# d'doubtnut 

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## PHYSICS

# BOOKS - DHANPAT RAI \& CO PHYSICS <br> <br> (HINGLISH) 

 <br> <br> (HINGLISH)}

## FLUIDS IN MOTION

## Problem For Self Practice

1. A metel plate 100 sq cm in area rests on a $2-\mathrm{mm}$
layer of castor oil, whose coefficient of viscosity is
1.55 SI units. Calculate the horizontal force
required to move the plate with a speed of 3 cm per second.
[Hint:
$F=-\eta A \frac{d v}{d x}$. Here $\frac{d v}{d x}=\frac{3 \times 10^{-2} m s^{-1}}{2 \times 10^{-3}}=15 s^{-1}$
.]

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2. A metal plate of area $5 \mathrm{~cm}^{2}$ is placed on a 0.5 mm thick castor oil layer .If a force of 22,500 dyne is needed to move the plate with a velcity of $3 \mathrm{cms}^{-1}$

Calculate the coeffcient of viscosity of castor oil.
3. A metal plate of area $0.02 m^{2}$ is lying on a liquid layer of thickness $10^{-3} \mathrm{~m}$ and coeffcient of viscosity 120 poise .Calcualate the horizontal force requirred to move the plate with a speed of $0.025 m s^{-1}$

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4. In an exeriment with poiseuille,s apparatus, the following observation were noted :

Volume of liquid collected per minure $=15 \mathrm{~cm}^{3}$
Heat of liquid $=30 \mathrm{~cm}$, Lrngth of tube $=25 \mathrm{~cm}$

Diamter of tube $=0.2 \mathrm{~cm}$, Density of liquir $=$ $2.3 \mathrm{gcm}^{-3}$

Find the coefficient of viscosity of the liquird.

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5. Water at $20^{\circ} \mathrm{C}$ is escaping from a cistern by ways of a horizontal capillary tube 10 cm long and 0.4 mm in diameter , at a distance of 50 cm below the
free surface of water in the cistren .Calculate the rate at which the water is escaping .Coefficient of viscossity of water at $20^{\circ} C=0.001$ decapoise .
6. Water is flowing througth a horizontal tube of length 0.25 m and radius $4 \times 10^{-4} \mathrm{~m}$ under a constant pressure head of 0.2 m of water, at the rate of $5 \times 10^{-6} \mathrm{~m}^{3}$ per minture Calcutae the coefficient of viscosity of water .Density of water $=1000 \mathrm{kgm}^{-3}$

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7. Water is conveyed thourth a horizontal tube 8 cm in diameter and 4 kilometer in length at the rate of

20 litre/s Assumming only viscous resistance ,
callcalute the pressure required to maintain the flow. Coefficient of viscosity of water is 0.001 pa s

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8. Calculate the mass of water flowing in 10 minutes
throuth a tube 1 mm in diameter and 0.40 m long ,if there is a constant pressure heat of 20 cm of water . Coefficient of visosity of water is 0.00089 Pas.

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9. The difference of height between the two limbs
of a manometer connected at the ends of 20 cm
long tube of 1 mm radius is 28 cm If $8 \mathrm{~cm} 8 \mathrm{~cm}^{3}$ of water is collected in 3 minutes, calculate the coefficient of viscosity .

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10. Alcohol flows through two capillary tubes under
a constant pressure head the diameters of the two
tubes are in the ratio of $4: 1$ and the lengths are in
the ratio 4 : 1 Compare the rates of flow of alcohols through the two tubes .

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11. Show that if two capillaries if radii $r_{1}$ and $r_{2}$
having lenths $l_{1}$ and $l_{2}$ respectively are set in series ,the rate of flow $Q$ is given by
$Q=\frac{\pi p}{8 \eta}\left[\frac{l_{1}}{r_{1}^{4}}+\frac{l_{2}}{r_{2}^{4}}\right]^{-1}$
where p is the pressure difference across the arrangement and $\eta$ is the cofficient of viscosity of the liquid.
12. The rate of flow of the liquid through the tube of length I and radius r , connected across $a$ perssure haed $h$ be $V$. If two tubes of the same length but of radius $r$ and $r / 2$ are connected in series, across the same pressure head $h$, find the rate of flow of liquid through the combination. If both the tubes are connected inparallel to the same pressure head, then find the rate of flow of liquid through the combination.

