Write short answer questions of the following:

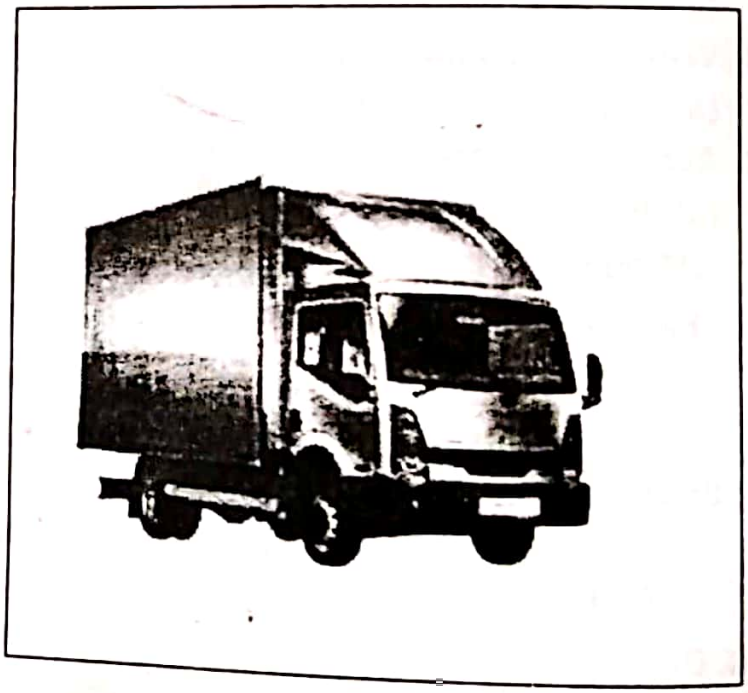
1. Smoke rises in a chimney faster when a breeze is blowing. Use Bernoulli's principle to explain this phenomena.

Ans. Since we know that the flow of any fluid depends upon the pressure difference between the two ends of any cross-section (chimney) therefore if there is a breeze blowing above the chimney i.e. if the speed of air at the upper point of the chimney increases, this will reduce the pressure at the upper end as compared to the lower end. So due to high pressure difference the smoke will flow (rises) faster from lower to upper end than when there is no breeze blowing. According to Bernoulli's equation in horizontal region, the change in $\Delta P.E \approx 0$, therefore;

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

i.e. increasing speed reduces the atmosphere pressure which causes the smoke to flow through the chimney at a faster rate.

2. Why do many trailer trucks use wind deflectors on the top of their cabs? How do such devices reduce fuel consumption?



Ans. Trailer trucks without wind deflectors suffer the following problems;

i. Fuel mileage is lowered due to air drag,
ii. Vehicle doesn't handle as good, and
iii. It's even less stable with any kind of wind

Using wind deflectors help lessen these problems by slightly changing a vehicle's aerodynamic contour. When wind hits the deflectors it is redirected over the open surface of the vehicle.

3. Consider the cross section of the wing on an aeroplane. The wing is designed such that the air travels faster over the top than under the bottom. Explain why there is a net upward (lift) force on the wing due to the Bernoulli's effect.

Ans. The wings of an aeroplane behave like horizontal regions to get $\Delta P.E \approx 0$, so

Bernoulli's equation become

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

When the aeroplane start moving upon the runway, the air travels much faster over top of the wing i.e. Vi increases which cause decrease in the pressure P_1 while the air travels slower below the wing and hence the pressure P_2 beneath the wing increases. Due to this pressure difference above and below the wing, a resultant up ward force is created normal or perpendicular to the flow. It is this force which provides the "lift" for the aeroplane.

4. When a fast – moving train passes a man standing on the platform at rest. He is likely to be drawn towards train. How does the Bernoulli's effect explain this phenomenon?

Ans. When a fast moving train passes a man standing on platform at rest, front of the train will take away the air along with it due to high speed and large size. This results in a huge pressure drop of air behind the train. Because from Bernoulli's equation in horizontal regions

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

i.e an increase in speed causes the drop of atmosphere pressure hence the surrounding air will rush towards the train with a high speed to fill in the empty space. Hence there is a chance that the person may also be pushed by this air flow towards the train and may get serious damage.

5. If you hold a sheet of paper and blow across the top surface, the paper rises. Explain.

Ans. If we hold a sheet of paper and produce a blow across its top surface i.e increases the speed of air at the top surface of the paper than as we know from Bernoulli's equation for this horizontal sheet

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

i.e increasing speed will produce a drop of pressure above the sheet. Hence due to difference in pressure the sheet of paper will experience a net upward force and therefore the paper will rise up due to Bernoulli's effect.

