Chapter # 06 (Fluid Dynamics)
Important Short Questions

1. What is Stoke's law? Write its formula and limitation.

Ans: Stoke's Law:

This law states that the drag force "F" acting on a sphere of radius "r" moving slowly with velocity "v" in a fluid of viscosity "η" is given by

$$F = 6\pi\eta rv$$

Limitation:

This law is valid only for spherical bodies among slowly. For high speeds drag force is not simply proportional to velocity.

2. Define terminal velocity. Write its formula and unit.

Ans: Terminal Velocity:

"The maximum and constant velocity of an object falling vertically downward is called terminal velocity."

$$v_t = \frac{2gr^2\rho}{9\eta}$$

Its unit is ms^{-1}.

3. What are the conditions for ideal fluid?

Ans: Condition for ideal fluid:

The conditions for ideal fluid are given below:

- The fluid is non-viscous i.e., there is no internal frictional force between adjacent layers of fluid.
- The fluid is incompressible i.e., its density is constant.
- The fluid motion is steady.
- The fluid is irrotational flow.

4. State equation of continuity. Write its equation.

Ans: Equation of Continuity:

"For an ideal fluid, the product of cross-sectional area of the pipe and the fluid speed at any point along the pipe is a constant.**"**

OR

"For an ideal fluid, the volume flow per second of the fluid (flow rate) always remains constant.**"**

$$A_1 v_1 = A_2 v_2$$

$$Av = \text{constant}$$

5. State Bernoulli's equation. Write its equation.

Ans: Bernoulli's Equation:

"The sum of pressure, K.E. per unit volume and P.E. per unit volume of an incompressible, non-viscous fluid flowing in steady state is constant at each point along a stream line.**"**

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{Constant}$$

6. State Torricelli's theorem. Write its equation.

Ans: Torricelli's Theorem:

"The speed of efflux is equal to the velocity gained by the fluid in falling through the distance ($h_1 - h_2$) under the action of gravity"

$$v_2 = \sqrt{2g(h_1 - h_2)}$$

7. Explain how the lift is produced in an aeroplane?

Ans: Lift on an aeroplane:

The lift on an aeroplane is due to the effect, where speed of fluid is high, its pressure will be low.

Explanation:

The design of wing deflects the air in such a way that streamlines are closer together above the wing than lower side. Air moves faster at the upper side of the wing than the lower side. Pressure is lower at the top of the wing. Hence, the wing experiences a net upward force.

8. Drive Venturi relation. OR Drive the relation between speed and pressure of the fluid.

Ans: Derivation of Venturi relation:

Suppose that an ideal fluid flows through a horizontal pipe system. The area of cross section of pipe at A_2. The speed of fluid at A_2 is greater than at A_1.

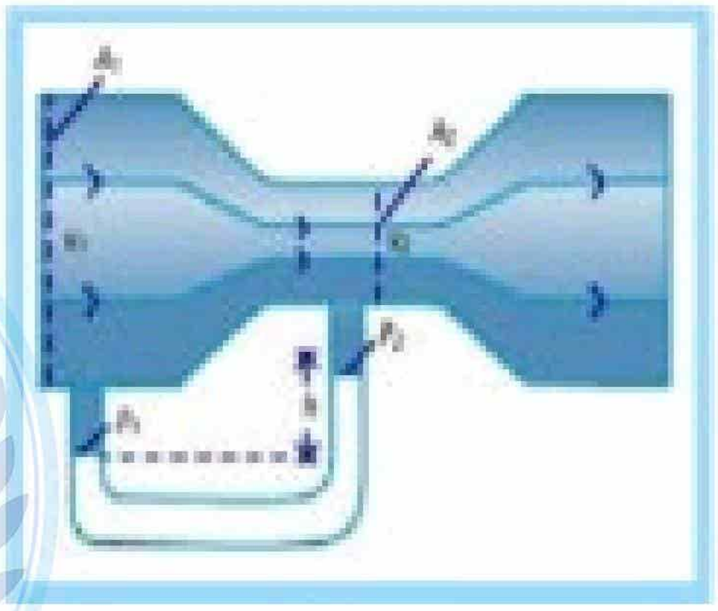
$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

As the pipe system is horizontal, therefore $h_1 = h_2$

$$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$$

$$P_1 - P_2 = \frac{1}{2}\rho V_2^2 - \frac{1}{2}\rho V_1^2$$

$$P_1 - P_2 = \frac{1}{2}\rho\left(V_2^2 - V_1^2\right)$$



Special Case:

If $A_1 >> A_2$, therefore $v_1 << v_2$

$$A_1 V_1 = A_2 V_2$$

$$v_1 = \left(\frac{A_2}{A_1}\right) v_2 \approx 0$$

$$P_1 - P_2 = \frac{1}{2}\rho\left(V_2^2 - 0\right)$$

$$P_1 - P_2 = \frac{1}{2}\rho V_2^2$$

9. What is difference between systolic pressure and diastolic pressure?

Ans:

Systolic Pressure	Diastolic Pressure
• The maximum pressure in the arteries when the heart contracts is called systolic pressure. • The value of systolic pressure is **120 torr**.	• The minimum pressure in the arteries when the heart is at rest is called diastolic pressure. • The value of diastolic pressure is **75 – 80 torr**

Exercise Short Questions

1. Explain what do you mean by terminal velocity?

Ans: The frictional effect between different layers of a flowing fluid is called viscosity of fluid.

Example:

(i) Glycerine, honey and thick tar has highest viscosity.
(ii) Water has low viscosity.

