I brought this bag of chips from Fort Collins to Laramie.

Fort Collins
(Elevation: 4984 ft)

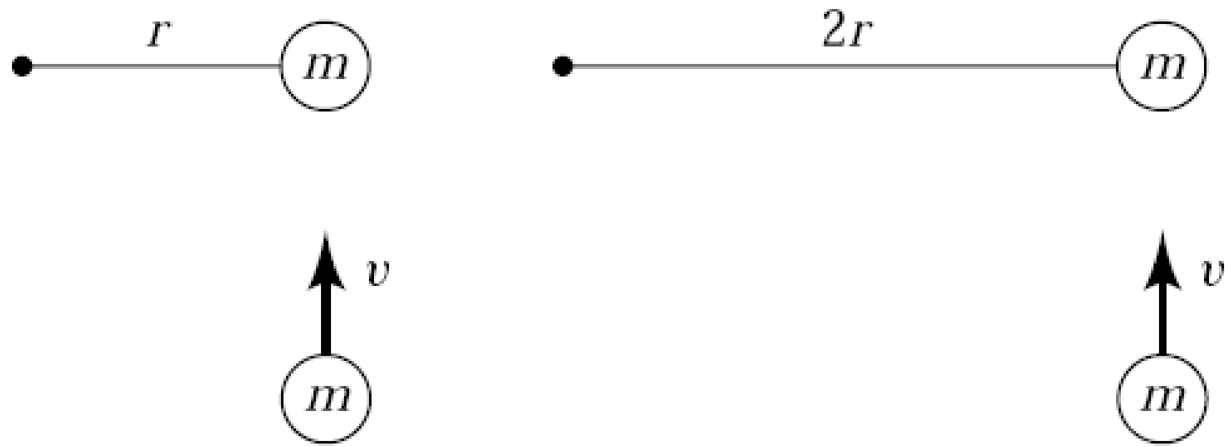
Laramie
(Elevation: 7156 ft)

Why does the bag of chips appear puffier here in Laramie? Text 'PHYSJC' and your answer to 22333.

Exam #2

- April 7, 5-7pm
- CR 214 (Wed Labs) & CR 222 (Thu Labs)
- Chapters 6-9
- One page single-sided equation sheet allowed.
- **Review session**: Wed, April 6 5-7pm, Enzi 195

Consider the situation shown at left below. A puck of mass m, moving at speed v hits an identical puck which is fastened to a pole using a string of length r. After the collision, the puck attached to the string revolves around the pole. Suppose we now lengthen the string by a factor 2, as shown on the right, and repeat the experiment. Compared to the angular speed in the first situation, the new angular speed is



K. twice as high
L. the same
M. half as much
N. none of the above

Ch 12.1-3
Density & Pressure

PHYS 1210 -- Prof. Jang-Condell

Chapter 12

Fluid Mechanics

PowerPoint® Lectures for
University Physics, Thirteenth Edition
– Hugh D. Young and Roger A. Freedman

Lectures by Wayne Anderson

Goals for Chapter 12

- To study the concept of density
- To investigate pressure in a fluid
- To study buoyancy in fluids
- To compare laminar versus turbulent fluid flow and how the fluid speed depends on the size of the tube
- To learn how to use Bernoulli's equation to relate pressure and flow speed of a fluid

Density

$$\rho = M/V$$

$$\rho_{water} = 1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$$

Densities of some common substances

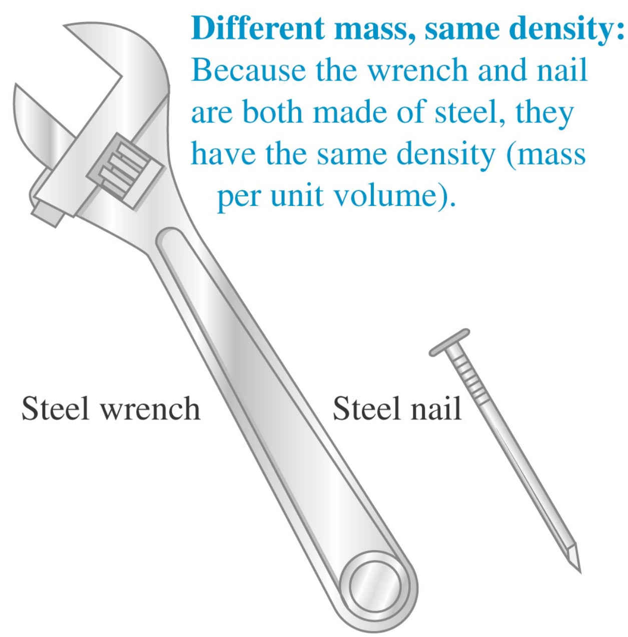
Table 12.1 Densities of Some Common Substances

