PHYSICS – CLASS XI

Chapter 9 : Mechanical Properties of Fluids

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

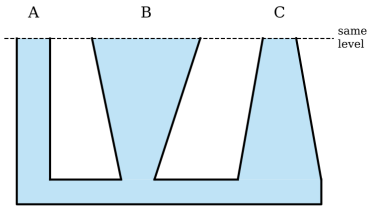
(d) Use of calculators is not permitted. Take $g = 10\ \text{m s}^{-2}$, the density of water = $1000\ \text{kg m}^{-3}$ and atmospheric pressure $P_0 = 1.0 \times 10^5\ \text{Pa}$ unless a different value is given in the question.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

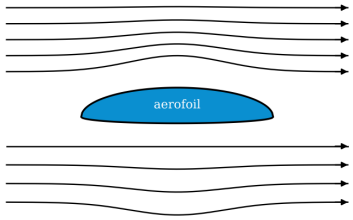
Questions 1 to 8 carry 1 mark each.

1. Three vessels A, B and C of different shapes are connected at the bottom by a horizontal pipe and filled with water up to the same level (figure). The pressure at the bottom of the vessels is **(1)**



(a) greatest in A
(b) greatest in B
(c) the same in A, B and C
(d) greatest in C

2. The figure shows streamlines of air flowing past an aerofoil (wing). Which statement is correct? **(1)**

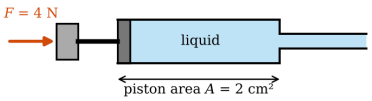


(a) The air speed above the wing is greater and the pressure above it is lower
(b) The air speed above the wing is greater and the pressure above it is greater
(c) The air speed above the wing is smaller and the pressure above it is lower
(d) The air speed and pressure are the same above and below the wing

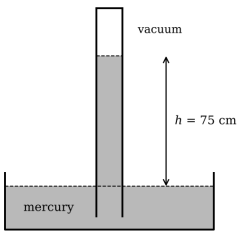
3. A spherical ball of radius r falling through a viscous liquid attains a terminal velocity v. A ball of the same material and radius $2r$ falling through the same liquid will attain a terminal velocity **(1)**
(a) $2v$
(b) $4v$
(c) $8v$
(d) $v/4$

4. **Assertion (A):** Two streamlines in a steady flow can never cross each other. **(1)**
Reason (R): At the point of intersection, a fluid particle would have two different velocities at the same instant.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

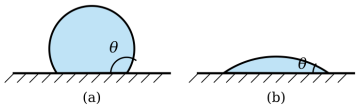
5. A thumb presses the plunger of a syringe with a force of 4 N (figure). The area of the plunger is 2 cm² (= 2 × 10⁻⁴ m²). Find the pressure transmitted to the liquid. **(1)**



6. In a mercury barometer the height of the mercury column is 75 cm (figure). If the density of mercury is 13.6 × 10³ kg m⁻³, find the atmospheric pressure. **(1)**



7. A drop of a liquid is placed on two different solid surfaces (a) and (b), and the angle of contact θ is as shown (figure). On which surface does the liquid wet the solid? Give a reason. **(1)**

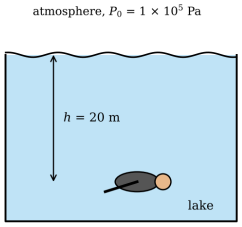


8. Find the excess pressure inside a water drop of radius 0.7 mm. The surface tension of water is 7×10^{-2} N m^{-1}. **(1)**

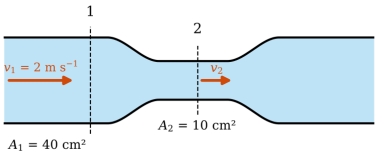
SECTION B

Questions 9 to 12 carry 2 marks each.

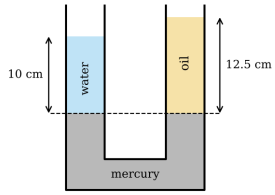
9. A diver is at a depth of 20 m below the surface of a lake (figure). Find (i) the gauge pressure and (ii) the absolute pressure at that depth. **(2)**



10. Water flows through a horizontal pipe whose cross-section decreases from A_1 = 40 cm² to A_2 = 10 cm² (figure). The speed of water in the wider part is 2 m s^{-1}. Find (i) the speed of water in the narrow part and (ii) the difference in pressure between the two parts. **(2)**



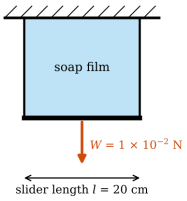
11. A U-tube contains mercury. Water of height 10 cm is poured into one arm and oil of height 12.5 cm into the other arm, and the mercury in the two arms stays at the same level (figure). Find the relative density of the oil. **(2)**



OR

Write the expressions for the excess pressure inside (i) a liquid drop and (ii) a soap bubble, each of radius r and surface tension S. Hence find the ratio of the two excess pressures.

