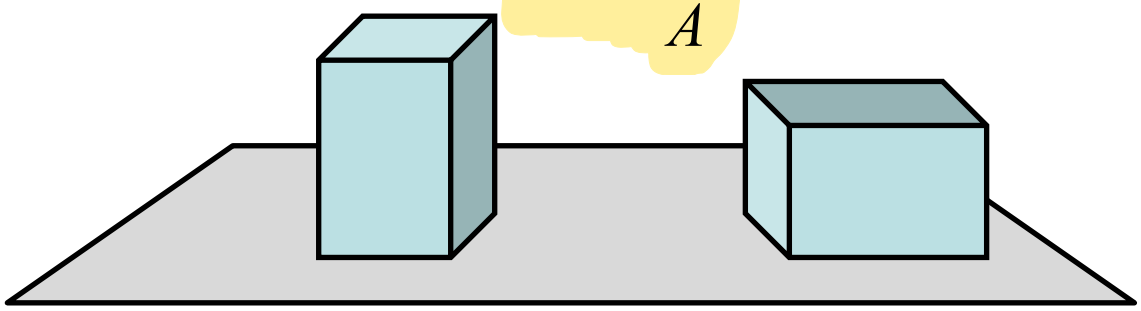
Fluid Mechanics

Pressure

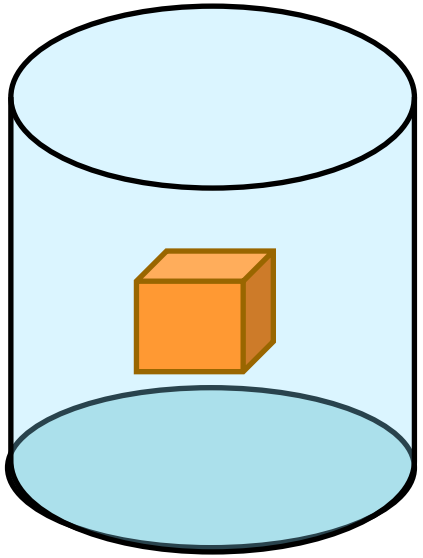
$$P = \frac{F}{A}$$

$$1\,Pa = 1\,N/m^2$$

$$P = \frac{mg}{A}$$



How many pressure forces are there on the block?