Material	Density (kg/m^3)*	Material	Density (kg/m^3)*
Air (1 atm, 20°C)	1.20	Iron, steel	7.8×10^3
Ethanol	0.81×10^3	Brass	8.6×10^3
Benzene	0.90×10^3	Copper	8.9×10^3
Ice	0.92×10^3	Silver	10.5×10^3
Water	1.00×10^3	Lead	11.3×10^3
Seawater	1.03×10^3	Mercury	13.6×10^3
Blood	1.06×10^3	Gold	19.3×10^3
Glycerine	1.26×10^3	Platinum	21.4×10^3
Concrete	2×10^3	White dwarf star	10^{10}
Aluminum	2.7×10^3	Neutron star	10^{18}

*To obtain the densities in grams per cubic centimeter, simply divide by 10^3.

Density

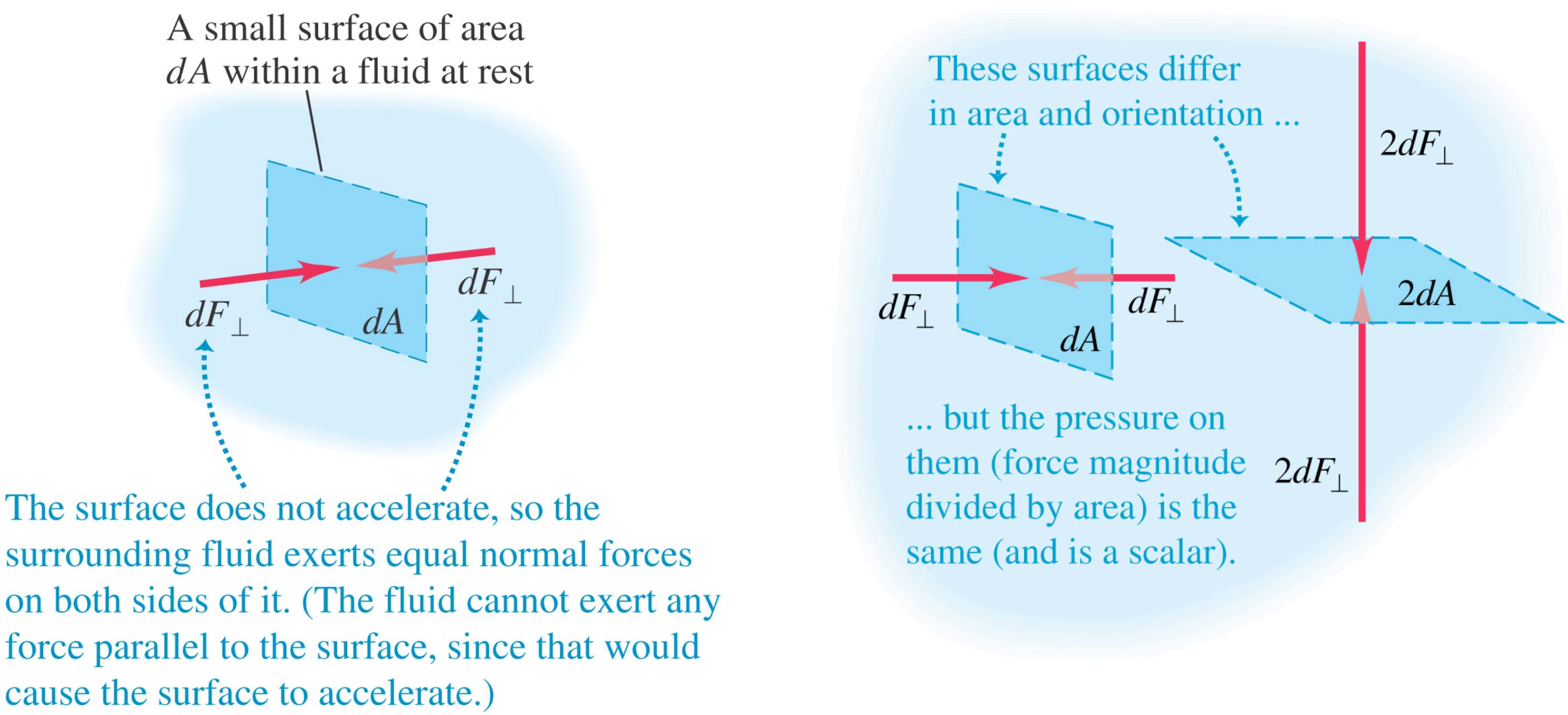
- The *density* of a material is its mass per unit volume: $\rho = m/V$.
- The *specific gravity* of a material is its density compared to that of water at 4°C.



