

# **Fluids**

**Knight Ch. 14**

**Physics 2C, Spring 2025**

# Agenda Today (April 1, 2025)

- Definitions: Fluids, (Mass) Density, Pressure
  - Units of Pressure: atm, Pa, mmHg=Torr, psi
- Variation of Pressure with Depth in a Fluid
- Buoyancy and Archimedes' Principle

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# Definitions: Fluids, (Mass) Density, Pressure

Fluids: Liquids and gases. Density: Mass/Volume. Pressure: Force/Area.

# Clicker/Poll Question

Which of the following is the best estimate for the mass of air in this room (GH242)?

- A. 3kg
- B. 300kg
- C. 3000kg
- D. 30,000kg
- E. Nah

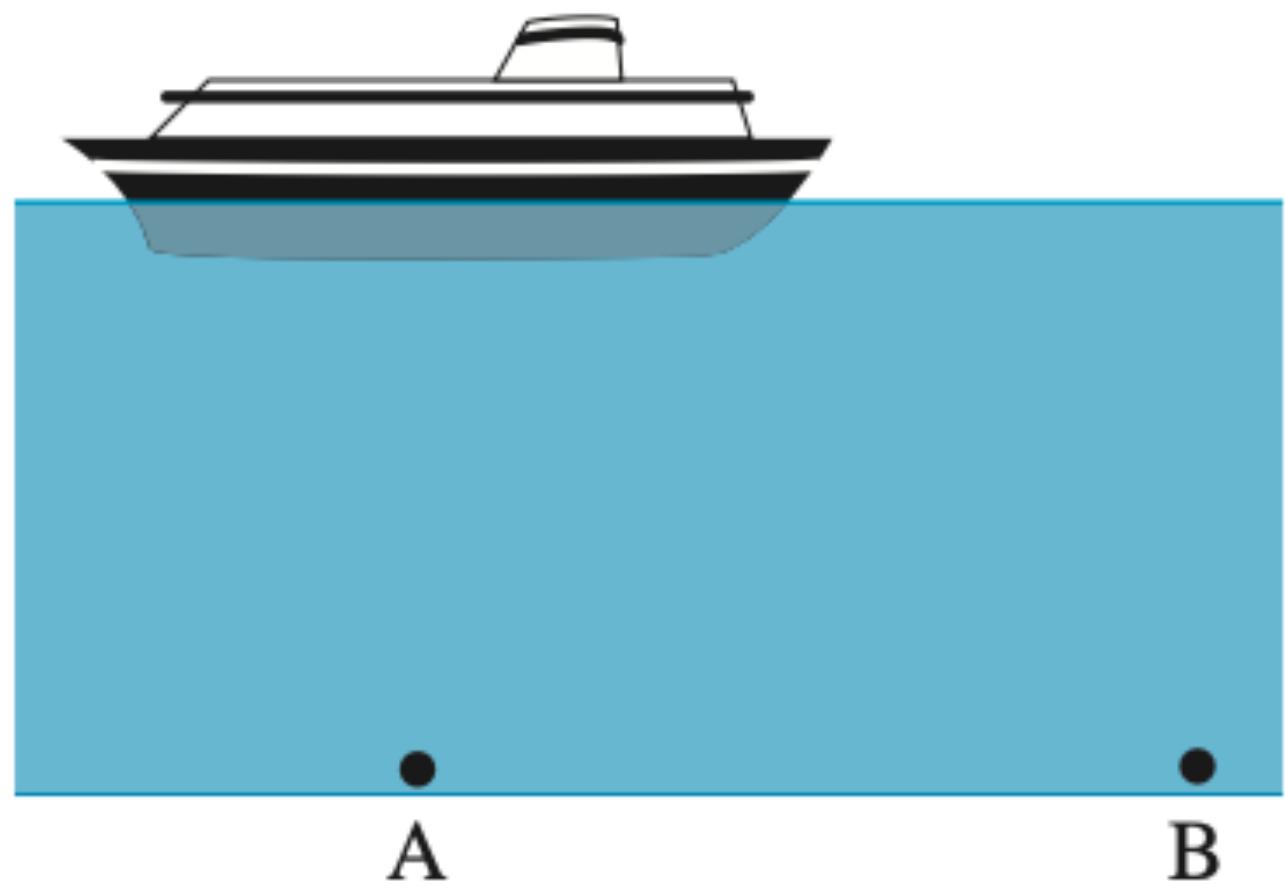
# Variation of Pressure with Depth in a Fluid

Pressure increases with depth in a fluid according to  $\Delta P = \rho gd$ .

