Terrain to Tide Challenge

How does understanding buoyancy help us create a vehicle that can conquer both land and water?

Terrain to Tide Challenge

Lesson Length

1-2 Class Periods

Overview

Ever wonder how vehicles can travel on both land and water? Get ready to explore the fascinating world of amphibious vehicles. In this project, we'll dive into two exciting concepts: buoyancy and design. Buoyancy is the magical force that keeps things afloat in water, while design is all about creating a vehicle that navigates land and water seamlessly. Using these principles, we'll uncover the secrets behind this incredible engineering feat.

VDOE CTE/SOL Courses & Standards:

Introduction to Technology and Engineering
Inventions and Innovations
Physical Science
Life Science

See page 10 for course standards

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Learning Objectives:

In this challenge students will:

1. Understand buoyancy and how it relates to an objects ability to float in water.
2. Explore the challenges and solutions involved in designing a vehicle that operates efficiently on land and water.
3. Experiment with hull shape, size, and design (and how that impacts the buoyancy of the vehicle).

Materials/Supplies:

Buoyancy Testing:

- Variety of materials that can include
  - Wood Block
  - Styrofoam Ball
  - Metal
  - Plastic
  - Glass Marbles
  - Rocks
  - Any other additional items that might be fun to test
- Tub to test in with water
  - Tote
  - Sink

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Materials/Supplies:

- *Materials can be modified as needed

Amphibious Vehicle:

- Styrofoam plates/trays/bowls
- Aluminum Foil
- Plastic Wrap
- Cardboard
- Straws
- Popsicle Sticks
- String
- Rubber Bands
- Paper Clips
- Pipe Cleaners
- Plastic Cups
- Plastic Spoons
- Toothpicks
- Cardboard Tubes (toilet paper tubes/paper towel tubes)
- Pool Noodles (cut into various sizes)
- Plastic Bottles (with bottle caps)
- Clay or Playdough
- Plastic Containers (cleand out yogurt containers/milk jugs/juice bottles/etc.)
- Wood Skewers
- Glue
- Tape
- Scissors
- Ruler
- Stapler
- Single Hole Punch
- Box Cutter/Exacto Knife *teacher discretion
- Hot Glue *teacher discretion

*Optional Materials

- Motor
- Batteries and Battery Case
- Metal Axles

Boat Testing:

- Weights
  - Pennies
  - Washers
  - Coins
- Tub to test in with water

Did you know that the first fully functional amphibious vehicle was invented over 80 years ago?

Key Vocabulary

- Buoyancy: upward force exerted by a fluid (like water) that opposes the weight of an object submerged in it.
- Archimedes Principle: states that any object submerged in a fluid (like water) experiences an upward force, or buoyant force, equal to the weight of the fluid that the object displaces.
- Hull: the main body of a ship or boat that sits in the water. It's the part that keeps the vessel afloat and provides shape, stability, and protection.
- Displacement: the amount of water that a ship or boat pushes aside, or displaces, when it is floating in the water.
- Amphibious: a vehicle that can travel on both land and water, seamlessly transitioning between the two
- Stability: a ship or vehicles ability to remain upright and balanced especially when it's moving or facing external forces like waves or wind.
- Propulsion: proess of moving an object forward.
- Hydrodynamics: the study of how fluids, such as water, move and interact with objects.

Background Information & Resources

Buoyancy for Middle School students - https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/12.6/primary/lesson/buoyancy-ms-ps/

