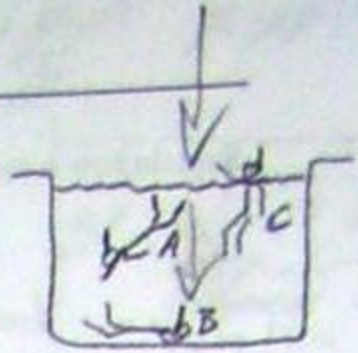
Physics II
Notes: Pressure and Fluids

Name: _____



1. In the first picture on the right, which swimmer is experiencing the greatest water pressure?

B

2. In the second picture on the right, who is experiencing the greatest air pressure?

C

3. Whether you're in air or water (or any other fluid), the origin of ambient pressure is the same. What creates the air pressure that we're feeling right now?

weight of air on top of us.

Units, Conversions, etc.:

Pressure (P) = $\frac{F}{A}$

1pa (pascal) = $1 N/m^2$

1psi = 1 pound per square inch

1psi = 6895 pa

Atmospheric Pressure (average, at sea level) = 14.7 psi ≈ 101,356 pa

Density of liquid water = ρ_{water} = 1 g/ml = 1000 kg/m^3

101,356 N/m^2

The symbol for density is ρ, which is referred to as "rho."

$\rho = \frac{m}{V}$

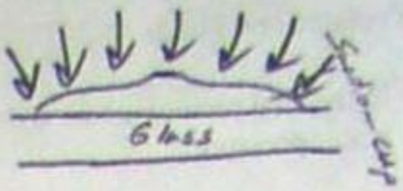
4. According to sources, an average human has about 1.8m^2 (≈2,800 in^2) of skin. What total force is pushing against an average human's skin? 182,000 N 40,950 lbs

5. Why doesn't this force crush us?

- We have equal pressure inside us
- pressure pushes from all direction
- Force is spread evenly over a large area
- We're mostly water, which is mostly incompressible.

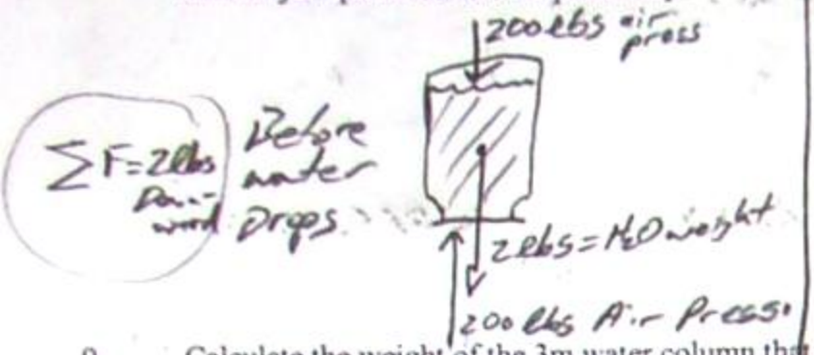
6. The two people on the right are inside trash bags. One has a vacuum hose inserted in the bag. The other does not. Use arrows to show how the sensation of vacuum packing is caused by air pressure pushing inward from the outside of the bag.

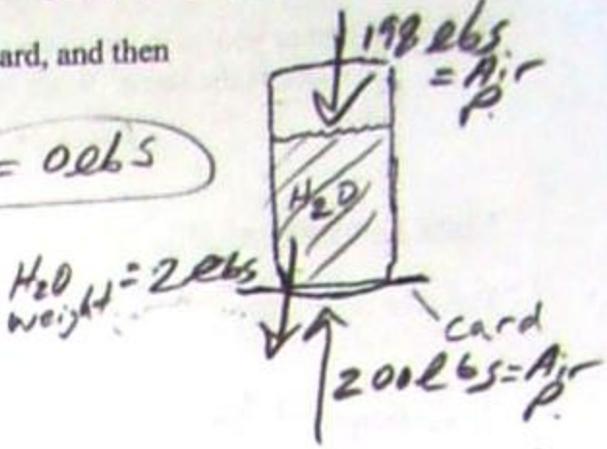
7. **Explain how a suction cup works.**



Air is squeezed out from beneath cup, so there is only pressure pushing down from the ~~top~~ outside.

