Lesson 5:
Industrial Engineering and Alka Seltzer Rockets

(Instruct/Play/Investigate/Test)

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Vocabulary

- ★ **Chemical reaction:** a process that rearranges atoms to create a new substance
- ★ **Kinetic Energy**: movement energy
- ★ **Optimization:** making the best or most effective use of a situation or resource
- ★ **Potential Energy**: stored energy

What is industrial engineering?

Industrial Engineering is a type of engineering that deals with the **optimization** of processes or systems.

Optimization is making the best or most effective use of a situation or resource.

What can be optimized? Cost, time, schedules, and quality can always be improved.

An **industrial engineer** can help optimize all of these things!

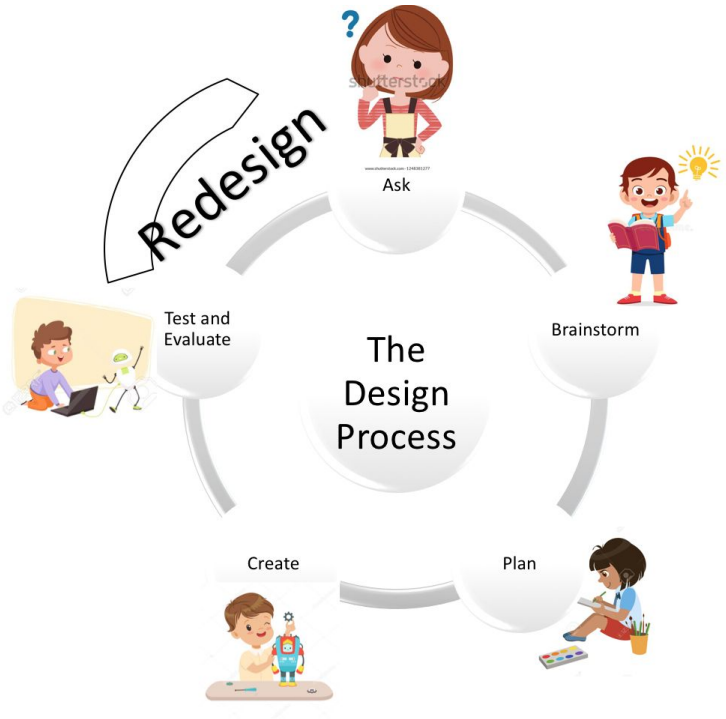
Industrial engineering

How can a task be done by workers so that they remain safe? This is another area that **industrial engineers** work to **optimize**.

What other things can you think of that may need to be optimized?

All types of industries and workplaces can use optimization!

Engineering Design Process



Industrial engineers use the Engineering Design Process to solve problems. The steps include:

1. Ask: figure out the problem, constraints, and criteria
2. Brainstorm: potential solutions
3. Plan: using the best solution
4. Create: a prototype of the solution
5. Test and Evaluate: what works and does not work
6. Redesign: improve the solution

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Industrial Engineering in Action

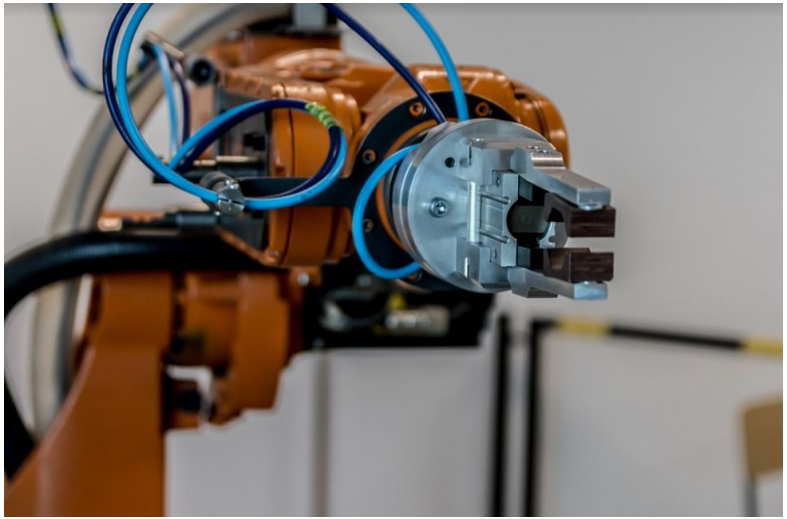
A toy plant needs to make more marbles. Polishing the marbles takes the most time because it is done manually.

Step 1: Ask

The Problem	You need to find a way to make more marbles.
The Constraints	The hours of work per day are fixed.
The Criteria	The changes need to be safe and not increase the cost of the marbles.

Industrial Engineering in Action

How can we solve this problem?



Step 2: Brainstorm

1. automation

   You could add an automatic polisher.

1. add workers

   Adding more workers will polish the marbles faster.

Industrial Engineering in Action

The best solution is add automation. It will add some initial cost, but adding workers will always add more to the cost. Adding workers will also require more space.

Step 3 and 4: Plan and Create

To create the marble polishing plant, you plan and build a plant that will polish the marbles.

Industrial Engineering in Action

You put your design to the test. It works! The problem is that the marble polisher gets hot and burns people.

Step 5 and 6: Test, Evaluate, & Redesign

Adding caution signs and protective barriers will stop people from getting burned by the new polisher.

Activity Time!

Let's be **engineers!**

Your job is to build a rocket that will shoot up at least 2 feet. You will use the **engineering design process** to help you complete this activity.

What is potential and kinetic energy?

Energy can make things move.