https://www.youtube.com/watch?v=nMlXU97E-uQ

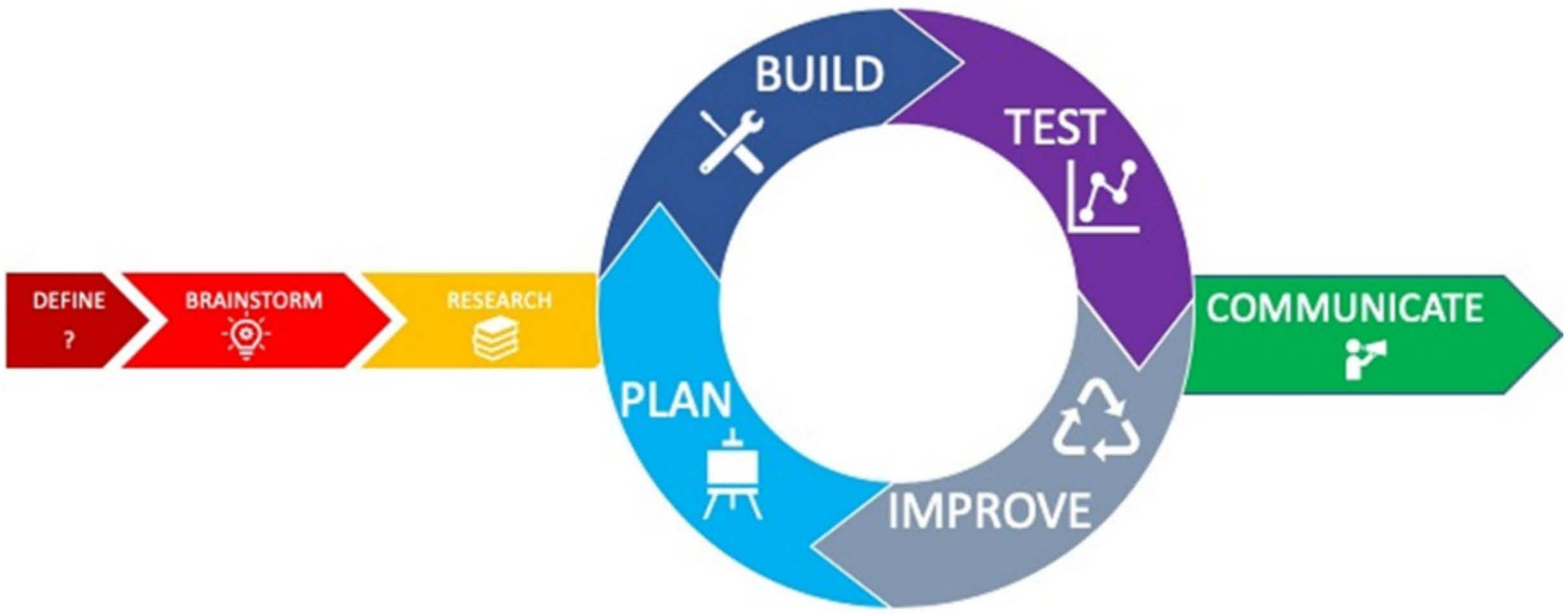
Terrain to Tide Challenge
Teacher Prep

Teacher Prep

Before beginning the challenge, students/teachers can collect recyclable materials to use. Make sure that they have been cleaned out.

For the testing components of this project (buoyancy and amphibious vehicle), the teacher will need to prepare a testing bin/pool/sink before and determine how students will view the test. This is determined based on classroom size, class size, and materials available. The teacher should also have all materials prepared for both buoyancy testing and amphibious vehicle construction.

Terrain to Tide Challenge Directions



- Define the problem and determine the parameters
- Brainstorm potential solutions
- Research the problem (this can be done before the brainstorm session)
- Plan: pick one solution, plan a prototype, and determine what data to collect to determine its effectiveness
- Build the prototype
- Test the prototype
- Improve the prototype and test it again
- Communicate the results

Buoyancy Testing

1. Show students objects that will be used for buoyancy test
2. Review what positively buoyant, negatively buoyant, and neutrally buoyant mean
3. Have students hypothesize what objects will be positively buoyant, negatively buoyant, or neutrally buoyant. Have students record their hypothese on a document (can be digital or paper). Have student identify and record specific characteristics of the objects they think will make them positively, negatively, or neutrally buoyant.
4. Test each of the objects or materials while students watch and record the results.
5. Discuss with the students the results and how their hypotheses compare.

