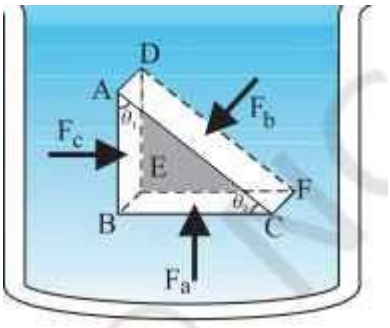
C.B.T. DECEMBER-2023
CLASS-XI (PHYSICS)

SYLLABUS COVERED: Properties of Bulk Matter
Chapter–10: Mechanical Properties of Fluids

CASE-STUDY-1

The French scientist Blaise Pascal observed that the pressure in a fluid at rest is the same at all points if they are at the same height. This fact may be demonstrated in a simple way. shows an element in the interior of a fluid at rest. This element ABC-DEF is in the form of a right-angled prism.



This prismatic element is very small so that every part of it can be considered at the same depth from the liquid surface so the effect of the gravity is the same at all these points. The forces on this element are those exerted by the rest of the fluid and normal to the surfaces of the element . Thus, the fluid exerts pressures P_a , P_b and P_c on this element of area corresponding to the normal forces F_a , F_b and F_c as shown in Fig on the faces BEFC, ADFC and ADEB denoted by A_a , A_b and A_c respectively. Then $F_b \sin\theta = F_c$, $F_b \cos\theta = F_a$ (by equilibrium) $A_b \sin\theta = A_c$, $A_b \cos\theta = A_a$ (by geometry)

$$\frac{Fa}{Fb} = \frac{Fb}{Fb} = \frac{Fc}{Fc}$$

$= P_a = P_b = P_c$

So pressure exerted is same in all directions in a fluid at rest.

Q.1 The Pascal law states that liquid at rest applies pressure at a point is _____ in all directions.

a) Same
b) Un-same
c) Not matching
d) Matching but not equal

Ans: -(a)

Explanation:

The Pascal law states that the liquid at rest applies pressure at a point is the same in all directions. This means that the pressure is there in spite of the direction. And it is present in the same direction and is having the same magnitude.

Q.2 **Two syringes of different cross-sections (without needles) filled with water are connected with a tightly fitted rubber tube filled with water. Diameters of the smaller piston and larger piston are 1.0 cm and 3.0 cm respectively. Find the force exerted on the larger piston when a force of 10 N is applied to the smaller piston**.

(a) 60N
(b) 90N
(c) Same
(d) Unequal

Answer: (b) Since pressure is transmitted undiminished throughout the fluid,

$F2=\frac{A2\ F1}{A1}$

Q.3 A hydraulic system is used to lift a 2000 kg vehicle in an auto garage. If the vehicle sits on a piston of area 0.5 square meter, and a force is applied to a piston of area 0.03 square meters, what is the minimum force that must be applied to lift the vehicle?

(a) 120 N
(b) 550 N
(c) 1176 N
(d) 1200 N

Ans C. 1176 N

The force exerted on the larger piston can be calculated using the formula: force = pressure x area. The pressure exerted on the larger piston is the same as the pressure exerted on the smaller piston, as they are connected by a hydraulic fluid. Therefore, the force exerted on the larger piston is (force on smaller piston) x (area of larger piston / area of smaller piston). Plugging in the values given, we get: force = (force on smaller piston) x (0.5 square meters / 0.03 square meters) = (force on smaller piston) x 16.67. Solving for the force on the smaller piston, we find that it must be at least 1176 N in order to lift the vehicle.

Q.4 Which of the following is true about the hydraulic system?

(a) The pressure exerted on a smaller piston is greater than on the larger piston.

(b) The pressure exerted on a larger piston is greater than on the smaller piston.
(c) The pressure exerted on a small piston is equal to that on the larger piston.

(d) No statement is true

Answer

C. The pressure exerted on a small piston is equal to that on the larger piston.

Q.5 Assertion: Pascal's law is the working principle of a hydraulic lift.
Reason: Pressure is thrust per unit area.

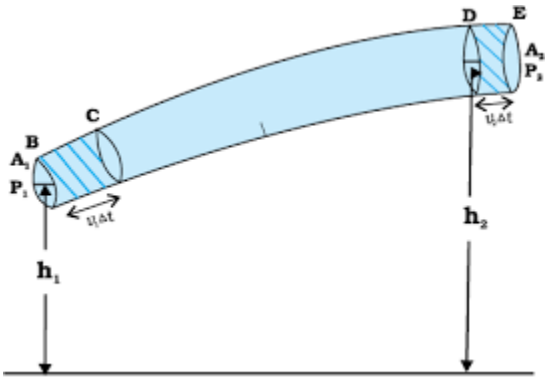
A. Both assertion and reason are correct and reason is the correct explanation for assertion.
B. Both assertion and reason are correct and reason is not the correct explanation for assertion.
C. Assertion is correct but reason is incorrect.
D. Assertion is incorrect but reason is correct.

