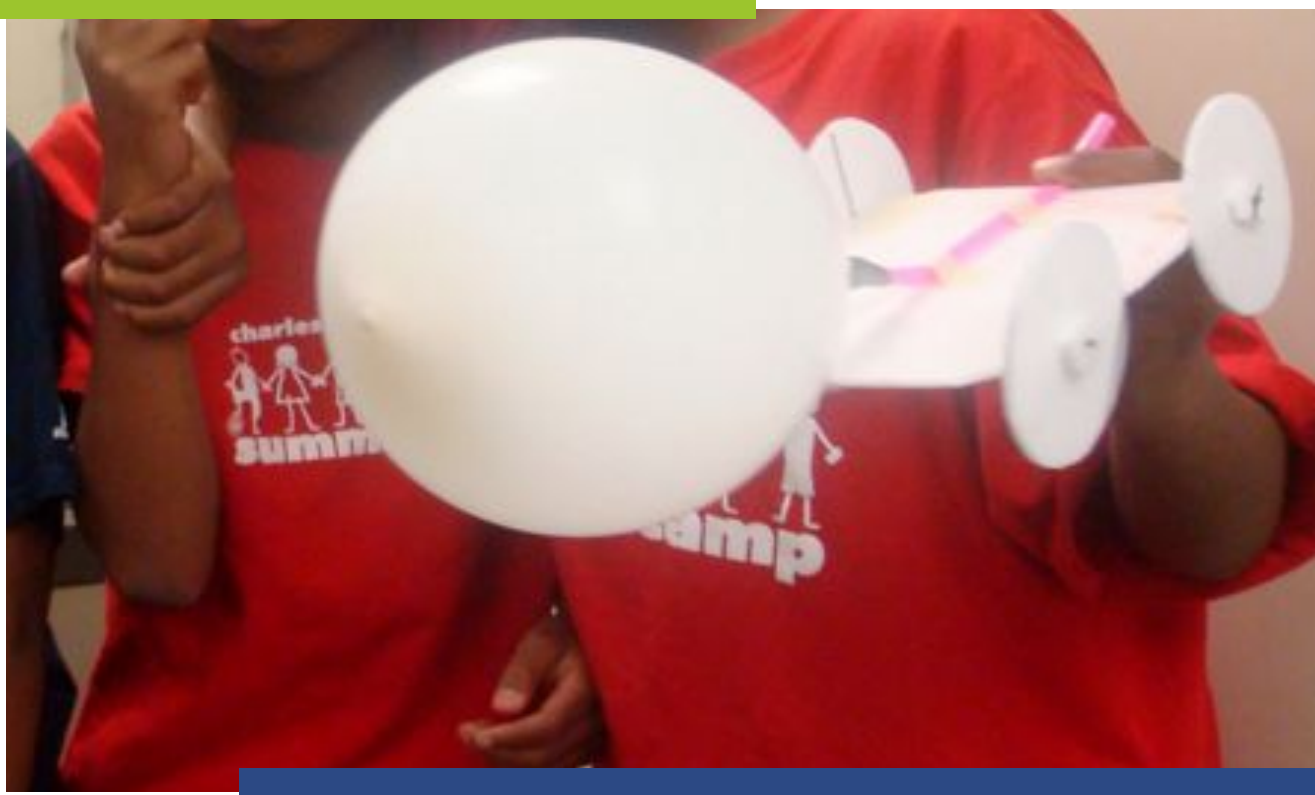
Balloon Car STEM Challenge



Using the Engineering Design Process

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About Vivify

Vivify is a K-12 STEM education resource company founded by two aerospace engineers, Natasha and Claire, with a passion for providing access to quality STEM education.

Our philosophy is that STEM transforms classrooms into an exciting world of curiosity, problem-solving, and creativity. STEM education can be an empowering interdisciplinary approach that brings math, science, and engineering concepts to life through challenging opportunities that mimic the complexities and excitement of the real world.

Every teacher or parent can incorporate STEM into their classroom or home given the right resources, and that is where Vivify comes in! We love creating STEM materials and are excited to bring STEM to more classrooms and homes! Click here to learn more about Vivify.

Connect with us for free STEM resources!

Subscribe to our newsletter and receive access to a library of free STEM resources through www.vivifystem.com. Follow us on social media or listen to "The STEM Space" podcast for more resources and ideas.