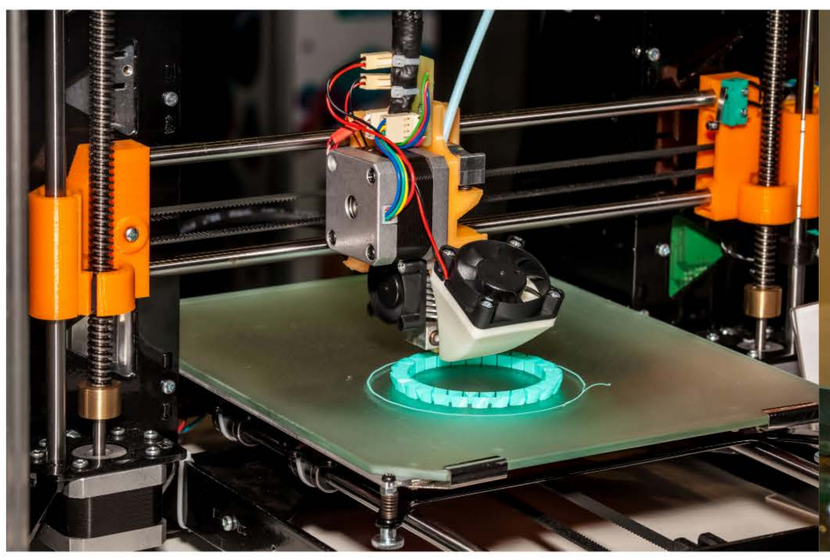
Terrain to Tide Challenge Directions

Amphibious Vehicle

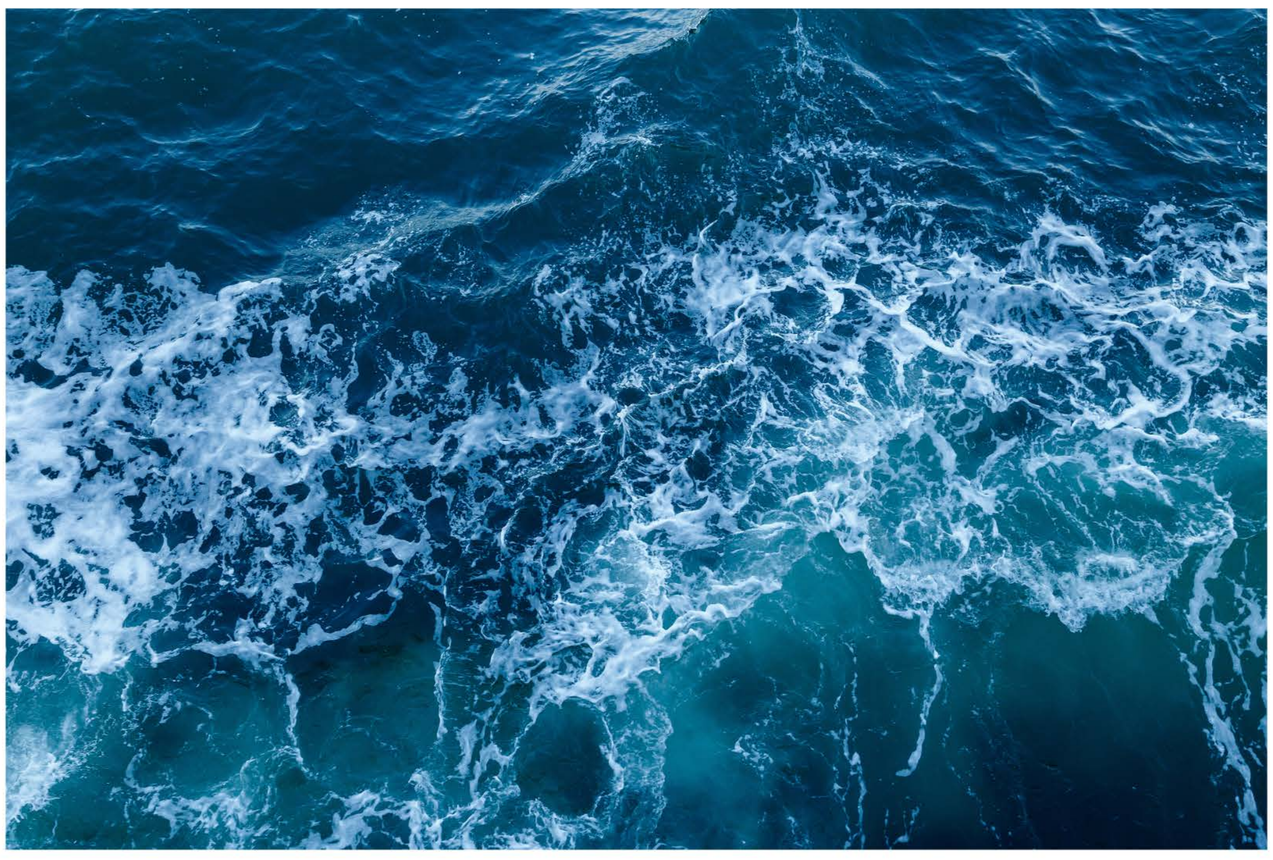
1. Present the challenge to the students
   Challenge: Design and build an amphibious vehicle that can go from land to water and is self-propelled.
2. Have students research amphibious vehicles that exist and discuss their findings
   a. Things to talk about:
      i. What are amphibious vehicles used for?
      ii. How do the designs differ?
3. In teams of 2, have students brainstorm ideas for their amphibious vehicle
   a. Brainstorming can look like sketches on paper, word clouds, or images pulled together from their research. You decide how you want this to look.
4. Have students decide on their solution and begin to plan how they will make their prototype
   a. This would be a good time to talk about ways the amphibious vehicle can be self-propelled
   b. Have the "course" set up to show students the land versus the water and how the amphibious vehicle will be traveling
5. Prototype construction
6. Test the prototype
   a. Up to the teacher on if there should be testing throughout the build process or if you want to wait until all prototypes are fully constructed
7. If time permits, students can redesign and retest their prototypes. If there is not time for that, students should complete a "report" that documents the positives and negatives of their prototype and how they would improve it
8. Students should do a small informal presentation on what they learned, their design, and what they would do different. Teacher's can add additonal talking points.

Terrain to Tide Challenge