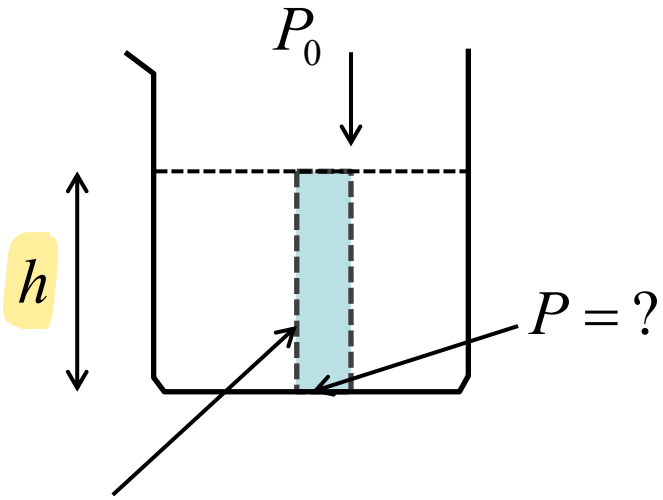


$1\,\text{atm}_{\text{sphere}} = 760$ Torr

Fluid Mechanics

Variation of Pressure with Depth

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



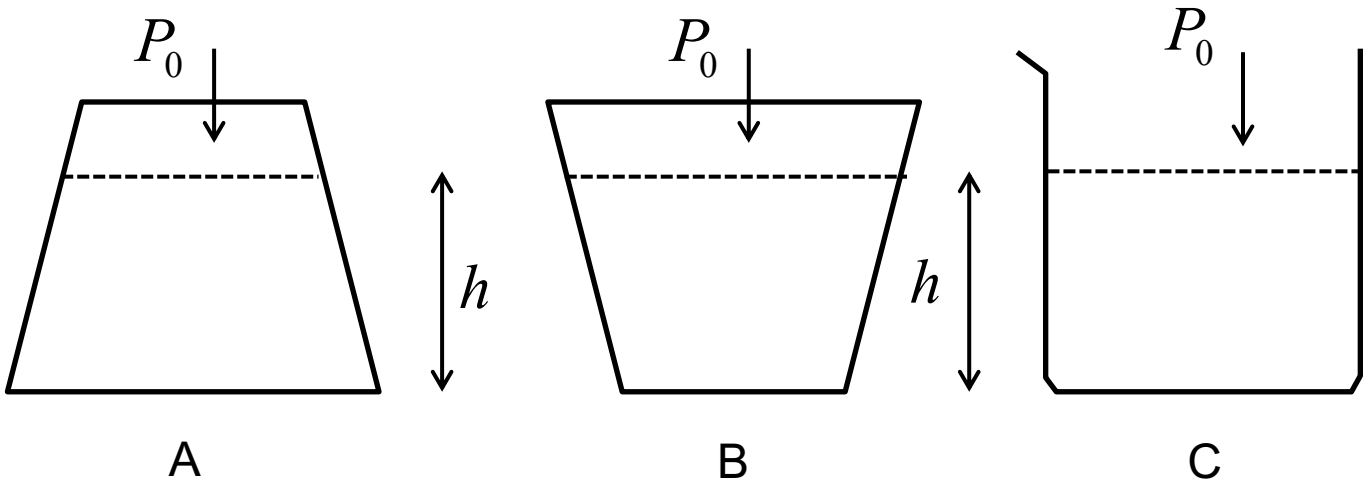
$$Volume = Ah$$

$$F_{weight} = mg = \rho Vg = \rho Ahg$$

$$F_0 = P_0 A$$

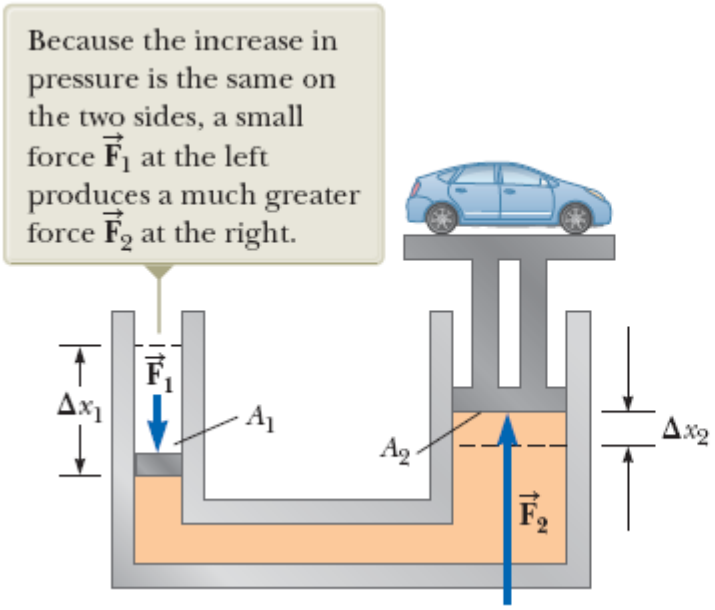
$$P_{bottom} = \frac{F_{weight} + F_0}{A} = \rho gh + P_0$$

Three open containers are filled with water to the same height. How does the pressure of the water on the bottom of the container compare?



a. A=B=C
b. A>B>C
c. B>C>A
d. C>A>B
e. A>C>B
f. B>A>C
g. None of the above

Application: hydraulic system



$$P_1 = P_2$$

$$F_2 = PA_2 > F_1 = PA_1$$

Fluid volume is conserved:

$$A_1\Delta x_1 = A_2\Delta x_2$$

$$\Delta x_1 > \Delta x_2$$

Pascal's law: a change in the pressure applied to a fluid is transmitted undiminished to every point of the fluid and to the walls of the container.