Follow us for more STEM! @vivifystem

Activity Overview

BALLOON CAR STEM CHALLENGE

Build a balloon-powered car that will travel 5 feet. This activity is part of the Starter STEM Challenges found here.

STEM career connection: Industrial Engineer

PAPER TABLE CHALLENGE

Build a paper table that is at least six inches high and can hold a heavy book for five seconds.

BUILD A BOAT CHALLENGE

Build an aluminum foil boat that can hold at least 25 pennies without sinking.

MIGHTY MACHINE CHALLENGE

Use the stored elastic energy of rubber bands to build a catapult that can launch an object 20 feet.

EGG DROP CHALLENGE

Drop an egg from 5 feet without cracking it.

BALLOON CAR CHALLENGE

Build a balloon-powered car that will travel 5 feet.

HELPING HAND CHALLENGE

Build a device that lets you grab an object 2 feet away and move to a container 10 feet away.

Standards Alignment

STANDARDS ALIGNMENT

This unit aligns with the following standards, but learning outcomes will vary depending on time spent and the selected focus of the activities and discussions.

Next Generation Science Standards (NGSS)	**3-5-ETS1-1.**	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
	3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
	3-5-ETS1-3.	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
	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.

Other Possible Topics

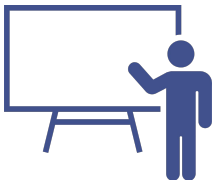
- Action and reaction of forces
- Friction
- Balance of forces
- Wheel and axle
- Kinetic and potential energy

IMPORTANT LINKS

The following are links to student handouts and teacher materials to support implementation of this lesson.

How to use Google Slide Links

These links makes a copy to your Google Drive to edit as needed. To print slides, click FILE and then PRINT. To convert to PDF, click FILE → DOWNLOAD → PDF.

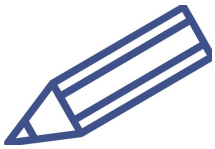


Teacher Instructional Slides & Video

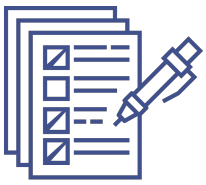
To support your students, we have create editable teacher companion presentation slides and instructional video to guide your students through the lesson. For slides, you will need a Google Account to access the links. This link makes a copy to your Google Drive.

Click for Editable Teacher Companion Slides.

Printable Student Handouts



To allow for teachers to customize worksheets, we are providing a link to the Google Slides version for editing student handouts for this lesson. Click here to access this editable packet via Google Slides.



Assessment Rubrics

STEM challenges can be used for various learning outcomes such as engineering process skills, communication, science concepts, etc. Learning outcomes will greatly differ based on how the STEM activity is implemented, time constraints, and other factors. We have provided editable templates as a starting point. Click here for editable rubrics.

Note to Teachers

Teacher instructions

1. **Introduce** the engineering design process using the handout provided. Explain to students that real-world engineers use this process to create engineering designs such as rockets, airplanes, skyscrapers, and computers. More great resources found here and here.

2. **Explain** the activity. Provide students with the STEM Challenge Sheet and explain how they will be using the engineering design process to complete a challenge.

   - Each challenge has specific constraints (or rules) that must be followed. Students should not immediately start building. They must first fully understand the problem and brainstorm ways to use the materials to build a solution.
   - Failure is an important part of the design process. There is not one correct solution for the challenge. Students must be creative as well as persistence during testing to keep trying until their design is successful. An aerospace engineer doesn't build a rocket without doing a lot of testing and re-designing!

3. **Pass** out the student Engineering Mission Sheet. Six different challenges are provided as described on the previous page. Each sheet includes:

   - **Mission**: this is the problem that the student needs to solve.
   - **Materials**: Some challenges require specific materials and others are a suggested list. All materials are cheap and common items.
   - **Engineering Design Constraints**: The rules of the mission.
   - **Design Considerations**: This includes important questions to think about or a connection to an relevant science facts.
   - **Math Connection**: Math problems related to the challenge.
   - **STEM Career Connection**: Connects the challenge to a real-world STEM career, current event or project, and a resource to learn more.

Note to Teachers

Take-Home Challenge

As a student-driven project, a successful design challenge requires a flexible time frame and relaxed environment to promote creativity and innovation. Unfortunately, a 50 minute class period with 30 other students does not always make the best environment.