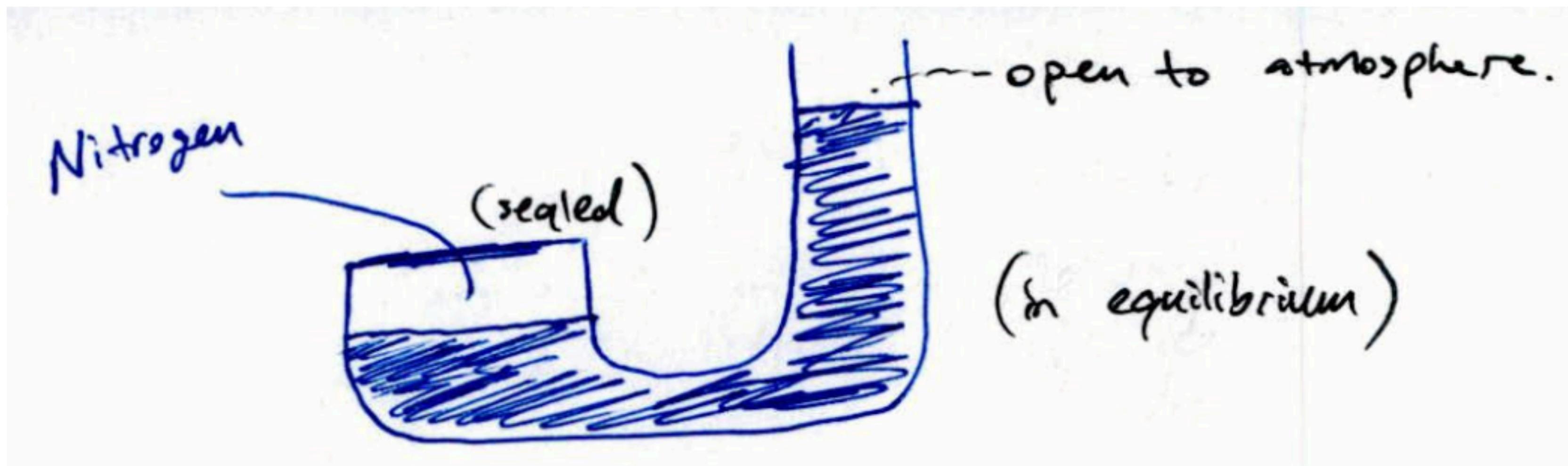
# Clicker/Poll Question

Is the pressure greater at point A or point B?

- A. Point A
- B. Point B
- C. The pressures are equal
- D. ???



# Clicker/Poll Question

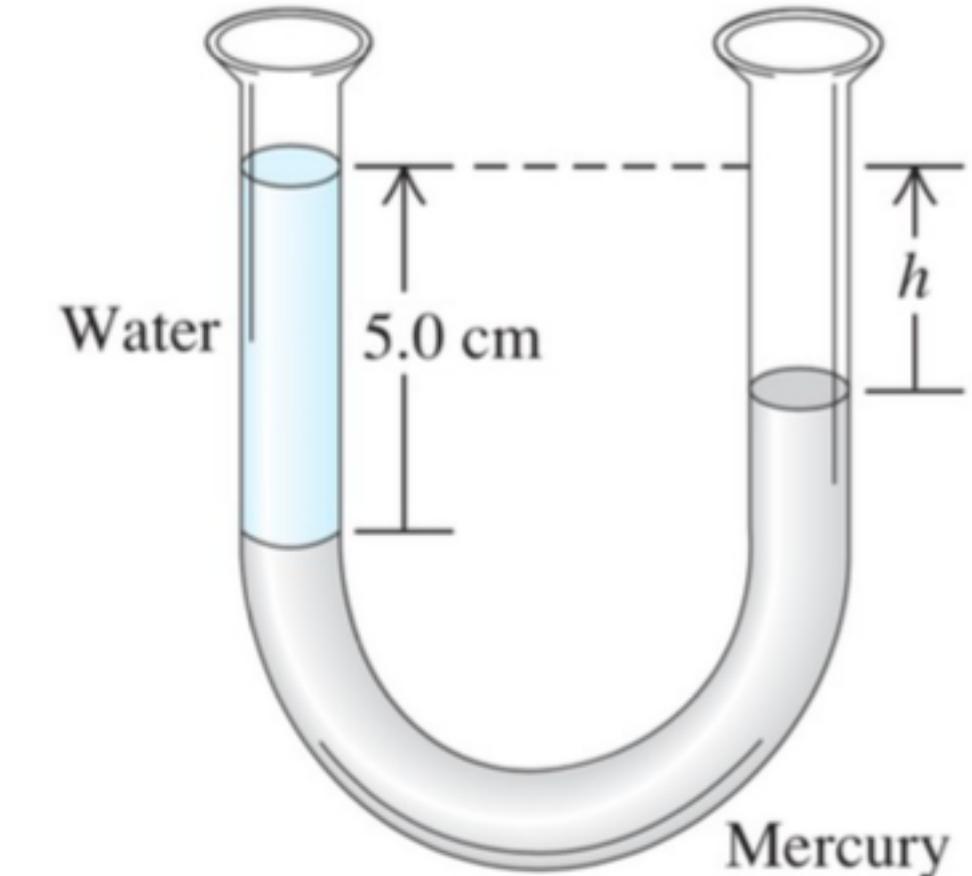


Which of the following is true of the pressure of the nitrogen in the sealed compartment?

- A. Equal to 1 atm
- B. Less than 1 atm
- C. Greater than 1 atm
- D. ???

# Example

A tube in the shape of a "U" holds both Hg (mercury) and water. The liquid/air interface at the top of both columns is open to the atmosphere.