Pressure in a fluid

- The pressure in a fluid is the normal force per unit area:

$$p = dF_{\perp}/dA.$$



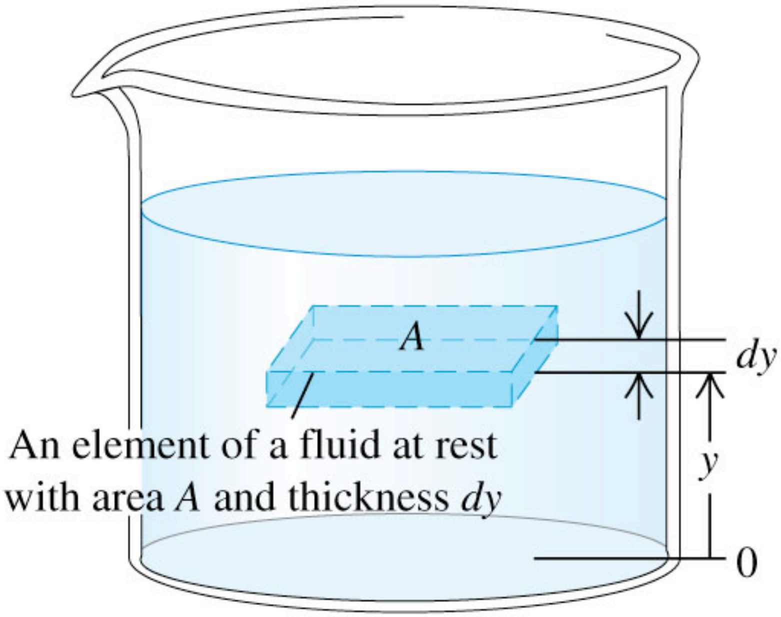
Units

Pressure = Force / Area

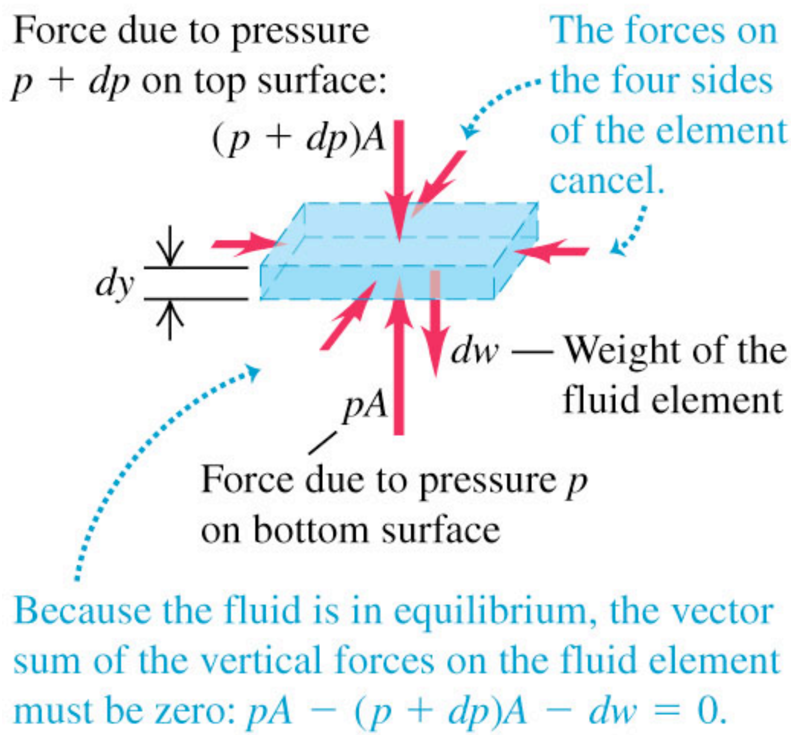
1 Pascal = 1 N/m^2

1 atm = 1.013×10^5 Pa = 1.013 bar

(a)