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13. There capillaries of length $I, 2 l$ and $l / 2$ are connected in series. Their radii are $\mathrm{r}, \mathrm{r} / 2$ and $r / 3$ respectively. If stream line flow is maintained and the pressure difference across the first capillary tube is $P_{1}$, find the pressure difference across (i) the second and (ii) the thired capillary tube.

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14. A metal sphere of radius 1 mm falls vertically in glycerine Find the viscous force exerted by the glycerine on the sphere when the speed of the sphere is $1 \mathrm{~cm}^{-1}$ For glycerine $. \eta=8.0$ poise .

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15. A drop of water of radius 0.0015 mm is falling in air. If the coefficient of viscosity of air is $1.8 \times 10^{-3} \mathrm{~kg} / \mathrm{m}^{3}$, what will be the terminal velocity of the drop? Density of water $=1.0 \times 10^{3} \mathrm{~kg} / \mathrm{m}^{3}$ and $g=9.8 \mathrm{~N} / \mathrm{kg}$. Density of air can be neglected.

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16. The terminal velocity of a copper ball of radius

2 mm falling through a tank of oil at $20^{\circ} \mathrm{C}$ is
$6.5 \mathrm{~cm} / \mathrm{s}$. Find the viscosity of the oil at $20^{\circ} \mathrm{C}$. Density of oil is $1.5 \times 10^{3} \mathrm{Kg} / \mathrm{m}^{3}$, density of copper is $8.9 \times 10^{3} \mathrm{Kg} / \mathrm{m}^{3}$.

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17. Find the terminal velocity of a rain drop of radius 0.01 mm . The coefficient of viscosity of air is $1.8 \times 10^{-5} \mathrm{~N}-s m^{-2}$ and its density is $1.2 \mathrm{kgm}^{-3}$ .Density of water $=1000 \mathrm{kgm}^{-3}$.

Takeg $=10 \mathrm{~ms}^{-2}$

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18. A ball bearing of radius 1.5 mm mode of iron of density $7.85 \mathrm{gcm}^{-3}$ is allowed to fall through a long columu of glycerice of density $1.25 \mathrm{gcm}^{-3}$ It is found to attain a terminal velocity of $2.25 \mathrm{cms}^{-1}$ .Determine the viscosity of glycerine in centipoise .

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19. Determine the radius of a drop of water failling though air, if it covers 4.1 cm in 4 seconds with a unifrom velocity Assume density of air is 0.001293 $g c m^{-3}$ and $\eta$ for air1.8 $\times 10^{-4}$ poise.
20. A spherical glass ball of mass $1.34 \times 10^{-4} \mathrm{~kg}$ and diameter $4.4 \times 10^{-3} \mathrm{~m}$ atakes 6.4 s to fall steadily thorugh a height of 0.381 m inside a large volume of oil of specitic gravity 0.943 Calcualte the visosity ifoil.

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21. Two exactly simlar rain drops falling with terminal velocity of $(2)^{1 / 3} m s^{-1}$ coalese to from a bigger drop Find the new terminal velocity of the bigger drop.
22. Two equal drops of water are falling through air with a steady velocity of $10 \mathrm{cms}^{-1}$ If drops recombine tofrom a single drop, what will be new terminal velocity?

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23. An air bubble of diameter 2 cm is allowed to rise through a long cylindrical columu of viscous liquid and travels at the rate of $0.21 \mathrm{cms}^{-1}$ If the density
of the liquid is $1.47 \mathrm{gcm}^{-3}$ find the cofficient of
vicosity .Given $g=9.8 \mathrm{~ms}^{-2}$ Density of air is to be neglecteed.

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24. Water flows at a speed of $6 m s^{-1}$ through a tube of radius 1 cm . Coefficient of viscosity of water at room temperature is 0.01 poise. What is the nature of the flow?

