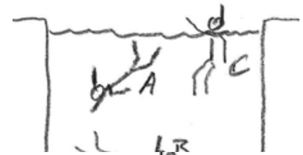
Physics II Name: ___________________________

Notes: Pressure and Fluids

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? **The weight of air above us.**

Pressure (P) = **F/A**

<u>Units, Conversions, etc</u>.:

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 = ___**1**_g/ml = __**1000**__ kg/m^3

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? _____ N ______ lbs

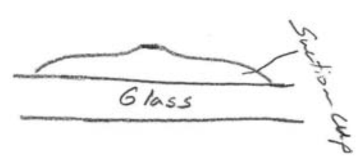
5. Why doesn't this force crush us?

- **It's pushing from every direction, so it doesn't smash us flat.**
- **It's spread over our bodies, not concentrated in one place.**
- **There's pressure inside us, pushing out. For example, the air in our lungs has about 14.7psi, and the air outside also has about 14.7psi.**
- **We're made mostly of water, which is essentially incompressible.**

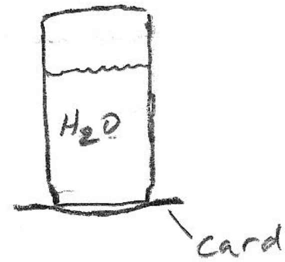
6. The two people on the right are inside trash bags. One has a vacuum hose inserted in the bag. The other does not. Use arrows to show how the sensation of vacuum packing is caused by air pressure pushing inward from the outside of the bag.

The left bag should have equal arrows pushing out from the inside and inside from the outside. The right bag should have no arrows pushing out from the inside – just arrows pushing in from the outside.

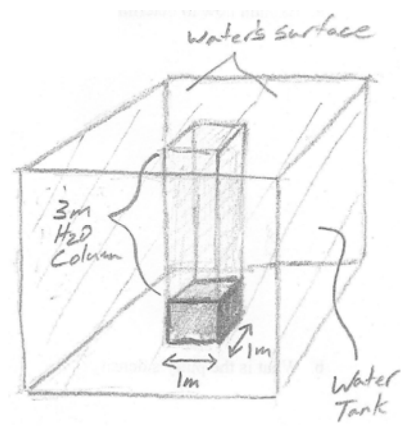
7. Explain how a suction cup works. **When a suction cup is pressed to glass, air "squirts" out from beneath it. The suction cup creates a seal, so that air cannot reenter. As there is no air pushing up from below on the suction cup to the right, but there is air pushing down from above, the difference in pressure pushes the suction cup into the glass. A suction cup does not be "sucked toward" the glass; it gets pushed toward the glass.**



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. **First, after the jar is flipped over, the water inside the jar begins to fall. This causes the air in the jar and above the water to expand. Expansion causes the pressure in that air to decrease. This means there is lower pressure in the jar air than in the outside air. The net force on the card is equal to the force of outside air pressure pushing upward on the bottom of the card minus the downward forces of the water's weight and the force of jar air pressure pushing down on the water. Since the water and the card come to equilibrium, that net force must be zero. The force of outside air pressure must exactly balance the sum of the inside air pressure force plus the water weight.**



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.



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.

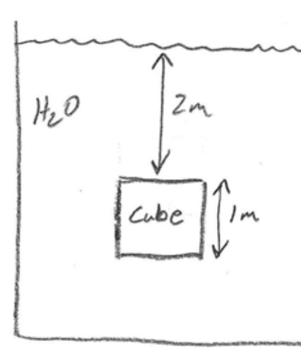
$P = 1000 kg/m^3 (9.8 m/s^2)\ 3m = 29{,}400 pa$

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

To do this, draw arrows all around the balloon, pushing toward the balloon's surface at right angles. Since there's more air pressure at lower elevations, lower arrows should be longer, and higher arrows should be shorter. It can then be seen that the sum of the "pushes" by the arrows is upward.

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

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



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

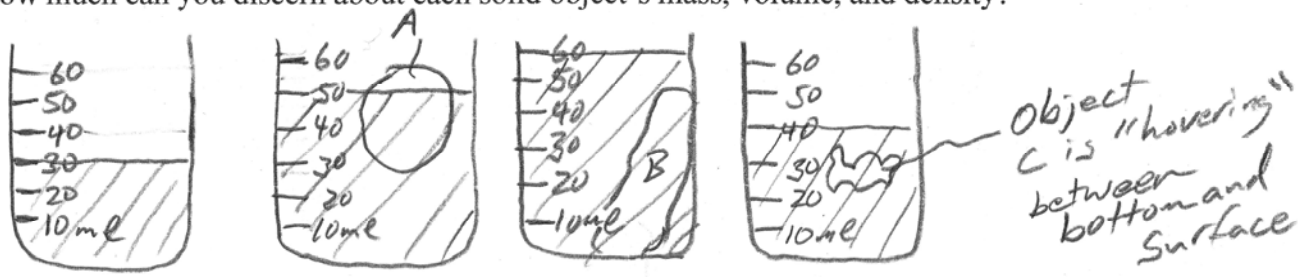
15. Calculate the mass and weight of the water displaced by the cube.

Archimedes' Principle: the buoyant force on an object =

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 __**less than**___ the mass of the water it displaces.

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?



Density of water = 1g/ml

<u>Object A:</u>
Mass of A = 20g **Volume of A > 20ml** **Density of A < 1g/ml**

<u>Object B:</u>
Mass of B > 30g **Volume of B > 30ml** **Density of B > 1g/ml**

u
Mass of C = 10g **Volume of C = 10ml** **Density of C = 1g/ml**