CBSE

MECHANICAL PROPERTIES OF FLUIDS WS 4

Class 11 - Physics

Section A

1. Bernoulli's equation is an example of conservation of **[1]**

   a) momentum
   b) angular momentum
   c) mass
   d) energy

2. Two water pipes of diameters 2 cm and 4 cm are connected with the main supply line. The velocity of flow of water in the pipe of 2 cm diameter is **[1]**

   a) 2 times that in the other pipe
   b) $\frac{1}{2}$ times that in the other pipe
   c) $\frac{1}{4}$ times that in the other pipe
   d) 4 times that in the other pipe

3. The velocity of efflux of a liquid through an orifice in the bottom of the tank does not depend upon **[1]**

   a) acceleration due to Force
   b) acceleration due to gravity
   c) height of liquid
   d) size of orifice

4. Scent sprayer is based on **[1]**

   a) Boyle's law
   b) Bernoulli's theorem
   c) Charles' law
   d) Archemedes' principle

5. Water flows along a horizontal pipe whose cross-section is not constant. The pressure is 1 cm of Hg, where the velocity is 35 cms^{-1}. At a point where the velocity is 65 cms^{-1}, the pressure will be **[1]**

   a) 1 cm of Hg
   b) 0.5 cm of Hg
   c) 8.9 cm of Hg
   d) 0.89 cm of Hg

6. **Assertion:** Bernoulli's theorem is applicable only on laminar flow. **[1]**
   Reason: Laminar flow is considered to be non-viscous.

   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.

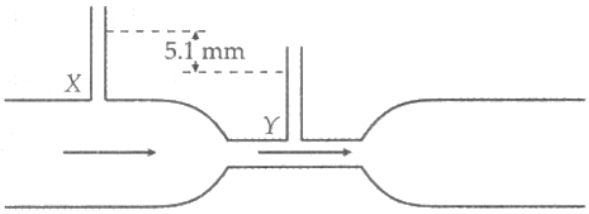
7. **State True or False:** **[1]**

   (a) Bernoulli's equation can be used to describe the flow of water through a rapid in a river. **[1]**

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

   (a) Equation of continuity is a special case of the law of conservation of _____. **[1]**

9. Figure shows a venturimeter, through which water is flowing. The speed of water at X is 2 cm s^{-1}. **[1]**



The speed of water at Y (taking g = 1,000 cm s^{-2}) is

a) 32 cm s^{-1} b) 1,024 cm s^{-1}

c) 23 cm s^{-1} d) 101 cm s^{-1}

10. The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is **[1]**

a) $\frac{VR^2}{n^3r^2}$ b) $\frac{V^2R}{nr}$

c) $\frac{VR^2}{n^2r^2}$ d) $\frac{VR^2}{nr^2}$

11. State Bernoulli's theorem. **[1]**

12. Why bullets are given cylindrical shapes? **[1]**

13. If air is blown very fast into the vertical hole of a spool of thread, a card laid flat against the other end does not fall. Why? **[1]**

14. Write the expressions for pressure head, gravitational head and velocity head. **[1]**

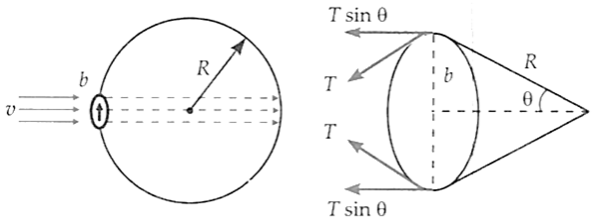
15. If the rate of flow of liquid through a horizontal pipe of length l and radius R is Q. What is rate of flow of liquid if length and radius of tube is doubled? **[1]**

Section B

16. A horizontal tube has different cross sectional areas at points A and B. The diameter of A is 4 cm and that of B is 2 cm. Two manometer limbs are attached at A and B. When a liquid of density 8.0 g 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. **[2]**

17. At what speed, the velocity head of water is equal to pressure head of 40 cm of Hg? **[2]**

18. A bubble having surface tension T and radius R is formed on a ring of radius b (b << R). Air is blown inside the tube with velocity v as shown. The air molecule collides perpendicularly with the wall of the bubble and stops. Calculate the radius at which the bubble separates from the ring. **[2]**



19. 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 additional pressure of 16 kg $\frac{f}{cm^2}$ is applied at the surface of water. **[2]**

20. Torricelli's barometer used mercury. Pascal duplicated it using French wine of density 984 kg m^{-3}. Determine the height of the wine column for normal atmospheric pressure. **[2]**

21. 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 1: 4. Compare the rates of flow of alcohols through the two tubes. **[2]**

22. A tornado consists of rapidly whirling air vortex. Why is the pressure always much lower in the centre than at **[2]**

the outside? How does this condition account for the destructive power of tornados?

