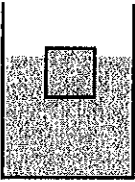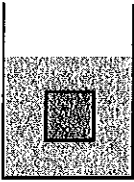1. Three objects are at rest in three beakers of water as shown.

a. Compare the mass, volume, and density of the objects to the mass, volume, and density of the displaced water. Explain your reasoning in each case.

Object 1 floats on top	Object 2 floats as shown	Object 3 sinks
Is $m_1 \left(\begin{matrix}>\\<\\=\end{matrix}\right) m_{\text{displaced water}}$? Explain.	Is $m_2 \left(\begin{matrix}>\\<\\=\end{matrix}\right) m_{\text{displaced water}}$? Explain.	Is $m_3 \left(\begin{matrix}>\\<\\=\end{matrix}\right) m_{\text{displaced water}}$? Explain.
Is $V_1 \left(\begin{matrix}>\\<\\=\end{matrix}\right) V_{\text{displaced water}}$? Explain.	Is $V_2 \left(\begin{matrix}>\\<\\=\end{matrix}\right) V_{\text{displaced water}}$? Explain.	Is $V_3 \left(\begin{matrix}>\\<\\=\end{matrix}\right) V_{\text{displaced water}}$? Explain.
Based on your answers above, is $\rho_1 \left(\begin{matrix}>\\<\\=\end{matrix}\right) \rho_{\text{displaced water}}$? Explain.	Based on your answers above, is $\rho_2 \left(\begin{matrix}>\\<\\=\end{matrix}\right) \rho_{\text{displaced water}}$? Explain.	Based on your answers above, is $\rho_3 \left(\begin{matrix}>\\<\\=\end{matrix}\right) \rho_{\text{displaced water}}$? Explain.

Tutorials in Introductory Physics
McDermott, Shaffer, & P.E.G., U. Wash.
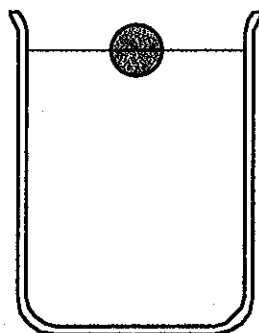
©Prentice Hall, Inc.
First Edition, 2002

b. Object 2 is released in the center of a beaker full of oil, which is slightly less dense than water. In the space provided, sketch the final position of the block. Explain your reasoning.
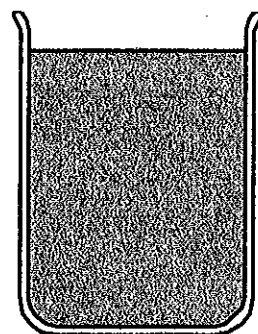
c. On the basis of your answers above, what must be true in order for an object to remain at rest when released in the center of an incompressible liquid?

d. Generalize your answers above to answer the following questions. How does the density of a fluid compare to that of (1) an object that floats in the liquid and (2) an object that sinks in the liquid? Explain.

2. A solid sphere of mass *m* floats in a beaker of water as shown. A second sphere of the same material but of mass 2*m* is placed in a second beaker of water. In the space provided, sketch the final position of the second sphere.
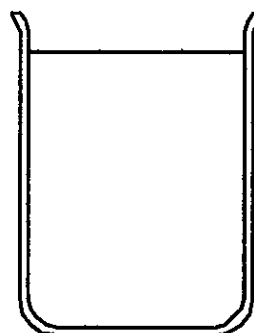
    a. In its final position, how does the buoyant force on the larger sphere compare to its weight?

    Sphere of mass *m*   Sphere of mass 2*m*

    b. How does the volume displaced by the larger sphere compare to that displaced by the smaller sphere?

    c. Are your answers to questions a and b consistent with Archimedes' principle? Explain.

Tutorials in Introductory Physics
McDermott, Shaffer, & P.E.G., U. Wash.

©Prentice Hall, Inc.
First Edition, 2002

3. Two objects of the same mass and volume but different shape are suspended from strings in a tank of water as shown.

Object A Object B

Consider the following student discussion:

Student 1: *"Both objects have the same volume, so both have the same buoyant force. Therefore the tensions in the two strings must be the same."*

Student 2: *"No, that can't be true. The bottom of object A is deeper in the water where the pressure is higher. Therefore the buoyant force on object A must be greater and the tension in that string must be less."*

Student 3: *"I mostly agree with you, student 1. The buoyant force is the same on both objects. However, you forgot the force exerted down on the top of the objects by the water above. That force is larger for object B because the top surface has a greater area, so the tension in the string supporting object B must be greater."*
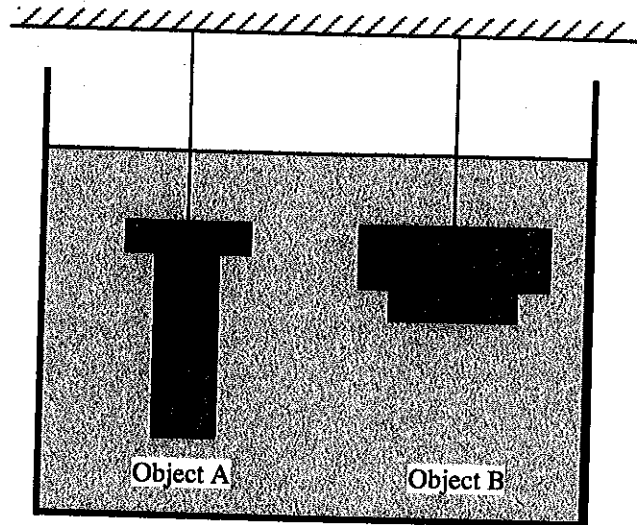
a. Do you agree with student 1? Explain your reasoning. If student 1 is incorrect, modify the statement so it is correct.

b. Do you agree with student 2? Explain your reasoning. If student 2 is incorrect, modify the statement so that it is correct.

c. Do you agree with student 3? Explain your reasoning. If student 3 is incorrect, modify the statement so that it is correct.

Tutorials in Introductory Physics
McDermott, Shaffer, & P.E.G., U. Wash.

©Prentice Hall, Inc.
First Edition, 2002