CBSE

MECHANICAL PROPERTIES OF FLUIDS WS 5

Class 11 - Physics

Section A

1. In a capillary tube experiment, a vertical, 30 cm long capillary tube is dipped in water. The water rises up to a height of 10 cm due to capillary action. If this experiment is conducted in a freely falling elevator, the length of the water column becomes **[1]**

   a) 20 cm
   b) zero
   c) 10 cm
   d) 30 cm

2. Two tubes of the same material but of different radii are dipped in a liquid. The height to which a liquid rises in one tube is 2.2cm and in the other is 6.6 cm. The ratio of their radii is: **[1]**

   a) 1:3
   b) 1:9
   c) 9:1
   d) 3:1

3. Two spherical soap bubbles of radoo a and b in vacuum coalesce under isothermal conditions. The resulting bubble has a radius given by **[1]**

   a) a + b
   b) $\frac{ab}{a+b}$
   c) $\frac{(a+b)}{2}$
   d) $\sqrt{a^2+b^2}$

4. For different capillaries of radius r, the condition of liquid rise (h) above the liquid surface is **[1]**

   a) $\frac{h}{r}$ = constant
   b) h - r = constant
   c) h + r = constant
   d) rh = constant

5. It is easier to spray water to which soap is added, because: **[1]**

   a) Addition of soap to water increases the surface tension of water
   b) Addition of soap to water decreases the surface tension of water
   c) Addition of soap to water makes surface tension of water zero
   d) Addition of soap to water increases its density

6. **Assertion:** A small drop of mercury is spherical but bigger drops are oval in shape. **[1]**
   Reason: Surface tension of liquid decreases with an increase in 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.

7. **State True or False:** **[1]**

   (a) Value of surface energy of liquid is numerically equal to the value of surface tension. **[1]**

8. **Fill in the blanks:** **[1]**

(a) Sap rises from the roots of a plant to its leaves and branches due to _____. **[1]**

9. A ring of radius R is kept on water surface. Surface tension of water is T and mass of the ring is m. **[1]**

What force is required to lift the ring from water surface?

a) mg + 2πTR

b) mg + πTR

c) mg + πR

d) mg + 4πTR

10. A drop of oil is placed on the surface of the water. Which of the following statements is correct? **[1]**

a) It will float as a distorted drop on the water surface

b) It will remain on it as a sphere

c) It will spread as a thin layer

d) It will partly change to spherical droplets and partly as a thin film

11. It is better to wash clothes in hot soap solution. Why? **[1]**

12. An oil drop on a hot cup of soup spreads over when the temperature of the soup falls. Why? **[1]**

13. What is the excess pressure inside a soap bubble of radius 5.00 mm? Surface tension of soap solution is 2.50 $\times$ 10^{-2} Nm^{-1}. **[1]**

14. What is the value of surface tension at the critical temperature? **[1]**

15. By which phenomenon, the water rises from roots to leaves of plants? **[1]**

Section B

16. A liquid drop of radius 4 mm breaks into 1000 identical drops. Find the change in surface energy. S = 0.07 Nm^{-1}. **[2]**

17. The pressure of air in a soap bubble of 0.7 cm diameter is 8 mm of water above the atmospheric pressure. Calculate the surface tension of soap solution. Take g = 9.8 ms^{-2}. **[2]**

18. The surface tension and vapour pressure of water at 20°C is 7.28 $\times$ 10^{-2} Nm^{-1} and 2.33 $\times$ 10^{3} Pa, respectively. What is the radius of the smallest spherical water droplet which can form without evaporating at 20°C? **[2]**

19. When sewing, why does a person often wet the end of a thread before trying to put it through the eye of a needle? **[2]**

20. Explain why **[2]**

a. Water with detergents dissolved in it should have small angles of contact.

b. A drop of liquid under no external forces is always spherical in shape.

21. Why is a soap solution a better cleansing agent than ordinary water? **[2]**

22. The sap in trees, which consists mainly of water in summer, rises in a system of capillaries of radius r = 2.5×10^{-5} m. The surface tension of sap is T= 7.28×10^{-2} Nm^{-1} and the angle of contact is 0°. Does surface tension alone account for the supply of water to the top of all trees? **[2]**

23. A rectangular plate of dimensions 6 cm $\times$ 4 cm and thickness 2 mm is placed with its largest face flat on the surface of water. **[2]**

i. What is the downward force on the plate due to surface tension? Surface tension of water = 7.0 $\times$ 10^{-2} Nm^{-1}.

ii. If the plate is placed vertical so that the longest side just touches the water surface, find the downward force on the plate.