A
dy
y
0
An element of a fluid at rest
with area A and thickness dy

(b)


Force due to pressure
p + dp on top surface:
(p + dp)A
The forces on
the four sides
of the element
cancel.
dy
dw — Weight of the
fluid element
pA
Force due to pressure p
on bottom surface
Because the fluid is in equilibrium, the vector
sum of the vertical forces on the fluid element
must be zero: pA − (p + dp)A − dw = 0.

Pressure versus depth

$$dp/dy = -\rho g$$

For an incompressible fluid:

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

I have an apparatus made of tubes of varying sizes and shapes. When I fill it with water, which tube will be filled to the highest height?

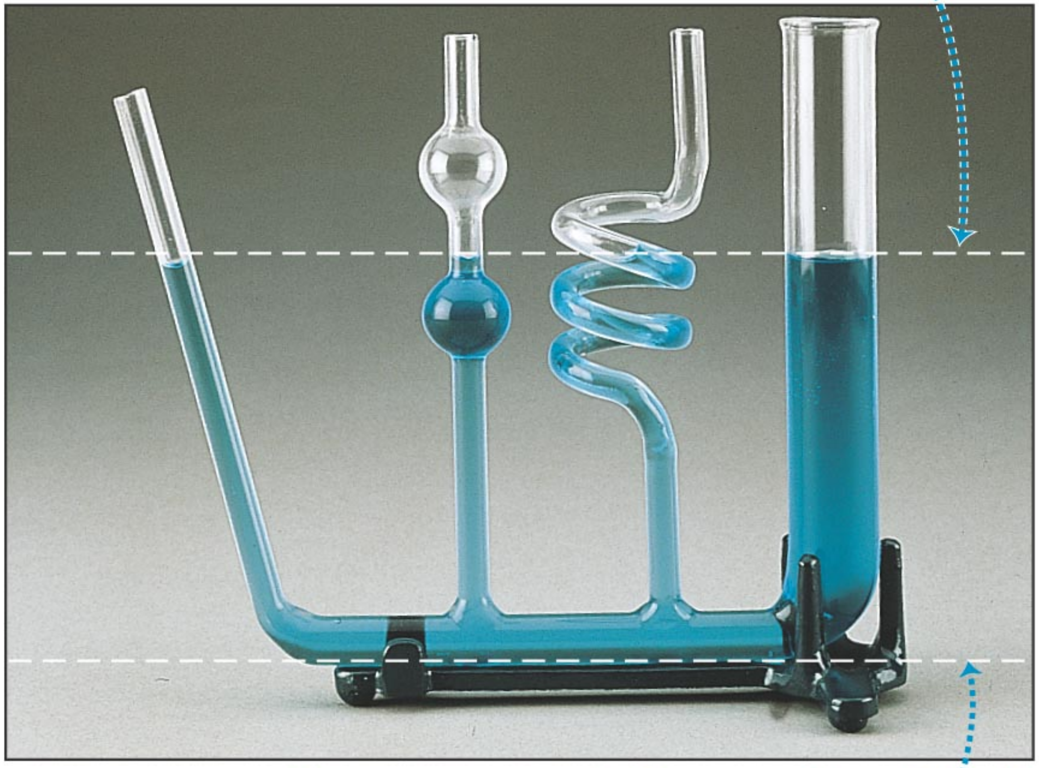
Text your answer to 22333.

Demo 1

Pressure at depth in a fluid

- The pressure at a depth h in a fluid of uniform density is given by $P = P_0 + \rho g h$. As Figure 12.6 to the right illustrates, the shape of the container does not matter.