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25. Find the critical velocity for air flowing through a tube of 2 cm diammeter .For air $\rho=1.3 \times 10^{-3} \mathrm{gcm}^{-3}$ and $\eta=181 \times 10^{-6}$ poise

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26. What should be the average velocity of water in
a tube of diameter 2 cm so that the flow is
laminar (ii) turbulent? The viscosity of water is
0.001 Pass. (for water pipes $R<2000$ stream line
flow, $R>3000$ turbulent flow)
27. Water flows through a horizontal pipe of varying cross-section at the rate of 20 litres per minutes, determine the velocity of water at a point where diameter is 4 cm

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28. Water is flowing though a cylindrical pipe of
cross -sectional area $0.04 \pi m^{2}$ at a speed of $1.0 \mathrm{~ms}^{-1}$ If the diameter of the pipe is halved ,then find the speed of flow of water through it .
29. The water entering a hauze flows with a speed
of $0.1 \mathrm{~ms}^{-1}$ through a pipe of 21 mm inside diameter .What is the speed of water at a point ,where pipe tapers to a diameter of 7 mm ?

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30. A garden hose having an internal diameter 2.0
cm is connected to a lawn sprinkle that consists of an enclosure with 24 holes , each 0.125 cm in diameter. If water in the hose has a speed of $90.0 \mathrm{cms}^{-1}$, find the speed of the water having the sprinkler hole.
31. In normal adult the average speed of the though the aorta (which has a radius of 0.9 cm ) is $0.33 \mathrm{~ms}^{-1}$ From the aorta ,the blood goes into major arteries which are 30 in number ,each of radius 0.5 Calculate the speed of blood through the arteries.

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32. At what speed the velocity head of a stream of water be equal to 40 cm of Hg

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33. Velocity of flow of water in a horizontal pipe is $4.9 \mathrm{~ms}^{-1}$ Find the velocity heat of water.

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34. Calculate the total energy per unit mass possessed by water at a point, where the pressure is $10 \mathrm{gh} \mathrm{f} / / \mathrm{sq} \mathrm{mm}$, velocity is $0.1 \mathrm{~ms}^{-1}$ and height of water level from the ground is
$0.20 m\left(g=9.8 m s^{-2}\right)$.
35. One end of a horizontal pipe is closed with the help of a valve and the reading of a barometer attached in the pipe is $3 \times 10^{5}$ pascal When the
value in the pipe is opened then the reading of barometer falls to $10^{5}$ pascal the velocity of water flowing through the pipe will be in $\mathrm{m} / \mathrm{s}$ -

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36. Water at a pressure of $4 \times 10^{4} \mathrm{Nm}^{-2}$ flows at
$2 m s^{-1}$ through a horizontal pipe of $0.02 m^{2}$. What
is the pressure in the smaller cross-section of the pipe?

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37. water enters at one end of a horizontal pipe of non-unifrom cross -section with a velocity of $0.4 m s^{-1}$ and leaves the other end with a velocity of $0.6 \mathrm{~ms}^{-1}$ The pressure of water at the first end is $1500 \mathrm{Nm}^{-2}$ Calculate the pressure at the other end Density of water $=1000 \mathrm{kgm}^{-3}$

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38. It water flows horizontally through a pipe of varying cross section and the pressure of water equals 10 cm of $H g$ at a point where the velocity of flow is $40 \mathrm{~cm} / \mathrm{s}$, what is the pressure at another point where the velocity of flow is $50 \mathrm{~cm} / \mathrm{s}$ ?

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39. Water flowing ina horizontal main of unifrom
bore has a velocity of $100 \mathrm{cms}^{-1}$ at a point ,where
the pressure is $1 / 10$ of the atmospheric pressure
.what will be the velocity at a point ,where the pressure is one half of that at the first point ?
40. Water is flowing through a horizontal pipe of varying cross-section. If the pressure of water equals 2 cm of Hg where velocity of flow is $32 \mathrm{cms}^{-1}$, what is the pressure at another point where the velocity of flow is $40 \mathrm{cms}^{-1}$ ?

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41. A pitot tube dipped in a river and its gauge indicates 5 cm of water column .What is the velocity of flow of water in the river?

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42. A pitot tube is fixed in a main pipe of diameter 20 cm and difference of pressure indicated by the gauge is 5 cm of water column. Find the volumn of water passing through the main pipe in one minute.

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43. A tank cotaining water has an orifice 10 m below
the surface of water in the tank. If there is no wastage of energy, find the speed of discharge.

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44. Calcualate speed of effux of kerosene from an orifice of a tank in which in the tank if there contaning water has an orifice of an tank in which pressure is 4 atmosphere .Density of kerosene is 0.72 kg per litre .One atmosphere $=1 \mathrm{kgfcm}^{-2}$.

