

Chapter	5 Solids and Fluid Dynamics	Class	1 st Year	Subject	Physics
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Give Short Answers of the Following Questions

1. The ratio stress/strain remains constant for small deformation. What will be effect on this ratio when the deformation made is very large?

Ans. The ratio of stress to strain remains same for small deformation.

Reason: As stress is directly proportional to strain within elastic limit and their ratio (i.e., stress/strain remains constant called elastic modulus.

$$\text{Stress} \propto \text{strain}$$

$$\text{Stress} = E \text{ strain}$$

$$E = \frac{\text{stress}}{\text{strain}}$$

When the deformation is very large so that stress exceeds beyond elastic limit, the stress-strain ratio does not remain constant, and the material's behavior becomes non-linear.

2. When pure water falls on a flat glass plate, it spreads on the plate while the mercury, when falls on the same plate gets converted into small globules. Why?

Ans. Mercury has greater surface tension as compare to water.

Explanation: As result of high surface tension and weak adhesion between mercury and glass causes it to form globules, while the high surface tension and strong adhesion between water and glass allow it to spread.

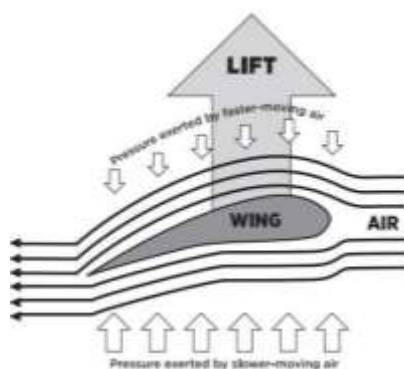
3. According to Bernoulli's theorem, the pressure of a fluid should remain uniform in a pipe of uniform radius. But actually, it goes on decreasing. Why is it so?

Ans. Explanation:

As Bernoulli's equation is derived for an ideal fluid which is non-viscous, incompressible, irrotational and have steady flow. But in practical case, to achieve these conditions is incompatible so the pressure of the fluid actually decreases as it flows through the pipe, due to the loss of energy. This is why the pressure drop is observed in practical cases.

4. Why wings of an aeroplane are rounded outward while flattened inward?

Ans. The wing of an aeroplane is designed to deflect the air so that streamlines are closer together above the wing than below it as illustrated in Fig. We have seen that where the streamlines are forced closer together, the speed faster. Thus, air is travelling faster on the upper side of the wing than on the lower. The pressure will be lower at the top of the wing, and the wing will be forced upward and the lift of an aeroplane is due to this effect.



Chapter	5 Solids and Fluid Dynamics	Class	1 st Year	Subject	Physics
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5. What is the difference in real fluid, ideal fluid and super fluid? Which one of these really exist in the world? Explain.

Ans. Real Fluids:

They exist in reality, have viscosity are affected by friction.

Ideal Fluids:

They are theoretical with zero viscosity, zero friction, have laminar flow and don't exist in reality.

Super fluids:

They also exist in reality at very low temperatures with zero viscosity.

So, we can say that real fluids and super fluids really exist in the world, while ideal fluids are purely theoretical concepts.

6. Why is the study of super fluids important for advancing our knowledge of low temperature physics?

Ans. Currently, there are few practical uses for super fluids. Super fluid helium-4 serves as a coolant for high-field magnets. Both helium-3 and helium-4 are utilized in advanced particle detectors. Researching super fluidity also helps us learn more about superconductivity.

Liquid helium is recognized for its great thermal conductivity and is used in cryogenic applications, including cooling superconducting magnets, scientific research, and medical uses. Additionally, it is employed in industry for leak testing and in the production of electronic and optical products.

7. What is meant by: (i) cohesive forces (ii) viscosity?

Ans. Cohesive Forces:

Cohesive forces are the intermolecular forces that hold molecules together within a substance, such as a liquid or solid. These forces are responsible for the substance's rigidity, elasticity, and resistance to deformation.

Viscosity:

Viscosity is the measure of a fluid's resistance to flow. It is a measure of the internal friction within a fluid, which opposes the relative motion of its layers.

8. Differentiate between streamline and turbulent flow of a fluid.

Ans. Difference between Laminar Flow and Turbulent Flow:

- In laminar flow, each particle of fluid moves along a smooth path which does not change with time.
- In turbulent flow the flow pattern is not smooth but continuously changes with time.
- In laminar flow, stream lines do not cross each other while in turbulent flow it does not happen.
- In turbulent flow, the velocity of fluid changes abruptly.

9. How does pressure changes with depth in fluids?

Ans. Pressure in fluids increases with depth due to the weight of the fluid above.

Chapter	5 Solids and Fluid Dynamics	Class	1 st Year	Subject	Physics
---------	-----------------------------	-------	----------------------	---------	---------

Explanation:

This phenomenon is described by the hydrostatic pressure equation:

$$P = p_o + \rho gh$$

When

P = pressure at a given depth

P_o = atmospheric pressure (pressure at the surface)

ρ = density of the fluid

g = acceleration due to gravity (approximately 9.8 m/s^2)

h = depth below the surface

So the pressure increases linearly with depth

10. How is variation in pressure related to speed of a fluid?

Ans. Relation between Speed and Pressure of the Fluid:

Where the speed is high, the pressure will be low.