The provided challenges can be used as STEM Take-Home Challenges. Students are provided with a Mission Sheet and a Student Handout that guides them through the engineering design process. The challenge, along with relevant math and science concepts, are reviewed in class, and then students are tasked with completing the challenge and recording results. All challenge materials are easily found around the home or you can provide a take-home pack. Parents are notified with a letter which encourages them to participate and support the learning process. Students then report back and share their final designs with the class.

In-Class Challenge

Challenges are best completed in a small team of 2-3 students. A rubric is provided for assessment. The students should not be graded solely on a successful design, but instead on a successfully completion and understanding of the engineering design process.

STEM Space At Home Series

Vivify has created a free series of STEM Space At Home videos: a series of engineering design challenges led by an engineer and using materials found at home. Videos include science demos, STEM career highlights, and a design challenge. Find the series here: https://www.vivifystem.com/stem-videos

Note to Teachers

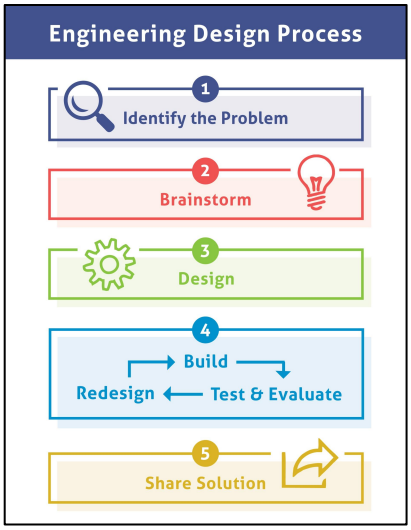
Implementing STEM

OVERVIEW OF STEM

The following STEM activity is a great way to incorporate the engineering design process into your classroom or afterschool program! This activity is a Stage 2 STEM activity. Learn more about the STEM stages here (bit.ly/stemstages). As a student-driven assignment, the purpose of the teacher is to act as a facilitator. You will provide the structure to the project, but students will take an active role in solution.

Students will:

- Learn about an engineering problem they need to solve.
- Connect the problem to STEM careers and a real-world event.
- Gather materials and brainstorm ideas.
- Draw a design idea.
- Build and test their device. Students will keep making changes and improving their design.
- Share their a final design.



What is the Engineering Design Process?

In STEM learning, students apply math and science concepts to solve an engineering problem using technology. Students tackle these problems with the Engineering Design Process which helps them brainstorm, develop a design, test, and redesign for an optimal solution. However, the Engineering Design Process should not be confused with the commonly used scientific method. Learn more here.

Stage 2 STEM

For Stage 2 STEM, students apply math and science concepts to problems using the Engineering Design Process. This process can be visualized with the diagram on the next page. Instead of immediately building, students are systematically guided through a process of brainstorming, designing, building, testing, re-designing, and sharing their solutions. For example, in the catapult challenge, students apply knowledge of elastic potential energy to design a catapult device to either hit a target or maximize distance. During the testing phase, students analyze catapult designs to re-design and improve their results. This process enhances student critical thinking skills while integrating math and science skills into an engaging hands-on engineering project. Real-world connections further enhance the activity.

HOW TO FACILITATE A STEM CHALLENGE

STEM challenges usually require at least 90 minutes of class instruction to fully utilize the engineering design process. Educators with shorter class periods can stretch the sessions over 2 - 3 classes. Recommendations for sessions are below. Keep in mind that educators often focus the most on building and testing. However, reflection is equally important and should not be skipped. Additionally, during a class discussion, teachers can use the building and testing experience to connect with important science concepts during reflection.

One 90 minute Session

Engage: 15 minutes
- Play video related to mission
- Discuss STEM career connection
- Introduce mission
- Provide science background

Activity: 60 minutes
- Provide activity instructions
- Divide into teams
- Brainstorm ideas
- Gather materials
- Build and test
- Improve and re-test

Reflection: 15 minutes
- Answer reflection questions
- Share solutions with class

