Lesson 3:
Chemical Engineering and Creating Slime
(Instruct/Play/Investigate/Test)

Vocabulary

- ★ **Chemical change:** a change in a substance that results in a new substance with different chemical properties
- ★ **Chemical properties:** a characteristic of a substance that can be observed
- ★ **Chemical reaction:** a process that rearranges atoms to create a new substance
- ★ **Physical change:** a change in form that does not create a new substance

What is chemical engineering?

Chemical Engineering is a branch of engineering that deals with the operation and design of chemical plants.

Chemical plants change materials into more useful materials through **chemical reactions** or **chemical processes**.

A **chemical engineer** can help design a plant to create things. Products like clothing, plastics, food, medications, and energy are made in chemical plants.

Chemical plants - and **chemical engineers** - change materials into more useful materials.

The picture shows a willow tree. It's bark contains a chemical used to make aspirin. A willow tree can't cure a headache.

But, a chemical plant can change the chemical in the bark into a powder that is used to make aspirin!

Think of other materials that you could turn into something more useful.

What are chemical and physical properties?

A **chemical change** is a change in a substance that results in a new substance with different **chemical properties**.

Chemical properties are characteristics of a substance that can be observed. Chemical properties can be seen, tasted, or measured. Toasting a marshmallow will cook it. The cooked part has different chemical properties. And it tastes better too! This is a **chemical change.**

Physical change is a change in form. Physical change does not create a new substance. When you cut fruit, you do not create new fruit, you just have smaller pieces!

Chemical change

Toasting a marshmallow, changes the chemical properties that you can see and taste!

Physical change

Cutting fruit changes the physical form, but not the chemical properties!

What are chemical and physical properties?

Look at this yummy breakfast! Making this breakfast involved both physical changes, like slicing the tomatoes, and chemical changes, like cooking the egg.

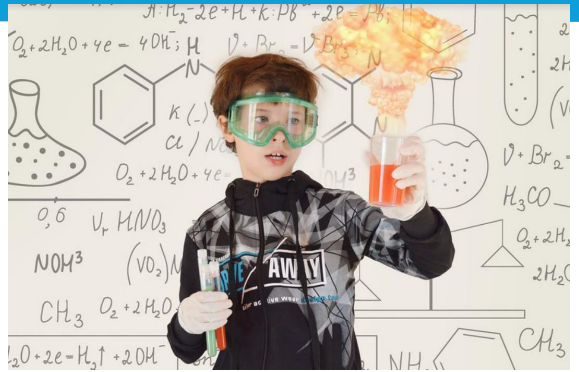
Chemical plants can change chemical or physical properties to make new materials.

Take a minute and think of some other examples of chemical and physical changes.

What are chemical reactions?

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

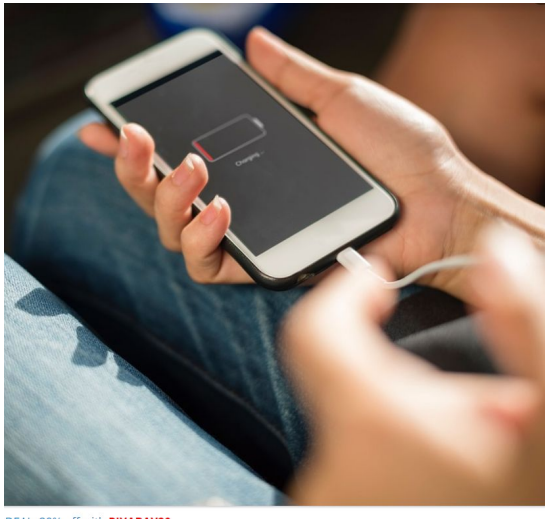
Chemical engineers need to think about **chemical reactions** and **chemical and physical properties**. They design chemical plants to make new or improved materials.



Chemical reactions are also used to make gasoline, fertilizer, cosmetics, and even slime!

How does this connect to chemical engineering?