23. A horizontal pipe line carries water in a streamline flow. At a point along the pipe where the cross-sectional area is 10 cm^2, the water velocity is 1 ms^{-1} and the pressure is 2000 Pa. What is the pressure at another point where the cross-sectional area is 5 cm^2? **[2]**

24. State and derive Torricelli's law of efflux. **[2]**

25. On which principle does a carburettor work? **[2]**

26. Explain why we cannot remove a filter paper from a funnel by blowing air into its narrow end. **[2]**

27. The accumulation of snow on the aeroplane may reduce the lift. Explain. **[2]**

28. A boat strikes an under water rock which punctures a hole 5 cm in diameter in its hull which is 1.5 m below the water line. At what rate in litre per second does water enter? **[2]**

29. At what velocity does water emerge from an orifice in a tank in which gauge pressure is 3×10^5 Nm^{-2} before the flow starts? The density of water = 1000 kgm^{-3}. **[2]**

30. Water is flowing with a speed of 2 $\frac{m}{s}$ in a horizontal pipe with cross-sectional area decreasing from 2×10^{-2} m^2 to 0.01 m^2 at pressure 4×10^4 Pa. What will be the pressure at small cross-section? **[2]**

31. A tank filled with fresh water has hole in its bottom and water is flowing out of it. If the size of the hole is increased what will be the change in : **[2]**

    i. Volume of water flowing out per second?

    ii. Velocity of the outcoming water?

    iii. If in the above tank, the fresh water is replaced by sea water, will the velocity of outcoming water change?

32. A garden hose having an internal diameter 2.0 cm is connected to a lawn sprinkler 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 cms^{-1}, find the speed of the water leaving the sprinkler holes. **[2]**

33. Calculate speed of efflux of kerosene from an orifice of a tank in which pressure is 4 atmosphere. The density of kerosene is 0.72 kg per litre. One atmosphere = 1.03 kg f cm^{-2}. **[2]**

34. What are the limitations of Bernoulli's theorem? **[2]**

35. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 4y from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are the same. Then, what is the value of R? **[2]**

Section C

36. In a test experiment on a model aeroplane in a wind tunnel, the flow speeds on the upper and lower surfaces of the wing are 70 ms^{-1} and 63 ms^{-1} respectively. What is the lift on the wing if its area is 2.5 m^2? Take the density of air to be 1.3 kg m^{-3}. **[3]**

37. Calculate the following: **[3]**

    i. Water flows steadily along a horizontal pipe at a rate of $8 \times 10^{-3} m^3/s$. If the area of cross-section of the pipe is 40×10^{-4} m^2, Calculate the flow velocity of water.

    ii. Find the total pressure in the pipe if the static pressure in the horizontal pipe is 3×10^4 Pa. Density of water is 1000 Kg/m^3.

    iii. What is the net flow velocity if the total pressure is 3.6×10^4 Pa?

38. Water rises up in a glass capillary up to a height of 9.0 cm, while mercury falls down by 3.4 cm in the same **[3]**

capillary. Assume angles of contact for water-glass and mercury-glass as 0^o and 135^o respectively. Determine the ratio of surface tensions of mercury and water. Take cos 135^o = -0.71.

39. In deriving Bernoulli's equation, we equated the work done on the fluid in the tube due to its change in the potential and kinetic energy. **[3]**

    a. What is the largest average velocity of blood flow in an artery of diameter 2×10^{-3} m if the flow must remain laminar?(Given, $\eta_{blood} = 2.084 \times 10^{-3} PaS$ and $\rho_{blood} = 1.06 \times 10^3 Kg/m^3$)

    b. Do the dissipative forces become more important as the fluid velocity increases? Discuss qualitatively.