24. A wire ring of 3 cm radius is rested on the surface of a liquid and then raised. The pull required is 3.03 g more before the film breaks than it is afterwards. Find the surface tension of the liquid. **[2]**

25. Oil spreads over the surface of water whereas water does not spread over the surface of oil. Why? **[2]**

26. Why are the droplets of mercury when brought in contact pulled together to from a bigger drop? Also state with reason whether the temperature of bigger drop will be the same, or more, or less than the temperature of the smaller drops? **[2]**

27. Describe a simple experiment for measuring the surface tension of a liquid. **[2]**

28. Small mercury drops are spherical and larger ones tend to flattened. Explain. **[2]**

29. Two soap bubbles in vacuum having radii 3 cm and 4 cm respectively coalesce under isothermal conditions to form a single bubble. What is the radius of the new bubble? **[2]**

30. Derive ascent formula. **[2]**

31. A capillary tube whose inside radius is 0.5 mm is dipped in water of surface tension 75 dyne cm^{-1}. To what height is the water raised by the capillary action above the normal level? What is the weight of water raised? **[2]**

32. Calculate the height to which water will rise in capillary tube of 1.5 mm diameter. Surface tension of water is 7.4 $\times$ 10^{-3} Nm^{-1}. **[2]**

33. The excess pressure inside a soap bubble of radius 6 mm is balanced by 2 mm column of oil of specific gravity 0.8. Find the surface tension of soap solution. **[2]**

34. Two soap bubbles of different diameter are in contact with a certain portion common to both the bubbles. What will be the shape of the common boundary as seen from inside the smaller bubble? Support your answer with a neat diagram and justify your answer. **[2]**

35. If a big drop of radius R is formed by 1000 small droplets of water, then find the radius of small drop? **[2]**

Section C

36. Show that a liquid at rest exerts a force perpendicular to the surface of the container at every point. **[3]**

37. What do you understand by capillarity phenomenon? Give two examples to illustrate it. **[3]**

38. If a 5 cm long capillary tube with 0.1 mm internal diameter opens at both ends and is slightly dipped in water having surface tension 75 dyne cm^{-1}, state whether **[3]**

    i. water will rise halfway in the capillary
    ii. water will rise up to the upper end of the capillary
    iii. water will overflow out of the upper end of the capillary.

    Explain your answer.

39. A liquid drop breaks into 27 small drops. If surface tension of the liquid is S, then find the energy released. **[3]**

40. A liquid drop of diameter 4mm breaks into 1000 droplets of equal size. Calculate the resultant change in the surface energy. The surface tension of the liquid is 0.07 Nm^{-1}. **[3]**

41. What is the excess pressure inside a bubble of soap solution of radius 5.00 mm, given that the surface tension of soap solution at the temperature (20^oC) is 2.50 $\times$ 10^{-2} Nm^{-1}? If an air bubble of the same dimension were formed at depth of 40.0 cm inside a container containing the soap solution (of relative density 1.20), what would be the pressure inside the bubble? (1 atmospheric pressure is 1.01 $\times$ 10^5 Pa). **[3]**

42. Describe the cleansing action of detergents. **[3]**

43. Two capillary tubes of length 15cm and 5cm and radii 0.06cm and 0.02cm respectively are connected in series. If the pressure difference across the end faces is equal to the pressure of 15cm high water column, then find the pressure difference across the : $\rightarrow$ **[3]**

i. First tube

ii. Second tube

44. Mercury has an angle of contact equal to 140^o with soda-lime glass. A narrow tube of radius 1.00 mm made of this glass is dipped in a trough containing mercury. By what amount does the mercury dip down in the tube relative to the liquid surface outside? Surface tension of mercury at the temperature of the experiment is 0.465 N m^{-1}. Density of mercury = 13.6×10^3 kgm^{-3}.. **[3]**

45. A mercury drop of radius 1.0 cm is sprayed into 10^6 droplets of equal size. Calculate the energy expended. The surface tension of mercury = 32×10^{-2} Nm^{-1}. **[3]**

46. A glass plate of length 10 cm, breadth 4 cm and thickness 0.4 cm, weighs 20 g in air. It is held vertically with a long side horizontal and half the plate immersed in water. What will be its apparent weight? The surface tension of water = 70 dyne cm^{-1}. **[3]**

47. A U-tube is made up of capillaries of bore 1 mm and 2 mm respectively. The tube is held vertically and partially filled with a liquid of surface tension 49 dyne cm^{-1} and zero contact angle. Calculate the density of the liquid, if the difference in the levels of the meniscus is 1.25 cm. Take g = 980 cms^{-2}. **[3]**

48. In a glass capillary tube, water rises upto a height of 10.0 cm while mercury fall down by 5.0 cm in the same capillary. If the angles of contact for mercury glass is 60^o and water glass is 0^o, then find the ratio of surface tension of mercury and water. **[3]**

49. Two mercury droplets of radii 0.1 cm. and 0.2 cm. collapse into one single drop. What amount of energy is released? The surface tension of mercury T = 435.5×10^{-3} N m^{-1}. **[3]**

50. To what height should a cylindrical vessel be filled with a homogeneous liquid to make the force, with which the liquid presses the side of the vessel equal to the force exerted by the liquid on the bottom of the vessel? **[3]**

51. The free surface of oil in a tanker, at rest, is horizontal. If the tanker starts accelerating the free surface will be titled by an angle θ. If the acceleration is a ms^{-2}, what will be the slope of the free surface? **[3]**