6. If you suddenly turn on your shower water at full speed, why is the shower curtain pushed inward?

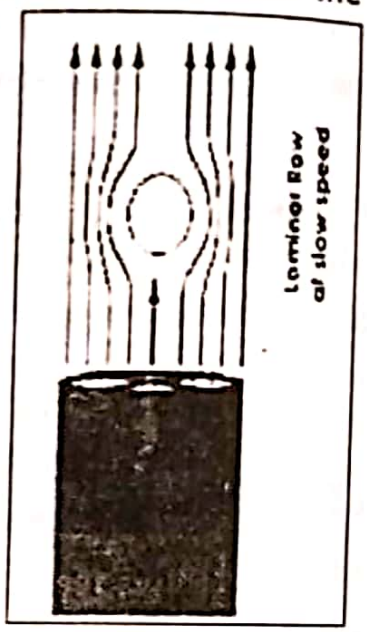
Ans. If we suddenly turn on our shower at full speed, the high speed shower water will fall downward and hence a pressure of air drop is produce above to fill this drop of pressure in accordance with Bernoulli's equation

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

The air from outside will rush inward and hence the shower curtain is also pushed inward by the inward coming air.

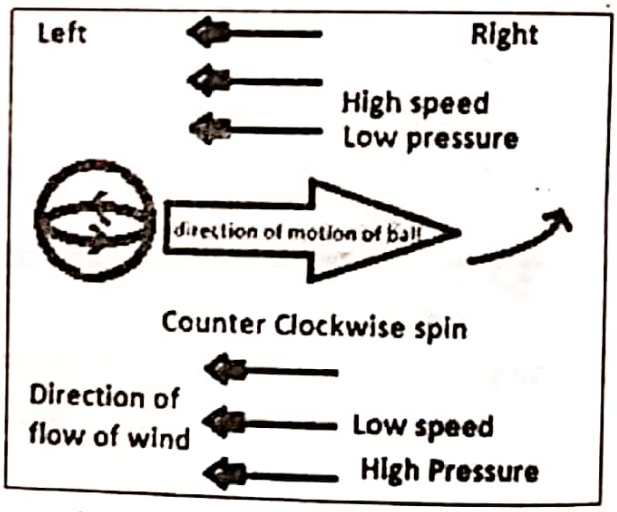
7. If air from a hair dryer is blown over the top of a ping – pong ball, it can be suspended in air. Explain how the ball can remain in equilibrium.

Ans. The air moving over the top of the ball will decrease the pressure above the ball, according Bernoulli's equation. The "hot" air moving over the top of the ball will decrease density of the air, which causes the pressure to decrease even more. Now the high pressure under the ball will produce a stronger force pushing the ball upward. When the force pushing upward is equal the weight of the ball, the ball will be "neutrally buoyant". So it is suspended in air.



8. A baseball moves past an observer from left to right spinning counterclockwise. In which direction will the ball tend to deflect?

Ans. Since the ball is moving past the observer from left to right so the flow of air across the ball will be from right to left. Also the spin of the ball is counter-clock wise. At the upper part, the spin motion is in the direction of air blow, so net force will increase causing a drop of pressure above the ball. While the spin motion below is opposite to air blow, causes decrease in net velocity, due to which the pressure below the ball increases. Due to this un-even pressure the ball will tend to deflect from high pressure side towards low pressure side. Therefore the ball will move away from the observer.



9. A spherical body is dropped in two different fluids and its terminal velocity is found to be different. Give the reasons.

Ans. The equation for terminal velocity is;

$$V_t = \frac{2\rho g r^2}{9\eta}$$

From above equation it is clear that $V_t \propto \frac{1}{\eta}$ i.e. the terminal velocity is inversely

proportional to the viscosity of the fluid. Since the given spherical body is dropped in to two different fluids, therefore the terminal velocity is different for both fluids. For instance, if one fluid is more viscous than other, then the terminal velocity in viscous fluid is less than the terminal velocity in less viscous fluid.

10. A liquid passed through a pipe and it was found that the rate of influx was equal to the rate of efflux. What information do you get about the liquid?

Ans. If the rate of influx i.e the amount (volume)of the fluid coming into the pipe per unit time (also called the volume flow rate) is the same as the rate of efflux i.e outgoing volume of the liquid per unit time i.e.

$$\frac{\Delta V_1}{\Delta t} = \frac{\Delta V_2}{\Delta t}$$

Then it means that the fluid is an ideal fluid i.e.

(1) It is non-viscous

(2) In non-compressible i.e. ρ = constant

(3) & its flow is laminar (or) stream line

11. An incompressible liquid is passed through a horizontal pipe and it is observed that the speed of a mass of liquid when emerges is greater than its speed when it enters the pipe. How can it be possible?

