Float Challenge

Overview

Apply science and mathematics to a real world engineering design solution. Students experience key lessons including the application of an engineering design process.

Objectives

Students will plan an investigation to provide evidence that the change in an objects' motion depends on the sum of the forces on the object and the mass of the object.

Students will apply Newton's first law of motion, that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

Students will apply Archimedes Principle, the buoyant force exerted on a body immersed in a fluid is equal to the weight of the fluid that the body displaces and it acts in the upward direction of the center of mass of the displaced fluid.

Activities

1. Engage students in review discussion of: what is an engineering design process; why use an engineering design process; why do engineering designers use ideation and create multiple solutions; what are constraints; why is it important to define the problem completely?

Engineering Design

K-12th grade with grade appropriate modifications

Materials

1 cubic foot crate

5 pound bag of flour

Sink or bin large enough for testing float projects in water

Set-Up/Preparation

Provide materials and tools for students to create the "float".

Have a scale available as Allow students to weight floats and create

5 pound bag of flour

Sink or bin large enough for testing float projects

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2. Review Archimedes Principle - the buoyant force exerted on a body immersed in a fluid is equal to the weight of the fluid that the body displaces and it acts in the upward direction of the center of mass of the displaced fluid. Lead discussion on the center of gravity theoretical assumptions and difference in real world mass distribution. Collectively or in small groups create sample example to run through the volume calculation and force balance equation.

3. Tell students that they will now apply what they have learned and consider engineering design constraints with the following challenge: "Your challenge is to keep our "person" (a 5 lb bag of flour), alive in an open body of water. We don't want this "person" to drown, so you must make sure that they have access to fresh air. The "person" is not allowed to get wet. I highly recommend that you follow the engineering design process. Come up with multiple possible solutions before getting too attached to one! Constraints: Your solution to this challenge must fit in a 1 foot cube box. You may use any found materials, but you may not purchase more than $10 in additional supplies."

4. Allow students time to step through and document science and engineering practices including 1. Defining problem, 2. Developing a prototype, 3. Carrying out an investigation, 4. Analyzing data, 5. Using mathematics, 6. Constructing and design solutions, 7. Engaging in argument from evidence, and 8. Obtaining, evaluating and communicating information.

5. Test solutions collectively for volume constraint and float challenge. Discuss lessons learned.

6. Challenges may be varied to include the most aesthetically pleasing, greatest weight holding (within the same volume), most stable (when a wave is applied), etc. Additional discussions can include design scenarios in which physical

Modifications

Vary the design challenge to include the most aesthetically pleasing, greatest weight holding, and most stable.

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testing is not possible, for example with a Mars mission when testing cannot be accomplished in advance.

Notes:

REFERENCES

Archimedes' Principle https://en.wikipedia.org/wiki/Archimedes%27_principle

SAMPLE STANDARDS

NGSS 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.

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

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

NGSS 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.

NGSS MS-PS2-2. Plan an investigation to provide evidence that the change in an objects;' motion depends on the sum of the forces on the object and the mass of the object.

CCSS.MATH.CONTENT.5MD.C.5A Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

MN Academic Mathematic Standard 5.3.2 determine the area of triangle and quadrilaterals; determine the surface area and volume of rectangular prisms in various contexts.