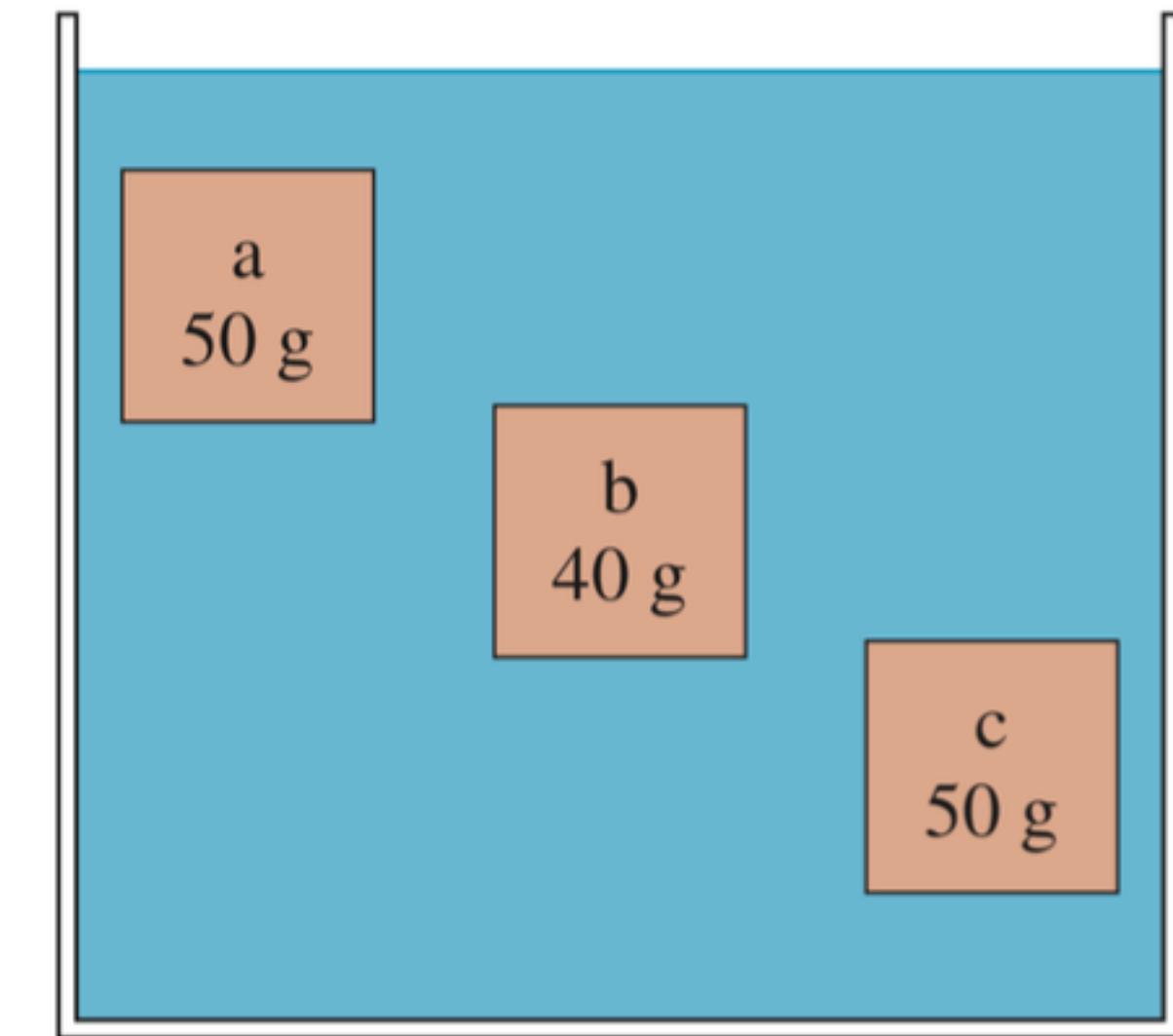
- (a) What is  $h$ , the amount by which the column of water on the left extends above the column of mercury on the right? Give your answer in centimeters (to three sig figs). Take  $\rho_{\text{Hg}} = 13.56 \text{ g/cm}^3$  (and, as usual,  $\rho_{\text{water}} = 1.00 \text{ g/cm}^3$ ).
- (b) What is the pressure at the interface between the two different liquids? Give the absolute pressure, in atm.

# Buoyancy / Archimedes' Principle

The upwards force on an object is equal to the weight of displaced water.

