

STUDYNEST | CLASS 11 PHYSICS QUESTION PAPER 1

Chapter 9: Mechanical Properties of Fluids

Maximum Marks: 40 | Suggested time: 60 minutes

Instructions: Answer all questions. Show calculation steps and units. Original practice paper, not an official examination.

Section A 1-mark questions - $8 \times 1 = 8$ marks

1. Define pressure. [1]
2. SI unit of dynamic viscosity? [1]
3. Continuity relation for incompressible flow? [1]
4. Bernoulli relation? [1]
5. Surface tension unit? [1]
6. Pressure rise at depth h ? [1]
7. Stokes drag? [1]
8. Excess pressure in a liquid drop? [1]

Section B 2-mark questions - $6 \times 2 = 12$ marks

9. Water at 3m depth, $\rho=1000$, $g=10$: gauge pressure? [2]
10. If pipe area halves, incompressible speed? [2]
11. Under Bernoulli assumptions, faster horizontal flow means pressure? [2]
12. Force from $p=5000$ Pa over area $.02 \text{ m}^2$? [2]
13. Drop $S=.06 \text{ N/m}$, $r=.003 \text{ m}$: excess pressure? [2]
14. Why is a soap bubble pressure difference twice a drop's? [2]

Section C 3-mark questions - $4 \times 3 = 12$ marks

15. Pipe area 4 cm^2 at 2 m/s narrows to 1 cm^2 . New speed? [3]
16. Horizontal water speeds 2 and 6 m/s , $\rho=1000$. Find p_1-p_2 . [3]
17. Stokes drag for $r=.5 \text{ mm}$, $=1 \text{ Pa s}$, $v=.02 \text{ m/s}$? [3]
18. Explain why pressure rises with depth. [3]

Section D 4-mark questions - $2 \times 4 = 8$ marks

19. Areas 6 cm^2 and 2 cm^2 ; inlet speed 1.5 m/s . Find outlet speed. [4]
20. Soap bubble $r=2\text{mm}$, $S=.03\text{N/m}$: excess pressure? [4]

End of question paper.

FORMULA AND EQUATION REFERENCE

Chapter-specific equations and relations

- Pressure $p=F/A$; hydrostatic gauge pressure $p_g=\rho g h$; absolute pressure $p=p_0+\rho g h$.
 - Continuity for incompressible flow: $A_1v_1=A_2v_2$.
 - Bernoulli along a streamline: $p+(1/2)\rho v^2+\rho gh=\text{constant}$.
 - Stokes' drag magnitude $F_d=6\pi\eta r v$ for a small sphere in laminar flow.
 - Liquid drop excess pressure $\Delta p=2S/r$; soap bubble $\Delta p=4S/r$ (two surfaces).
 - Flow speed ratio: $v_2/v_1=A_1/A_2$ for the same volume flow rate.
 - Bernoulli at equal heights: $p_1-p_2=(1/2)\rho(v_2^2-v_1^2)$.
 - Force from uniform pressure: $F=pA$; surface tension unit N/m.
- Use equations only when their assumptions apply; keep units consistent.

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STEP-BY-STEP SOLUTIONS

Concept questions are answered directly; numerical problems show the governing equation and substitution.

Question 1

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Normal force per unit area.

Final answer: Normal force per unit area.

Question 2

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Pa s.

Final answer: Pa s.

Question 3

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $A_1 v_1 = A_2 v_2$.

Final answer: $A_1 v_1 = A_2 v_2$.

Question 4

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $p + \rho v^2 + \rho gh = \text{constant}$.

Final answer: $p + \rho v^2 + \rho gh = \text{constant}$.

Question 5

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: N/m.

Final answer: N/m.

Question 6

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: ρgh .

Final answer: ρgh .

Question 7

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $6\pi r v$.

Final answer: $6\pi r v$.

Question 8

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $2S/r$.

Final answer: $2S/r$.

Question 9

Working: Gauge pressure $p = \rho gh = 1000(10)(3) = 30,000$ Pa. This is pressure above atmospheric pressure.

Final answer: 30,000 Pa.

Question 10

Working: Continuity gives $A_1 v_1 = A_2 v_2$. If $A_2 = A_1/2$, then $v_2 = (A_1/A_2)v_1 = 2v_1$: speed doubles.

Final answer: Doubles.

Question 11

Working: At equal height, $p + (1/2)\rho v^2 = \text{constant}$. If speed rises, the kinetic term rises, so static pressure must fall: $p_2 < p_1$.

Final answer: Lower.

Question 12

Working: $F = pA = 5000(0.02) = 100$ N.

Final answer: 100 N.

Question 13

Working: For a liquid drop $\Delta p = 2S/r = 2(0.06)/0.003 = 0.12/0.003 = 40$ Pa.

Final answer: 40 Pa.

Question 14

Working: A liquid drop has one liquid-air surface, so $\Delta p = 2S/r$. A soap bubble has inner and outer surfaces, so the two contributions give $\Delta p = 4S/r$, twice the drop's value at the same S and r .

Final answer: Bubble has two liquid-air surfaces; $\Delta p = 4S/r$.

Question 15

Working: $A_1 v_1 = A_2 v_2$. Therefore $v_2 = (4 \text{ cm}^2)(2 \text{ m/s}) / (1 \text{ cm}^2) = 8 \text{ m/s}$.

Final answer: 8 m/s.

Question 16

Working: Bernoulli at equal height: $p_1 - p_2 = \frac{1}{2} \rho (v_2^2 - v_1^2) = 0.5(1000)(36 - 4) = 500(32) = 16,000 \text{ Pa}$.

Final answer: 16,000 Pa.

Question 17

Working: Stokes' drag $F = 6\pi \eta r v = 6\pi(1)(0.0005)(0.02) = 1.884 \times 10^{-4} \text{ N}$, approximately $1.88 \times 10^{-4} \text{ N}$.

Final answer: approx $1.88 \times 10^{-4} \text{ N}$.

Question 18

Working: Consider a stationary column of liquid of height h . Its weight creates a pressure increment $\Delta p = \text{weight}/\text{area} = \rho A h g / A = \rho g h$. Therefore pressure increases with depth.

Final answer: Hydrostatic balance gives $p = p_0 + \rho g h$ due to weight of fluid above.

Question 19

Working: Use continuity: $v_2 = A_1 v_1 / A_2 = (6 \text{ cm}^2)(1.5 \text{ m/s}) / (2 \text{ cm}^2) = 4.5 \text{ m/s}$.

Final answer: 4.5 m/s.

Question 20

Working: For a soap bubble, $\Delta p = 4S/r = 4(0.03)/0.002 = 0.12/0.002 = 60 \text{ Pa}$.

Final answer: $\Delta p = 4S/r = 60 \text{ Pa}$.

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