PHYSICS ASSIGMENT

MECHANICAL PROPERTIES OF FLUIDS 1

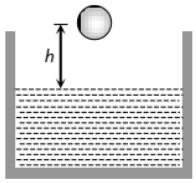
1. A small spherical ball falling through a viscous medium of negligible density has terminal velocity v. Another ball of the same mass but of radius twice that of the earlier falling through the same viscous medium will have terminal velocity

a) v b) $\frac{v}{4}$ c) $\frac{v}{2}$ d) $2v$

2. The relative velocity of two consecutive layers is 8 cm/s. If the perpendicular distance between the layers is 0.1 cm, then the velocity gradient will be

a) $8sec^{-1}$ b) 80 sec^{-1} c) 0.8 sec^{-1} d) 0.08 sec^{-1}

3. A ball of radius r and density ρ falls freely under gravity through a distance h before entering water. Velocity of ball does not change even on entering wate r. If viscosity of water is η, the value of h is given by



a) $\frac{2}{9}r^2\left(\frac{1-\rho}{\eta}\right)g$ b) $\frac{2}{81}r^2\left(\frac{\rho-1}{\eta}\right)g$ c) $\frac{2}{81}r^4\left(\frac{\rho-1}{\eta}\right)^2 g$ d) $\frac{2}{9}r^4\left(\frac{\rho-1}{\eta}\right)^2 g$

4. The excess pressure inside a spherical drop of radius r of a liquid of surface tension T is

a) Directly proportional to r and inversely proportional to T

b) Directly proportional to $T$and inversely proportional to r

c) Directly proportional to the product of $T$and r

d) Inversely proportional to the product of $T$and r

5. Speed of 2 cm radius ball in a viscous liquid is 20 cms^{-1}. Then the speed of 1 cm radius ball in the same liquid is

a) 5 cms^{-1} b) 10 cms^{-1} c) 40 cms^{-1} d) 80 cms^{-1}

6. Water rises in a capillary tube to a height h. Choose false statement regarding capillary rise from the following.

a) On the surface of Jupiter, height will be less than h

b) In a lift moving up with constant acceleration height is less than h

c) On the surface of moon the height is more than h

d) In a lift moving down with constant acceleration height is less than h

7. What is the ratio of surface energy of 1 small drop and 1 large drop if 1000 drops combined to form 1 large drop?
a) 100 : 1 b) 1000 : 1 c) 10 : 1 d) 1 : 100

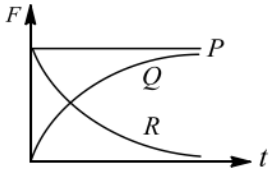
8. Determine the energy stored in the surface of a soap bubble of radius 2.1 cm if its surface tension is 4.5×10^{-2} Nm^{-1}.
a) 8 mJ b) 2.46 mJ c) 4.93×10^{-4} J d) None of these

9. If two soap bubble of different radii are connected by a tube
a) Air flows from the bigger bubble to the smaller bubble till the sizes become equal
b) Air flows from bigger bubble to the smaller bubble till the sizes are interchanged
c) Air flows from the smaller bubble to the bigger
d) There is no flow of air

10. The surface tension of soap solution is 0.03 Nm^{-1} . the work done in blowing to from a soap bubble of surface area 40 cm^2, (in J), is
a) 1.2×10^{-4} b) 2.4×10^{-4} c) 12×10^{-4} d) 24×10^{-4}

11. When a pinch of salt or any other salt which is soluble in water is added to water, its surface tension
a) Increases b) Decreases
c) May increase or decrease depending upon salt d) None of the above

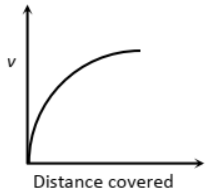
12. A spherical ball is dropped in a long column of viscous liquid. Which of the following graphs represent the variation of
(i)gravitational force with time
(ii) viscous force with time
(iii) net force acting on the ball with time?

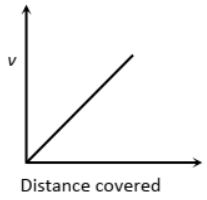


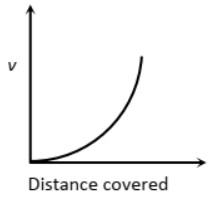
a) Q, R, P b) R, Q, P c) P, Q, R d) R, P, Q

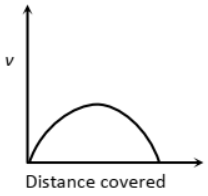
13. A metallic sphere of mass M falls through glycerine with a terminal velocity v. If we drop a ball of mass $8\ M$ of same metal into a column of glycerine, the terminal velocity of the ball will be
a) $2\ v$ b) $4\ v$ c) $8\ v$ d) $16\ v$

