CBSE

MECHANICAL PROPERTIES OF FLUIDS WS 3

Class 11 - Physics

Section A

1. A raindrop is released from a cloud 1000 m above ground. When the drop is about to hit the ground, its speed will be **[1]**

   a) Cannot be predicted
   b) Constant terminal speed
   c) Decreasing due to retardation from air drag
   d) Increasing due to acceleration due to gravity

2. A sphere of mass M and radius R is falling in a viscous fluid. The terminal velocity attained by the falling object will be proportional to **[1]**

   a) $\frac{1}{R}$
   b) R
   c) $\frac{1}{R^2}$
   d) R^2

3. The ratio of the terminal velocities of two drops of radii R and $\frac{R}{2}$ is **[1]**

   a) 4
   b) 1
   c) $\frac{1}{2}$
   d) 2

4. The viscous force exerted by the liquid flowing between two plates in a streamlined flow depends upon **[1]**

   a) all of these
   b) coefficient viscosity of the liquid
   c) area of plates
   d) velocity gradient in the direction perpendicular in the plates

5. If dimensions of critical velocity v_c, of liquid flowing through a tube, are expressed as $\left[\eta^x p^y r^2\right]$, where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by **[1]**

   a) -1, -1, -1
   b) 1, 1, 1
   c) -1, -1, 1
   d) 1, -1, -1

6. The force required to separate two glass plates of area 10^{-2} m^2 with a film of water 0.05 mm thick between them, is (surface tension of water is $70 \times 10^3 \frac{N}{m}$) **[1]**

   a) 14 N
   b) 20 N
   c) 25 N
   d) 28 N

7. Neglecting the density of air, the terminal velocity obtained by a raindrop of radius 0.3 mm falling through air of viscosity 1.8×10^{-5} Nsm^{-2} will be **[1]**

   a) $3.7\ ms^{-1}$
   b) $10.9\ ms^{-1}$
   c) $12.8\ ms^{-1}$
   d) $7.48\ ms^{-1}$

8. The most characteristic property of a liquid is **[1]**

a) elasticity
b) fluidity
c) formlessness
d) volume conservation

9. As the temperature of water increases, its viscosity **[1]**

a) remain unchanged
b) increases or decreases depending on the external pressure
c) increases
d) decreases

10. **Assertion:** If a liquid in a vessel is stirred and left to itself, the motion disappears after few minutes. **[1]**
Reason: The moving liquid exerts equal and opposite force.

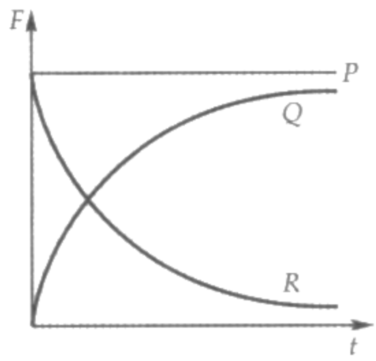
a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
c) Assertion is correct statement but reason is wrong statement.
d) Assertion is wrong statement but reason is correct statement.

11. **Assertion:** The machine parts are jammed in winter. **[1]**
Reason: The viscosity of the lubricants used in the machines increases at low temperature.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
c) Assertion is correct statement but reason is wrong statement.
d) Assertion is wrong statement but reason is correct statement.

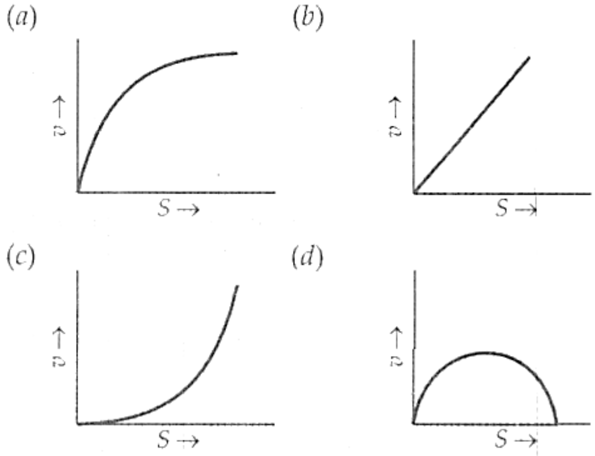
12. A spherical ball is dropped in a long column of viscous liquid. Which of the following graphs represent the variation of **[1]**

i. gravitational force with time
ii. viscous force with time
iii. net force acting on the ball with time?



