Physics 131- Fundamentals of Physics for Biologists I

Professor: Arpita Upadhyaya

- Quiz 9
- Pressure
- Buoyancy
- Flow

- EXAM 2 on Thursday April 17
- Review Session on Wednesday with Dr. Redish, 5-7 pm, Room 1412

Quiz 9

1. (2 pts) A container has an enclosed volume of gas (G1), with N molecules at temperature T. We introduce N molecules of another species of gas (G2), with 2 times the mass, at constant temperature.

1a. (2 pts) What happens to the pressure?

A. Remains the same
B. Doubles
C. Becomes 4 times larger
D. Increases by 50%
E. None of the above

1b. (2 pts) How do the molecular speeds of the two gases compare?

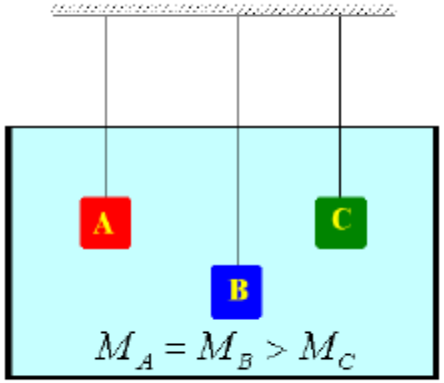
A. G1 and G2 molecules have the same speed
B. Speed of G1 molecules is larger (by a factor of 2)
C. Speed of G1 molecules is larger (by a factor between 1 and 2)
D. Speed of G2 molecules is larger (by a factor of 2)
E. Speed of G2 molecules is larger (by a factor between 1 and 2)
F. None of the above

Quiz 9

2. (3 pts) Three cubes of equal volume are hung on strings. A and B have the same mass and block C has less. The blocks are lowered into a fish tank and they hang at rest as shown.

How do the forces exerted by the water on the **top surfaces** of cubes A, B and C compare?

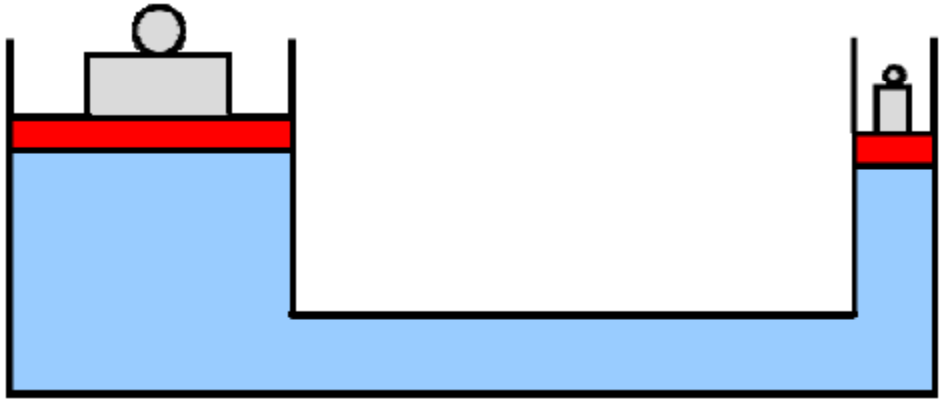
A. $F_A = F_B = F_C$
B. $F_A > F_B > F_C$
C. $F_A > F_B = F_C$
D. $F_B > F_A > F_C$
E. $F_A = F_C > F_B$
F. $F_B > F_A = F_C$
G. None of these



Quiz 9

3. (3 pts) A container is filled with oil and fitted on both ends with pistons (tightly fitting cylinders that can slide up and down). The radius of the right piston is 10 mm. A weight of 5 N must be placed on the right piston to balance the weight of a 50,000 N truck. What is the radius of the left piston?

A. 1 mm
B. 10 mm
C. 100 mm
D. 500 mm
E. 1000 mm
F. Insufficient information



Foothold ideas: Pressure

- At a boundary or wall, the pressure in a constrained fluid creates a force perpendicular to the surface.

$$\vec{F} = p\vec{A}$$

- The constrained gas or liquid has an internal pressure, meaning that it would create a force against any surface placed anywhere inside the gas or liquid in any orientation.

Foothold ideas: Pressure 1

- In a gas the molecules are moving very fast in all directions. On the average the momentum cancels out.
- If you put in a wall keeping the gas on only one side, only the momentum in one direction acts on the wall (N2, N3), creating a force.
- In a non-flowing gas, the force/area is a constant, the pressure. It is proportional to the number of molecules and their mv^2.