Take It Further!

- If classroom is equipped with 3D printers, CNC Machines, or Laser Engravers, you can have the students create their amphibious vehicle using those pieces of equipment.



- Salt can be added to the testing water (in both the buoyancy testing and amphibious vehicle challenge) to see how salt effects buoyancy.
  - https://www.youtube.com/watch?v=pldlkbCDOSI



Terrain to Tide Challenge

VDOE CTE/SOL Courses & Standards:

All Workplace Readiness Skills Competencies can be addressed throughout the project.

Introduction to Technology and Engineering

- Examining Resources of Technology
  - Differentiate between types of materials
  - Create sketches and drawings
- Designing Solutions
  - Describe the VDOE engineering design process
  - Demonstrate the use of an engineering design process
- Using the Engineering Design Process
  - Define the goal of a challenge
  - Design a device using criteria and constraints
  - Evaluate viable solutions
  - Select a solution
  - Plan the model or prototype
  - Assess the design
  - Describe how the solution could be improved
  - Communicate the results
  - Use the engineering design process as part of a team

Inventions and Innovations

- Exploring Tools for Invention and Innovation
  - Create sketches and drawings
  - Model various mechanisms used in inventions and innovations
- Exploring Design and Creativity
  - Describe the steps of the VDOE engineering design process
- Applying the Engineering Design Process
  - Plan a solution to an engineering design problem
  - Build a model or prototype of the proposed solution
  - Communicate the process and results of the proposed solution