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

13. A lead shot of 1 mm diameter falls through a long column of glycerine. The variation of its velocity v with distance covered (S) is represented by **[1]**



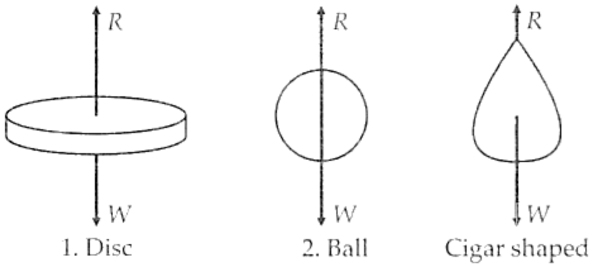
a) Option a

b) Option c

c) Option d

d) Option b

14. When a body falls in air, the resistance of air depends on a greater extent on the shape of the body. Three different shapes are given **[1]**



Identify the combination of air resistances, which truly represents the physical situation (The cross-sectional areas are the same).

a) $1 < 2 < 3$

b) $3 < 1 < 2$

c) $2 < 3 < 1$

d) $3 < 2 < 1$

15. Define poise. **[1]**

16. A gas bubble of diameter 2 cm rises steadily at the rate of 25 mm s^{-1} through a solution of density 2.25 g cm^{-3}. Calculate the coefficient of viscosity of the liquid. Neglect the density of the gas. **[1]**

17. Name the CGS and SI units of the coefficient of viscosity. **[1]**

18. Define SI unit of coefficient of viscosity. **[1]**

19. Write the dimensions of coefficient of viscosity and surface tension. **[1]**

20. Stoke's formula for viscous drag is not really valid for oil drops of extremely minute sizes. Why not? **[1]**

21. One flask contains glycerine and other contains water. Both are stirred vigorously and kept on the table. Which liquid will come rest to earlier than the other? **[1]**

22. Why oils of different viscosity are used in different seasons? **[1]**

23. A circular metal plate of radius 5 cm, rests on a layer of caster oil 2 mm thick, whose coefficient of viscosity is 15.5 poise. Calculate the horizontal force required to move the plate with a speed of 5 cm s^{-1}. **[1]**

24. Water is conveyed through a horizontal tube 8 cm in diameter and 4 kilometer in length at the rate of 20 litres/s. Assuming only viscous resistance, calculate the pressure required to maintain the flow. Coefficient of the viscosity of water is 0.001 Pa s. **[1]**

25. What is the reason that a constant driving force is always required for the maintenance of the flow of oil through the pipelines in the oil refineries? **[1]**

26. Why should the lubricant oil be of high viscosity? **[1]**

27. Obtain a relation between SI unit and cgs unit of coefficient of viscosity (η). **[1]**

28. Which fall faster - big raindrops or small raindrops? **[1]**

29. Why is it not possible to separate two pieces of paper joined by glue or gum? **[1]**

30. Give the relationship between poise and decapose. **[1]**

31. Draw a graph between the velocity of a small sphere dropped from rest into a viscous liquid and time. Also indicate the terminal velocity as v_t on the graph. **[1]**

32. Why does an object entering the earth's atmosphere at high-velocity catch fire? **[1]**

33. What is the nature of graph between the terminal velocity of a spherical body and the square of its radius? **[1]**

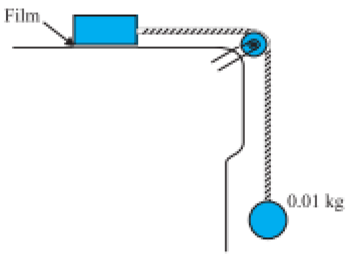
34. A metal plate of area 0.02 m^2 is lying on a liquid layer of thickness 10^{-3}m and coefficient of viscosity 120 poise. Calculate the horizontal force required to move the plate with a speed of 0.025 ms^{-1}. **[1]**