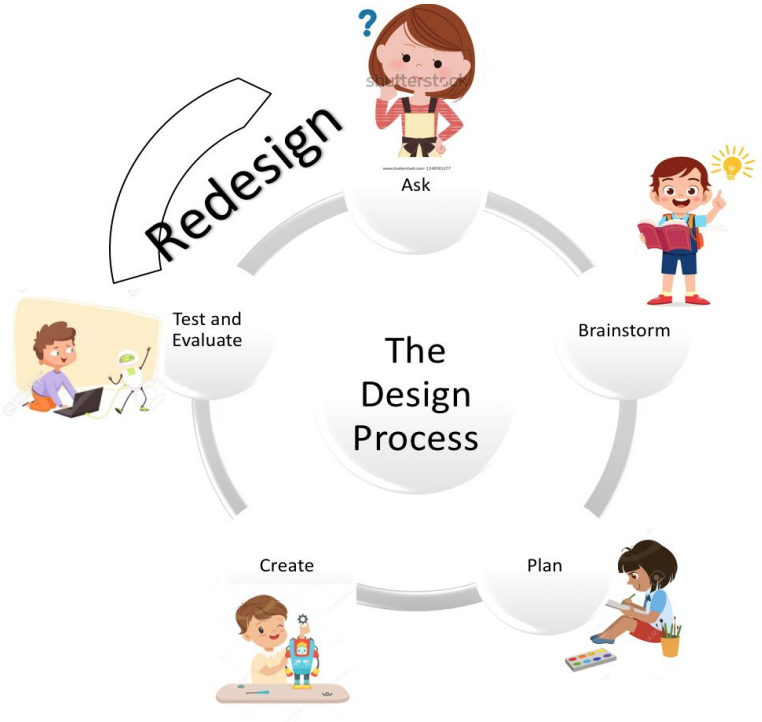
Have you ever wanted to improve the properties of something? Make a shirt softer, water cleaner, or a surface less (or more) sticky? If you have, then you're thinking like a **chemical engineer!**



Remember that **chemical engineering** involves solving problems using **chemical reactions** or **chemical processes**. Changing **chemical** or **physical properties** can create a better or more useful material.

Almost all industries use chemical engineering. Think about batteries. Making a new battery that is smaller, costs less, or lasts longer is done by chemical engineers!

Engineering Design Process



Chemical 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

Chemical Engineering in Action

An orange grove owner wants to sell more orange juice, but shipping is expensive. You are asked to design a plant to concentrate the orange juice to save money on shipping.

Step 1: Ask

The Problem	You need to find a way to concentrate the orange juice.
The Constraints	You need to stick to the budget and make sure the plant is something the workers can build.
The Criteria	It needs to safe, realistic, and easily acceptable.

Chemical Engineering in Action

How can we solve this problem? How do we remove the water from the orange juice to make it more concentrated?

Step 2: Brainstorm

1. Evaporation

   Remove the water by heating the orange juice.

1. Filtration

   Filtering the orange juice will concentrate the juice.

Chemical Engineering in Action

The best solution is to evaporate the water. Filters clog and have to be replaced. They also let some of the good juice go through!

Step 3 and 4: Plan and Create

To create the orange juice concentration plant, you plan and build a plant that will heat the orange juice to remove the water.

Chemical Engineering in Action

You put your design to the test. It works! The problem is that the orange juice is so concentrated that it cannot be pumped easily.

Step 5 and 6: Test, Evaluate, & Redesign

Evaporating less water allows you to fix your design so that it works better and solves your problem.

Activity Time!

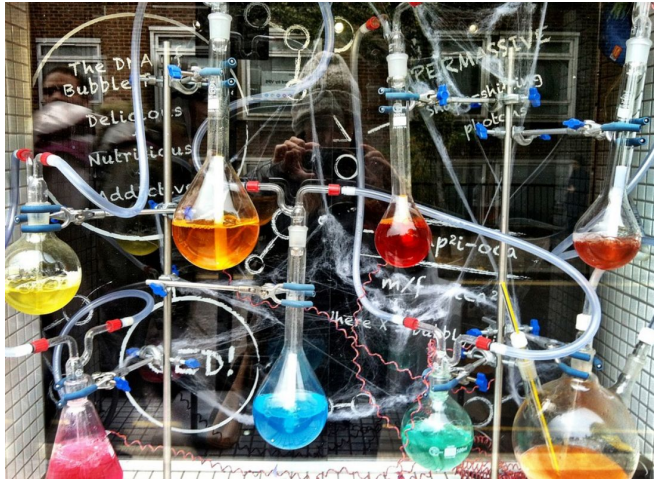
Let's be **engineers!**

Your job is to create slime that has the color and other properties chosen by your team, but it must be sticky! You will use the **engineering design process** to help you complete this activity.