40. Air is streaming past a horizontal airplane wing such that its speed is 120 ms^{-1} over the upper surface and 90 ms^{-1} at the lower surface. If the density of air is 1.3 kgm^{-3}, find the difference in pressure between the top and bottom of the wing. If wing is 10 m long and has an average width of 2 m, calculate the gross lift of the wing. **[3]**

41. Water is flowing with a speed of 2.0 m s^{-1} in a horizontal pipe with cross-sectional area decreasing from 2×10^{-2} m^2 to 1×10^{-2} m^2 at pressure 4×10^4 Pa. What will be the pressure at smaller cross-section? **[3]**

42. A freshwater reservoir is 10 m deep. A horizontal pipe 2 cm in diameter passes through the reservoir 8.0 m below the water surface. A plug secures the pipe opening. At a certain time the plug is removed. What volume of water flows out of the pipe in 1 h? Assume cross-section area of the reservoir to be too large. **[3]**

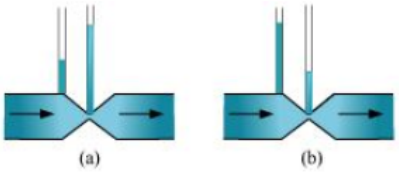
43. Briefly discuss the use of Bernoulli's principle in working of an atomiser (i.e., the spray gun used for perfumes etc.). **[3]**

44. Two exactly similar rain drops falling with a terminal velocity of $(2)^{\frac{1}{3}}$ ms^{-1} coalesce to form a bigger drop. Find the new terminal velocity of the bigger drop. **[3]**

45. State and prove the equation of continuity for steady flow of an ideal fluid. **[3]**

46. Water from a tap emerges vertically downward with an initial speed of 1.0 ms^{-1}. The cross-sectional area of the tap is 10^{-4} m^2. Assume that the pressure is constant throughout the stream of water, and that the flow is steady. What is the cross-sectional area of the stream 0.15 m below the tap? **[3]**

47. Figures (a) and (b) refer to the steady flow of a (non-viscous) liquid. Which of the two figures is incorrect? Why? **[3]**



48. A liquid is kept in a cylindrical vessel that is being rotated about its axis. The liquid rises at the sides. If the radius of the vessel is 0.05 m and the speed of rotation is 2 rps, find the difference in the heights of the liquid at the centre of the vessel and at its sides. **[3]**

49. In a horizontal pipeline of uniform area of cross – section, the pressure falls by 5 N/m^2 between two points separated by a distance of 1 Km. What is the change in kinetic energy per Kg of oil flowing at these points? Given Density of oil = 800 Kg/m^3? **[3]**

50. Briefly explain Magnus effect. **[3]**

51. A ball floats on the surface of water in a container exposed to the atmosphere. Will the ball remain immersed at its initial depth or will it sink or rise somewhat if the container is shifted to the moon? **[3]**

52. A pipe is running full of water. At a certain point A it tapers from 60 cm to 20 cm at point B. The pressure difference between A and B is 1 m of water column. Find the rate of flow of water through the pipe. **[3]**

53. Explain why **[3]**

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

b. When we try to close a water tap with our fingers, fast jets of water gush through the openings between our fingers

c. The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection

54. A cylindrical vessel of radius 3 cm has at the bottom a horizontal capillary tube of length 20 cm and internal 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. **[3]**

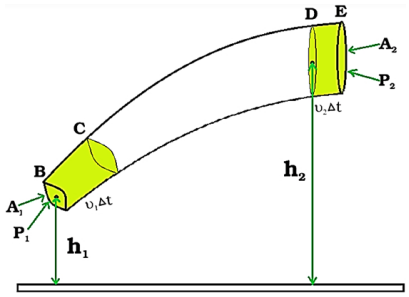
55. Consider the two horizontal pipes of different diameters which are connected together and the water is flowing through these two pipes. In the first pipe, the pressure is $3.0 \times 10^4 N/m^2$ and the speed of the water flowing is 5 m/s. If the diameters of the pipes are 4 cm and 6 cm, respectively, then what will be the speed and the pressure of the water in the second pipe? Density of the water is $10^3 kg/m^3$ **[3]**

Section D

Question No. 56 to 60 are based on the given text. Read the text carefully and answer the questions: **[5]**

Consider the flow at two regions 1 (i.e. BC) and 2 (i.e. DE). Consider the fluid initially lying between B and D. In an infinitesimally time interval Δt, this fluid would have moved. Suppose v_1 is the speed at which fluid would have moved. Suppose v_1 is the speed at B and v_2 at D, then fluid initially at B has moved a distance $v_1\Delta t$ to C ($v_1\Delta t$ is small enough to assume constant cross-section along BC).