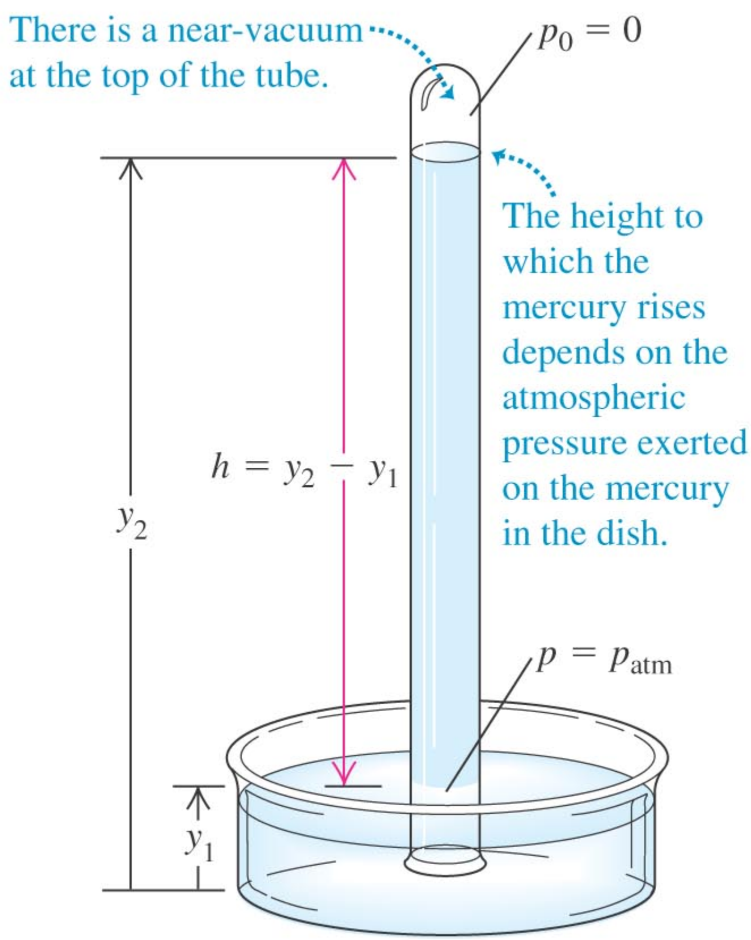
The pressure at the top of each liquid column is atmospheric pressure, p_0.



The pressure at the bottom of each liquid column has the same value p.

The difference between p and p_0 is ρgh, where h is the distance from the top to the bottom of the liquid column. Hence all columns have the same height.

A mercury barometer



- 1 torr = 1 mm of mercury (mm Hg)
- 1 atm = 760 torr
- Depends on temperature of mercury and on *g*

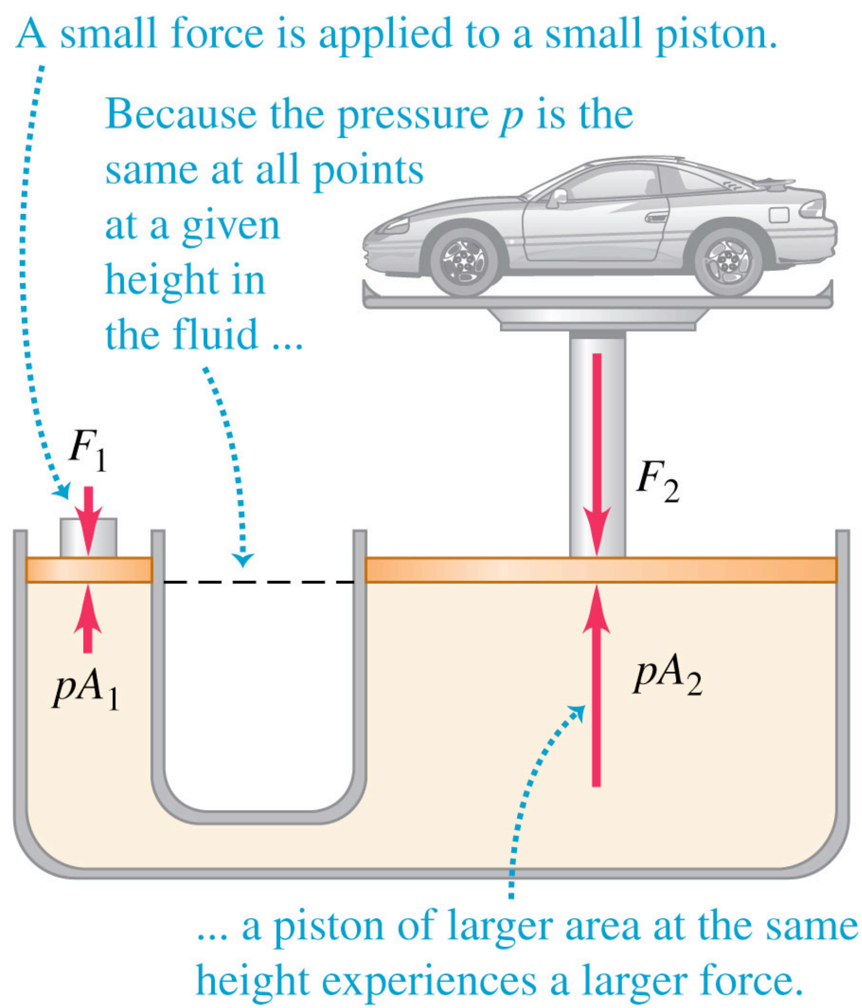
When a hole is made in the side of a container holding water, water flows out and follows a parabolic trajectory. If the container is dropped in free fall, the water flow

