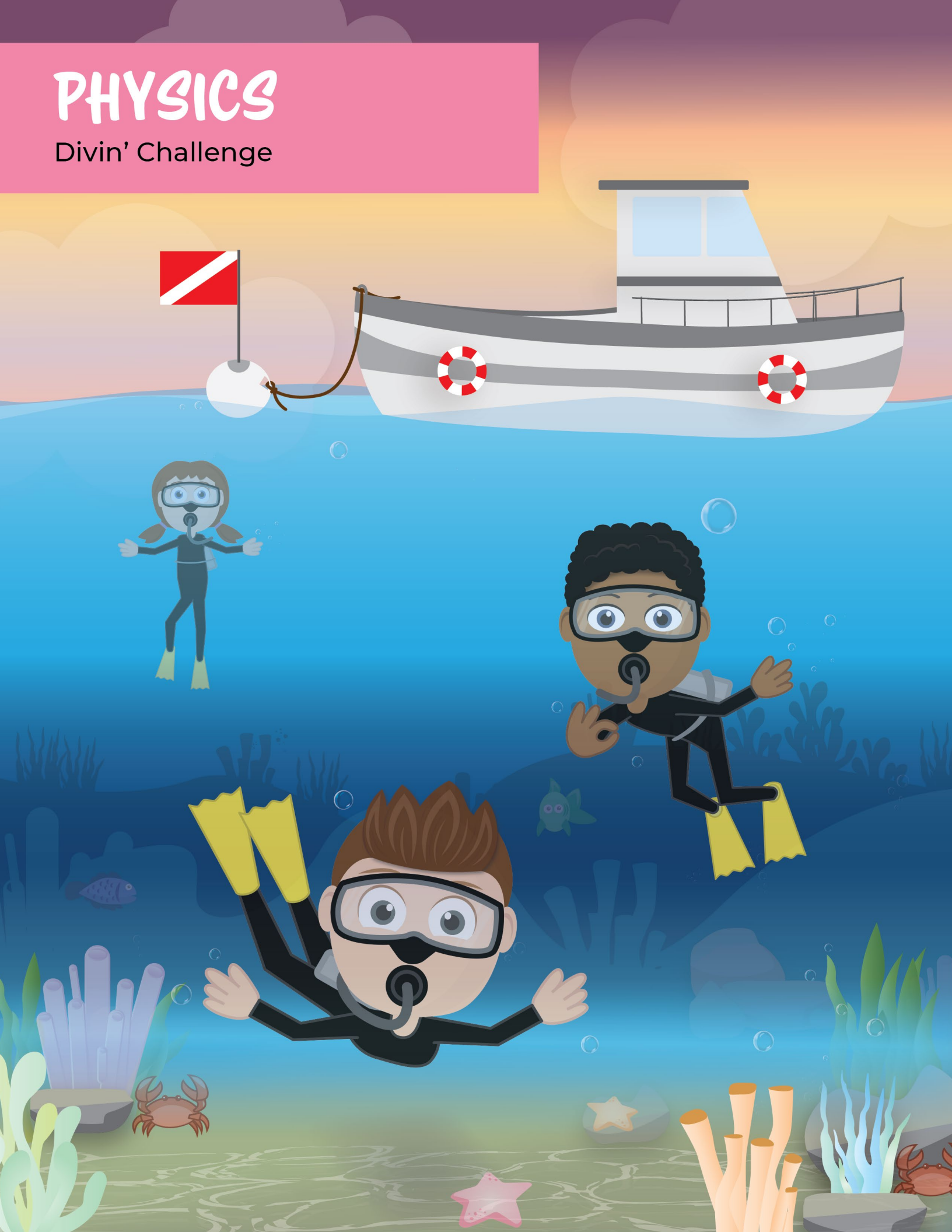
PHYSICS

Divin' Challenge



Divin' Challenge

NGSS

3-PS2-1; MS-PS2-2

Objective

The student will understand the basic concepts of density, buoyancy, pressure, and states of matter.

The student will be able to conduct a series of experiments to manipulate a hook in a bottle to grab targets at various depths in an effort to learn more about density, buoyancy, pressure, and states of matter.

Vocabulary

Buoyancy: An upward force exerted by a fluid that opposes the weight of an immersed object.