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

Slime is made through a **chemical reaction** between glue and borax.

What are some characteristics of good slime? How do you think you can use these characteristics do design your ideal slime? What variables would you change? Changing variables will lead to unique designs!



Slime

Engineering helps us create unique materials!

Can we use **engineering** to create a unique slime?

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**.

Engineering helps us create unique materials!

Can we use **engineering** to create unique slime?

Let's find out!

Slime is made through a **chemical reaction** between **GLUE** and **BORAX**.

Add art: STEAM person dumping a powder into a bowl of liquid (glue)

What you need:

Glue (2 cups): clear glue, school glue, or white glue
Borax (5 teaspoons)
Bowl or beaker
Stir stick
Optional: food coloring, glitter, shaving cream

Why slime?

What can you do with **slime**?

If it's sticky, you can clean with it!

You can relieve stress by playing with it!

You can impress your friends with how many kinds you can make!

Types of Slime

Glitter Slime: Just add glitter!

Sticky Slime: Use it to pick up crumbs and small objects - like cleaning your keyboard!

Fluffy Slime: Add shaving cream to your basic ingredients.

Popping Slime: Add small styrofoam pellets to add a POP!

Add art: STEAM person pulling slime between their hands

Engineering Design Process

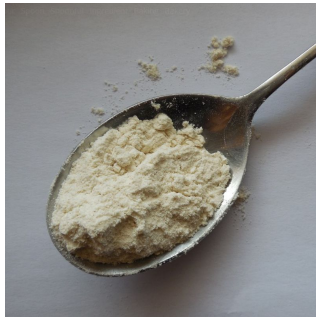
Step 1: Ask

The Problem	You want to design slime that is fun and also sticky enough to pick up toast crumbs off the counter. Your grown-ups will thank you.
The Constraints	You get 3 tries. You can't use more than 2 cups of glue and 5 teaspoons of borax for your 3 trials.
The Criteria	You can pick the color, glitter, or foam. But the slime must pick up toast crumbs!

Step 2: Brainstorm

We want our slime to be sticky enough to pick up those crumbs we leave on the counter every day after breakfast. What variables can we change to make the slime more or less sticky?

Let’s start with a basic recipe. Then you can see what you might want to change from there!
Add ½ cup glue and 2 teaspoons borax to the bowl or beaker. Stir with the stir stick. What happens? Play with the slime, see how it feels. Just don’t eat it!



Step 3: Plan

Now that you have a starting point for the slime recipe, plan to vary the ingredient amounts to make the slime more sticky. Plan what you will change to make 2 more variations of slime with more or less borax and glue.

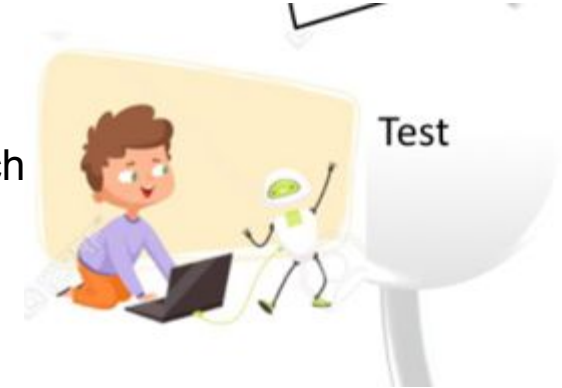
	Glue	Borax
1		
2		
3		

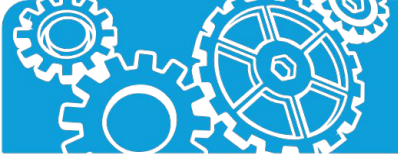
Now, it's time to **create!**

Use your materials to create a **prototype** (or example) of your slime. Mix up each of your trials in separate bowls.

Test your prototype.

- Now it’s time to make some toast and try to pick up the crumbs! Which trial wins? Did you succeed in making the desired slime with the required criteria?





Engineers always look for the best possible solutions!

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

What if you want your slime less sticky?