Answer B

the correct option is B.

CASE-STUDY-2

Consider a fluid moving in a pipe of varying cross-sectional area. Let the pipe be at varying heights as shown in Fig.



We now suppose that an incompressible fluid is flowing through the pipe in a steady flow. Its velocity must change as a consequence of equation of continuity. A force is required to produce acceleration .Bernoulli's equation is a general expression that relates the pressure difference between two points in a pipe to both velocity changes (kinetic energy change) and elevation (height) changes (potential energy change).

Q.6 **Consider a tank of height 20m filled with liquid of density 100kg/m3. The area of tank is 10m2. If the tank has a hole of area 2m^2 at the bottom, find the speed of the liquid flowing out through the hole when the height of liquid in the tank is 10m . Assume speed of liquid descending at top of tank is 5m/s.**

a) 20m/s
b) 14.14m/s
c) 15m/s
d) 20.615m/s

Answer

C. 15m/s

Explanation: We can't consider the speed of efflux to be $\sqrt{2gh}$ as the areas are comparable. So, we use Bernoulli theorem between the top of the tank and the hole. Pressure at the top of tank and hole will be same, equal to P_0, since both are exposed to the atmosphere.

$$P_0 + \rho gH + \frac{1}{2}\rho v_1^2 = p_0 + \frac{1}{2}\rho v_2^2$$

$$v_2 = \sqrt{2\left(gh + \frac{v_1^2}{2}\right)}$$

$$v_2 = \sqrt{2\left(10 \times 10 + \frac{25}{2}\right)}$$

$$v_2 = 15 m/s$$

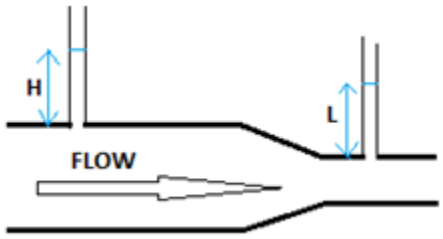
Q.7 **The speed of efflux, in case of a tank with a hole at the bottom, depends upon which of the following factors? Assume that the area of the tank is > > area of hole.**

a) area of tank
b) density of liquid
c) height of hole from liquid
d) atmospheric pressure value

Answer:

Explanation: Given that the area of the tank is > > area of hole, we can use the formula v = $\sqrt{2gh}$. This shows that speed depends only on acceleration due to gravity and height of hole from the surface.

Q.8 **What will be the relation between H & L?**



a) H = L
b) H > L
c) H < L
d) depends on the horizontal distance between the two tubes

Answer: - Answer: b

Explanation: By using Bernoulli's equation P + ρgh + 1/2ρv² = constant,

we can say that more the velocity less is the pressure at the same horizontal level.
Height of liquid in the tube will be proportional to pressure at that point in the venturi tube.
So, H > L.

Q.9 **A cylindrical tank of Height H has a hole on its side. It is kept on a flat surface. Assuming that hole's area is much smaller than the area of the tank, what should be the distance of the hole below the top surface so that water coming out of the hole travels the maximum horizontal distance at the instant when the height of water is H?**

a) H
b) H/3
c) H/2
d) same for all positions
Answer: c
Explanation: Let the hole be at a height x below the top surface.
The distance of hole from the ground will be H-x.
Speed of efflux 'v' = $\sqrt{2gh}$.
Let the time taken for water to reach the ground be 't'. H-x = 1/2gt^2.

$$t = \sqrt{\frac{2(H-x)}{g}}$$

For maximum range, v*t should be maximum.

$$\frac{d}{dx}\sqrt{\frac{2(H-x)}{g}} = 0$$

The numerator should be zero but denominator should be non-zero.
∴ H ≠ x (for denominator to be non-zero)
∴ H = 2x OR x = H/2.

Q.10 Assertion: The velocity of flow of a liquid is smaller when pressure is larger and vice-versa.

Reason: According to Bernoulli's theorem, for the streamline flow of all ideal liquid, the total energy per unit mass remains constant.

A

If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
B

If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
C

If Assertion is correct but Reason is incorrect.

D

If Assertion is incorrect but Reason is correct.

Answer

D If Assertion is incorrect but Reason is correct.