Section B

35. **State True or False:** **[2]**
    (a) The terminal velocity of a body in a freely falling system is not zero. **[1]**
    (b) The dissipative forces become more important as the fluid velocity increases. **[1]**

36. **Fill in the blanks:** **[2]**
    (a) With the increase in pressure, visocity of water ________ while of that of other liquids ________. **[1]**
    (b) The terminal velocity is ________ proportional to the coefficient of viscosity of the fluid. **[1]**

37. A metal block of area 0.10 m^2 is connected to a 0.010 kg mass via a string that passes over an ideal pulley (considered massless and frictionless), as in the figure. **[2]**



A liquid with a film thickness of 0.30 mm is placed between the block and the table. When released the block moves to the right with a constant speed of 0.085 m s^{-1}. Find the coefficient of viscosity of the liquid.

38. An iron ball of radius 0.3 cm falls through a column of oil of density 0.94 g cm^{-3}. It is found to attain a terminal velocity of 0.5 cms^{-1}. Determine the viscosity of the oil. Given that density of iron is 7.8 g cm^{-3}. **[2]**

39. The velocity of water in a river is 18 kmh^{-1} near the surface. If the river is 5 m deep, find the shearing stress between horizontal layers of water. The coefficient of viscosity of water 10^{-2} poise. **[2]**

40. The velocity of water in a river is 180 kmh^{-1} near the surface. If the river is 5 m deep, find the shearing stress between horizontal layers of water. Coefficient of viscosity of water = 10^{-2} poise. **[2]**

41. A small ball of mass m and density ρ is dropped in a viscous liquid of density ρ. After some time, the ball falls with a constant velocity. Calculate the viscous force on the ball. **[2]**

42. Near the surface of the river, the velocity of water is 160 kmh^{-1}. Find the shearing stress between horizontal layers of water, if the river is 6 m deep and the coefficient of viscosity of water is 10^{-2} poise. **[2]**

43. What is the cause of viscosity in a fluid? How does the flow of fluid depend on viscosity? **[2]**

44. What is stoke's law and what are the factors on which viscous drag depends? **[2]**

45. Find out the dimensions of coefficient of viscosity? **[2]**

46. A capillary tube 1 mm in diameter and 20 cm in length is fitted horizontally to a vessel kept full of alcohol. The depth of the centre of capillary tube below the surface of alcohol is 20 cm. If the viscosity and density of alcohol are 0.012 cgs unit and 0.8 g cm^{-3} respectively, find the amount of the alcohol that will flow out in 5 minutes. Given that g = 980 cms^{-2}. **[2]**

47. Consider a drop of rain having radius 0.4mm and terminal velocity 2 m/s. Find the viscous force on the raindrops, if the viscosity of air is 18×10^{-5} dyne $cm^{-2}s$. **[2]**

48. A rain drop of radius 0.3 mm falls through air with a terminal velocity of ms^{-1}. The viscosity of air is 18×10^{-5} poise. Find the viscous force on the rain drop. **[2]**

49. What is terminal velocity? What is the terminal velocity of a body in a freely falling system? **[2]**

50. A metal plate of area 5 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 velocity of 3 cms^{-1}, calculate the coefficient of viscosity of castor oil. **[2]**

51. The reading of a pressure metre attached to a closed water pipe is 2.5×10^5 N/m^2. On opening the valve of pipe, the reading of the pressure metre reduces to 2.0×10^5 N/m^2. Calculate the speed of water flowing through the pipe? **[2]**

52. A large bottle is fitted with a siphon made of capillary glass tube. Compare the Co-efficient of viscosity of water and petrol if the time taken to empty the bottle in the two cases is in the ratio 2:5. Given specific gravity of petrol = 0.8 **[2]**

53. A flat square plate of side 20 cm 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 of 1 ms^{-1}, calculate the coefficient of viscosity of the liquid. **[2]**

54. If 27 drops of rain were to be combined to form one new large spherical drop, then what should be the velocity of this large spherical drop? Consider the terminal velocity of 27 drops of equal size falling through the air is 0.20 ms^{-1}. **[2]**