A. diminishes.
B. stops altogether.
C. goes out in a straight line.
D. curves upward.

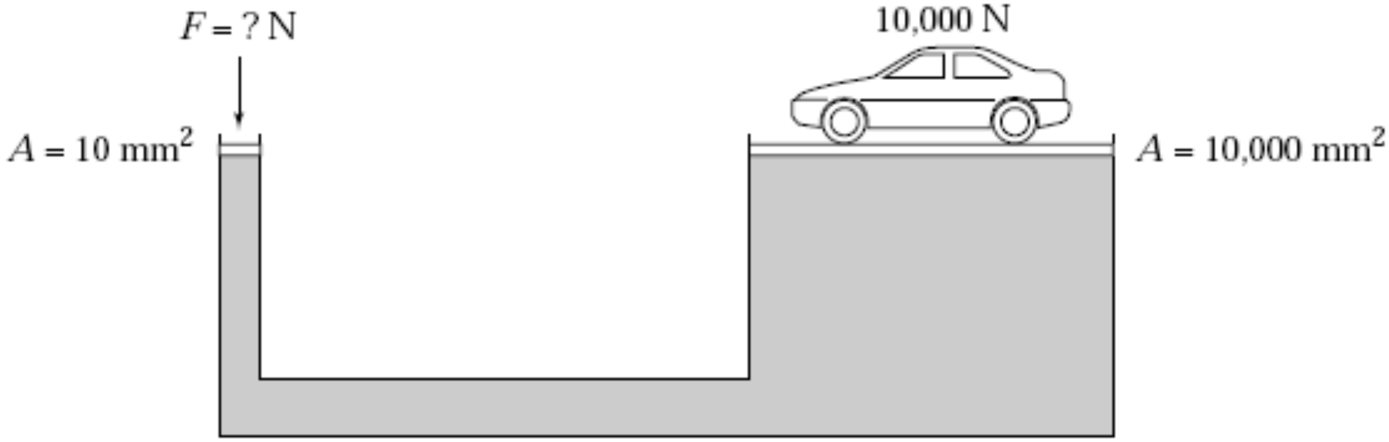
Demo 2

Pascal's law

- *Pascal's law*: Pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and the walls of the containing vessel.
- The hydraulic lift shown to the right is an application of Pascal's law.



A container is filled with oil and fitted on both ends with pistons. The area of the left piston is 10 mm^2; that of the right piston 10,000 mm^2. What force must be exerted on the left piston to keep the 10,000-N car on the right at the same height?



F. 10 N
G. 100 N
H. 10,000 N
I. 10^8 N
J. insufficient information

- The **gauge** pressure is the pressure above atmospheric pressure. The **absolute** pressure is the total pressure.
- When you measure your bike tire's pressure to be 40 pounds per square inch (psi), that is its **gauge** pressure.

Demo 3

- The **gauge** pressure is the pressure above atmospheric pressure. The **absolute** pressure is the total pressure.
- When you measure your bike tire's pressure to be 40 pounds per square inch (psi), that is its **gauge** pressure.
- If the air pressure in Laramie is 0.77 atm, what is the **absolute** pressure of the bike tire?
- If you ride your bike to Ft. Collins, where the air pressure is 0.85 atm, what is the **gauge** pressure of the tire?