Proof:

Suppose that water flows through a horizontal pipe system as shown in figure. The area of cross-section of the pipe at A is greater than the area of cross-section at B. According to equation of continuity. The speed of fluid at B is greater than at A.

Applying Bernoulli's equation at points A and B, we have

$$P_A + \frac{1}{2} \rho v_A^2 + \rho gh_A = P_B + \frac{1}{2} \rho v_B^2 + \rho gh_B \text{--- (1)}$$

Where

P_A = pressure of water at A

v_A = speed of water at A

P_B = pressure of water at B

v_B = speed of water at B

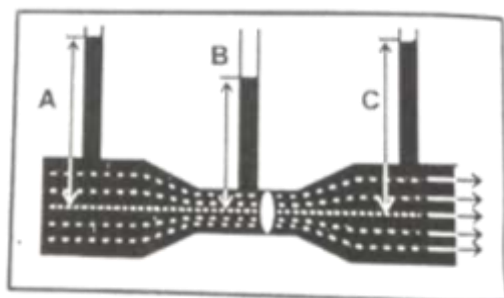
As the pipe system is horizontal, therefore $h_A = h_B$.

Hence average P.E. is same at both ends. So equation (1) becomes

$$P_A + \frac{1}{2} \rho v_A^2 = P_B + \frac{1}{2} \rho v_B^2 \text{--- (2)}$$

This shows that the pressure in narrow pipe where stream lines are closer together is smaller than wider pipe. Thus

Where speed is high, the pressure will be low.



Chapter	5 Solids and Fluid Dynamics	Class	1 st Year	Subject	Physics
---------	-----------------------------	-------	----------------------	---------	---------

11. How the flow rate is related to the cross-sectional area and velocity of the fluid?

Ans. The equation of continuity is based on the principle of conservation of mass, which states that the mass flow rate remains constant throughout a pipe.

Thus, the rate of flow of the liquid = $\frac{\text{Volume}}{\text{Time}} = \frac{Avt}{t} = Av$ constant

So, when we change the area of cross-section, the speed of fluid will change itself so that the flow rate remain the same.

12. How do you study the variation of a fluid at different points in a hose with varying diameter?

Ans. According to equation of continuity:

$$Av = \text{constant}$$

$$v = \text{constant} \left(\frac{1}{A} \right)$$

$$v = \text{constant} \left(\frac{1}{\pi r^2} \right)$$

$$v = \text{constant} \left(\frac{1}{\pi \left(\frac{d}{2} \right)^2} \right) \because r = \frac{d}{2}$$

$$v = \text{constant} \left(\frac{4}{\pi d^2} \right)$$

Or, we can write

$$v \propto \left(\frac{1}{d^2} \right)$$

So, speed of fluid inversely with square of diameter

13. Why does an object float or sink according to Archimedes Principle?

Ans. According to Archimedes' Principle:

"The buoyancy force (or upward force) exerted on an object immersed in a fluid is equal to the weight of the fluid displaced by the object."

An object will float if the weight of the fluid displaced is greater than the weight of the object. This occurs when the object is less dense than the fluid.

14. How does Archimedes reportedly discover the principle that bears his name?

Ans. Archimedes was a Greek scientist. He discovered the principle, subsequently named after him, after noticing that water in a bathtub overflowed when he stepped into it. He ran through the streets shouting 'Eureka!' which means 'I have got it'. This knowledge helped him to determine the purity of the gold in the crown made for the king.

15. Why standing near fast moving train is dangerous? Explain briefly.

Ans. Person standing near fast moving train is in danger zone.

Reason:

Chapter	5 Solids and Fluid Dynamics	Class	1 st Year	Subject	Physics
---------	-----------------------------	-------	----------------------	---------	---------

When fast moving train passes near the person, speed of air between train and the person increases. According to Bernoulli's relation

Where the speed of fluid is high, its pressure will be low.

So pressure between train and the person decrease. Hence large pressure behind the person pushes him towards the train.

16. What are some potential applications of superfluidity?

Ans. Currently, there are few practical uses for superfluids. Superfluid helium-4 serves as a coolant for high-field magnets. Both helium-3 and helium-4 are utilized in advanced particle detectors. Researching superfluidity also helps us learn more about superconductivity. Liquid helium is recognized for its great thermal conductivity and is used in cryogenic applications, including cooling superconducting magnets, scientific research, and medical uses. Additionally, it employed in industry for leak testing and in the production of electronic and optical products.

17. Differentiate between stress, strain and Young's modulus. Write down their SI units.

Ans. Stress

The force applied on unit area to produce any change in length, volume or shape of a body is called stress.

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

$$\sigma = \frac{F}{A}$$

SI units is N/m² or pascal and dimension is [ML⁻¹ T⁻²].

Strain

Strain is the measure of deformation of a solid material when stress is applied on it.

It has no units because it is a ratio of same quantities.

(Young's Modulus:

The ratio of tensile stress to the tensile strain is called Young's modulus.

$$\text{Young modulus} = - \frac{\text{tensile stress}}{\text{tensile strain}}$$

$$Y = \frac{F/A}{\Delta l/l} = \frac{Fl}{\Delta l A}$$

Since strain has no units, so unit of young's modulus is same as stress N/m² or pascal).