NO Reading assignment

H.w Due today

Bonus H.w available
(can go over 100% in H.w)

O2L updated

Properties of pressure in a fluid

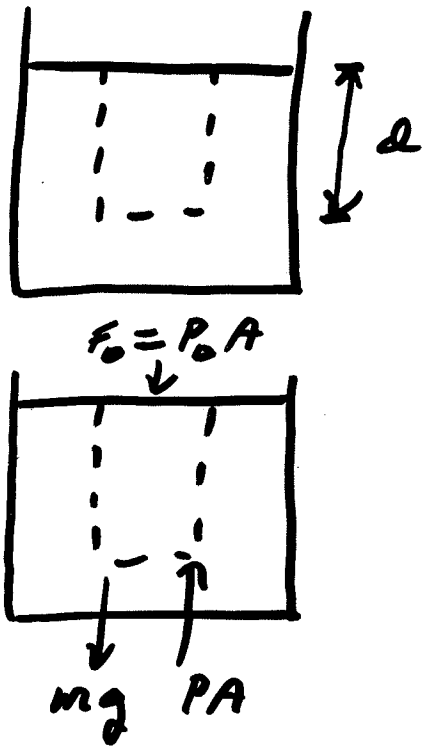
1) At any point that a fluid is in contact with a surface, the pressure is exerted perpendicular to surface

2) At any point inside a fluid, pressure is directed in all directions with same magnitude

3) Pressure at any point depends only on the depth of the point

Suppose there is a volume of fluid with a uniform density which has a depth d and area A

what forces act on this volume of fluid?



$$\Sigma F_y = 0$$

$$PA - mg - P_0 A = 0$$

$$PA - \rho V g - P_0 A = 0$$

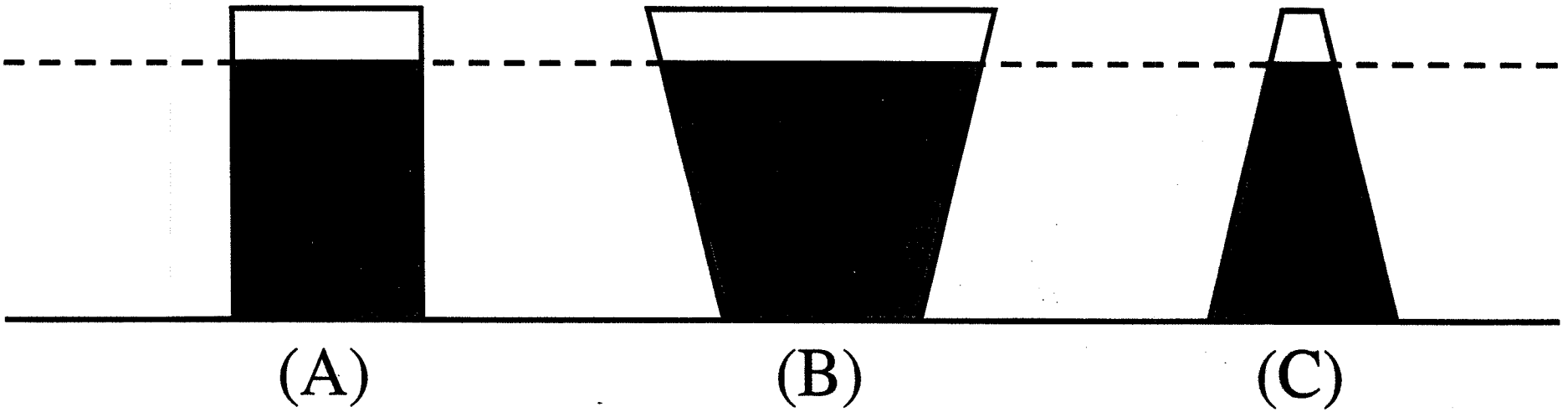
$$PA - \rho d A g - P_0 A = 0$$

$$P - \rho d g - P_0 = 0$$

$$\boxed{P = P_0 + \rho g d}$$

Interactive Question

Three drinking glasses all have the same area base and are all filled to the same level. Which glass has the greatest liquid pressure at the bottom?