In the same interval Δt, the fluid initially at D moves to E, a distance equal to $v_2\Delta t$. Pressures p_1 and p_2 act as shown on the plane faces of areas A_1 and A_2 binding the two regions as shown in figure



56. The work done on the fluid at BC is

a) $p_1A_1\Delta t$ b) $A_1\Delta v$

c) $p_1v_1\Delta t$ d) $p_1\Delta v$

57. The work done on the fluid of DE is

a) $p_2v_2\Delta t$ b) $p_2\Delta V$

c) $p_1A_2\Delta t$ d) $-p_2\Delta V$

58. Total work done on the fluid is

a) $p_1\Delta V$ b) $p_2\Delta V$

c) $\frac{p_1-p_2}{2}\Delta V$ d) $(p_1 - p_2)\ \Delta V$

59. The change in its kinetic energy is

a) $\frac{1}{2}\rho\Delta V(v_2^2 + v_1^2)$ b) $\rho\Delta V(v_2^2 - v_1^2)$

c) $\frac{1}{2}\Delta V(v_2^2 - v_1^2)$ d) $\frac{1}{2}\rho\Delta V(v_2^2 - v_1^2)$

60. Expression of Bernoulli's equation is

a) $p + \rho v^2 + \frac{1}{2}\rho gh$ = constant b) $p + \frac{1}{2}\rho v^2 + \rho gh$ = constant

c) $\frac{1}{2}\rho v^2 + \rho gh$ = constant d) $p + \frac{1}{2}\rho v^2$ = constant

61. A liquid is in a streamline flow through a pipe of non-uniform cross-section such that the sum of its kinetic energy, potential energy and pressure energy per unit volume remains constant. Name the theorem and prove it and write its two applications. **[5]**

62. A plane is in level flight at constant speed and each of its two wings has an area of 25 m^2. If the speed of the air is 180 km/h over the lower wing and 234 km/h over the upper wing surface, determine the plane's mass. (Take air density to be 1 kg m^{-3}) **[5]**

63. State Bernoulli's theorem. With the help of suitable diagram, establish Bernoulli's equation for liquid flow. Give two practical applications of it. **[5]**

64. Water stands at a height H in a tank whose side walls are vertical. A hole is made in one of the walls at a depth h below the water surface, **[5]**

i. Find at what distance from the foot of the wall does the emerging stream of water strike the floor?

ii. For what value of h, is this range maximum?

iii. Can a hole be made at another depth so that the second stream has the same range?

65. A liquid is in streamlined flow through a pipe of non-uniform cross-section. Prove the sum of its kinetic energy, pressure energy and potential energy per unit volume remains constant. **[5]**

66. State and prove Bernoulli's principle for the flow of non-viscous, incompressible liquid in streamlined flow. Give its limitations. **[5]**

67. **[5]**

i. State and prove Bernoulli's theorem.

ii. A cylindrical vessel of uniform cross-section contains liquid upto the height 'H'. At a depth 'h' = $\frac{H}{2}$ below the free surface of the liquid there is an orifice. Using Bernoulli's theorem, find the velocity of efflux of liquid.

68. If a liquid is flowing through a horizontal tube, write down the formula for the volume of the liquid flowing per second through it. Water is flowing through a horizontal tube of radius 2r and length 1 m at a rate of 60L/s, when connected to a pressure difference of h cm of water. Another tube of same length but radius r is connected in series with this tube and the combination is connected to the same pressure head. Find out the pressure difference across each tube and the rate of flow of water through the combination. **[5]**

69. What is meant by Streamline flow? State the equation of Continuity. Write the properties of an ideal fluid. Establish Bernoulli's equation as applied to an ideal fuel. **[5]**

70. **[5]**

i. State Bernoulli's equation.

ii. Name the physical quantity corresponding to each term of this equation.

iii. What type of liquid flow obeys this equation?

iv. Show that this equation is same as the equation due to Pascal's law in the presence of gravity if a liquid or gas is at rest.

71. Give the principle and explain the working of hydraulic brakes with a suitable diagram. **[5]**

72. State and prove Bernoulli's theorem. **[5]**

73. Calculate the rate of flow of glycerine of density 1.25×10^3 kgm^{-3} through the conical section of a pipe if the radii of its ends are 0.1 m and 0.04 m and pressure-drop across its length is 10 Nm^{-2}. **[5]**

74. Explain why **[5]**

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

ii. When we try to close a water tap with our fingers, fast jets of water gush through the openings between our fingers.

iii. The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection.

iv. A fluid flowing out of a small hole in a vessel results in a backward thrust on the vessel.

v. A spinning cricket ball in air does not follow a parabolic trajectory.

75. A non-viscous liquid of constant density 1000 kgm^{-3} flows in a streamline motion along a tube of variable cross-section. The tube is a kept inclined in the vertical plane as shown in figure. The area of cross-section of the tube at two points P and Q at heights of 2 m and 5 m are respectively, 4×10^{-3} m^2 and 8×10^{-3} m^2. The velocity of the liquid at point P is 1 ms^{-1}. Find the work done per unit volume by the pressure and the gravity forces as the fluid flows from point P to Q. **[5]**