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45. Water flows at the rate of 4 litres per second through an orifice at the bottom of tank which contains water 720 cm deep .Find the rate of
escape of water if additionalpressure of $16 \mathrm{f} / \mathrm{cm}$ is applied at the surface of water.

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46. The diameter of a pipe at two points, where a
venturimeter is connected is 8 cm and 5 cm and the
difference of levels in it is 4 cm . Calculate the volume of water flowing through the pipe per second.

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47. A pipe is running full of water. At a certain point $A$ it tapers from 60 cm diameter to 20 cm diameter at $B$. The pressure difference between $A$ and $B$ is 100 cm of water column. Find the rate of flow of water through the pipe.

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48. The diameter of the throat of a venturimeter is

6 cm .when it is inserted in a horizontal pipe line of
diameter 10 cm the pressure difference between
the pipe and the thraot equal 8 cm of water.
Calulate the rate of flow.

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49. A venturimeter is connected to two points in the mains where its radii are 20 cm . And 10 cm . Respectively and the levels of water column in the tube differ by 10 cms . How much water flows through the pipe per minute?

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50. A venturimeter is 37.5 cm . Diameter in mains
and 15 cm . Diameter in throat. The difference
between the pressure of water in the mais and the
throat is 23 cm of Hg . Find the discharge in litres / min unte. Sp. Gravity of Hg. 13.56.

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## Others

1. The relative velocity of two parallel layers of water
is $8 \mathrm{~cm} / \mathrm{sec}$. If the perpendicular distance between
the layers is 0.1 cm , then velocity gradient will be
2. A metal plate $5 \mathrm{~cm} \times 5 \mathrm{~cm}$ rests on layer of castor oil 1 mm thick whose coefficient of viscosity is 1.55
$N s m^{-1}$. Find the horizontal force required to move the plate with a speed of $2 \mathrm{~cm}^{-1}$.

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3. A squre metal plate of 10 cm side moves parallel to another plate with a velocity of $10 \mathrm{cms}^{-1}$, both plates immersed in water. If the viscous force is 200 dyne and viscosity of water is 0.01 poise, what is their distance a part.
4. A flat plate of 20 cm squre moves over another similar plate with a thin layer of 0.4 cm of a liquid between them. If a force of one kg. wt. moves one of the plates uniformly with a velocity with a velcoity of $1 \mathrm{~ms}^{-1}$ calculate the strain rate, sheraing stres and coefficient of viscosity.

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5. The velocity of water in a rier is $18 \mathrm{kmh}^{-1}$ near the surface. If the river is 5 m deepm, find the
shearing stress between the horizontal lyers of water. The coefficient of viscosity of water ${ }^{`}=10^{\wedge}-2$ poise.

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6. Check the dimensional consistency of the poiseuille's formula for the laminar flow in a tube:

$$
V=\frac{\pi R^{4}\left(p_{1}-p_{2}\right)}{8 \eta l}
$$

7. A capillary tube of 1 mm diameter and 20 cm long is fitted horizontally to a vessel kept full of alcohol
of density $0.8 \mathrm{gm} / / \mathrm{c} . \mathrm{c}$. The depth of centre of capillary tube below the surface of alcohol is 20 cm .

If the visosity of oil is $0.12 d y n e \mathrm{~cm}^{-2} \mathrm{~s}$, find the amount of liquid that will flow in 5 minuts.

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8. water flows through a horizontal tube of length

20 cm and internal radius 0.081 cm under a constant
head of the liquid 20 cm high. If $864 \mathrm{~cm}^{3}$ of water
issues from the tube in 12 minutes, calculate the
coefficient of viscosity of water. Density of water=1g

$$
\mathrm{cm}^{-2} \text { and } \mathrm{g}=981 \mathrm{~cm}^{-3}
$$

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9. Glycerine flows steadily through a horizontal
tube of length 1.5 m and radius 1.0 cm . if the amount of glycerine collected per second at one end is
$4.0 \times 10^{-3} \mathrm{kgs}^{-1}$, what is the pressuer difference between the two ends of the tube? (density of glycerine $=1.3 \times 10^{3} \mathrm{kgm}^{-3}$ and viscosity of glycerine $=0.83 \mathrm{Nsm}^{-2}$ ).
10. In giving a patient a blood transfusion, the bottle is set up so that the level of blood is 1.3 m above the needle, which has an internal diameter of 0.36 mm and 3 cm in length. If $4.5 \mathrm{~cm}^{3}$ of blood passes through the meedle in one minute, calculate the viscosity of blood. The density of blood is 1020 $\mathrm{kg} m^{-3}$.