Ans. According to Bernoulli's equation in a horizontal region (pipe) a slow stream of an ideal fluid can be converted in a fast jet by narrowing the exit area. Also according to equation of continuity:

$$A_1V_1 = A_2V_2$$

$$\frac{A_1}{A_2} = \frac{V_2}{V_1}$$

When $A_2 < A1$ then $V_2 > V_1$.

i.e. the smaller is the cross-section area of the exit, the greater will be the speed of efflux.

12. Why does the pipe of paper squeezes when air is blown through it?

Ans. Since according to Bernoulli's equation or due to venture effect for horizontal regions

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

i.e. when air is blown through the pipe the speed V will increases which will produce a decrease of pressure inside the pipe of paper. When pressure inside the pipe become less than the external atmosphere pressure. The outside air will start exerting pressure on the pipe from all side to go inside the pipe in

order to normalize the pressure. Due to this external inward pressure the pipe of paper will squeezed.

13. When water falls from a tap, its cross-sectional area decreases as it comes down. Explain why?

Ans. As we know from equation of continuity that, the product of cross-sectional area A and fluid speed V for an ideal fluid always remain constant.

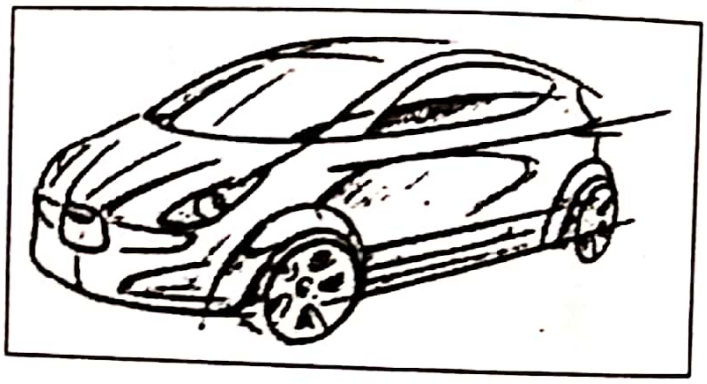
Mathematically:

$$A\,V = \text{Constant}$$

So as the water falls down due to gravitational pull its speed increases and to keep the product "AV=constant", the cross-sectional area of the water decreases.

14. Why a car has oblong shape design?

Ans. Since we know that when a body moves through some viscous medium like air an opposing force called as viscous drag must be offered to it. This drag force will depend upon the shape, size and speed etc. of the moving body through the fluid (air) or medium. This is why the shape of the cars are made oblong, because this minimize the drag force acting upon the car. Also making such oblong shapes the speed of the vehicles may be made better and it can also help to reduce the fuel consumption.



15. It is often seen that leaves lying on the road start following the fast moving car when it passes through the road. Why?

Ans. Since the road behave like a horizontal region with $\Delta P.E \approx 0$

So the Bernoulli's equation become

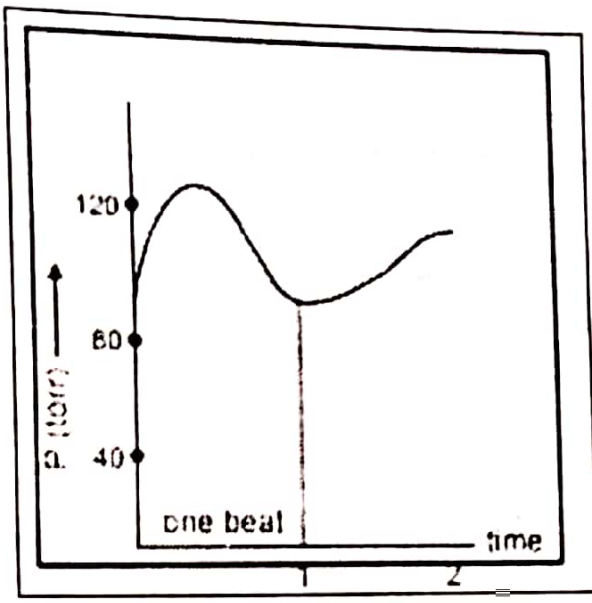
$$P + \frac{1}{2}\rho V^2 = \text{Constant}$$

Now when a fast moving car pass by road then due to its high speed it will take away air from that region with itself and we get a pressure drop behind the car. To fill the vacant region, the air from surrounding areas will rush in the direction of car and the leaves etc. lying on the road also start following the car.

16. How do the pulsations in pulse show the heart beat?

Ans. Pulsation means the change of the pressure of the blood in body vessels during

heart-beats. The heart pumps the blood in vessels and hence the blood pressure increases. The blood pressure is minimum when the heart is silent i.e. not pumping. The variation in the blood pressure is normally from high pressure of 120 torr called systolic pressure to a low pressure of about 75-80 torr called diastolic pressure. Hence pulsations in pulse show the heart beat.



17. Describe the working of an engine carburetor and paint spray.

Ans. refer to theory.