Cartesian Diver Construction

Introduction

Cartesian divers are great toys that can be used to teach important science concepts of density, buoyancy, and Boyle's law. These concepts have applications in fish physiology, scuba diving, and submersibles. How can a craft be designed to retrieve an object from the ocean floor and bring it to the surface? Use Cartesian divers as models for designing and testing solutions to this and many other creative challenges.

Opportunities for Inquiry and Engineering Design

The standard Cartesian diver technique can be transitioned to guided inquiry and an engineering design challenge using some or all of the following approaches, which will increase the level of student engagement and their ownership of the results. To avoid impulse designing and meet NGSS objectives for engineering design, it is important to allow students time to brainstorm ideas and to consider the pros and cons of each proposed design. If time allows, students may present their designs to the class.

- Demonstrate the standard Cartesian diver and instruct students to observe what happens when the bottle is squeezed. Allow students to brainstorm how the diver sinks and rises. Once the students describe and explain the operation of the diver, give them the materials and have them construct their own divers, writing their own step-by-step procedures.
- An alternative method is to give each group of students a functioning Cartesian diver without demonstration and challenge them to make the diver sink and rise without opening the bottle. Students must then explain how the diver works and how to construct the entire system.
- Even after thoroughly examining a Cartesian diver, students may have misconceptions about how it works. Most divers have an opening at the bottom. Ask students what would happen if the diver were closed (a simple drop of hot-melt glue after filling the pipet bulb to the proper level can accomplish this). Allow students to plan and carry out investigations and then engage in argument from evidence to support or refute various ideas about how both the standard and closed-system divers work.
- Present a design challenge with specific criteria and constraints to the students. For example, challenge the students to design a Cartesian diver toy with three to five divers that will descend in a pre-determined order. The toy should have a "theme" that enhances the design. Or challenge students to design a diver that will retrieve a given weight from the bottom of the bottle.
- Challenge students to design a Cartesian diver made of different materials, e.g., small inverted test tubes, syringes or balloons with the proper ballast.

Alignment to the NGSS

Disciplinary Core Ideas: Grades 6–8

Physical Science

MS-PS1 Matter and Its Interactions

PS1.A: Structure and Properties of Matter

ETS1.B: Developing Possible Solutions

ETS1.C: Optimizing the Design Solution

MS-PS2 Motion and Stability: Forces and Interactions

PS2.A: Forces and Motion

Engineering, Technology, and Applications of Science Performance Expectations

Students who demonstrate understanding can:

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices

Asking questions and defining problems

Developing and using models

Planning and carrying out investigations

Analyzing and interpreting data

Constructing explanations and designing solutions

Engaging in argument from evidence

Obtaining, evaluating, and communicating information

Crosscutting Concepts

Patterns

Cause and Effect

Systems and System Models

Structure and Function

Stability and Change of Systems

The *Cartesian Diver Construction Kit* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP9082	Cartesian Diver Construction Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.