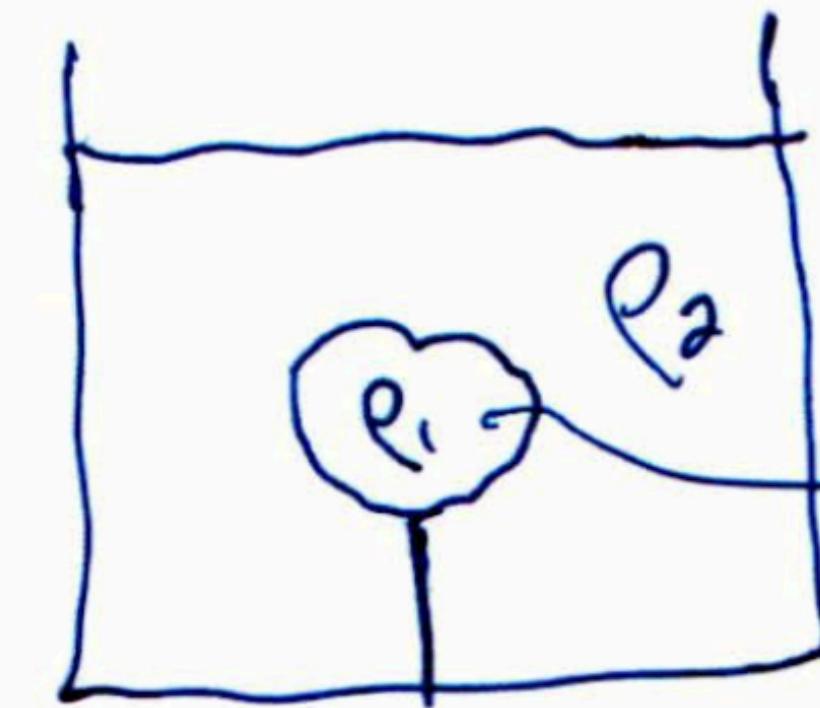
# Clicker/Poll Question

Blocks a, b, and c in the following figure have the same volume. Rank in order, from largest to smallest, the sizes of the buoyant forces  $F_a$ ,  $F_b$ , and  $F_c$  on a, b, and c. Explain.



- A.  $F_c > F_b > F_a$
- B.  $F_c = F_a > F_b$
- C.  $F_a = F_b = F_c$
- D. None of the above
- E. ???

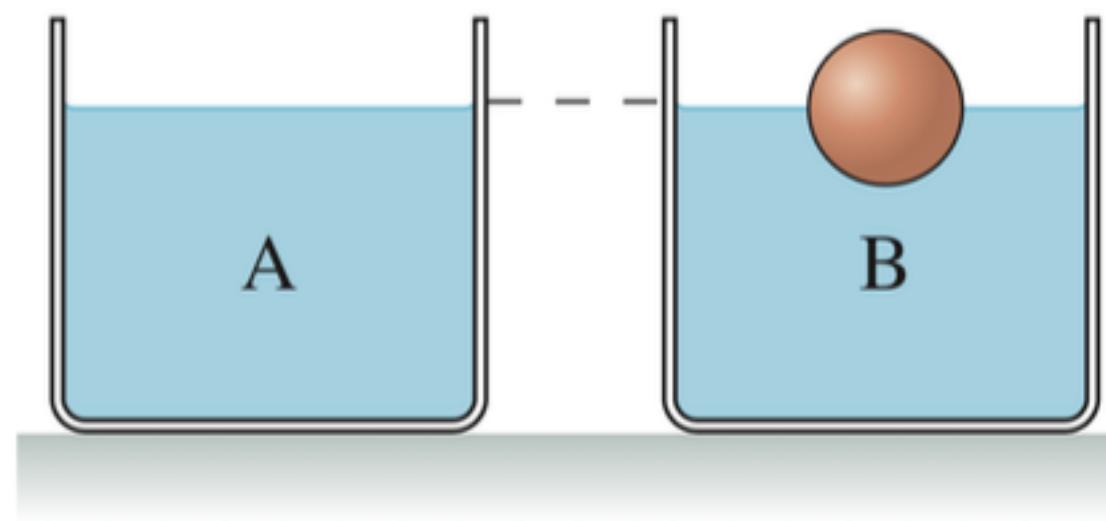
# Example



mass  $\mu$  of material of  
density  $\rho_c$  (in fluid  $\rho_2$ )  
 $\rho_2 > \rho_1$

What's the tension in the string?

# Clicker/Poll Question



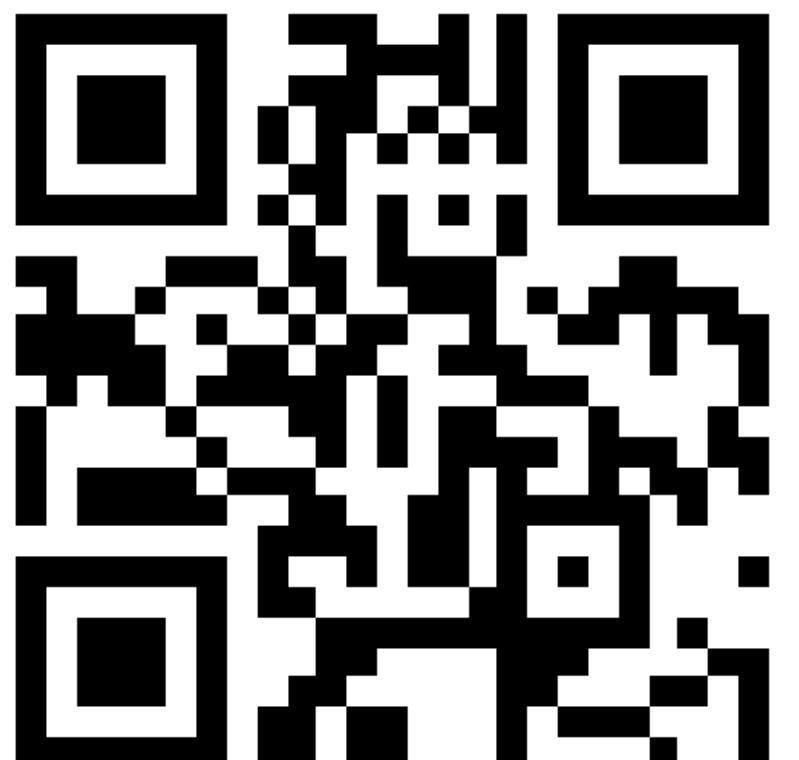
The two identical beakers in the figure are filled to the same height with water. Beaker B has a plastic sphere floating in it. Which beaker, with all its contents, weighs more? Or are they equal? Explain.

