condition)

★ $A_1V_1 = A_2V_2$

$\frac{dVol^n}{dt} = AV$

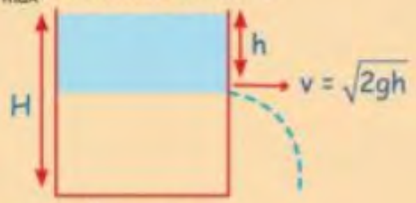
$\frac{dm}{dt} = \rho AV$

$P + \rho gh + 1/2\, \rho V^2 = \text{cosnt}$

$P_1 + 0 + \frac{1}{2}\rho V_1^2 = P_2 + 0 + \frac{1}{2}\rho V_2^2$

$P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$

★ $R_{max} = H$ when $h = H/2$



$R = 2\sqrt{h(H-h)}$

$F_{thrust} = \rho A_{hole}\, 2gh$

★ पानी की धार tap water $V_2^2 = V_1^2 + 2gh$

★ Venturimeter

$$V_2 = \sqrt{\frac{2g\Delta h}{\left(1 - \frac{A_2^2}{A_1^2}\right)}}$$

★ Reynolds No

$R_h = \frac{\rho Vd}{\eta}$

★ $f_v = \eta A \frac{dv}{dx}$

$\frac{f_v}{A} = \eta \cdot \frac{dv}{dx} = \eta\left(\frac{v-0}{h}\right)$ = shear stress

★ $F_f = 6\pi r\eta v$

★ at terminal velocity $F_{net} = 0$

$mg = B + 6\pi r\eta v$

$mg = B + 6\pi r\eta v$

$V = \frac{2}{9}\frac{9r^2}{\eta}(\rho_s - \rho_l)$

Q. 1. STATEMENT-1 : The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

and

STATEMENT-2 : In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant. **[IIT-JEE 2008]**

(A) STATEMENT-1 is True, STATEMENT-2 is True ; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True ; STATEMENT-2 is NOT a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

Ans : (A)

17. A person in a lift is holding a water jar, which has a small hole at the lower end of its side. When the lift is at rest, the water jet coming out of the hole hits the floor of the lift at a distance d of 1.2 m from the person. In the following, state of the lift's motion is given in List I and the distance where the water jet hits the floor of the lift is given in List II. Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

[JEE Advanced-2014]

List - I		List-II	
(P)	Lift is accelerating vertically up. 1·2	(1)	$d = 1.2$ m
(Q)	Lift is accelerating vertically down with an acceleration less than the gravitational acceleration. 1·2	(2)	$d > 1.2$ m
(R)	Lift is moving vertically up with constant speed. 1·2	(3)	$d < 1.2$ m
(S)	Lift is falling freely. ≡ पानी × 4	(4)	No water leaks out of the jar

Code :

(A) P-2, Q-3, R-2, S-4

(B) P-2, Q-3, R-1, S-4

✓ (C) P-1, Q-1, R-1, S-4

(D) P-2, Q-3, R-1, S-1

Q. Water is filled in a container upto height 3m. A small hole of area 'a' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A. If $\frac{a}{A} = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole) **[IIT-JEE' 2005 (Scr)]**

(A) 48 (B) 51 (C) 50 (D) 51.5

H|W

Ans : (C)

QUESTION

The terminal velocity (v_t) of the spherical rain drop depends on the radius (r) of the spherical rain drops as: (JEE Mains 2022)

1. $r^{1/2}$
2. r
3. r^2
4. r^3

Ans. (3)

QUESTION

The velocity of a small ball of mass 'm' and density d_1, when dropped in a container filled with glycerine, becomes constant after some time. If the density of glycerine is d_2, then the viscous force acting on the ball, will be: **(JEE Mains 2022)**

(1) $mg\left(1-\frac{d_1}{d_2}\right)$

(2) $mg\left(1-\frac{d_2}{d_1}\right)$

(3) $mg\left(\frac{d_1}{d_2}-1\right)$

(4) $mg\left(\frac{d_2}{d_1}-1\right)$

Ans. (2)

QUESTION

A water drop of radius 1 μm falls in a situation where the effect of buoyant force is negligible. Co-efficient of viscosity of air is $1.8 \times 10^{-5}\ \mathrm{Nsm^{-2}}$ and its density is negligible as compared to that of water $10^6\ \mathrm{gm^{-3}}$. Terminal velocity of the water drop is: (Take acceleration due to gravity $= 10\ \mathrm{ms^{-2}}$). **(JEE Mains 2022)**

(1) $145.4 \times 10^{-6}\ \mathrm{ms^{-1}}$

(2) $118.0 \times 10^{-6}\ \mathrm{ms^{-1}}$

(3) $132.6 \times 10^{-6}\ \mathrm{ms^{-1}}$

(4) $123.4 \times 10^{-6}\ \mathrm{ms^{-1}}$

Ans. (4)

QUESTION

A small ball of mass M and density ρ is dropped in a viscous liquid of density ρ_0. After some time, the ball falls with a constant velocity. What is the viscous force on the ball?

(06 April 2023 - Shift 1)

(1) $F = Mg\left(1 + \frac{\rho_0}{\rho}\right)$

(2) $F = Mg\left(1 + \frac{\rho}{\rho_0}\right)$

(3) $F = Mg\left(1 - \frac{\rho_0}{\rho}\right)$

(4) $F = Mg(1 \pm \rho\rho_0)$

Ans. (3)

QUESTION

A small ball of mass m and density ρ is dropped in a viscous liquid of density ρ_0. After sometime, the ball falls with constant velocity. The viscous force on the ball is:

(06 Apr. 2024 - Shift 1)

(1) $mg(1-\rho\rho_0)$

(2) $mg\left(1+\frac{\rho}{\rho_0}\right)$

(3) $mg\left(\frac{\rho_0}{\rho}-1\right)$

(4) $mg\left(1-\frac{\rho_0}{\rho}\right)$

Ans. (4)

Homework

- Ques are Attached.
- JM PYQ sheet ques based on today class (33 - 43),

Must try $\rightarrow$ (1-9), (21-24), (29-45)

Inhe Jalool Jalool Solve Talen. ...

THANK YOU