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11. A liquid flows through a pipe of 1.0 mm radius and 10 cm length under a pressure $10^{4}$ dyne $\mathrm{cm}^{-2}$.

Calculate the rate of flow and the speed of the liquid coming out of the tube. The coefficient of viscosity of the liquid is 1.25 centipoise.

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12. Two tubes $A$ and $B$ of lengths 100 cm and 50 cm
have radii 0.1 mm and 0.2 mm respectively. If a liquid passintg though the two tubes is of mercury, determine the pressure at the junction of $A$ and $B$.
13. Two capillary tubes $A B$ and $B C$ are joined end to end at $B, A B$ is 16 cm long and of diameter 4 mm whereas $B C$ is 4 cm long and of diameter 2 mm . The composite tube is held horizontally with A connected to a vessel of water giving a constant head of 3 cm and $C$ is openn to the air. Calculate the pressure difference between B and C .

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14. The level of liquid in a cylinderical vessel is kept constant at 30 cm . It has three identical horizontal tubes of length 39 cm , each coming out at heights

0,4 and 8 cm respectively. Calculate the length of a single overflow tube of the same radius as that of identical tubes which can replace the three when placed horizontally at bottom of the cylinder.

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15. A large bottle is fitted with a siphon made of
capillary glass tubing. Compare the times taken to empty the bottle when it is filled. (i) with water (ii) with petrol of density 0.8 cgs units. The viscosity of water and petrol are 0.1 and 0.2 cgs units repectively.
16. Three capillary tubes of the same radius $r$ but of
length $l_{1}, l_{2}$ and $l_{3}$ are fitted horizontally to the bottom of a long cylinder containing a liquid at constant head and flowing through these tubes.

Find the length of a single overflow tube of the same radius $r$, which can replaced the three capillaries.

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17. A rain drop radius 0.3 mm falling vertically downwards in air has a terminal velocity of $1 \frac{m}{s}$

The viscosity of air is $18 \times 10^{-5}$ poise. The viscous
force on the drop is

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18. find the terminal velocity of a steel ball 2 mm in
diameter falling through glycerine. Relative density
of steel $=8$, relative density of glycerine $=1.3$ and
viscosity of glycerine=8.3 poise.
19. An iron ball of radius 0.3 cm falls through a column of oil of density $0.94 \mathrm{~cm}^{-3}$.lt is found to attain a terminal velocity of $0.5 \mathrm{~cm}^{-1}$ Determine the viscosity of the oil, Given that density of iron is $7.8 \mathrm{~g} \mathrm{~cm}^{-3}$

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20. In Millikan's oil drop experiment, what is the
terminal speed of a speed of a drop of radius
$2.0 \times 10^{5} \mathrm{~m}$ and density $1.2 \times 10^{3} \mathrm{~m}^{-3}$ ? Take the
viscosity of air at the temperature of the experimental to be $1.8 \times 10^{-5} \mathrm{Nsm}^{2}$. How much is
the viscous force on the drop at that speed?
Neglect buoyancy of the drop due to air.

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21. With what terminal velocity will an air bubble of density $1 \mathrm{kgm}^{-3}$ and 0.6 mm diameter rise in a liquid of viscosity $0.15 \mathrm{Nsm}^{-2}$ and specific gravity
0.9 ? What is the terminal velocity of the same bubble in water of $\eta=1 \times 10^{-3} \mathrm{Nsm}^{-2}$ ?

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22. A gas buble of diameter 2 cm rises steadily at the rate of $2.5 \mathrm{mms}^{-1}$ through a solution of density $2.25 \mathrm{~g} \mathrm{~cm}^{-3}$. Calculate the cofficient of viscosity of the Iquid. Neglect the density of the gas.

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23. Eight rain drops of radius $1 m m$ each falling downwards with a terminal velocity of $5 \mathrm{cms}^{-1}$ collapse to form a bigger drop. Find the terminal velocity of bigger drop.
24. If n equal rain droplets falling through air with equal steady velocity of $10 \mathrm{cms}^{-1}$ coalesce, find the terminal velocity of big drop formed.