Density: Mass of a substance per unit volume. More simply, the weight of something compared to how much space it takes up. (Density equals Mass / Volume).

Mass: The quantity of matter that a body contains, as measured by its acceleration under a given force or by the force exerted on it by a gravitational field. Mass is an intrinsic property of matter.

Volume: The amount of space that a substance or object occupies.

Pressure: The ratio of force to the area over which that force is distributed.

Background

The purpose of the activity is to manipulate various tubes within water to various depths. In order to do so, the ideas behind Pascal's law and Archimedes' Principle are applied.

Pascal's Law

This law highlights that pressure is consistent throughout an enclosed fluid, or in this case

of the experiment, the 2-liter bottle, meaning that only the forces of gravity and pressure are acting on the system. However, this is drastically changed in the system when a targeted stress is applied, such as is the case in the experiment when you squeeze the bottle. Therefore, the bottle no longer follows Pascal's Law of uniform pressure. As a result, there is an additional force applied to the bottle which affects the air inside the tube that leads to displacement to change the pressure for negative buoyancy to sink the tube.

Archimedes Principle

The principle states that a buoyant force is equal to the weight of the displaced object. Therefore, the weight of the object being displaced will sink IF it is less. Likewise, the object will float if it is equal.

Archimedes Principle is important when considering the topics of buoyancy, especially for the development of ships. Additionally, trying to float in the pool or a lake largely uses the principle described because the body is at equilibrium and there must be an equal buoyancy pressure to allow for the float to occur successfully.

During the experiment, consider how manipulation of the bottle changes the behavior of the tubes. When the pressure on the container is released, the air expands, which in turn increases the weight of the water displaced and the tub will again move to the surface to float.

Materials

Note: the same supplies are reused in most of the activities. Groups can be 2-3 students or individual (supplies will vary depending on this)

One Versus One Pressure

- 2 100 mL plastic syringes with a cap
- Duct tape (for securing caps)

Tube Diver Experiment

- 2-liters plastic bottle
- 10 mL plastic pipette (skinny neck) – (5 total)
- Hex nut (5 total)

- Clear plastic cup
- Water
- Scissors

Find your Targets Challenge

- All elements from previous 'Tube Diver Experiment'
- Coat wire or pipe cleaner

Procedure

Lesson

1. Do some sort of ice break activity as a community building component to start your activity.
2. Go over the background information with the students and vocabulary words to introduce the topic for the day embedded in the activity.

Activities

One Versus One Pressure

1. Pull out your 100mL syringes and fill one with air and the other with 30mL of water
2. Have two student volunteers race to see who can compress the syringes fastest.

What's happening: Air (gas) is compressible, while water (liquid) is not to a certain extent. The reason is that there is more space between molecules in air, while molecules are closer together in the water.

Tube Diver Experiment

1. Set up your tubes:
    a. Fill up a cup of water ¾ full as your test space for the tube.
    b. Put the hex nut onto the 10 mL pipette so that it is snug up to the bulb. Cut off the neck of pipette so that about 1 cm remains below the hex nut.
    c. Make 5 of these and drop into the cup of water to check if they float.
    d. Then push on the bulb to suck water into the tube. Observe what happens to the flotation.

What's happening: The tube has become denser because water was added to the bulb and water in the tube is denser than the air in the tube. Drawing up all of the water will see the tube sink in the cup.

2. Now that you have seen how they sink, label the tubes 1-5.
3. Fill tubes with various amounts of water so that the tubes drop in the 2-liter bottle in the order of 1-5 when you push on the sides of the bottle.

Find your Targets Challenge

4. Add a “poke” attachment to one of the five tubes. This is your vessel for finding targets
5. Get the other 4 tubes to sink to various depths in the tube and manipulate the fifth tube to “poke” one of the targets. Can you “poke” all 4 tubes??

Guiding Questions

- Why do some things float and others sink?
- What is something you can think of in your everyday life that has a large density?
- How would changing the volume or mass of an object affect its density?

Career/Future Application

Density is an important concept across many fields of science. Understanding density, buoyancy, and different states of matter is important for engineers, chemists, physicists, and many more careers. Additionally, shipbuilders must recognize buoyancy as an important force for ships to float.

Sources

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