

Conceptual Fluid Mechanics

- Q.1 explain why an air bubble grows in size as it moves from bottom to top in water?
 A.1 All the fluids have tendency to move from higher pressure to the lower pressure side. As the pressure in water is more at the bottom than at the top therefore it rises upwards in direction of decreasing pressure. According to Boyle's law $PV = \text{constant}$, if pressure decreases volume should increase thus radius increases for bubble.
- Q.2 Water flows faster than honey. Why?
 A.2 Water flows faster because rate of flow of liquid through a pipe is inversely proportional to the coefficient of viscosity. As honey has larger value of η , therefore it flows slower or smaller rate.
- Q.3 Machine parts are jammed in winter. Why?
 Machine parts are hammed in winter because the coefficient of viscosity of lubricant increases with the decrease in temperature. Thus it results in jamming.
- Q.4 A bigger rain drop falls faster than smaller one. Why?
 A.4 After falling certain distance through the atmosphere the raindrops acquire terminal velocity. The magnitude of the terminal velocity is directly proportional to the square of radius of the drop. Thus larger drop will have greater terminal velocity relative to smaller parts.
- Q.5 How do viscosity of liquids and gasses changes with temperature?
 A.5 The viscosity of liquid decreases with the rise in temperature. Thus as the temperature rises the viscosity will falls
 For all the gases increase in temperature results in increase in viscosity of the gas.
- Q.6 Explain the difference between solid friction and viscosity.
 A.6 Both solid friction and viscosity opposes the relative motion but the main difference are
 [a] Solid friction is directly proportional to the normal reaction whereas the fluid friction is independent of the normal reaction.
 [b] Solid friction is independent of the area of contact between the surfaces whereas the fluid friction is directly proportional to the area of contact between the surfaces.
- Q.7 rain drops falling under gravity don't acquire very high velocities. Why?
 A.7 This happens because as the rain drops fall, the viscous drag acts on them and its direction is opposite to the direction of motion of the drop. The magnitude of viscous force increases with increase in velocity. Thus, a stage is reached where the viscous drag balances the weight of the body in fluid and it starts moving with constant velocity called terminal velocity.
- Q.8 Why does velocity of water increases when it enters a narrower pipe from a broader pipe?
 A.8 In a stream of liquid flowing , the rate of flow of liquid flow is given by equation of continuity i.e. $av = \text{constant}$. Thus, if area of the pipe decreases the velocity should increase so that av remains constant.
- Q.9 What happens to the pressure of the liquid when it enters a region where the speed increases?
 A.9 According to energy conservation if the speed of the fluid increases the pressure is going to decrease in that region.
- Q.10 According to Bernoulli's theorem, the pressure of water should remain uniform in a pipe of uniform radius. But actually it goes on decreasing, why it is so?
 A.10 As water flows through the pipe viscous drag acts on it. Some work has to be done to move the water which results in decrease in pressure energy. It is due to this reason that house

located at large distance from water tank receives water at lower pressure than the house located closer to water tank.

Q.11 two streamlines never cut each other. Why?

A.11 Two stream lines should never cut each other as the tangent to the streamline gives us the direction of the fluid flow. If they intersect than at the point of intersection their will be two directions of fluid flow which is never possible.

Q.12 Still water runs deep. Why?

A.12 This is in accordance with equation of continuity, if the area of cross section is large the velocity will be small.

Q.13 Two boats moving parallel to each other and near are pulled towards each other why?

A.13 When two boats are moving parallel to each other and close, the velocity of water between the two boats increases, thus decreasing pressure between the two boats. As pressure on the other side of boat is large they experience an inwards force and are pulled inwards.

Q.14 What is effect on the equilibrium of the physical balance when air is blown below one pan?

A.14 Due to air blown below one of the pan, the pressure below that pan decreases and it experiences a downward force. Thus, the pan will go down if air is blown underneath it.

Q.15 What is terminal velocity of the body in a freely falling system?

A.15 As the terminal velocity is directly proportional to the acceleration of the body, thus for freely falling system acceleration due to gravity is zero and terminal velocity is also zero.

Q.16 The diameter of ball A is twice the diameter of ball B. what is the ratio of the terminal velocity of the balls?

A.16 The terminal velocity of the balls is directly proportional to the square of radius, thus if radius ratio is 2:1, the ratio of terminal velocity is 4:1

Q.17 When air is blown between the two balls suspended in air, they attract each other. Why?

A.17 When air is blown between the two balls, it will result in fall in pressure between the two balls. Thus, a pressure difference exists between the two sides of the balls and they are attracted inwards.

Q.18 The hotter liquid flows faster than a colder liquid. Why?

A.18 Hotter liquid flows faster because of its smaller coefficient of viscosity. We know that if the temperature of the liquid rises the coefficient of viscosity is going to decrease.

Q.19 In instead of fresh water sea water is filled in a container. Will the velocity of efflux change?

A.19 No velocity of flux does not depend on the density of the liquid, it depends only on the height of water column above the orifice and the acceleration due to gravity. Thus it will be same for sea water and fresh water.

Q.20 The velocity of river is less on the banks than in the middle. Why?

A.20 The river flows in the form of streams. The forces of adhesion are less on the streams in the middle than those near the banks. Due to which the velocity of streams near the banks is least and is maximum in the middle of the river.

Q.21 What is meant by critical velocity of the liquid?