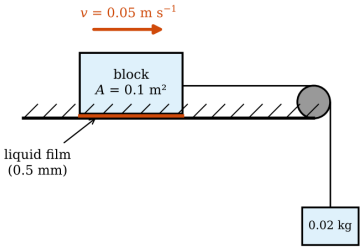
12. A U-shaped wire dipped in soap solution is held vertically with a light slider of length 20 cm at its lower end. The soap film formed supports a weight of 1.0×10^{-2} N (including the slider) (figure). (i) Why is the force on the slider $2Sl$ and not Sl? (ii) Find the surface tension of the soap solution. **(2)**



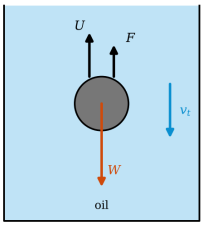
SECTION C

Questions 13 to 15 carry 3 marks each.

13. A metal block of area 0.1 m² is connected by a string over a smooth pulley to a mass of 0.02 kg (figure). A liquid film of thickness 0.5 mm lies between the block and the table. On release, the block moves to the right with a constant speed of 0.05 m s⁻¹. Find (i) the shearing stress on the liquid film, (ii) the strain rate and (iii) the coefficient of viscosity of the liquid. **(3)**

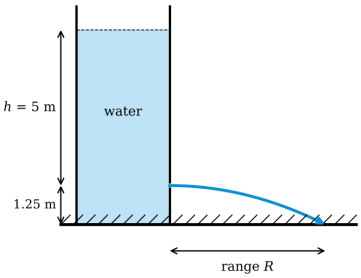


14. A ball of radius 3 mm and density 3×10^3 kg m^{-3} falls through oil of density 1×10^3 kg m^{-3} and coefficient of viscosity 0.2 Pa s (figure). (i) Name the three forces acting on the ball at terminal velocity. (ii) Find the terminal velocity of the ball. (iii) Find the terminal velocity if the radius of the ball is doubled. **(3)**

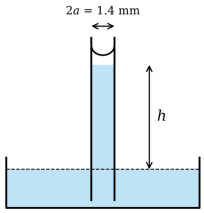


OR

Water stands 5 m above a small hole in the side of a large open tank. The hole is 1.25 m above the level ground (figure). Find (i) the speed with which water emerges from the hole, (ii) the time taken by a water particle to reach the ground and (iii) the horizontal distance (range) at which the jet strikes the ground.



15. A vertical capillary tube of internal radius 0.7 mm is dipped in water of surface tension 7×10^{-2} N m^{-1} and angle of contact zero (figure). (i) Write the expression for the capillary rise h. (ii) Find the height to which water rises. (iii) Find the rise in a tube of half this radius. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

16. In a hydraulic lift (figure) the small piston has an area of 40 cm² and the large piston an area of 2000 cm². A car of mass 1000 kg stands on the large piston. **(5)**

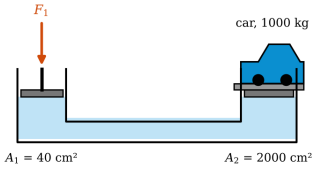
(a) State Pascal's law. (1)

(b) Find the mechanical advantage of the lift. (1)

(c) Find the force F_1 that must be applied on the small piston to just lift the car. (1)

(d) Find the pressure in the liquid. (1)

(e) The car is raised by 4 cm. Find the distance moved by the small piston and verify that the work done on the small piston equals the gain in potential energy of the car. (1)



OR

An open tank has a 2 m layer of oil of density 800 kg m⁻³ floating on a 3 m layer of water. The area of the base is 2 m² (figure).

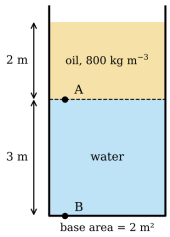
(a) Find the gauge pressure at the oil–water interface A. (1)

(b) Find the gauge pressure at the bottom B. (1)

(c) Find the absolute pressure at B. (1)

(d) Find the force exerted by the liquids on the base. (1)

(e) Does the pressure at B depend on the shape of the vessel? Name the related phenomenon. (1)



17. Water flows steadily through a pipe that rises by 2 m and narrows (figure). At section 1: area 4×10^{-3} m², speed 1 m s⁻¹, pressure 1.8×10^{5} Pa. At section 2: area 1×10^{-3} m². **(5)**

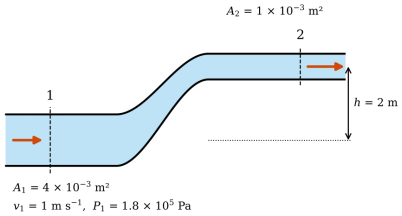
(a) State Bernoulli's principle. (1)

(b) Find the speed of water at section 2. (1)

(c) Find the volume of water flowing per second. (1)

(d) Find the change in kinetic energy per unit volume between the sections. (1)

(e) Find the pressure at section 2. (1)



OR

An aeroplane wing has an area of 30 m². In level flight the air speed is 90 m s⁻¹ over the upper surface and 70 m s⁻¹ below it (figure). The density of air is 1.25 kg m⁻³.

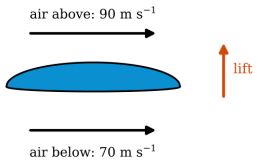
(a) Why is the pressure below the wing greater than above it? (1)

(b) Find the pressure difference between the lower and upper surfaces. (1)

(c) Find the upward lift on the wing. (1)

(d) Find the maximum mass the wing can support. (1)

(e) Name the effect which makes a spinning cricket ball swerve in air. (1)



— END OF QUESTION PAPER —