14. A lead shot of $1mm$ diameter falls through a long column of glycerine. The variation of its velocity v. with distance covered is represented by

a) 

b) 

c) 

d) 

15. If the excess pressure inside a soap bubble is balanced by oil column of height 2 mm, then the surface tension of soap solution will be ($r = 1$ cm and density $d = 0.8$ g $cc^{-1)}$

a) 3.9 Nm^{-1} b) 3.9×10^{-1} Nm^{-1} c) 3.9×10^{-2} Nm^{-1} d) 3.9 dyne m^{-1}

16. Surface tension of a liquid is due to

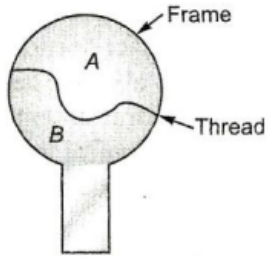
a) Gravitational force between molecules
b) Electrical force between molecules
c) Adhesive force between molecules
d) Cohesive force between molecules

17. A 20 cm long capillary tube is dipped in water. The water rises upto 8 cm. If the entire arrangement is put in a freely falling elevator, the length of water column in the capillary tube will be

a) 8 cm b) 10 cm c) 4 cm d) 20 cm

18. A thread is tied slightly loose to a wire frame as in figure and the frame is dipped into a soap solution and taken out. The frame is completely covered with the film. When the portion A is punctured with a pin, the

thread

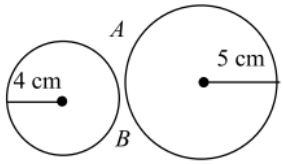


a) Becomes concave towards A
b) Becomes convex towards A
c) Either (a) or (b) depending on the size of A with respect to B
d) Remain in the initial position

19. The viscous force acting on a rain drop of radius 0.35 mm falling through air with a velocity of 1 ms^{-1}, is ($\eta = 2 \times 10^{-4}$ N s m^{-2})

a) 6.6×10^{-6} N b) 6.6×10^{-5} N c) 1.32×10^{-7} N d) 13.2×10^{-7} N

20. Two soap bubbles of radii r_1 and r_2 equal to 4 cm and 5 cm respectively are touching each other over a common surface AB (shown in figure). Its radius will be



a) 4 cm b) 4.5 cm c) 5 cm d) 20 cm

ANSWERKEY

1.	C	2.	B	3.	C	4.	A	5.	A	6.	D	7.	D
8.	C	9.	C	10.	B	11.	A	12.	C	13.	B	14.	A
15.	C	16.	D	17.	D	18.	C	19.	D	20.	D		

SOLUTIONS :

1. **(c)**

Terminal velocity of the ball through a viscous medium

$$v = \frac{2}{9} \times \frac{g}{\eta}(\rho - \sigma) r^2$$

$$v = \frac{2}{9} \times \frac{g}{\eta}(\rho) r^2$$

because viscous medium of negligible density $(\sigma = 0)$

$$v = \frac{2}{9} \times \frac{g}{\eta} \times \frac{m}{\frac{4}{3}\pi r^3} \times r^2 \qquad \left(\therefore e = \frac{m}{\frac{4}{3}\pi r^3}\right)$$

or $v = \frac{2}{9} \times \frac{g}{\eta} \times \frac{m}{\frac{4}{3}\pi r^3}$

$$\Rightarrow \quad v = \frac{1}{r}$$

For the second ball

$$v \propto \frac{1}{2r}$$

Because radius of second ball is twice that of the first ball

$$\frac{v}{v} = \frac{2r}{r} \text{ or } v' = \frac{v}{2}$$

2. **(b)**

$$\frac{dv}{dx} = \frac{8}{0.1} = 80 s^{-1}$$

3. **(c)**

Velocity of ball when it strikes the water surface

$v = \sqrt{2gh}$ ...(i)

Terminal velocity of ball inside the water

$v = \frac{2}{9} r^2 g \left(\frac{\rho - 1}{\eta}\right)$ ...(ii)

Equating (i) and (ii) we get $\sqrt{2gh} = \frac{2}{9}\frac{r^2 g}{\eta}(\rho - 1)$

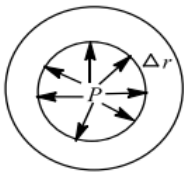
$\Rightarrow h = \frac{2}{81} r^4 \left(\frac{\rho - 1}{\eta}\right)^2 g$

4. **(a)**

The excess pressure inside a liquid drop is

$\Delta p = \frac{2T}{r}$

or $\Delta p \propto \frac{T}{r}$



The excess pressure inside a liquid drop is directly proportional to surface tension (T) and inversely proportional to radius (r).