52. The lower end of a capillary tube of diameter 2 mm is dipped 8 cm below the surface of water in a beaker. What is the pressure required in the tube in order to blow a hemispherical bubble at its end in water? The surface tension of water at temperature of the experiments is $7.30 \times 10^{-2}Nm^{-1}$, atm = 1.01×10^5Pa, density of water = 1000 kg/m^3, g = 9.80 ms^{-2}. Also, calculate the excess pressure. **[3]**

53. A soap bubble is blown to a diameter of 7 cm. If 36,960 erg of work is done in blowing it further, find the new radius if the surface tension of soap solution is 40 dyne cm^{-1}. **[3]**

54. If a number of little droplets of water of surface tension σ, all of the same radius r combine to form a single drop of radius R and the energy released is converted into kinetic energy, find the velocity acquired by the bigger drop. **[3]**

55. What amount of energy will be liberated if 1000 droplets of water, each of diameter 10^{-8} m, coalesce to form a bigger drop? Surface tension of water is 0.072 Nm^{-1}. **[3]**

Section D

56. i. Explain the principle and working of Hydraulic lift with the help of a schematic diagram. **[5]**

ii. To keep a piece of paper horizontal, you should blow over, not under it. Why?

57. Two narrow bores of diameters 3.0 mm and 6.0 mm are joined together to form a U-tube open at both ends. If the U-tube contains water, what is the difference in its levels in the two limbs of the tube? Surface tension of **[5]**

water at the temperature of the experiment is 7.3×10^{-2} N m^{-1}. Take the angle of contact to be zero and density of water to be 1.0×10^3 kg m^{-3} (g = 9.8 m s^{-2}).

58. State Pascal's law. Discuss its two practical applications. **[5]**

59. What is capillarity? Derive an expression for the height to which the liquid rises in a capillary tube of radius r with angle of contact θ. Give two examples of capillarity from daily life. **[5]**

60. If two soap bubbles of radii a and b coalesce to from a single bubble of radius c and If the external pressure is P, show that the surface tension T of soap solution is : $\rightarrow T = \frac{P(c^3 - a^3 - b^3)}{4(a^2 + b^2 - c^2)}$. **[5]**

61. i. Derive an expression for the rise of liquid in capillary tube of uniform diameter and sufficient length. **[5]**
    ii. A liquid drop of diameter D breaks up into 27 tiny drops. Find the resulting change in energy. Take surface tension of the liquid as σ.

62. State the conditions for the equilibrium of floating bodies. Also, discuss the stability of a floating body. **[5]**

63. Derive excess of pressure inside an air bubble. **[5]**

64. Show that there is always an excess pressure on the concave side of the meniscus of a liquid. Obtain expression for the excess pressure inside **[5]**
    i. a liquid drop,
    ii. liquid bubble
    iii. air bubble inside a liquid.

65. Explain why **[5]**
    i. A balloon filled with liquid helium does not rise in air indefinitely but halts after a certain height.
    ii. The angle of contact of mercury with glass is obtuse while that of water with glass is acute.
    iii. A drop of liquid under no external force is always spherical in shape.

66. Explain why **[5]**
    i. The angle of contact of mercury with glass is obtuse, while that of water with glass is acute.
    ii. The surface tension of a liquid is independent of the area of the surface.
    iii. Water with detergents dissolved in it should have small angles of contact.
    iv. A drop of liquid under no external forces is always spherical in shape.

67. i. What is the phenomenon of capillarity? Derive an expression for the rise of liquid in a capillary tube. **[5]**
    ii. What will happen if the length of the capillary tube is smaller than the height to which the liquid rises? Explain briefly.

68. How is the surface tension of a liquid explained on the basis of intermolecular forces? From where the energy comes when a liquid rises against gravity in a capillary tube? **[5]**

69. Explain why: **[5]**
    i. The angle of contact of mercury with glass is obtuse, while that of water with glass is acute.
    ii. Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. (Put differently, water wets the glass while mercury does not).
    iii. Surface tension of a liquid is independent of the area of the surface.
    iv. Water with detergent disolved in it should have small angles of contact.
    v. A drop of liquid under no external forces is always spherical in shape.

70. Derive an expression for the excess of pressure inside a soap bubble. **[5]**

71. Define surface tension and surface energy. Write units and dimensions of surface tension. Also prove that **[5]**

surface energy is numerically equal to the surface tension.

72. i. How do the insects run on the surface of water? **[5]**

ii. Derive an expression for excess pressure inside a soap bubble.

iii. Define the term surface energy. Write down its dimensional formula and units.

73. Two mercury droplets of radii 0.1 cm and 0.2 cm collapse into one single drop. What amount of energy is released? The surface tension of mercury S = 435.5 $\times$ 10^{-3}N/m. **[5]**

When two or more droplets collapse to form a bigger drop, then its surface area decreases and energy is released equal to $S\triangle A$.

74. What is capillarity? Derive an expression for the height to which a liquid rises in a capillary tube of radius r. **[5]**

75. A glass U-tube is such that the diameter of one limb is 3.0 mm and that of the other is 6.00 mm The tube is inverted vertically with the open ends below the surface of water in a beaker. What is the difference between the heights to which water rises in the two limbs? Surface tension of water is 0.07 Nm^{-1}. Assume that the angle of contact between water and glass is 0^o. **[5]**