- It measures that how much force is required to slide one layer of the liquid over layer.
- It is represented by "η". And its unit is $kgm^{-1}s^{-1}$ or $Nm^{-2}s$
- Its dimension is $[ML^{-1}T^{-1}]$.

2. What is meant by drag force? What are the factors upon which drag force acting upon a small sphere of radius r moving down through a liquid, depend?

Ans: Drag Force:

When an object moving through a fluid, it experience a retarding force called drag force.

Factors:

According to Stoke's law, drag force is given by,

$$F = 6\pi \eta r v_t$$

This equation shows that drag force depends upon;

- Speed of sphere (v)
- Radius of Sphere (r)
- Coefficient of viscosity of medium (η)

3. Why fog droplets appear to be suspended in air?

Ans: Fog droplets appear to be suspended in air.

Reason:

Terminal velocity of a fog droplet is

$$v_t = \frac{mg}{6\pi\eta r}$$

$$v_t \propto mg$$

As the weight of a fog droplets is very small, the drag force becomes equal to its weight very quickly. Thus, terminal velocity is very small and hence the droplet appears to be suspended.

4. Explain the difference between laminar flow and turbulent flow?

Ans:

Laminar Flow	Turbulent Flow
• If every particle that passes a particular point moves along exactly the same path, as following by the particle which passed that point earlier, then the fluid is called laminar flow. • In this case, each particle of fluid moves along a smooth path called streamline or laminar. **Examples** • Flow of gentle breeze. • Flow of water around dolphins.	• The irregular or unsteady flow of the fluid is called turbulent flow. • In turbulent flow, there is great disorder and a constantly changing pattern. **Examples** • Flow of water from the top of mountain. • Water flow at sea shores. • Flow of water in the form of water fall.

5. State the Bernoulli's relation for a liquid in motion and describe some of its application?

Ans: It states that;

"For an ideal fluid, the sum of pressure, kinetic energy per unit volume and the P.E per unit volume at any point along a streamline always remains constant."

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{Constant}$$

Applications:

- The swing of ball
- Lift on an aeroplane
- Working of carburettor
- Blood flow

6. A person is standing near a fast-moving train. Is there any danger that he will fall towards it?

Ans: Yes, there is danger that he will fall towards the train.

Reason:

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

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

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

7. Identify the correct answer. What do you infer from Bernoulli's theorem?

(a) Where the speed of liquid is high the pressure will be low?

(b) Where the speed of the liquid is high the pressure is also high?

(c) This theorem is valid only for turbulent flow of the liquid?

Ans: Where the speed of liquid is high the pressure will be low.

8. Two row boats moving parallel in the same direction are pulled towards each other. Explain?

Ans: When the two row boats moving parallel in the same direction then the speed of water between the boats is greater than the speed of water on the other sides of the boats.

According to Bernoulli's equation;

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

Therefore, the pressure of between the boats decreases and they are pulled towards each other.

8. Explain, how the swing is produced in a fast-moving cricket ball?

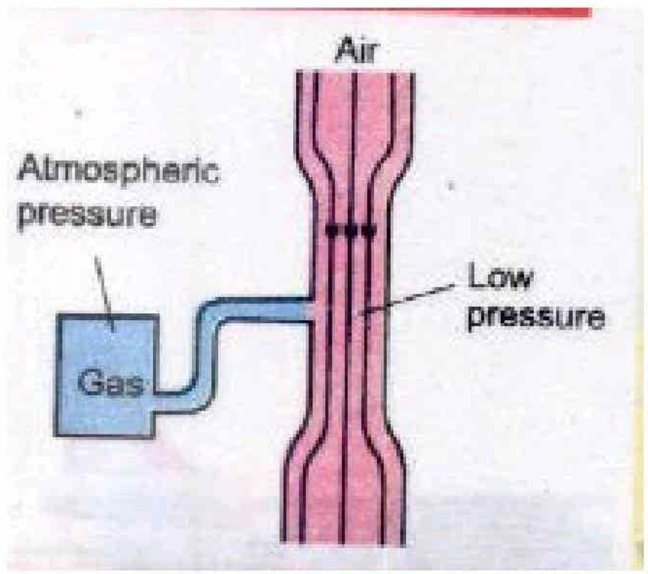
Ans: When the ball moves forwards as well as spins, the speed of air on its one side becomes greater as compared to the other. According to Bernoulli's equation;

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

So, at that side, the pressure of air decrease. A net force acts on the ball extra curvature to the ball called swing.

9. Explain the working of a carburettor of a motorcar using Bernoulli's principle.

Ans: The carburettor of a car engine uses a Venturi duct to feed the correct mature of air and fuel (Petrol) to the cylinders. Air is drawn through the duct and along the pipe to the cylinders. A tiny inlet at the side of duct is fed with petrol, the air through the duct moves very fast, creating low pressure in the duct, which draws petrol vapours into the air stream.



10. For what position will be maximum blood pressure (Systolic pressure) in the body having the smallest value. **(a) Standing Up** **(b) Sitting** **(c) Lying horizontal** **(d) Standing on one's head?**

Ans: Lying horizontal.

(a) Standing upright, systolic pressure has maximum value in the neck.

(b) Sitting, systolic pressure has maximum value in the neck.

(d) In this case, pressure has maximum value in the legs.

11. In an orbiting space station, would the blood pressure in major arteries in the leg ever be greater than the blood pressure in major arteries in the neck?

Ans: Blood pressure would be same.

Reason: -

In a orbiting space station, everything is in a state of weightlessness. So, pressure will be same in major arteries of both in neck and legs.