- A. A weighs more than B
- B. B weighs more than A
- C. Beakers A and B weigh exactly the same
- D. Not enough info to determine
- E. ???

# Agenda Today (April 3, 2025)

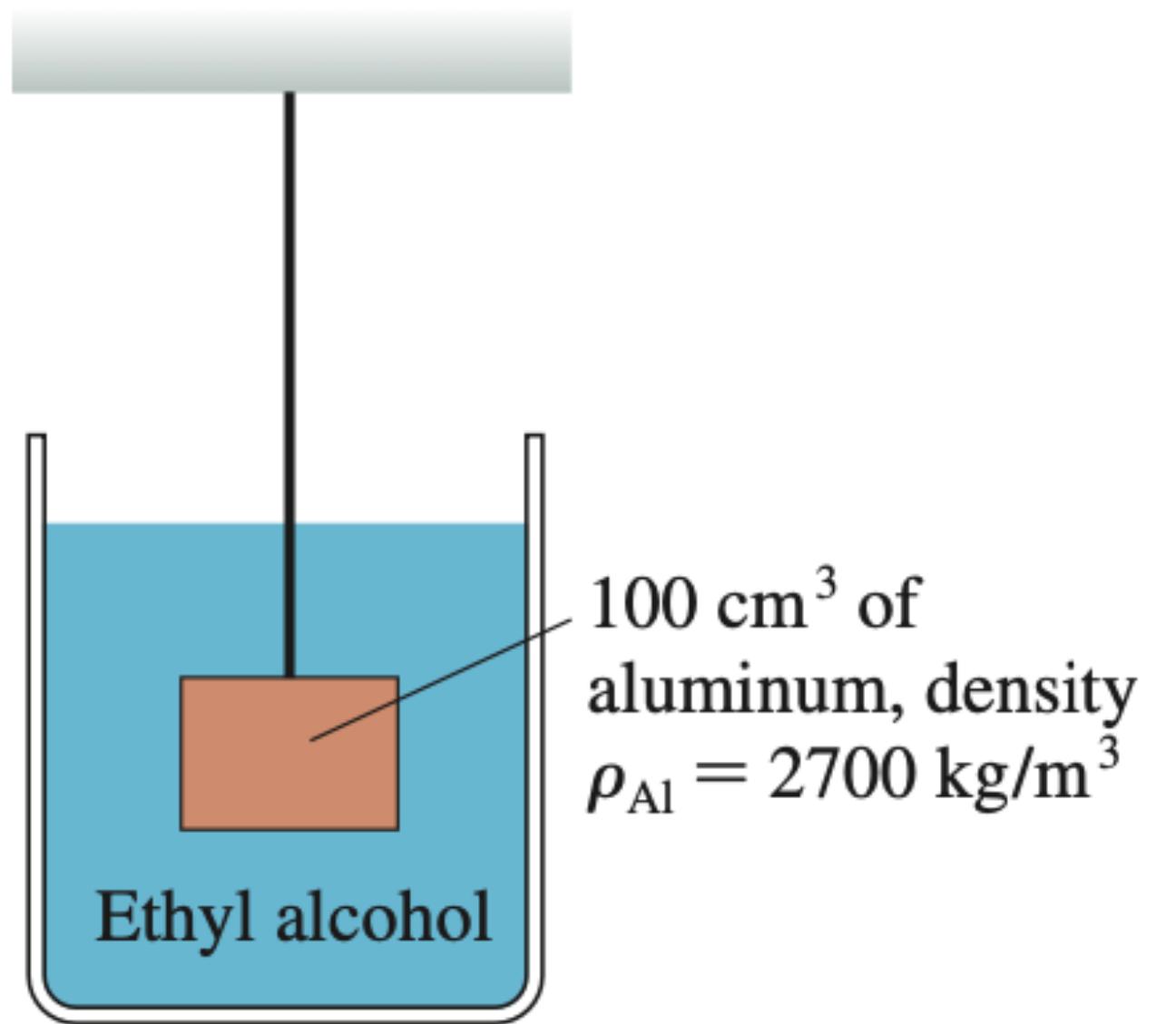
- Buoyancy and Archimedes' Principle
- Pascal's Principle
- Incompressibility / Continuity Equation
- Bernoulli's Equation

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# Try it yourself...

What is the tension in the string?



# Clicker/Poll Question

Suppose you're in a very small pond, and you have a rock in the boat. You throw the rock out of the boat and the rock sinks to the bottom of the pond. What happens to the water level of the pond?

- A. It goes down slightly
- B. It goes up slightly
- C. It remains exactly the same level
- D. ???