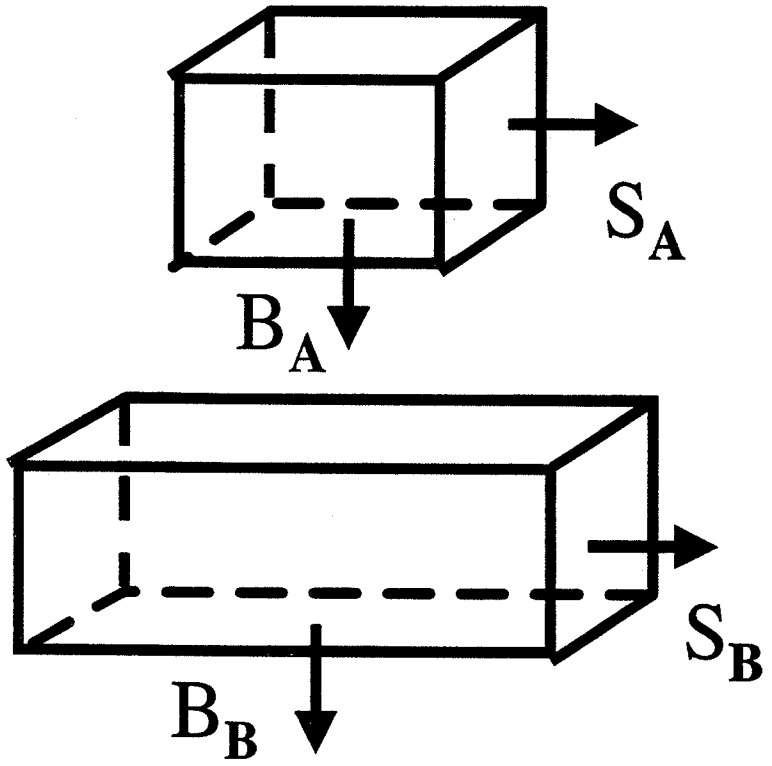


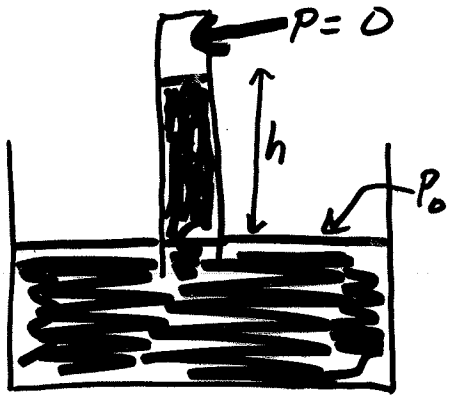
A) Glass A
B) Glass B
C) Glass C
D) All have the same pressure

Interactive Question

Consider two fish tanks that are the same height and the same width. Tank **A** is 3 feet long and tank **B** is 6 feet long. S_A is the force on the side of tank **A**, and S_B is force on the side of tank **B**. B_A is the force on the bottom of tank **A**, and B_B is force on the bottom of tank **B**. Which statement below is true?

A) $S_A = S_B$ and $B_A = B_B$
B) $S_A = 2S_B$ and $B_A = B_B$
C) $2S_A = S_B$ and $2B_A = B_B$
D) $S_A = S_B$ and $2B_A = B_B$
E) $S_A = 2S_B$ and $B_A = 2B_B$





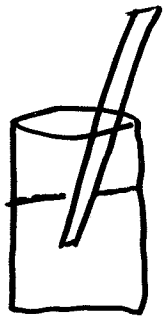
measurements of pressure

$P_o = \rho g h$

for mercury at atmospheric pressure $P_o \approx 760\,mm$

water $P_o \approx 10.3\,m$

Can I suck water through a straw 15 m long?



NO

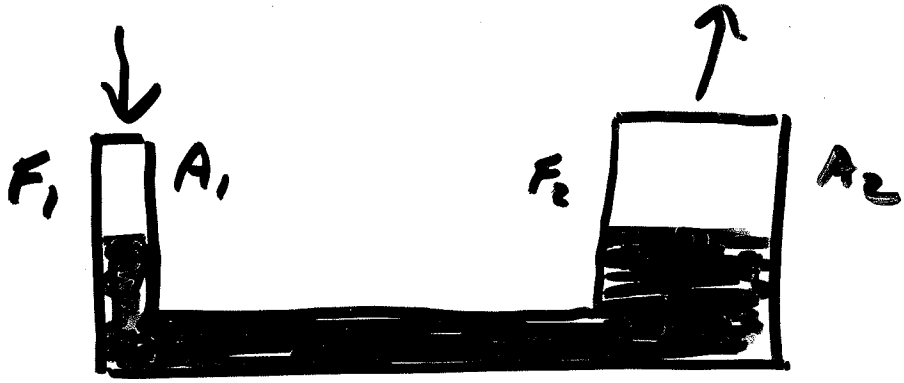
Pascal's principle

$$P = P_0 + \rho g h$$

IF external pressure increases, total pressure increases by same amount

Pressure applied to a confined fluid increases the pressure throughout by the same amount

