Will It Rise?

Test an underwater pod using forces and displaced water.

P.4.c "Design solutions to determine the magnitude and direction of the buoyant force acting on an object and the effects of the buoyant forces on the object's motion."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the measurements needed to find each buoyant force, then circle the words that show its direction. Number the steps you would use to predict the pod's motion after release.

Testing a Sensor Pod

1. A research team lowers a sealed sensor pod into a freshwater tank to test whether it will rise after release. A spring scale reads 10 N when the pod hangs in air. When the pod is fully underwater but does not touch the tank, the scale reads 2 N. In both tests, the pod is motionless, and the scale pulls upward. The underwater reading is smaller because water also pushes upward on the pod. Subtracting the underwater scale reading from the weight in air gives the buoyant force. The team keeps the pod fully submerged while recording the reading.

2. The team checks its result another way. It collects the water pushed aside by the fully submerged pod and measures 0.80 L. Near Earth's surface, 1.0 L of freshwater weighs about 10 N. The buoyant force equals the weight of the displaced water. Next, the team attaches a sealed foam module to the pod. The combined object weighs 11 N in air and displaces 1.4 L of water when held fully underwater. The team plans to compare the weight of this displaced water with the combined object's weight before releasing it.

3. Forces can predict what happens just after release. If the upward buoyant force is less than the downward weight, the object begins to move downward. If the buoyant force is greater, it begins to move upward. These predictions ignore water resistance, which grows as the object moves and can change its later motion. A rising object may reach the surface and float. There, less of it sits underwater, so it displaces less water. At rest, its upward buoyant force equals its weight. The team will watch both versions of the pod to test its predictions.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the two spring-scale readings to find the buoyant force on the pod without foam. Give its magnitude and direction.

2. Use the displaced-water measurement to check the buoyant force on the pod without foam. Show your calculation and state the direction.

3. If the pod without foam is released while fully underwater, which way does it begin to move? Find the net force, ignoring water resistance.

4. Find the buoyant force on the pod with foam when it is fully underwater. Predict its initial motion and the volume of freshwater it displaces if it later floats at rest.

3 YOUR TURN

Your own words

Design a test for a different object that weighs 12 N in air. Choose a fully submerged displacement from 0.5 L to 1.5 L of freshwater, describe how you would measure it and check the buoyant force with a spring scale, then calculate the force and predict the object's initial motion after release, ignoring water resistance.

Will It Rise?

PART 1 · READ AND MARK

Underline the measurements needed to find each buoyant force, then circle the words that show its direction. Number the steps you would use to predict the pod's motion after release. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the two spring-scale readings to find the buoyant force on the pod without foam. Give its magnitude and direction.	**10 N − 2 N = 8 N upward.**
2	Use the displaced-water measurement to check the buoyant force on the pod without foam. Show your calculation and state the direction.	**0.80 L × 10 N/L = 8 N upward.**
3	If the pod without foam is released while fully underwater, which way does it begin to move? Find the net force, ignoring water resistance.	**It begins to move downward because its 10 N weight exceeds the 8 N upward buoyant force. The net force is 2 N downward.**
4	Find the buoyant force on the pod with foam when it is fully underwater. Predict its initial motion and the volume of freshwater it displaces if it later floats at rest.	**Its buoyant force is 1.4 L × 10 N/L = 14 N upward, so it initially moves upward with a net force of 3 N upward. At rest, it displaces 1.1 L, whose weight is 11 N.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would collect the water displaced when the object is fully submerged and measure its volume. I choose 0.90 L, so the water weighs 9 N and the buoyant force is 9 N upward. I would check by measuring the object's 12 N weight in air and its scale reading underwater, which should be 3 N. After release, the net force would be 3 N downward, so the object would begin to move downward.

Accept equivalent calculations and clear upward or downward directions. For the open task, the chosen volume must produce a spring-scale reading of 12 N minus the calculated buoyant force; if the buoyant force is 12 N, the object has no initial net force.