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25. Fine particles of sand are shaken up in water contained in a tell cylinder. If the depta of water in the cylinder is 24 cm , calculate the size of the largest particle of sand that can remain suspended after the expiry of 40 minutes. Given density of
sand $=2.6 \mathrm{gcm}^{-3}$ and viscosity of water $=0.01$ poise.
Assume that all the particles are spherical and are of different sizes.

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26. A sphere is dropped under gravity through a
fluid of viscosity $\eta$. Taking the average acceleration as half of the initial acceleration, show that the
time to attain the terminal velocity is independent of the fluid density.

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27. Verify that the quantity $\frac{p v t}{n}$ (Reynold's number) is dimensionles.

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28. What should be the maximum average velocity of water in a tube of diameter 0.5 cm , so that the flow is laminar? The viscosity of water is $0.00125 \mathrm{Nsm}^{-2}$.
29. Water is following in a pipe of radius 1.5 cm with an average velocity of $15 \mathrm{cms}^{-1}$. What is the nature of flow? Given coeffcient of viscosity of water is $10^{-3} \mathrm{~kg} \mathrm{~m}^{-1} \mathrm{~s}^{-1}$ and its density is $10^{3} \mathrm{kgm}^{-3}$.

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30. What should be the average velocity of a water in a tube of radius 0.005 m , so that the flow is just turbulent? The viscosity of water is $0.001 \mathrm{~Pa}-\mathrm{s}$.
31. Water flows through a horizontal pipe of varying area of cross-section at the rate of 10 cubic metre per minute. Determine the velocity of water at a point where radius of pipe is 10 cm .

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32. A liquid uis flowing through a pape of varying cross-section. At a certain cross-section,the dimerter of the pipe is 5 cm and Velocity of flow of the liquid is $25 \mathrm{cms}^{-1}$. Colculate the velocity of flow at another cross-sectionwhere the dimeter is 1 cm .
33. Water flow through a horizontal pipe whose internal diameter is 2.0 cm at a speed of $1.0 \mathrm{~ms}^{-1}$ What should be the diameter of the nozzle, If the water is to emerge at a speed of $4.0 \mathrm{~ms}^{-1}$ ?

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34. The cylinderical tube of a spray pump has a cross-section of $8.0 \mathrm{~cm}^{2}$ one end of which has 40 fine holes each of diameter 1.0 mm . If the liquid flow inside the tube is 1.5 m per minute, what is the speed of ejection of the liquid through the holes?

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35. At what speed the velocity head of a stream of water be equal to 40 cm of Hg

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36. At what speed will the velocity head of a stream of water be equal to 20 cm of mercury. Taking $\left(g=10 m s^{-2}\right)$.
37. Calculate the total energy possessed by one kg of water at a point where the pressure is $20 \mathrm{~g} \mathrm{f} /$ $m n^{2}$, velocity is $0.1 m s^{-1}$ and the height is 50 cm above the ground level.

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38. The reading of pressure meter attached with a closed pipe is $3.5 \times 10^{5} \mathrm{Nm}^{-2}$. On opening the value of the pipe, the reading of the pressure meter is reduced to $3.0 \times 10^{5} \mathrm{Nm}^{-2}$. Calculate the speed of the water flowing in the pipe.

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39. In a test experiment on a model aeroplane in a wind tunnel, the flow speeds on the upper and lower surface of the wing are $70 \mathrm{~ms}^{-1}$ and $63 \mathrm{~ms}^{-1}$ respectivley. What is the lift on the wing if its area is $2.5 \mathrm{~m}^{2}$ ? Take the density of air is $1.3 \mathrm{kgm}^{-3}$.

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40. Water is flowing through a horizontal pipe of varying cross-section. If the pressure of water equals 2 cm of Hg where velocity of flow is
$32 \mathrm{cms}^{-1}$, what is the pressure at another point where the velocity of flow is $40 \mathrm{cms}^{-1}$ ?

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41. Calculate the minimum pressure required to force the blood from the heart to the top of the head (vertical distance $=40 \mathrm{~cm}$ ). Assume that the denisity of blood to be $1.04 \mathrm{~g} / \mathrm{cm}^{3}$. Friction is to be neglected.
42. Water is flowing through two horizontal pipes
of different diameters which are connected together. In the first pipe the speed of water $4 \mathrm{~m} / \mathrm{s}$ and the pressure is $2.0 \times 10^{4} \mathrm{~N} / \mathrm{m}^{2}$. Calculate the speed and pressure of water in the second pipe. The diameter of the pipes the diameter of the pipes are 3 cm and 6 cm respectively.