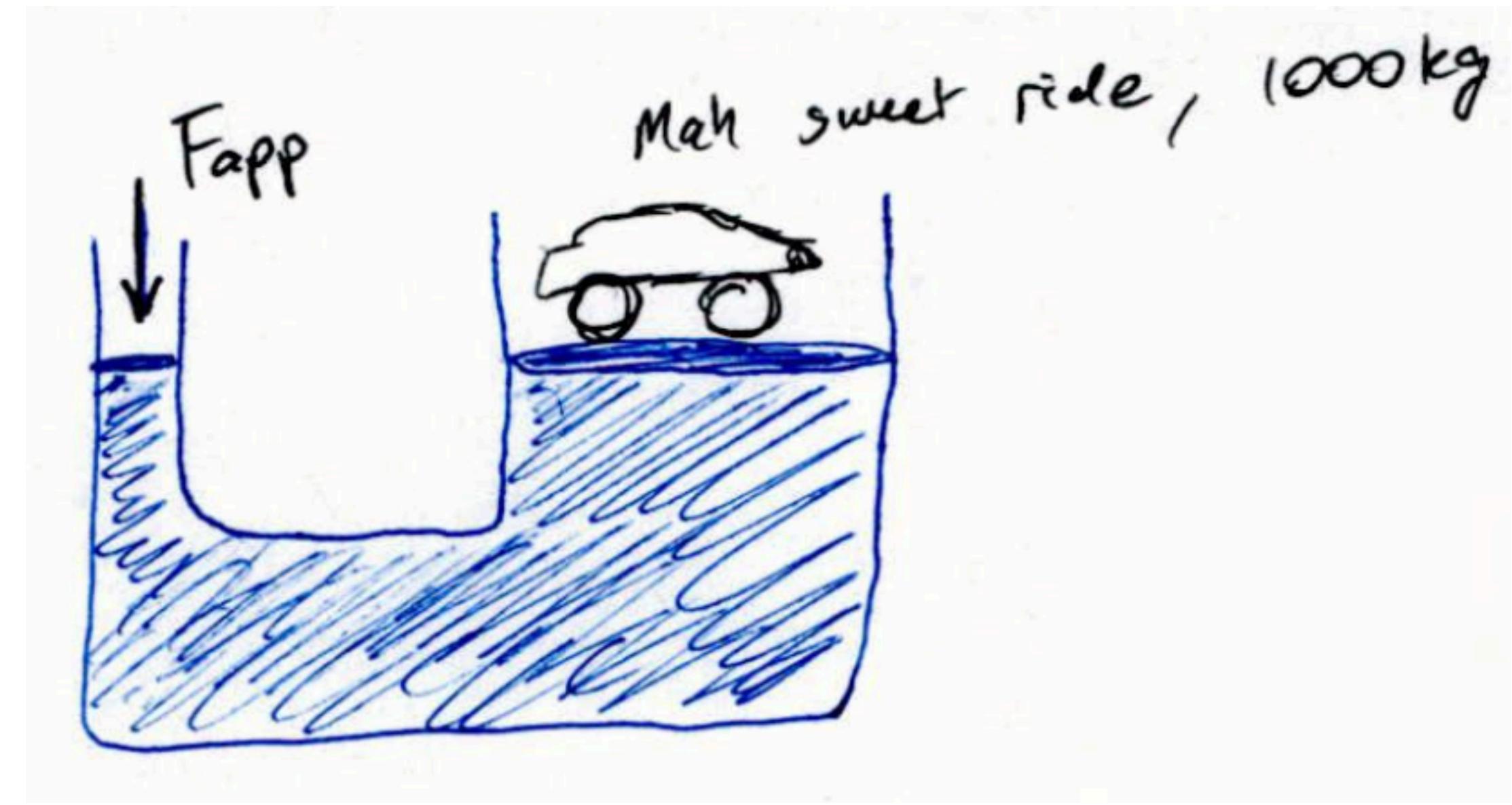
# Pascal's Principle

Increases in pressure felt everywhere in fluid; forces can multiply/divide.

# Clicker/Poll Question

If the radius of the larger platform is 10x the radius of the smaller cylinder, what force is required from  $F_{app}$  to hold the car up?

- A. 10 N
- B. 100 N
- C. 1000 N
- D. 10 kN
- E. None of the above is close



# Continuity Equation

Because of conservation of mass:  $\rho v A = \text{constant}$  along a “flow tube”

# Clicker/Poll Question

The Mississippi River seems to speed up from 2m/s to 4m/s, even though the width of the river doesn't change. What can you infer about the depth?

- A. It decreased to one-fourth the initial depth.
- B. It decreased to half the initial depth.
- C. It increased to double the initial depth.
- D. It increased to 4x the initial depth.
- E. ???