Foothold ideas: Pressure 2

- A constrained fluid has an internal pressure –like an internal force at every point in all directions. (Pressure has no direction.)
- At a boundary or wall, the pressure creates a force perpendicular to the wall. $\vec{F} = p\vec{A}$
- The pressure in a fluid increases with depth. (N0, N2)

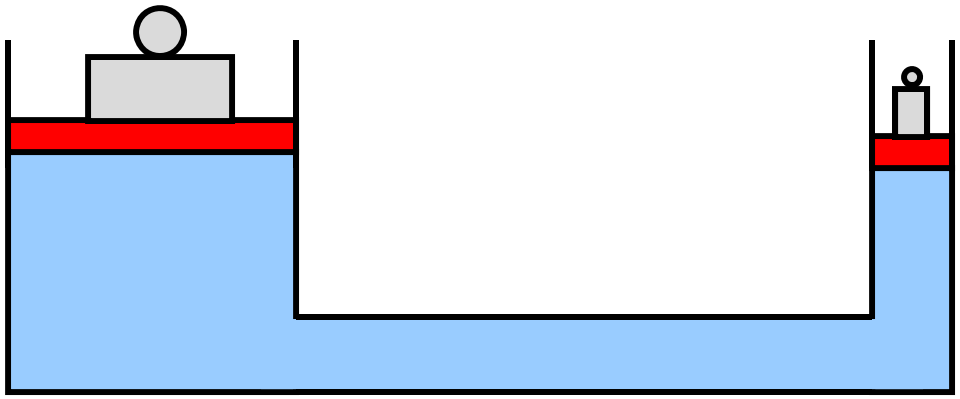
$$p = p_0 + \rho g d$$

- The pressure in a fluid is the same on any horizontal plane no matter what the shape or openings of the container. (Vessel shaped like Utah.)

Pascal's Principle

A force exerted on a part of a fluid is transmitted through the fluid and expressed in all directions.

$$\frac{W_1}{A_1} = \frac{W_2}{A_2}$$



Foothold ideas: Buoyancy

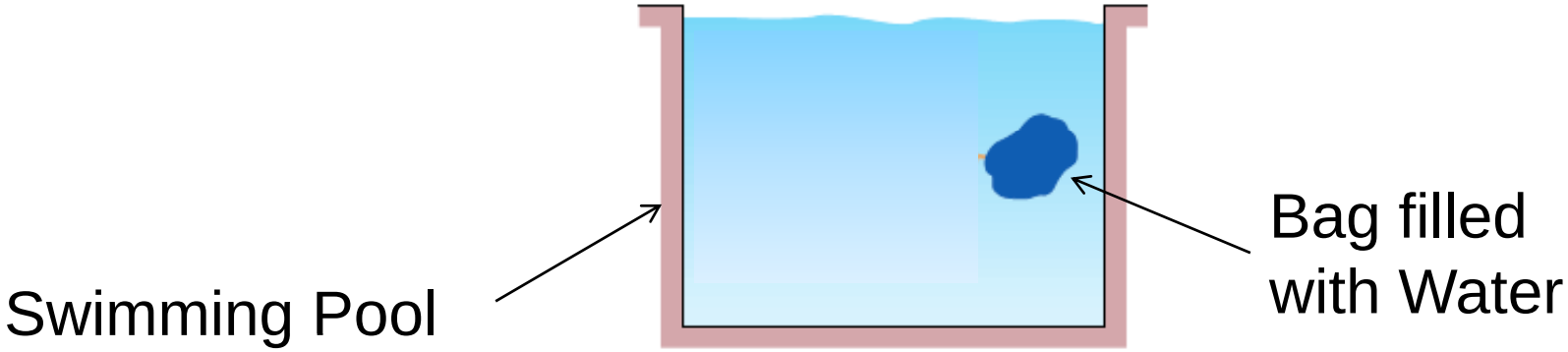
- ***Archimedes' principle***: When an object is immersed in a fluid (in gravity), the result of the fluid's pressure variation with depth is an upward force on the object equal to the weight of the water that would have been there if the object were not.
- As a result, an object whose density is less than that of the fluid will float, one whose density is greater than that of the fluid will sink.
- An object less dense than the fluid will float with a fraction of its volume under the fluid equal to the ratio of its density to the fluid's density.

