Office hours today in White Hall 105
11:30-12:30

Buoyant Force
You hold an inflated ball with a volume of 8.18x10^-3 m^3 just below the water’s surface in your swimming pool. With what force do you have to apply to keep the ball from popping back up above the water? (assume the volume of the ball does not change)

Buoyant force: ALWAYS use the density of the SURROUNDING FLUID pushing on an object!

\[ F_B = B = \rho Vg \]

Density of freshwater = 1000 kg/m^3
Density of ball = 1.3 kg/m^3
Assume now you push the ball deep into the water, such that it shrinks a little bit due to the higher water pressure. In this case, down at the bottom of the pool, does the buoyant force get higher or lower than it was near the top of the water? Assume water density is constant.

A. Higher  
B. Lower  
C. The buoyant force stays the same  
D. Not enough information to determine

If an object with a density equal to water is placed just below the surface of a pool of stagnant water, will it sink or float?

A. Sink  
B. Float  
C. Neither  
D. Not enough information to determine

IF OBJECT WILL FLOAT:

\[ V_{\text{fluid-displaced}} = \frac{V_{\text{object}} \cdot \rho_{\text{fluid}}}{\rho_{\text{object}}} \]

[Note: equation valid as long as object is less dense than fluid.]

What does this mean?

Consider two balls of the SAME DENSITY but different size. Which one will have a higher percentage of its total volume submerged when placed in water?

\[ \rho = 0.1 \text{ kg/m}^3 \]

ball 1  
ball 2
What happens when object is more dense than the fluid?

[How does a steel ship float?]

The hull contains mostly air and displaces a lot of water... enough so that $F_b = F_g$ and it floats.

Your questions?

What forces apply to the ball (neglecting gravity)?

Ball on string (in outer space) is moving at constant angular velocity, $\omega$. Tangential velocity vector shown in green.

A. Centripetal force from the string tension.
B. Force along the velocity vector (tangential).
C. Both A and B.
D. Not enough information to determine.
Does the ball apply a torque?

Tangential VELOCITY vector of ball shown in green

Ball on string is moving at constant angular velocity, \( \omega \).

A. Yes
B. No
C. Not enough information to determine

Density of freshwater = 1000 kg/m³

You put a 1 m³ block of aluminum into a still freshwater lake and it sinks to the bottom, at a depth of 10m. By how much does the volume of the aluminum shrink due to the pressure difference at the top and bottom of the lake? The bulk modulus for aluminum is 7.0x10¹⁰ Pa, and the shear modulus is 2.5 x 10¹³ Pa.

**Shrinking aluminum**
(because squished by pressure difference): What equation will come into play?

A. \( \Delta P = -\frac{B \Delta V}{V} \)
B. \( \frac{F/A}{S} = \frac{\Delta x}{h} \)
C. \( \Delta V = \beta V_0 \Delta T \)
D. \( I_n = \Delta L/\Delta t \)

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\( \Delta P = -B \frac{\Delta V}{V} \)

**Change in pressure in a liquid:** let's look at fluid equations. What equation will we use?

A. \( P = \frac{F}{A} \)
B. \( F_B = \rho V g \)
C. \( P = P_0 + \rho gh \)
D. \( P_1 + 1/2 \rho v_1^2 + \rho g y_1 = P_2 + 1/2 \rho v_2^2 + \rho g y_2 \)
E. Either C or D (though C is more direct)

You’re making a Jupiter + Sun orbiting mobile to sell on Etsy and want the support rod to be horizontally balanced when hanging (as shown above). Assume the wooden support rod is massless.

How massive should you make the Jupiter model?
A piece of pipe of cross-sectional area 1 m² feels a water pressure of $7 \times 10^7$ Pa at point A. What is the pressure at point B, which is 5 m above point A and has the same cross-sectional area?

**What if point B has a different cross-sectional area than point A?**