5. **(a)**

Terminal velocity, $v = \frac{2r^2(\rho - \rho_0)g}{9\eta}$

$ie, v \propto r^2$

$\therefore \frac{v_1}{v} = \frac{r_1^2}{r^2}$

Or $v_1 = v\left(\frac{r_1}{r}\right)^2$

$= 20\left(\frac{1}{2}\right)^2 = 5\ \text{cms}^{-1}$

6. **D**

The height (h) to which water rises in a capillary tube is given by

$$h = \frac{2T\cos\theta}{r\rho g}$$

where θ is angle of contact , r the radius, ρ the density and g acceleration due to gravity.
When lift moves down with constant acceleration, height is less than h, because effective value of acceleration due to gravity increases hence h decreases.

7. **(d)**

As, $\frac{4}{3}\pi R^3 = 1000 \times \frac{4}{3}\pi r^3$

$R = 10r$

Surface energy of small drop $E_1 = S \times 4\pi r^2$

Surface energy of large drop $E_2 = S \times 4\pi(10\,r)^2$

$E_1/E_2 = 1/100$

8. **(c)**

Surface energy $U = S \times 2 \times 4\pi R^2$

(As there are 2 surfaces in soap bubble)

$U = 4.5 \times 10^{-2} \times 8\pi \times (2.1 \times 10^{-2})^2$

$= 4.93 \times 10^{-4}$ J

9. **(c)**

The excess pressure inside the soap bubble is inversely proportional to radius of soap bubble $ie, p \propto 1/r, r$ being radius of soap bubble. If follows that pressure inside a smaller bubble is greater than that inside a bigger bubble. Thus, if these two bubbles are connected by a tube, air will flow from smaller bubble grows at the expense of the smaller one.

10. **(b)**

In case of soap bubble

$W = T \times 2 \times \Delta A$

$= 0.03 \times 2 \times 40 \times 10^{-4} = 2.4 \times 10^{-4}$ J

11. **(a)**

When a highly soluble salt (like sodium chloride) is dissolved in water, the surface tension of water increases

12. **(c)**

Gravitational force remains constant on the falling spherical ball. It is represented by straight line P. The viscous force ($F = 6\pi\eta rv$) increases as the velocity increases with time. Hence, it is represented by curve Q. Net force = gravitational force – viscous force. As viscous force increases, net force decreases and finally becomes zero. Then the body falls with a constant terminal velocity. It is thus represented by curve R

13. **(b)**

$M = \frac{4}{3}\pi r^3\rho$ and $8M = \frac{4}{3}\pi R^3\rho$

So $R^3 = 8r^3$

So $R = 2r$; Now $v \propto r^2$ so,

$\frac{v_1}{v} = \left(\frac{2r}{r}\right)^2 = 4$ or $v_1 = 4v$

14. **NA**

15. **(c)**

Excess pressure inside a soap bubble of radius R is

$= \frac{4T}{R}$ ..... (i)

Where T is surface tension of liquid film.

Pressure due to oil column

$= h\rho g$ ..... (ii)

Where h is height of column, ρ the density and g the gravity.

From Eqs. (i) and (ii), we get

$\frac{4T}{R} = h\rho g$

$\Rightarrow \; T = \frac{h\rho gR}{4}$

Given, $h = 2$ mm $= 0.2$ cm, $g = 980 \text{cms}^{-2}$,

$\rho = 0.8\ \text{gcc}^{-1}, R = 1$ cm

$\therefore \; T = \frac{0.2 \times 0.8 \times 980}{4}$

$= 3.92 \times 10$ dyne cm^{-1}

In Nm^{-1}

$T = 3.9 \times 10 \times \frac{10^{-5}}{10^{-2}} = 3.9 \times 10^{-2}\ \text{Nm}^{-1}$

16. **(d)**

Surface tension of a liquid is due to force of attraction between like molecules of a liquid *ie* cohesive force between the molecules

17. **(d)**

Water fills the tube entirely in gravity less condition.

18. **(c)**

The air pressure inside a soap bubble is

$p = \frac{4T}{R}$

Which is greater than the atmospheric pressure. If a hole is made at *A*, air will flow outside through *A*. then the thread becomes convex looking from *A* and from *B* towards *A* it is concave. Hence, becoming concave or convex, depends on size of *A* with respect to *B*.

19. **(d)**

From the formula the viscous force is given by

$F = 6\pi\eta r v$

$= 6 \times \frac{22}{7} \times 2 \times 10^{-4} \times 0.35 \times 10^{-3} \times 1$

$= 13.2 \times 10^{-7}\text{N}$

20.

(d)

$\frac{4S}{r_1} - \frac{4S}{r_2} = \frac{4S}{r}$

$\text{Or}\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}\text{ or } r = 20\text{ cm}$