Engineering Design

Potential and Kinetic Energy Activity

Spool racers

Challenge

Design, build, test and improve your own spool racer.

Materials Needed

Essential items

- Spool
- Rubber band
- Washer
- Pencil
- Toothpick
- Tape

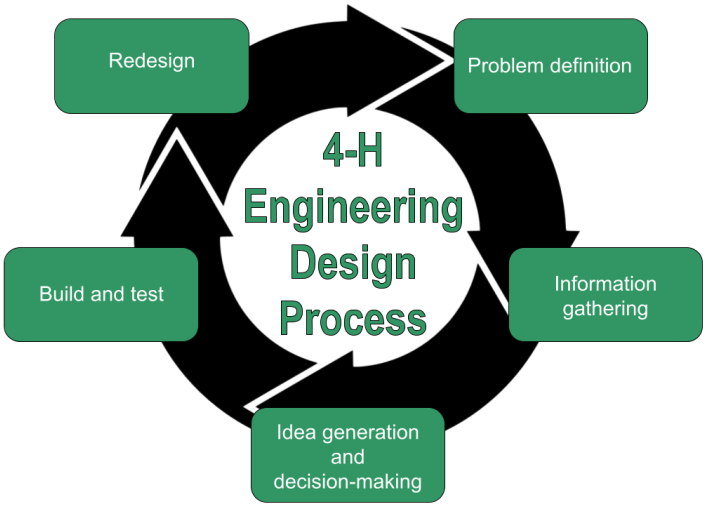
Optional

- Different types of washers
- Different sizes and types of rubber bands
- Stopwatch or timing device
- Tape measure or other measuring device

Introduction

There are many types of potential energy; in this activity we will be exploring the potential energy stored in the elasticity of a rubber band. You will use the 4-H engineering design process to complete this challenge.

Energy: the ability to do work
Potential energy: energy stored in an object or system
Kinetic energy: the type of energy found in moving objects
Constraints: limitations to creating the perfect design; these limitations could be things like not having all the materials or resources (including time) that you would need



Engineering Design Process

Use the engineering design process to develop your final solution. Be sure to take notes or create diagrams for each step of the process.

1. Problem definition: Define the problem and identify the constraints

Using materials provided, create a "spool racer." This spool racer will demonstrate how potential energy can be converted to kinetic energy.

Your basic challenge is to make the spool move using only the materials provided. You are encouraged to set your own criteria for success. For example, your final product might be a spool racer that travels the greatest distance. Or perhaps, your final product might be a spool racer that goes the fastest over a specific distance.

In your own words, what is the problem you are addressing? *(You might come back to this step after you test your first design in order to address a specific problem, such as getting your spool racer to go in a straight line, or to get your spool racer to go further, or faster.)*

What are the constraints or limitations that you have to work within? (Possible answers: Materials you have to work with, time you have to make improvements, experience you have, or don't have, in using rubber bands to create kinetic energy)

How will you know if you are successful (what are your criteria for success)? (Possible answer: The spool racer moves)

2. Information gathering: Research possible solutions

To see the concept and one example of how to build a spool racer, watch this video of Steve Spangler's Wind Up Racer (https://www.youtube.com/watch?v=k8yZwrEaXiw). If you are not able to watch the video, there are written instructions on page 6 of this document.

Which of the materials can store energy (potential energy)?

What ways can you use the materials provided to get spool to convert potential energy to kinetic energy?

3. Idea generation and decision making: Develop a plan

- Hint: Keep your initial plan simple.
- Draw and label a sketch.
- Make a materials list and how you will use them..
- Include details about how you will measure the success of your design *(for example, how will you measure how straight it goes, or how far it goes or how fast it goes?)*
- Pick which design solution you will try first.

What design ideas do you have for a solution to the problem?

Do you have all the materials you need to create your solution? If not, can any of the materials you do have be used in a different way?

How will you know if your design is successful? Are there some things you can measure to determine how successful your solution is? (Possible answers: the spool racer moves in a straight line or the spool racer moves over 30 centimeters)

4. Build and test your design

Refer back to your criteria for success. How does your design solution meet those criteria?

5. Redesign: Make adjustments to your design

Look at your design critically.

What are the variables that affect the success of your design?

What do you think is working really well?

What do you think is not working well? How can you fix it?

As you make changes to your design in order to improve it, **change only one thing (variable) at a time** so that you can definitively say that the change did, or did not, affect your design.

If there are variables you want to change, go back to the decision making stage of the engineering design process.

If you have different ideas about the design that involve several variables, you might want to go back to the information gathering stage of the engineering design process.

If you understand the problem differently, or decide you want to try different criteria for success, go back to the problem definition stage of the engineering design process.

Reflect on your solution

Consider sharing your final design solution with another person. To prepare to share your solution, answer these questions:

1. What is something you feel is really successful in your design solution (what is key to the success of your design)?
2. What was something that was challenging or difficult to overcome in this challenge?
3. How does your final design solution compare to your first design solution?
4. What change(s) did you make that had the greatest impact on your design solutions?
5. Compare your final design solution against the criteria for success.
6. What skills did you use that were most important to helping you complete this challenge?
7. What is something you learned during this challenge that might help you in other areas of your life?

Resources Used

Spangler, S. (2024). "Wind up racer." Steve Spangler, Inc. https://stevespangler.com/experiments/wind-up-racer/, accessed 5/30/24.

Emerson. (n.d.) "STEM: Spool Racer." Emerson. https://www.emerson.com/documents/corporate/stem-spool-racer-activity-en-us-7045910.pdf, accessed 5/30/24

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One Way to Build a Spool Racer

1. Push the rubber band through the spool so that each of the rubber band is sticking out the end of the spool. The toothpick could be used to help you push the rubber band out the other end of the spool.
2. Break the toothpick so that it is not wider than the spool and then stick that toothpick through one end of the rubber band. Tape the toothpick to the spool so that it anchors the rubber band to the spool.
3. On the other end of the spool push the end of the rubber band through the washer so that the washer is next to the spool.
4. Slide a pencil through the loop of the rubber band (the washer will be between the spool and the pencil).
5. Hold the spool in one hand and with your other hand, spin the pencil around so that it winds up the rubber band in the spool.
6. Set the spool and pencil down on a smooth, flat surface and let go.