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43. The corss-sectional area of water pipe entering
the basement is $4 \times 10^{-4} \mathrm{~m}^{2}$. The pressure at this
point is $3 \times 10^{5} \mathrm{Nm}^{-2}$ and the speed of water is 2
$m s^{-1}$. This pipe tapers to a cross-sectional area of
$2 \times 10^{-4} \mathrm{~m}^{2}$ when it reaches the second flooe.

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44. The pressure difference between two points along a horizontal pipe, through which water is flowing, is 1.4 cm of mercury. If ,due to non-unifrom cross-section, the speed of flow of water at the point of greater cross-section is $60 \mathrm{~cm} \mathrm{~s} s^{-1}$, calculate the speed at the other point.
45. A point tube is mounted on an aeroplane wing to measure the speed of the plane. The tube contains alcohol and shows a level difference of 40 cm . What is the speed of the plane reative to air ?
(sp. Gr. Of alcohol $=0.8$ and density of air $=1 \mathrm{~kg}$ $\left.m^{-3}\right)$.

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46. A pitot tube is fixed in a main pipe of diameter

20 cm and difference of pressure indicated by the gauge is 5 cm of water column. Find the volumn of
water passing through the main pipe in one minute.

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47. Water flows out of a small hole in the wall of a
large tank near its bottom. What is the speed of efflux of water when height of water level in the tank is 5.0 m ?

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48. At what velocity does water emerge from an orifice in a tank in which gauge pressure is $3 x$ $10^{5} \mathrm{Nm}^{-2}$ before the flow starts? Density of water
$=1000 \mathrm{kgm}^{-3}$.

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49. A boat strikes an under water rock which punctures a hole 5 cm in dimeter in its hull which is 1.5 m below the water line. At what rate in liter per second does water enter ?
50. A drum of 30 cm radius has a capacityof 220 $d m^{3}$ of water and is placed on a solid block of exactly the same size as of drum .If a small hole is made at lower end of drum perpendicular to its length, find th horizontal range of water on the ground in the beginning. Given $\mathrm{g}=980 \mathrm{~cm} s^{2}$.

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51. Water from a tank issues into air through a horizontal nozzle and striken a fixed wall at right angles to the nozzle and 50 cm from it. If the depth of the nozzle below the free surface of water in the
tank is 32 cm , calculate (i)velocity of efflux of water and (ii) the vertical distance below the nozzle of the point where the jet strikes the wall.

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52. A horizontal tube has different cross-sectional areas at point $A$ and $B$. The diameter of $A$ is 4 cm and that of Bis 2 cm . Two manometer limbs are attached at A and B. When a liquid of density 8.0 g $\mathrm{cm}^{-3}$ flows through the tube, the pressure difference between the limbs of the manometer is 8 cm . Calculate the rate of flow of the liquid in the tube.
53. Three capillaries of lengths $l_{1}, l_{2}$ and $l_{3}$ and radii $r_{1}, r_{2}$ and $r_{3}$ respectively are joined in series. If p is pressure difference across the combination of capallaries, what will be the volume of liquid flowing per second?

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54. A cylindrical vessel of radius 3 cm has at the bottom a horizontal capallary tube of length 20 cm and intrnal radius 0.4 mm . If the vessel is filled with
water, find the time taken by it to empty one half of
its contents. Given that the viscosity of water is
0.01 poise.

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55. A soap bubble of radius 4 cm and surface tension 30 dyne $\mathrm{cm}^{-1}$ is blown at the end of a tube of length 10 cm and intenal radius 0.2 cm If the viscosity of air is $1.89 \times 10^{-4}$ poise, Find the time taken by the bubble to be reduced ota radius of 2 cm .
56. A metallic sphere of radius $1.0 \times 10^{-3} \mathrm{~m}$ and density $1.0 \times 10^{4} \mathrm{~kg} / \mathrm{m}^{3}$ enters a tank of water, after a free fall through a distance of $h$ in the earth's gravitational field. If its velocity remains unchanged after entering water, determine the value of $h$. Given: coefficient of viscosity of water $=1.0 \times 10^{-3} \mathrm{Ns} / \mathrm{m}^{2}, g=10 \mathrm{~ms}^{-2}$ and density of water $=1.0 \times 10^{3} \mathrm{~kg} / \mathrm{m}^{3}$.