An object hung from a spring scale is lowered into water. When the object is immersed, the scale will read

1. a larger value
2. a smaller value
3. the same value
4. can't tell – not enough info

Making sense of Buoyant Forces

- Draw a free body diagram for the bag of water

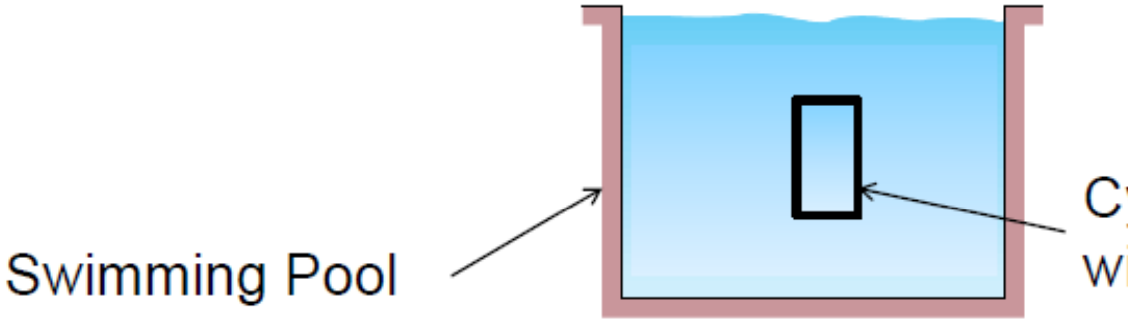


- Replace the bag a water with a rock of equal volume in the free body diagram
  - What changed?
  - How large is upward force on rock due to water?

Whiteboard, TA & LA

Making sense of Buoyant Forces

Draw a free body diagram for the cylinder of water



Whiteboard, TA & LA

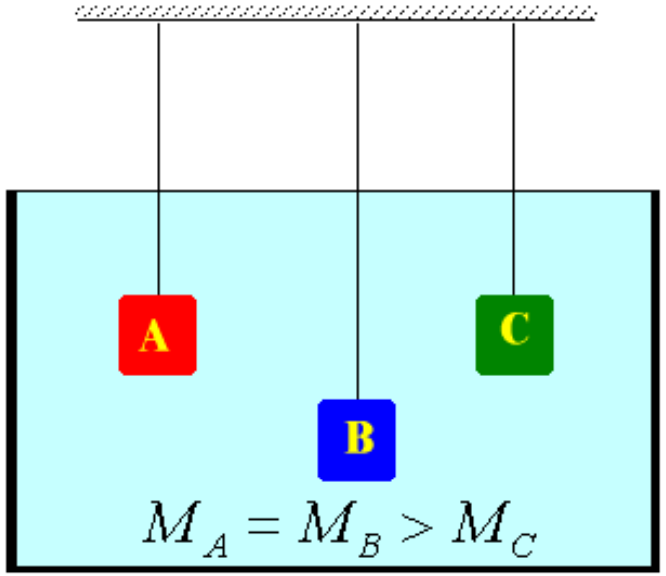
Three cubes of equal volume are hung on strings. A and B have the same mass and block C has less. The blocks are lowered into a fish tank and they hang at rest as shown.

How does the force exerted by the water on the top surface of each cube compare to the force exerted by the water on the *bottom* surface of that same cube?

A. The force on top is bigger

Ⓑ The force on bottom is bigger

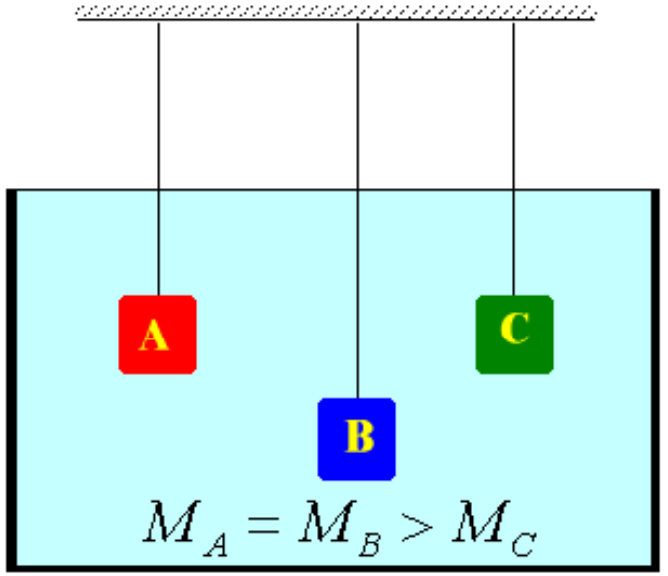
C. They are the same.



Three cubes of equal volume are hung on strings. A and B have the same mass and block C has less. The blocks are lowered into a fish tank and they hang at rest as shown.

How do the buoyant forces exerted by the water on the three cubes rank?

A. $BF_B > BF_A = BF_C$
B. $BF_B = BF_A > BF_C$
C. $BF_B > BF_A > BF_C$
D. $BF_A = BF_B = BF_C$
E. Some other ranking



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)

1. rises.
2. drops.
3. remains the same.