

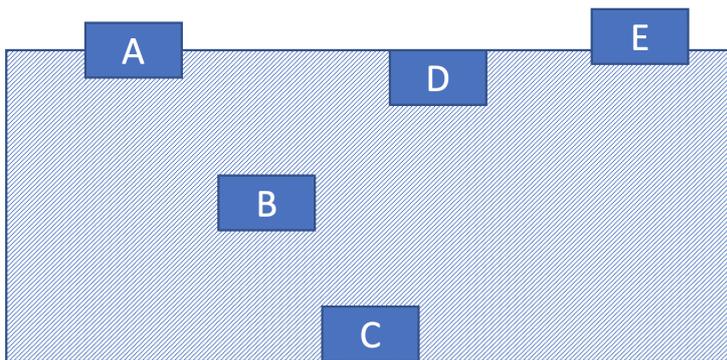
Name \_\_\_\_\_

Buoyant Force: Upward directed force acting on object partially/fully submerged in a fluid.

Archimedes' Principle:  $F_B = W_{\text{displaced fluid}}$  (Buoyant force = Weight of displaced fluid)

Recall:  $m = \rho Vol$ , so  $W_{\text{displ}} = mg = \rho_{\text{fluid}} Vol_{\text{displ}} g$  and  $W_{\text{obj}} = mg = \rho_{\text{obj}} Vol_{\text{obj}} g$

1. Make a prediction: Suppose we put an ice cube in a cup, and fill the cup with water to the brim. When the ice cube melts, what will happen? **A**: Some water will fall out of the cup, **B**: the water level will stay at the brim, **C**: the water level will lower
2. A cork has a density of  $200\text{kg}/\text{m}^3$ . What fraction of its height will be submerged in water?
3. Rank the following objects according to their densities, largest to smallest. All of the objects are at rest. What must be true about the density of object B compared to the density of the liquid?  
**A**:  $\rho_B > \rho_{\text{liq}}$ , **B**:  $\rho_B = \rho_{\text{liq}}$ , **C**:  $\rho_B < \rho_{\text{liq}}$



4. Why can a boat made of steel float, even though it is denser than water?
5. Think back to your prediction about the melting ice cube. Explain what happened using Archimedes' Principle.

6. An empty boat is floating with  $1/3$  of its height submerged in water. The boat has a volume of  $0.8m^3$ .
- (a) What is the density of the boat?
  - (b) What is the maximum number of people that can stand on the boat before it sinks? Assume the average mass of a person is  $70kg$ .
7. Suppose we find a gold pendant on the beach. We want to determine whether it is pure gold or a cheap knockoff. The density of gold is  $19,300kg/m^3$ . We can weigh the pendant on a scale and find that it weighs  $0.965N$  in the air. Then we can weigh the pendant when it is submerged in water (with a density of  $\rho = 1000kg/m^3$ ) and it weighs  $0.915N$ , a little bit less because the buoyant force of the water on the pendant.
- (a) What is the mass of the pendant?
  - (b) What is the volume of the pendant?
  - (c) Is it pure gold?
8. In the movie *Up* a house was floated with balloons. The balloons were filled with helium, which has a density of  $0.18kg/m^3$  and the volume of a balloon is about  $0.0042m^3$ . The density of air is  $1.3kg/m^3$ . Approximately how many balloons would be needed to lift a house with a mass of  $45,000kg$ ?