BONUS H.W Due today

NO office hours today

updating webct prior to final

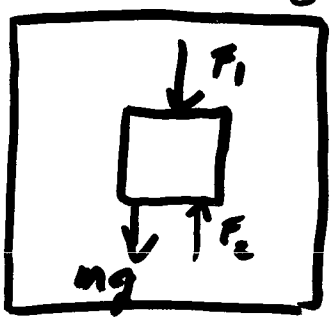
Buoyancy

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



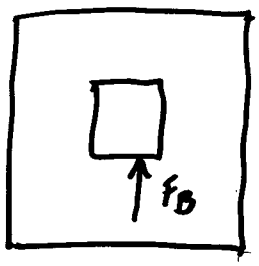
$$\begin{aligned}\Sigma F_y &= F_2 - F_1 - mg \\ &= P_2 A - P_1 A - mg \\ &= \rho g h_2 A - \rho g h_1 A - mg \\ &= \rho g A (h_2 - h_1) - mg \\ &= \rho g V - mg \\ &= m_f g - mg \\ &\uparrow \\ &F_B\end{aligned}$$

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

Buoyancy

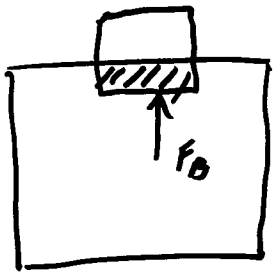
object which is submerged in a fluid

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



object is floating in a liquid

$$F_B = \rho_f V_f g$$



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) $F_B = \rho_A V_A g$

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

$= 12.6\ N$

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

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

$= 1.75\ N$

Interactive Question

A boat carrying a large boulder is floating on a lake. The boulder is thrown overboard and sinks. The water level in the lake, with respect to the shore

A) rises.
B) drops.
C) remains the same.

Interactive Question

Consider an object that floats in water but sinks in oil. When the object floats in water, half of it is submerged. If we slowly pour oil on top of the water so it completely covers the object, the object

A) moves up.
B) stays in the same place.
C) moves down.

ex) If a crown weighed on a scale is 9.8N and crown weighed in water is 9.0N, is crown pure gold?

$F_B = m_w g = \rho_w V_w g = \rho_w V_c g$

① $g V_c = \frac{F_B}{\rho_w}$

$w_c = m_c g = \rho_c V_c g$

② $g V_c = \frac{w_c}{\rho_c}$

① = ②

$$\frac{F_B}{\rho_w} = \frac{w_c}{\rho_c}$$

$$\rho_c = \frac{w_c \rho_w}{F_B}$$

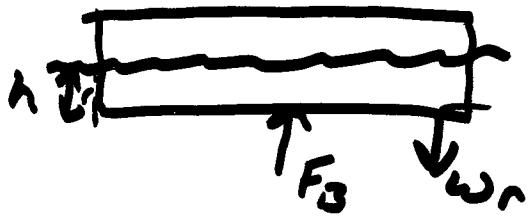
$$\rho_c = \frac{9.8N \cdot 1000 kg/m^3}{(9.8N - 9.0N)}$$

$$= 1.2 \times 10^4 kg/m^3$$

$\rho_{gold} = 1.9 \times 10^4 kg/m^3$

NO

EX) A raft is made of wood having a density of 600 kg/m³. Its surface area is 5.7 m² and its volume is 0.6 m³. How much of it is below water level?



$\Sigma F_y = F_B - W_r = 0$

$F_B = W_r$ Newton

$F_B = W_w$ archimedes

$W_r = \rho_r V_r g \Rightarrow \rho_r V_r g = \rho_w V_w g$

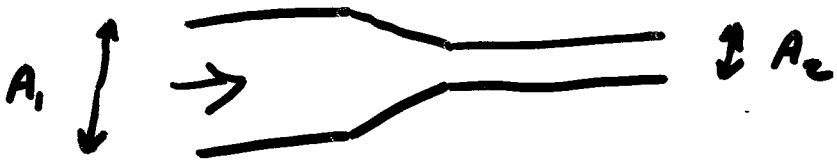
$W_w = \rho_w V_w g$

$\rho_r V_r = \rho_w V_w = \rho_w h \cdot A_w$

$$h = \frac{\rho_r V_r}{\rho_w A_w} = \frac{(600\ kg/m^3)(0.6\ m^3)}{(1000\ kg/m^3)(5.7\ m^2)}$$

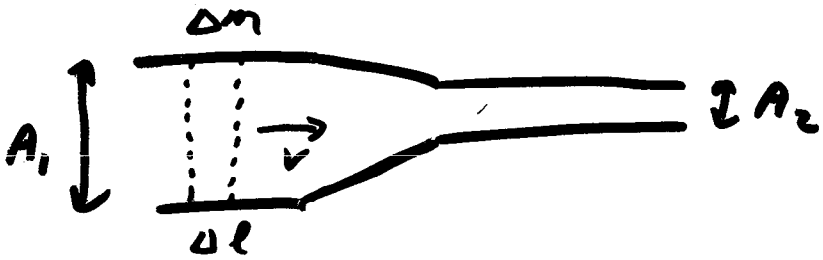
$$\boxed{h = 0.63\ m}$$

fluids in motion



Lets look at fluids that cannot be compressed (water, blood, oil...)

Determine how much fluid moves in a given time



$$\frac{\Delta m}{\Delta t} = \rho \frac{\Delta V}{\Delta t} = \rho A \frac{\Delta l}{\Delta t} = \rho A v$$

since fluid incompressible, the amount passing any point along pipe must be the same

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

$$\boxed{A_1 v_1 = A_2 v_2}$$

FINAL EXAM

Wednesday May 7 10:30-12:30
HERE

"Double" midterm exams

32 Questions
2 free
- $\frac{1}{2}$ concept $\frac{1}{2}$ calculational

Angular motion
torques
equilibrium
angular momentum
} Chapter 8, 9 more emphasis

~1 Question on fluids