# Bernoulli's Equation

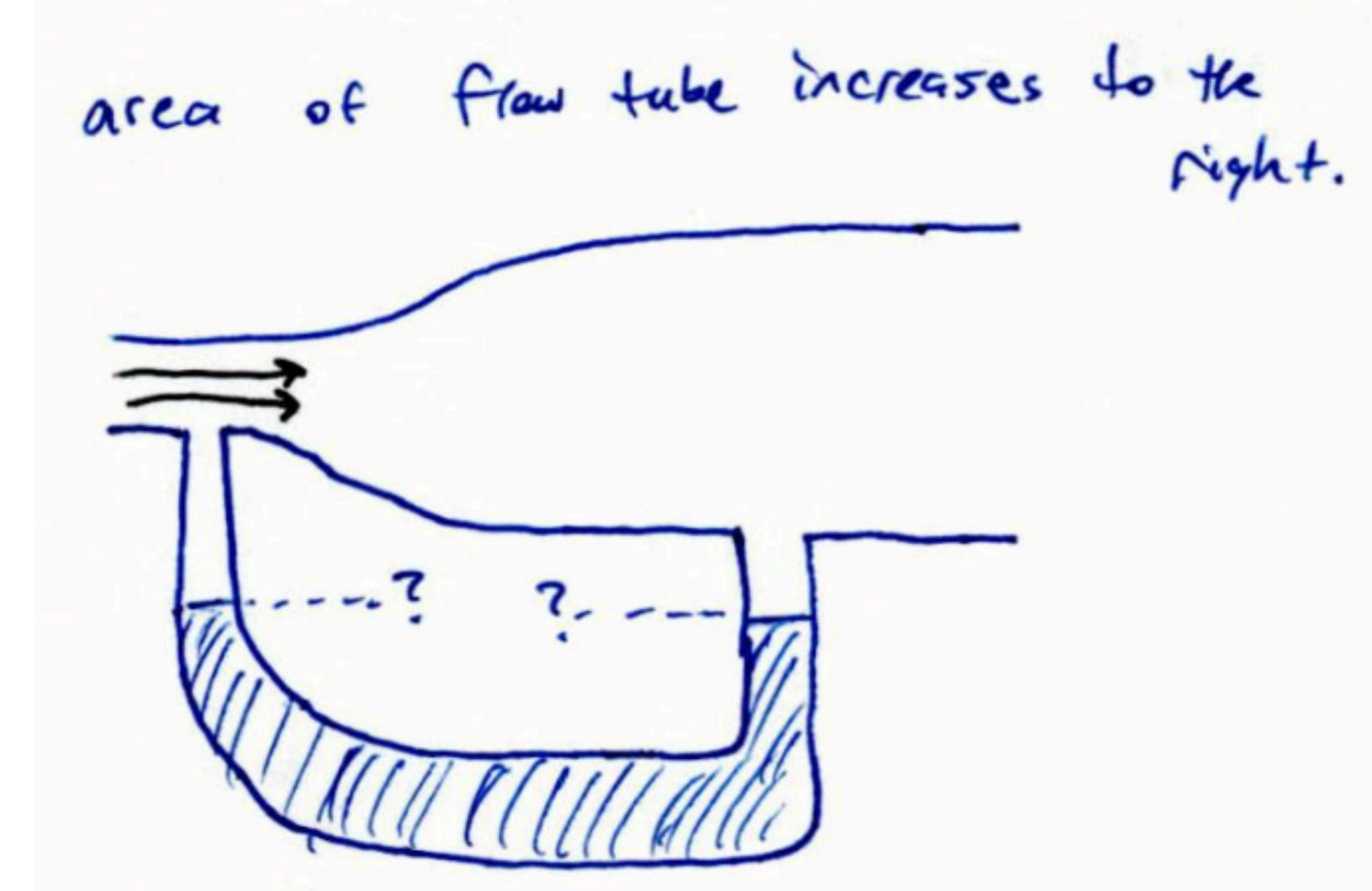
Conserved quantity from conservation of energy (for 2 points along same streamline).

# Clicker/Poll Question

An incompressible gas moves through the following air tube.

How does the water level compare for the two columns?

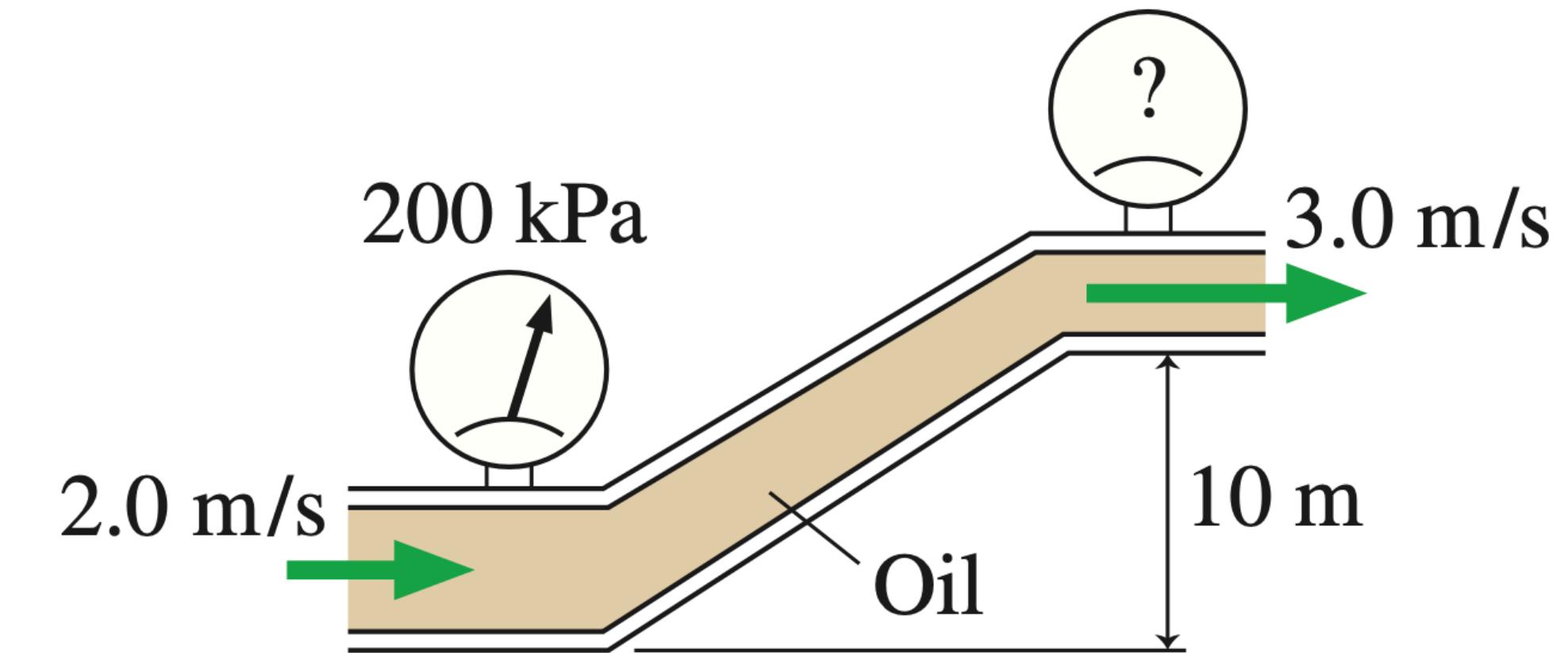
- A. The water level on the left is higher.
- B. The water level on the right is higher.
- C. The two water levels are at the same height.
- D. ???