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57. An oil drop of radius $4 \times 10^{-4} \mathrm{~mm}$ falls freely in air whose coefficient of visocsity is $1.8 \times 10^{-4}$ paise. Calculate its terminal velocity if the density of oil is $0.9 \mathrm{gcm}^{-3}$ and that of air is $1.293 \mathrm{glitre}^{-1}$ and $g=9.80 \mathrm{cms}^{-2}$

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58. Water stands at a depth $H$ in a tank whose side walls are vertical. A hole is made on one of the walls
at a depth $h$ below the water surface. Find at what
distance from the foot of the wall does the emerging stream of water strike the floor and for
what value of $h$ this range is maximum ? What is the maximum possible range ?

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59. Air is streaming past a horizontal air plane wing such that its speed is $120 \mathrm{~ms}^{-1}$ over the upper surface and $90 \mathrm{~ms}^{-1}$ at the lower surface. If the density of air is $1.3 \mathrm{kgm}^{-3} \mathrm{~m}$ find the difference in pressure between the top and bottom of the wing. If the wing is 10 m long and has an average width of $2 m$, calculate the gross lift of the wing.
60. A horizontal pipeline carries water in a streamline flow. At a point along the pipe, where the cross- sectional area is $10 \mathrm{~cm}^{2}$, the water velocity is $1 \mathrm{~ms}^{-1}$ and the pressure is 2000 Pa . The pressure of water at another point where the crosssectional area is $5 \mathrm{~cm}^{2}$, is........Pa. (Density of water $=10^{3} \mathrm{~kg} \cdot \mathrm{~m}^{-3}$ )

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61. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides, if
the radius of vessel is $0.05 m$ and the speed of rotation is $2 r e v / s$, find difference in the height of the liquid at the centre of the vessel and its sides.

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62. Calculate the rate of flow of glycerine of density.
$1.25 \times 10^{3} \mathrm{~kg} / \mathrm{m}^{3}$ through the conical section of a
pipe. If the radii of its ends are 1.0 m and $0.04 m$ and the pressure drop across its length is $10 \mathrm{~N} / \mathrm{m}^{2}$
63. Water is flowing continuously from a tap having an internal diameter $8 \times 10^{-3} \mathrm{~m}$. The water velocity as it leves the tap is $0.4 m s^{-1}$. The diameter of the water stream at a distance $2 \times 10^{-1} \mathrm{~m}$ below the tap is close to $\left(g=10 \mathrm{~m} / \mathrm{s}^{2}\right)$

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64. A non-viscous liquid of constant density $1000 \mathrm{~kg} / \mathrm{m}^{3}$ flows in a streamline motion along a tube of variable cross section. The tube is kept inclined in the vertical plane as shown in Figure.

The area of cross section of the tube two point $P$
and $Q$ at heights of 2 metres and 5 metres are respectively $4 \times 10^{-3} \mathrm{~m}^{2}$ and $8 \times 10^{-3} \mathrm{~m}^{2}$. The velocity of the liquid at point P is $1 m / s$. Find the work done per unit volume by the pressure and the gravity forces as the fluid flows from point P to Q .


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65. Water from a tap emerges vertically downwards with an initial spped of $1.0 \mathrm{~ms}^{-1}$. The crosssectional area of the tap is $10^{-4} \mathrm{~m}^{2}$. Assume that the pressure is constant throughout the stream of water, and that the flow is steady. The crosssectional area of the stream 0.15 m below the tap is

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66. A cylinderical tank of height 0.4 m is open at the
top and has a diameter 0.16 m . Water is filled in it up
to height of 0.16 m . Find the time taken to empty
the tank through a hole of radius $5 \times 10^{-3} m$ in its bottom.

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67. A cylindrical tank $1 m$ in radius rests on a platform $5 m$ high. Initially the tank is filled with water to a height of 5 m . A plug whose area is $10^{-4} \mathrm{~m}^{2}$, is removed from an orifice on the side of the tank at the bottom. Calculate the following :
(a) Initial speed with which the water flows from the orifice.
(b) Initial speed with which the water strikes the ground,
(c) Time taken to empty the tank to half its original
value.

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