hydraulic lift



$$P_1 = \frac{F_1}{A_1} \qquad P_2 = \frac{F_2}{A_2}$$

Pascal's principle $\Rightarrow P_1 = P_2$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \boxed{F_2 = F_1 \left(\frac{A_2}{A_1}\right)}$$

if $A_2 > A_1$ $F_2 > F_1$

ex] A hydraulic press is used in a trash compactor

radius of input piston = 6.4×10^{-3} m

radius of output piston = 5.1×10^{-2} m

If input force is 330 N, what is output force?

$$F_2 = F_1 \left(\frac{A_2}{A_1} \right)$$

$$F_2 = (330\text{N}) \left(\frac{\pi (5.1 \times 10^{-2}\text{m})^2}{\pi (6.4 \times 10^{-3}\text{m})^2} \right)$$

21,000 N

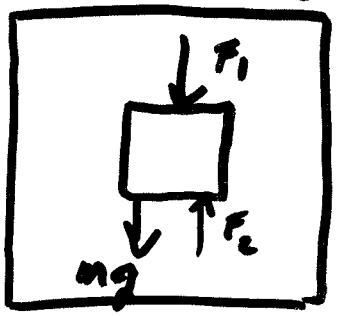
Buoyancy

Any object partially or totally submerged in a liquid has a buoyant force

⇒ Archimedes' principle

Any body completely or partially submerged in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the body

object submerged in a liquid



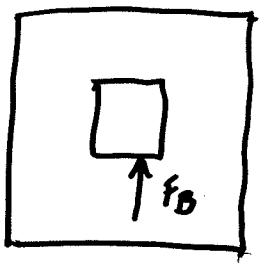
$$\begin{aligned}\Sigma F_y &= F_2 - F_1 - mg \\ &= P_2 A - P_1 A - mg \\ &= \rho g h_2 A - \rho g h_1 A - mg \\ &= \rho g A (h_2 - h_1) - mg \\ &= \rho g V - mg \\ &= m_f g - mg \\ &\uparrow \\ &F_B\end{aligned}$$

$$F_B = W_{fluid} = m_{fluid} g = \rho_f V_f g$$

Buoyancy

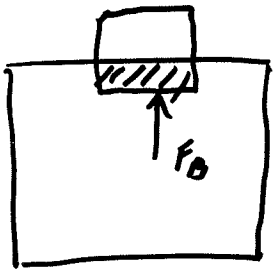
object which is submerged in a fluid

$$F_B = \rho_f V_{object} g$$



object is floating in a liquid

$$F_B = \rho_f V_f g$$



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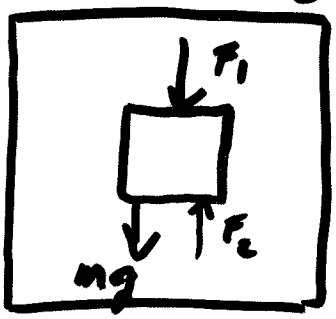

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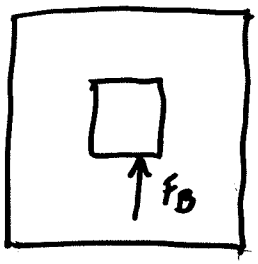

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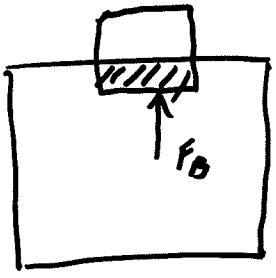


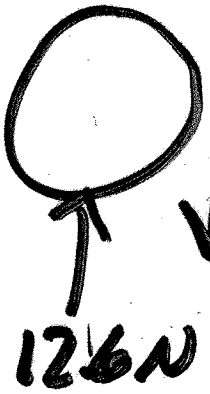
Ex) What is buoyant force on a balloon filled with $1.0\ m^3$ Helium at sea level?

b) what is gravitational force on the balloon?

a) $F_B = \omega_f = \rho_A V_A g = \rho_A V_{balloon} g$

$(1.29\ kg/m^3)(1\ m^3)(9.8\ m/s^2)$

$= \boxed{12.6\ N}$



b) $F_g = mg = \rho_{He} V_{He} g$

$(.179\ kg/m^3)(1\ m^3)(9.8\ m/s^2)$

$\boxed{1.75\ N}$