Measuring Pressure

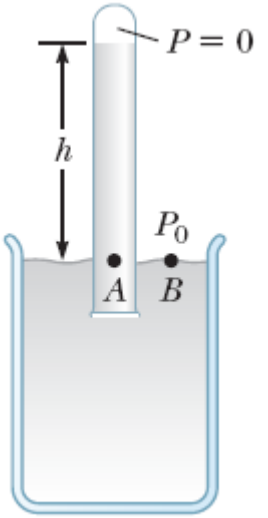
$$P_A = P_B = P_0$$

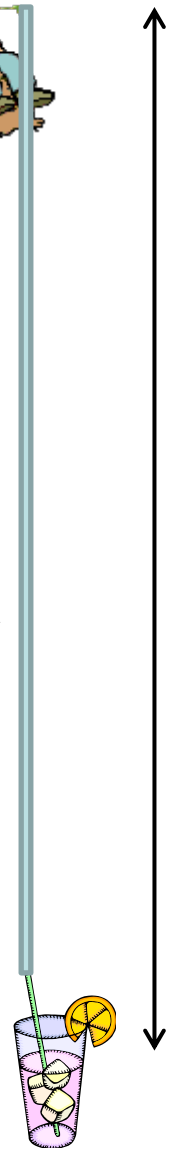
$$P_A = \rho g h = P_0$$

If using water:

$$\rho g h = P_0$$

$$h = \frac{P_0}{\rho g} = \frac{1.013 \times 10^5 \ Pa}{(1 \times 10^3 \, kg/m^3)(9.80 m/s^2)} = 10.34 \ m$$

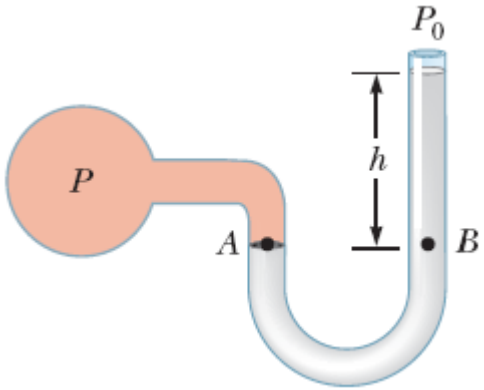




$$h = 10.34 \ m$$

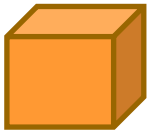
$$\approx 34 \ ft$$

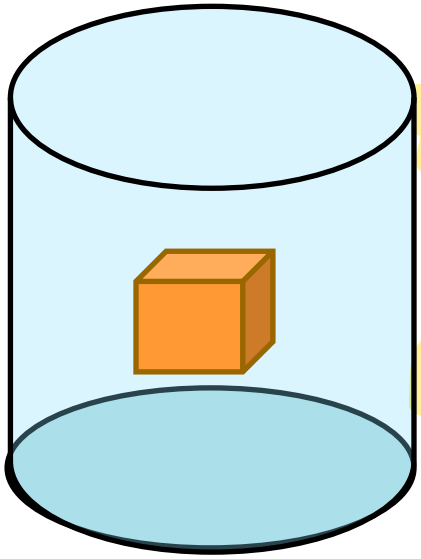
$$P_A = P_B = P_0 + \rho g h$$



Buoyant Forces and Archimedes's Principle

$$F_1 = P_1 A$$





$$F_2 = P_2 A = (P_1 + \rho g h) A$$

$$= F_1 + \rho g h A$$

How many pressure forces are there on the block?