Archimedes
ca. 287-ca. 212 BCE

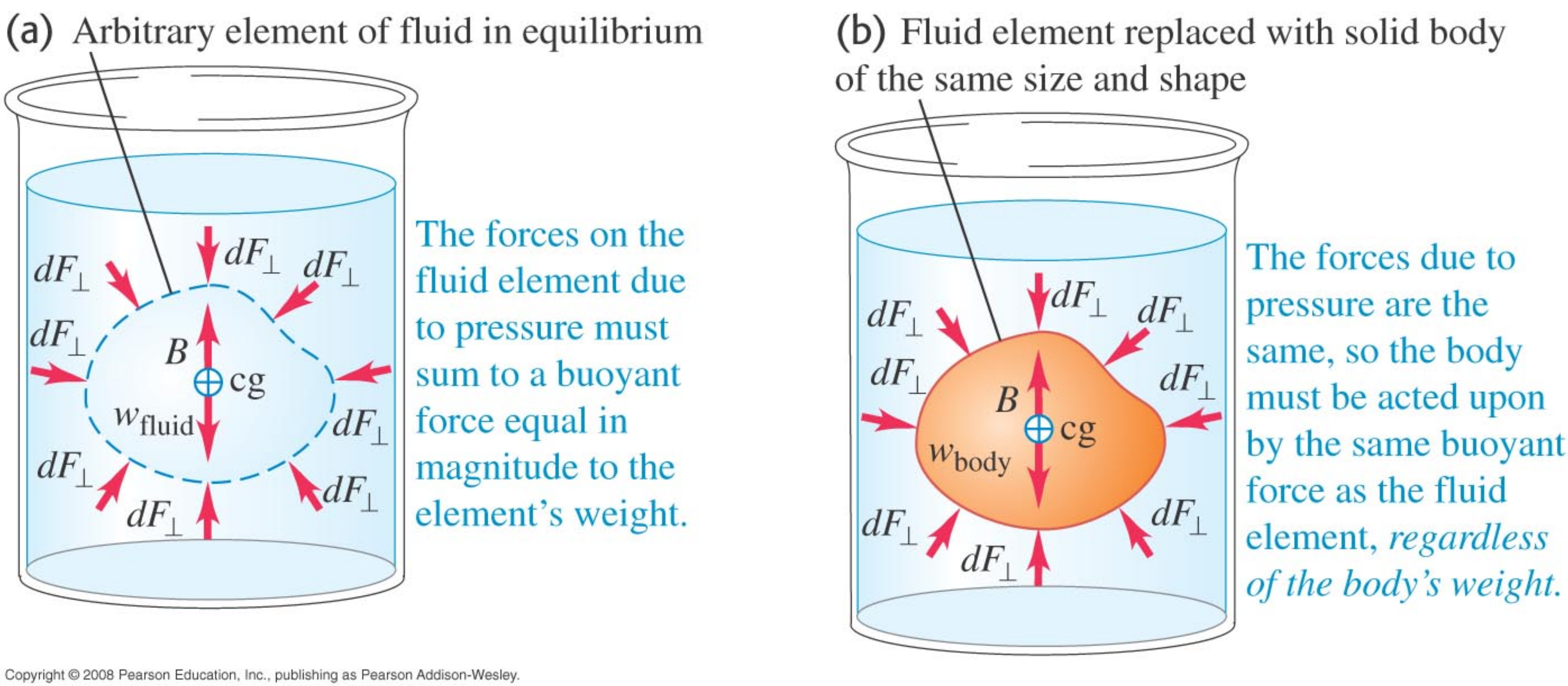
Ancient Greek mathematician

Eureka!