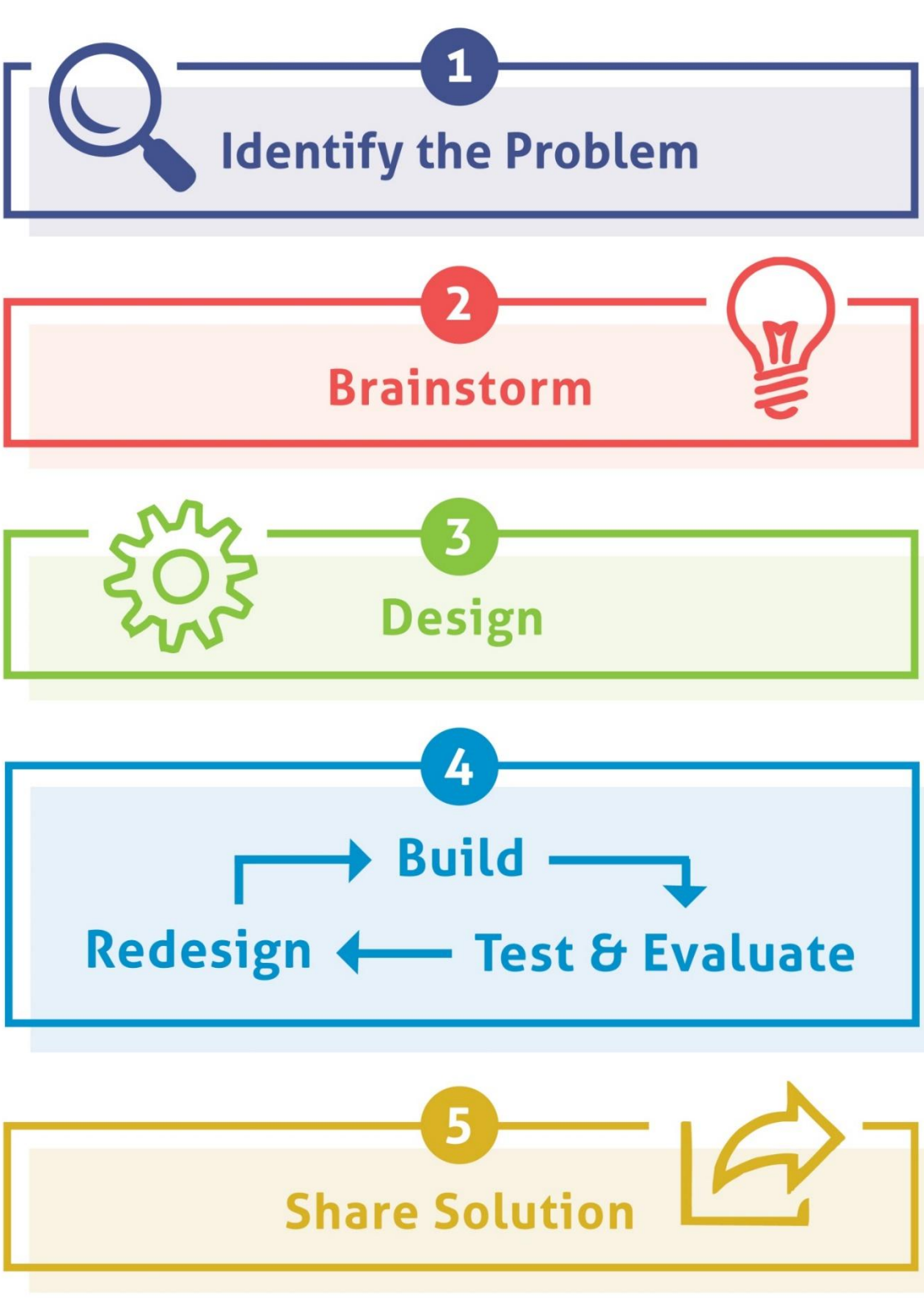
Session 1
- Play video related to mission
- Discuss STEM career connection
- Introduce mission
- Provide science background
- Divide into teams
- Brainstorm ideas

Session 2
- Play a video related to the mission
- Refresher on mission
- Gather materials
- Build and test
- Reflect

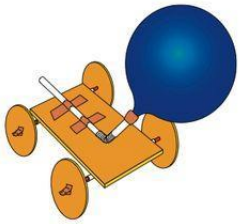
Session 3
- Play a video related to the mission
- Refresher on mission
- Improve designs and re-test
- Share solutions
- Reflect

Click here for more resources on implementing STEM challenges.

Engineering Design Process



Balloon Car Mission



Build a balloon-powered car that will travel 5 feet.