# Example

Suppose the measuring devices are reading gauge pressure (pressure above atmospheric pressure).

What does the top gauge read?



Take the density of oil to be  $0.80 \text{ g/cm}^3$

# Example

How hard do you have to blow air over a penny to get it to lift?

The radius of a penny is  $r = 1.0$  cm, and it has mass  $m = 2.5$  g.

# Try it yourself...

Water emerges from the pipe shown w/ speed 4.0m/s.

- What is the water pressure as it exits into the air?
- What is the height  $h$  of the standing column of water?

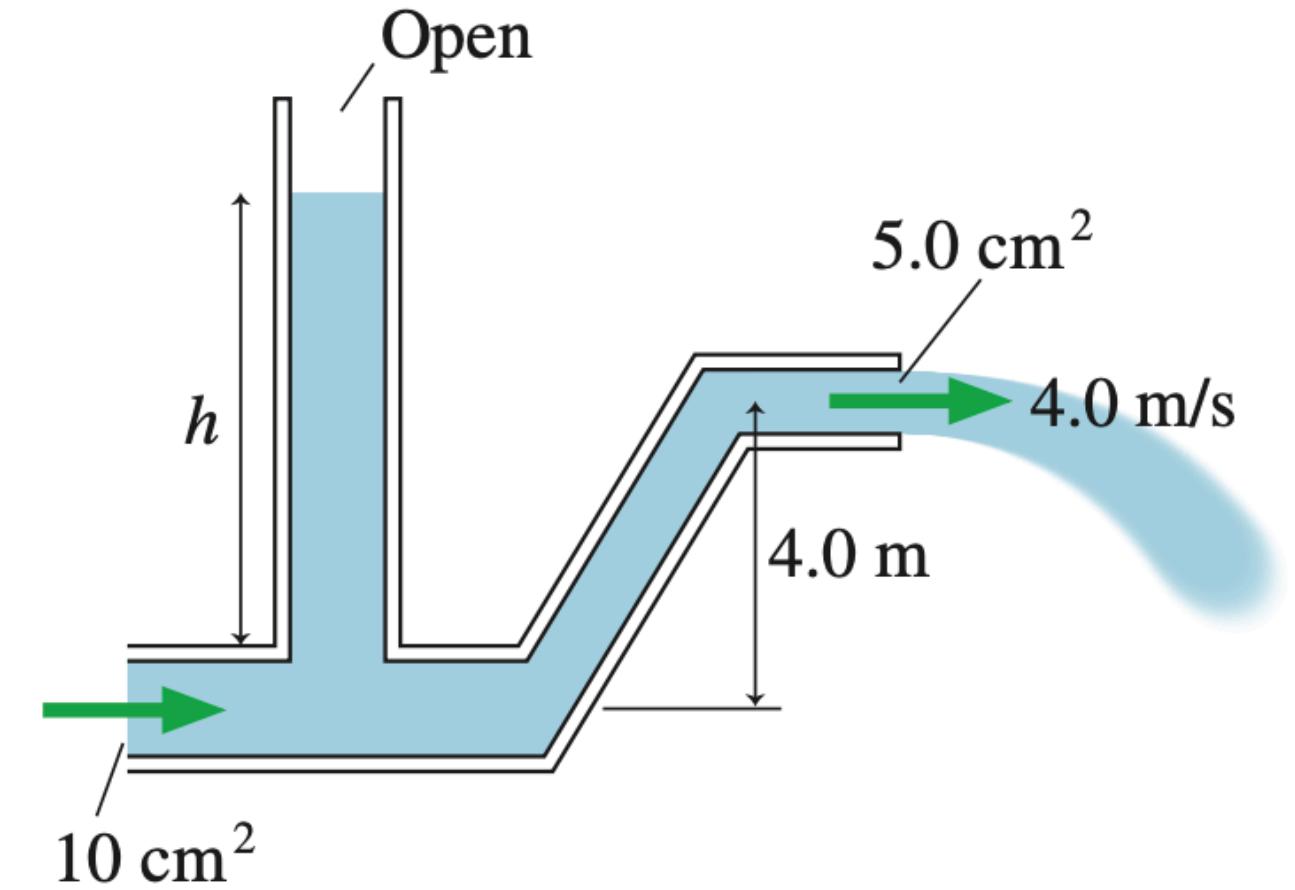


FIGURE P14.60