8. **What happens if you fill a jar with water, cover it with a laminated card, and then turn the jar upside down? Explain why.**



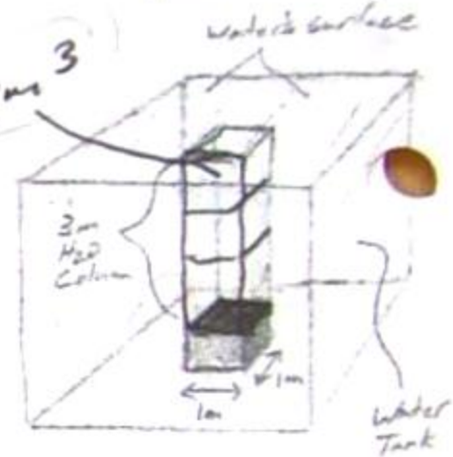


9. Calculate the weight of the 3m water column that is positioned directly above the box on the right. Then calculate the pressure on the box's top surface.

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

$F = 3000kg(9.8 m/s^2) = 29,400N$

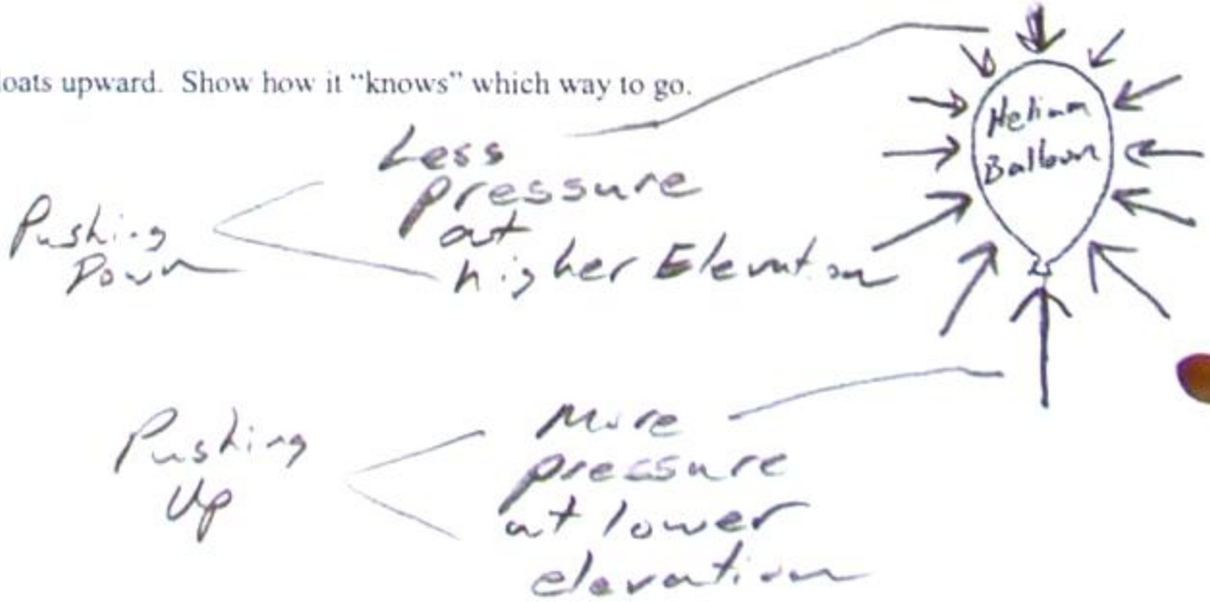
$\rho_{H_2O} = 1000 kg/m^3$ $\quad P = \frac{29,400N}{1m^2} = 29,400pa$



10. More generally, the pressure exerted on a surface of area A at a depth of h below the surface of a liquid of density ρ is P = ~~ρgh~~. This formula should yield the same answer to #9.