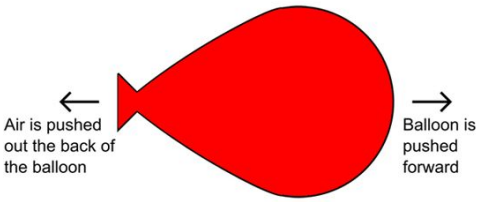
Materials Suggested

- ❑ **Power:** Latex balloons
- ❑ **Car body**: Plastic bottle, plastic cup, cardboard
- ❑ **Wheels**: CDs, bottle caps, empty rolls of tape
- ❑ **Axles**: Wooden pencils, skewers
- ❑ **Other materials**: plastic straws, glue, tape, paper clips, scissors, rubber bands

Engineering Design Constraints

1. The car must be propelled forward by the air escaping the balloon.
2. The car must be sturdy and not fall apart when in use.
3. The car must travel at least five feet.
4. The car must travel in approximately a straight line.

Design Considerations



Have you ever blown up a balloon and let it go? The air rapidly escapes the balloon making it fly away. Your challenge is to harness this energy to propel a car forward!

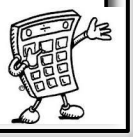
The balloon-powered car has three main parts: the body, the wheels, and the axles. The axles connect the wheels to the body and allow them to spin. Think about what materials you will use for each part and how they will connect together.

Math Connection: Let's calculate the average speed of your balloon car. The equation for this is:

$$average\ speed = \frac{total\ distance}{total\ time}$$

Measure the total distance traveled in inches or centimeters and divide by the total time (seconds).

- What is your average speed? _____
- Convert to ft/sec or m/sec: _____



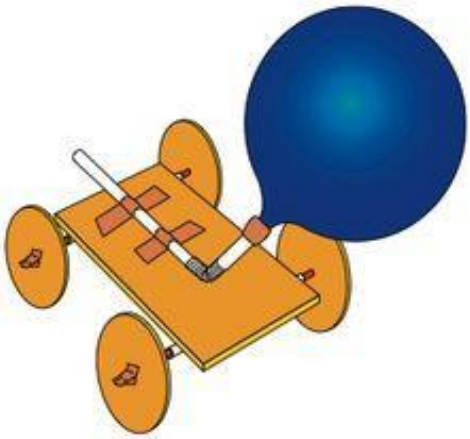
STEM Career Connection: Industrial Engineer

Industrial engineers determine the most effective way to use people, machines, materials, information, and energy to make a product or service.

Cool Project: Industrial engineers helped design the Walt Disney World theme parks to maximize enjoyment for visitors including easy access to rides, food, and entertainment. 52 million people visit the park each year!

Learn more: Download the TinkerBox app to play a fun physics and engineering puzzle game!

Balloon Car Challenge



Build a balloon-powered car that will travel 5 feet.

CONSTRAINTS

- The car must be propelled forward by the air escaping the balloon.
- The car must be sturdy and not fall apart when in use.
- The car must travel at least five feet.
- The car must travel in approximately a straight line.

Balloon Car Challenge

1

Identify the Problem

Build a balloon-powered car that will travel 5 feet.

Constraints

- The car must be propelled forward by the air escaping the balloon.
- The car must be sturdy.
- The car must travel at least five feet.
- The car must travel in about a straight line.

2

Brainstorm

Before we start designing, think about the following:

How will you create the wheel and axle? How will you connect the balloon?

3

Design

Sketch your design idea below.

Tip: a rougher wheel edge will improve traction, or the ability to grip the ground.

4

Build

5

Test → Evaluate → Improve

Test your car! Complete the table below to record results. Use the back of this page if you need more room.

Keep making changes and re-testing to improve your design. Can you make your rover travel further or faster?

Trial	Distance traveled	Time	Straight line?	Pass distance test?	Design Notes
1			Yes / No	Yes / No	
2			Yes / No	Yes / No	
3			Yes / No	Yes / No	
Farthest distance traveled:					

6 Reflect & Share

1. Share your design! How does it work?

2. What happened during building and testing?

3. What improvements did you make to your car that helped you to be successful?

Want more STEM?

For a complete list of all of Vivify STEM resources by topic and grade, go to:
https://www.vivifystem.com/curriculum-map

Help! I need to plan a year-long STEM class! What should I cover? What is appropriate for each grade level?

We can help! Click here for guidance on a scope and sequence of a STEM class plus resources and examples for planning a STEM curriculum map.

3 Stages of STEM

STEM generally revolves around the Engineering Design Process that embraces failure, relies on teamwork, and requires critical thinking and creativity. While exciting, educators often become intimidated as a search for curriculum leads to an overwhelming range of activities from index towers to robotics competitions. At Vivify, we believe that not all STEM is created equal. Educators should adopt a 3 Stages of STEM approach by progressively building towards more complex projects.

Click images for lessons for each stage!