A.21 The velocity of liquid above which the streamline flow changes into turbulent flow is called critical velocity of the liquid.

Q.22 It is not advised to stand near a fast moving train on the platform. Why?

- A.22 When train moves at a high speed, the air streams near the train also start moving with high velocity. Thus pressure between person standing near train and the train will decrease. The pressure on other side of the person is large. Thus force acts on the person towards the train.
- Q.23 How will the weight of the body be affected when it falls through the viscous medium with terminal velocity?
- A.23 If body is moving with terminal velocity, the net force on the person is zero as the weight acting downwards is balanced by the upthrust and viscous drag. Thus effective weight of the person will be zero.
- Q.24 A small sphere of mass m is dropped from a height. After it has fallen through 100m it acquires terminal velocity and then continue to move at that speed. The work done by air friction in first 100m is W_1 and the next 100m is W_2 , then compare W_1 and W_2 .
- A.24 Since viscous force is directly proportional to the velocity, the average velocity in first 100m is less than the velocity in next 100m. Thus viscous force as well as work done will be more in next 100m.
- Q.25 Flags flutter in breeze. Why?
- A.25 When air is blowing, the air layer moves with unequal velocity on two sides of the cloth of the flag. Thus there will be unequal pressure on both the sides which results in fluttering of flag.
- Q.26 When a drop of water is split into large number of drops, the change total potential energy of small drops and the potential energy of bigger drop is zero, positive or negative.
- A.26 Positive change takes place, because on splitting a big drop the surface area of drops increases and hence work has to be done in doing so as increase in surface area implies increase in surface energy.
- Q.27 What is the work done in blowing a soap bubble of radius S and surface tension T ?
- A.27 If soap bubble of radius r is formed its area is $8\pi r^2$, thus work done in blowing the soap bubble is $8\pi r^2 T$.
- Q.28 What will be the effect on angle of contact of the liquid if the temperature increases?
- A.28 With the increase in temperature the surface tension of the liquid decreases. Due to this the liquid surface appears flatter and thus angle of contact increases.
- Q.29 when shaving brush is taken out of water its hair cling. Why?
- A.29 Due to surface tension, the water forms a film between the hairs of brush. This water film tends to contract to acquire the minimum surface area thus the brush hairs tends to cling.
- Q.30 Water can rise upto a height of 10cm in a given capillary tube. If the capillary tube is of same diameter but of length 6cm is held vertically in water, will the water come out in the form of fountain? Explain.
- A.30 In case of capillary rise phenomenon Jurin's law is applicable which means that product of h and r is always constant. If height of capillary tube is insufficient the radius of curvature increases but liquid never overflows.
- Q.31 Why does the cotton wick in an oil filled lamp keep on burning?
- A.31 In the cotton wick there are large number of capillaries, oil rises through the capillaries and burn.
- Q.32 What is the effect of impurities on the surface tension of water?
- A.32 Impurities can be of two types soluble and insoluble. When a soluble impurity is added to water it increases the surface tension of water, but partially soluble impurity when dissolved in water decreases the surface tension of water.

- Q.33 In soldering addition of flux makes soldering easy. Why?
A.33 When flux is added the molten tin will have smaller surface tension. If surface tension is low it spreads more uniformly over the surface and soldering is easier.
- Q.34 Surface tension of lubricating oils and paints if kept low, why?
A.34 Paints and lubricating oils are of good quality if small amount spreads over a large region. If the surface tension is low liquids tends to spread more.
- Q.35 Why some oil spreads uniformly on water, when others float as drops?
A.35 The force of surface tension of some oils is less than the surface tension of water. These oils when poured on the surface of water are pulled from all directions due to higher forces of surface tension of water and as such they spread uniformly. But if the surface tension of oil is greater than water they float as drops.
- Q.36 Why the tip of the nib of pen is split?
A.36 The tip of the nib of pen is split in order to provide a capillary tube which helps ink to rise to the end of the nib and enables smooth writing.
- Q.37 Put a piece of chalk in water. The chalk will emit bubbles in all directions. Explain this phenomenon.
A.37 A chalk has pores in all directions which acts as narrow capillaries. When a piece of chalk is immersed in water, the water enters into these capillaries and forces the air out in the form of bubbles in water.
- Q.38 A shot is obtained by pouring molten lead through narrow holes into water from certain height. The falling lead solidifies and takes the form of small spheres. Explain the phenomenon.
A.38 The molten lead comes out of narrow hole in the form of stream of lead. When it falls from height into water, it breaks into spherical drops due to surface tension. These are cooled on entering water and thus solidify into small spheres.
- Q.39 A block of wood floats in a bucket of water. Will the block sink more or less if the lift is accelerating up?
A.39 A block of wood will neither sink more nor less, because when lift accelerates up or down in both the cases the variation in g takes place. This effects both weight and upthrust equally. If lift accelerates upwards both weight and upthrust increases but volume of wood under water remains unchanged.
- Q.40 Why bits of camphor dance on the surface of water?
A.40 When bits of camphor are dropped on water, they lower the surface tension where they are dipping and as camphor is of irregular shape, unequal forces of surface tension acts on them. Due to these unbalanced forces they appear to dance on the surface of water.
- Q.41 It is better to wash clothes in hot soap solution. Why?
A.41 The force of surface tension decreases by heating the soap solution therefore it spreads more easily on the clothes as compared to cold soap solution. Thus washing of clothes becomes easier.