Physical Science

- PS. 1 The student will demonstrate an understanding of scientific and engineering practices by
  - a) asking questions and defining problems
  - b) planning and carrying out investigations
  - c) interpreting, analyzing, and evaluating data
  - d) constructing and critiquing conclusions and explanations
  - e) developing and using models
  - f) obtaining, evaluating, and communicating information

Life Science

- LS. 1 The student will demonstrate an understanding of scientific and engineering practices by
  - a) asking questions and defining problems
  - b) planning and carrying out investigations
  - c) interpreting, analyzing, and evaluating data
  - d) constructing and critiquing conclusions and explanations
  - e) developing and using models
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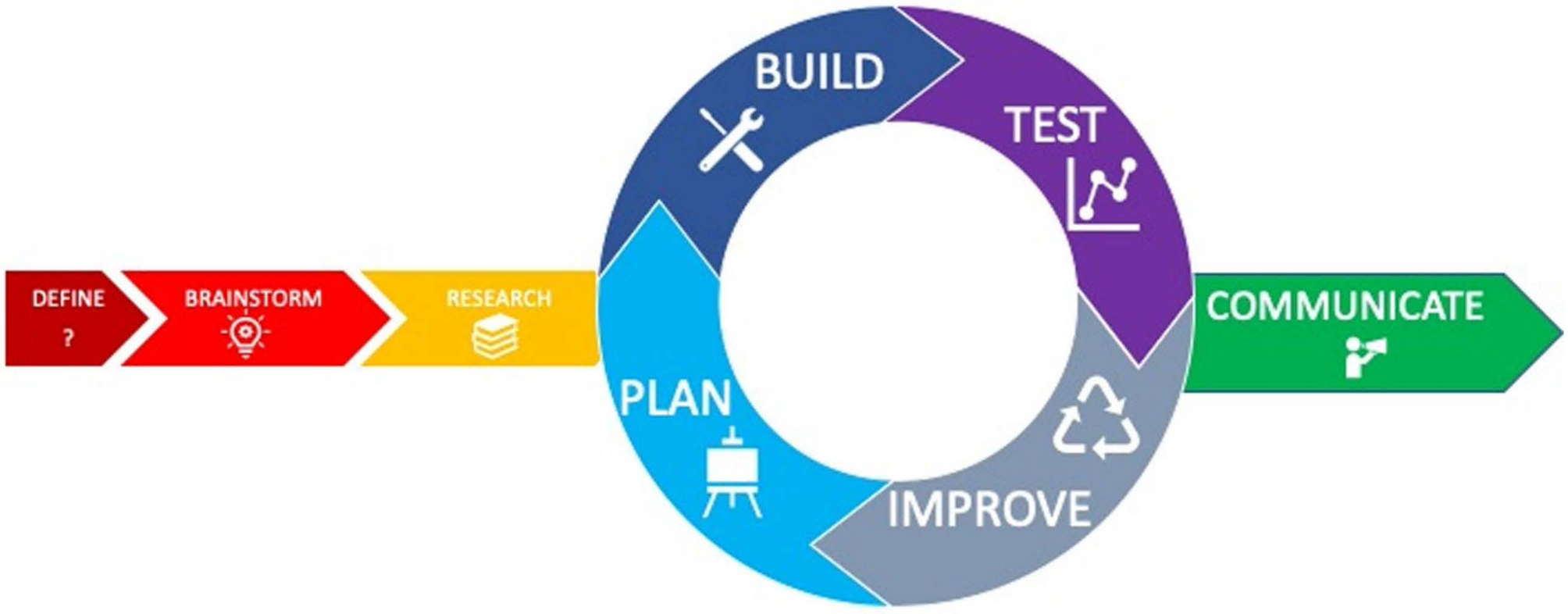
Project Management Plan

Team Member Roles

Team Goals & Timelines

Team Member Tasking

Research Planning



Sketches & Design Planning