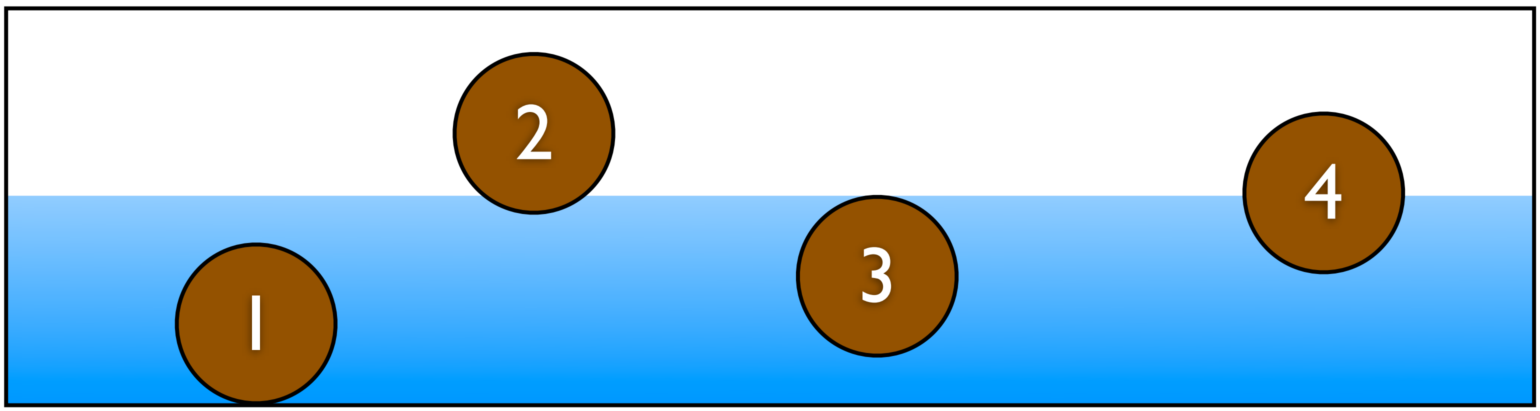
King Hiero II had a gold crown made for himself, and asked Archimedes to determine if it was pure gold. Thinking about this while taking a bath, Archimedes realized that the volume of water displaced would be the volume of the crown.

Archimedes Principle

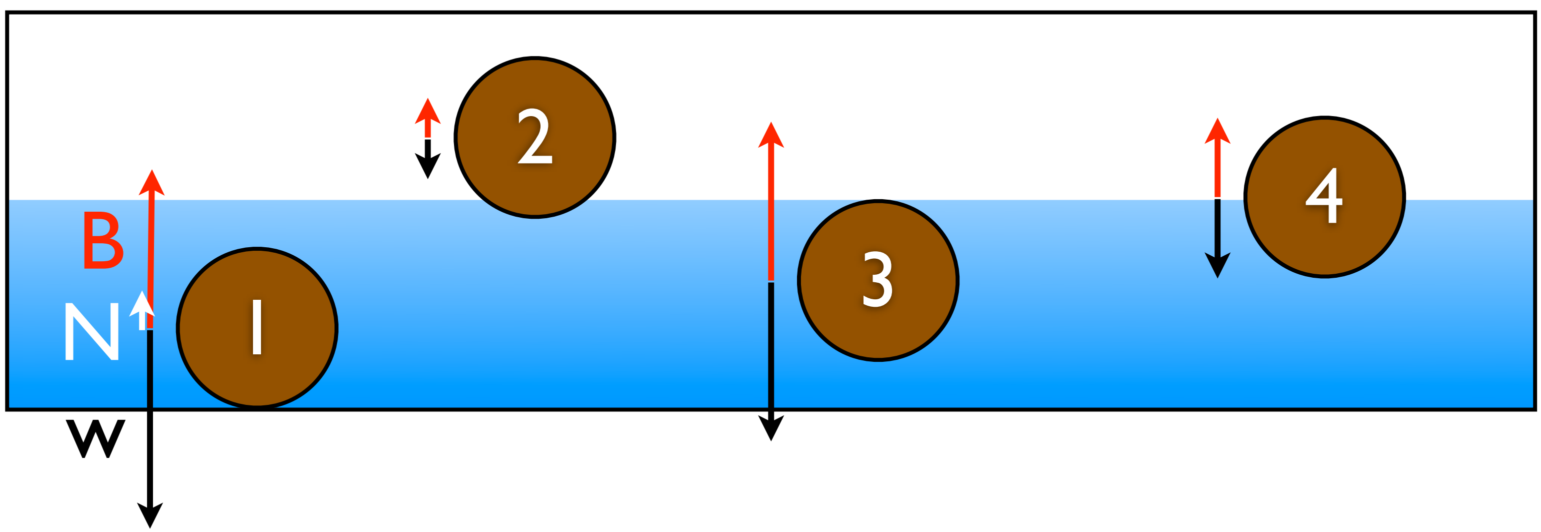
- *Archimedes' Principle*: When a body is completely or partially immersed in a fluid, the fluid exerts an upward force (the "buoyant force") on the body equal to the weight of the fluid displaced by the body. (See Figure 12.11 below.)



Rank these objects in water from smallest to greatest density.



Text your answer to 22333



$$B = g\rho_{\text{fluid}}V$$