Think of a rock on a cliff. It isn't moving, but it has the potential to move! **Potential energy** is energy that is stored. That energy can be released by gravity, or by a chemical reaction!

Once the rock begins to fall, it has **kinetic energy**. Kinetic energy is energy in motion.

What is potential and kinetic energy?

Let’s take a look at a rocket.

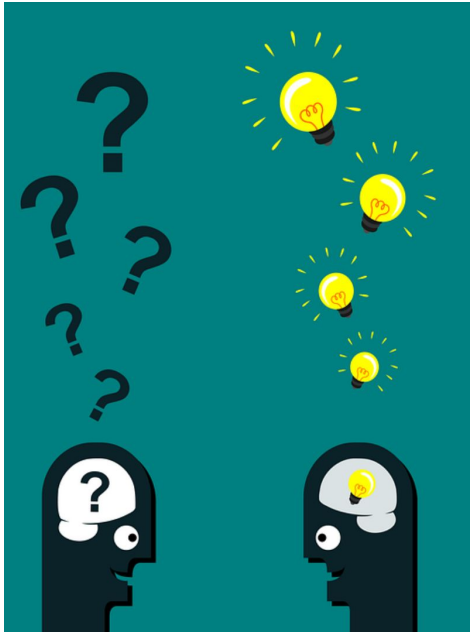
Rocket fuel has stored **potential energy.** The energy is released by a **chemical reaction** to cause movement. This movement is now **kinetic energy**!

A **chemical reaction** is a process that rearranges atoms to create a new substance through a **chemical change**. The burning of rocket fuel is a **chemical reaction.** The reaction creates kinetic energy by causing an explosion. This causes the rocket to move.

What things would need to be optimized in the rocket to burn the fuel and create lift-off?

How does this connect to engineering?

You need to provide a big enough reaction for lift-off. You need to direct the reaction so that the rocket goes up. How will the weather affect a rocket launch? What other things do you need to think about?



Today's task is to use our creativity to create Alka seltzer rockets. We'll use the **engineering design process**—a set of steps that engineers use to solve problems.

Alka seltzer reacts with water to form gas. This **chemical reaction** can propel your rocket!

Think of all the design criteria you will need to optimize to make this activity successful!

Engineering helps us create rockets!

Can we use **engineering** to create a rocket?

Let's find out!

Edit art to have one of the STEAM people holding flask

A **chemical reaction** is a process that rearranges atoms to create a new substance through a **chemical change**.

A **chemical reaction** can create **kinetic energy** by releasing a gas that can push an object up!

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Alka Seltzer Rockets

Engineering helps us create rockets!

Can we use **engineering** to create rockets?

Let's find out!

Alka seltzer reacts with water to form gas. This **chemical reaction** can propel your rocket!

What you need:

Alka Seltzer antacid tablets (1 packet of 2 tablets)
Water
Film canister or similar size container with lid
Index card
Tape (clear might be best)
Crayons
Yard stick

Engineering Design Process

Step 1: Ask

The Problem	You want to a rocket that will go up at least 2 feet.
The Constraints	You get 3 tries. You can't use more than 1 Alka Seltzer tablet per trial and only have 2 tablets for all 3 trials.
The Criteria	The rocket must shoot up into the air at least 2 feet.

Step 2: Brainstorm

We want the rocket to shoot 2 feet into the air. What can you change to make the rocket shoot higher? These are your design variables.

Step 3: Plan

Make a plan to change your variables to achieve your design criteria. Which recipe will shoot up at least 2 feet?

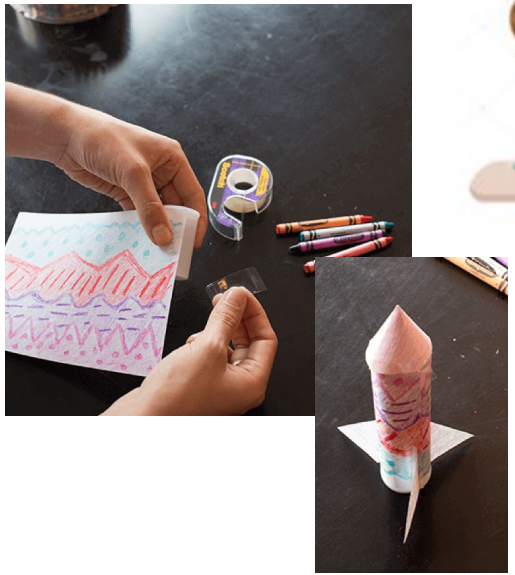
	Water	Alka Seltzer
1	Fill canister ⅔ full	½ tablet
2		
3		

Now, it's time to **create!**

Use your materials to create a **prototype** (or example) of your rocket.

Decorate your index card. Tape the card around the film canister to create the body of the rocket.

Make a paper cone and legs for your rocket.



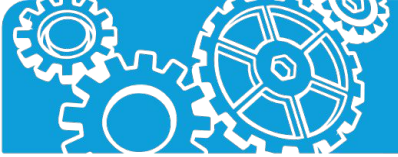
HINT: take this experiment outside for less mess!

Test your prototype.

- Did you meet the criteria? Did any of the trials make the rocket shoot up 2 feet?
- Did you meet the constraints?

TEST:

Fill the canister with water.
Drop in part of an Alka Seltzer tablet.
Immediately put the lid on!
Place the canister on a flat surface with the lid **DOWN!**
Have another student or grown up hold the yardstick to measure the blast height.



Engineers always look for the best possible solutions!

What is one way that you could **improve** your design?