Six in total – four of the horizontal ones cancel

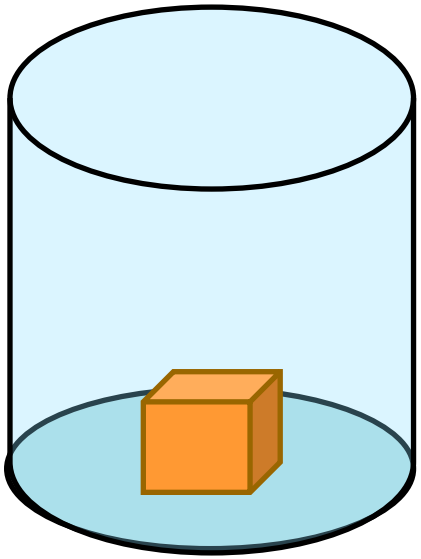
$$F_{buoyancy} = F_2 - F_1 = \rho g h A = \rho g V_{disp}$$

$$F_{buoyancy} = g M_{disp\_fluid} \qquad \textit{weight of the displcaced fluid}$$

Buoyant Forces and Archimedes's Principle

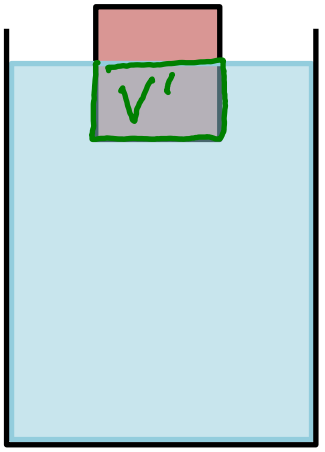
If the block tightly sit on the bottom of the container, what is the buoyant force?

No buoyant force

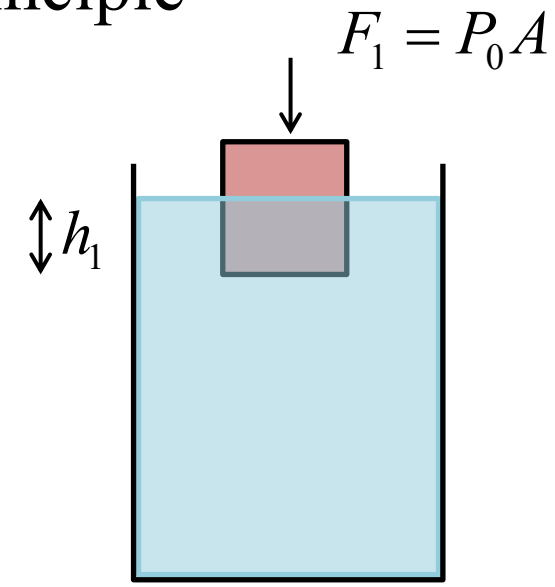


Buoyant Forces and Archimedes's Principle

If the block float on surface, what is the buoyant force?



Buoyant Forces and Archimedes's Principle



If the block float on surface, what is the buoyant force?

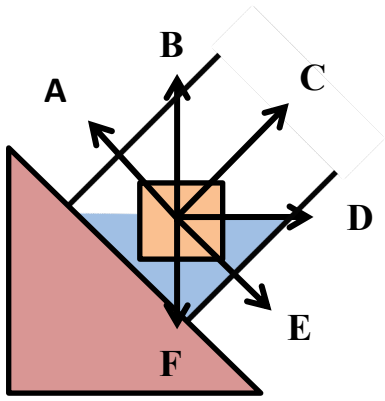
$$F_{buoyancy} = F_2 - F_1 = \rho g h_1 A = \rho g V_{disp}$$

$$F_1 = P_0 A$$

$$F_{buoyancy} = F_2 - F_1 = \rho g h_1 A = \rho g V_{disp}$$

$$F_{buoyancy} = m_{block} g$$

A wooden block floats in water in a tank which is glued to an inclined plane on the surface of Earth (image on the right). Which arrow points in the direction of the net force on the block?



a) A
b) B
c) C
d) D
e) E
f) F
g) None of the above