55. The sides of a horizontal pipe carrying dirty water get dirty. Why? **[2]**

56. The terminal velocity of a tiny droplet is v. N number of such identical droplets combine together forming a bigger drop. Find the terminal velocity of the bigger drop. **[2]**

Section C

57. Show that the Reynold's number represents the ratio of the inertial force per unit area to the viscous force per unit area. **[3]**

58. The flow rate of water from a tap of diameter 1.25 cm is 0.48 $\frac{L}{min}$. The coefficient of viscosity of water is 10^{-3} Pa s. After some time the flow rate is increased to 3 L/min. Characterise the flow for both the flow rates. **[3]**

59. A metallic sphere of radius 1.0×10^{-3}m and density 1.0×10^4kg 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 = 1.0×10^{-3} Nsm^{-2}, g = 10 ms^{-2} and density of water = $1.0 \times 10^3 kgm^{-3}$. **[3]**

60. Fine particles of sand are shaken up in water contained in a tall cylinder. If the depth 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 g cm^{-3} and viscosity of water = 0.01 poise. Assume that all the particles are spherical and are of different sizes. **[3]**

61. A solid body floating in water has $\frac{1}{6}$th of the volume above the surface. What fraction of its volume will project upward if it floats in a liquid of specific gravity 1.2? **[3]**

62. In giving a patient a blood transfusion, the bottle is set up so that the level of blood is 1.3 m above needle, which has an internal diameter of 0.36 mm and is 3 cm in length. If 4.5 cm^3 of blood passes through the needle in one minute, calculate the viscosity of blood. The density of blood is 1020 kgm^{-3}. **[3]**

63. What is terminal velocity and derive an expression for it? **[3]**

64. Show that if n equal rain droplets falling through air with equal steady velocity of 10 cms^{-1} coalesces, the resultant drop attains a new terminal velocity of 10 $n^{\frac{2}{3}}$ cms^{-1}. **[3]**

65. With what terminal velocity will an air bubble of density 1 kgm^{-3} and 0.8 mm in diameter rise in a liquid of viscosity 0.15 Nsm^{-2} and specific gravity 0.9? What is the terminal velocity of same bubble in water of $\eta = 1 \times 10^{-3}$ Nsm^{-2}? **[3]**

66. A sphere is dropped under gravity through a fluid of viscosity η. Taking the average acceleration as half of the initial acceleration, show that the time taken to attain the terminal velocity is independent of the fluid density. **[3]**

67. A piece of wood of relative density 0.25 floats in a pail containing oil of relative density 0.81. What is the fraction of the volume of the wood above the surface of the oil? **[3]**

68. A spherical ball of radius 3.0×10^{-4} m and density 10^4 kg m^{-3} falls freely under gravity through a distance h before entering a tank of water. If after entering the water, the velocity of the ball does not change, find value of h. Given that viscosity of water is 9.8×10^{-5} N s m^{-2}. **[3]**

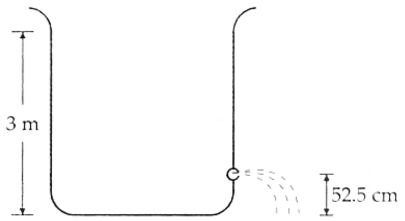
69. A spherical glass ball of mass 1.34×10^{-4} kg and diameter 4.4×10^{-3}m takes 6.4 s to fall steadily through a height of 0.381 m inside a large volume of oil of specific gravity 0.943. Calculate the viscosity of oil. **[3]**

Section D

70. State Poiseuille's formula. Deduce it on the basis of dimensional considerations. **[5]**

71. **[5]**
    a. What is the largest average velocity of blood flow in an artery of radius 2×10^{-3} m if the flow must remain laminar?
    b. What is the corresponding flow rate? (Take viscosity of blood to be 2.084×10^{-3} Pas).

72. Water is filled in a cylindrical container to a height of 3 m, as shown in Fig. The ratio of the cross-sectional area of the orifice and the beaker is 0.1. Find the speed of the liquid coming out from the orifice. Given g = 10 ms^{-2}. **[5]**



73. Discuss the variation of fluid viscosity with temperature and pressure. Also, find the units and dimensions of coefficient of viscosity. **[5]**