$P = 1000 kg/m^3 (9.8 m/s^2) 3m = 29,400pa$

11. A helium balloon floats upward. Show how it "knows" which way to go.



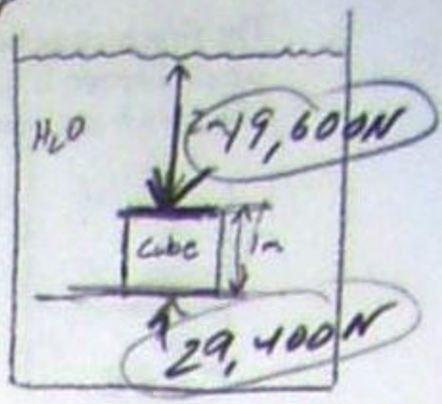
$P = \frac{F}{A}$ $F = PA$

12. Calculate the downward force acting on the cube (below, right).

$P = \rho g h = 1000 kg/m^3 (9.8 m/s^2) 2m$

$P = 19{,}600 pa = 19{,}600 N/m^2$

$F = 19{,}600 N$



13. Calculate the upward force acting on the cube on the right.

$P = \rho g h = 1000 kg/m^3 (9.8 m/s^2) 3m$

$P = 29{,}400 pa = 29{,}400 N/m^2 = P$ $A = 1 m^2$

$F = 29{,}400 N$ $1 m^2 (29{,}400 N/m^2)$

14. What is the net force of pressure (the *buoyant force*) acting on the box on the right?

$\Sigma F = 29{,}400N - 19{,}600N =$ 9,800N upward

15. Calculate the mass and weight of the water displaced by the cube.

Volume $= 1 m^3$

$\rho_{H_2O} = 1000 kg/m^3$

$m_{H_2O} = 1000 kg$

$W = mg = 1000 kg (9.8 m/s^2) =$ 9800N

Archimedes' Principle: the buoyant force on an object = the weight of the fluid it displaces.

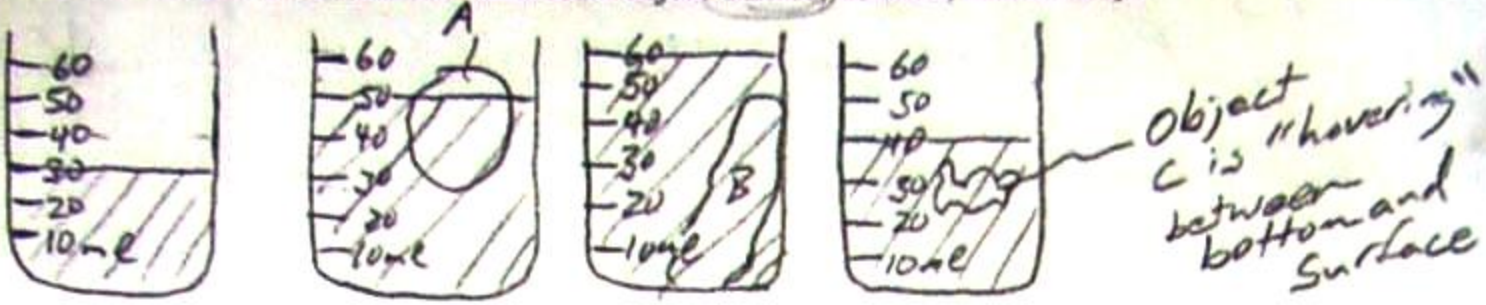
16. If an object is either positively buoyant (floating) or neutrally buoyant (same density as fluid), the object has a mass that is equal to the mass of the water it displaces.

17. If an object is negatively buoyant (sinking), the object has a mass that is greater than the mass of the water it displaces.

These have masses equal to the darkened water volumes

This object has more mass than this much H_2O

The first picture below shows a beaker containing only water. The other three pictures show what would happen if three different solid objects were added to the first beaker. From the pictures, how much can you discern about each solid object's mass, volume, and density?



$\rho_{H_2O} = 1\ g/mL$

A

Volume > 20 mL

mass = 20 g

density < 1 g/mL

B

Vol = 30 mL

m > 30 g

ρ > 1 g/mL

C

V = 10 mL

m = 10 g

ρ = 1 g/mL