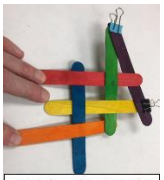
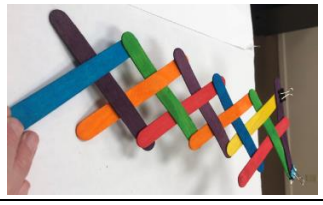

Modeling the start of a chain reaction

GYSTC
GEORGIA YOUTH SCIENCE & TECHNOLOGY CENTERS



Title: The Chain Reaction STEM Challenge

Estimated Time: 1-2 periods

Core Ideas (GSE Standard and elements):

S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.

a. Plan and carry out investigations of physical changes by manipulating, separating and mixing dry and liquid materials.

c. Plan and carry out an investigation to determine if a chemical change occurred based on observable evidence (color, gas, temperature change, odor, new substance produced).

S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.

b. Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed.

c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical (i.e., density, melting point, boiling point) properties of matter.

d. Construct an argument based on observational evidence to support the claim that when a change in a substance occurs, it can be classified as either chemical or physical.

Literature Connections: Books	**Literature Connections: Close Reads**
Pancakes, Pancakes, Eric Carle	Chemical Changes Close Read
Science and Engineering Practices: **Asking Questions and Defining Problems:** Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. **Constructing Explanations and Designing Solutions:** Use evidence to construct or support an explanation or design a solution to a problem.	**Crosscutting Concepts:** **Structure and Function:** The way an object is structured/designed determines many of its properties and functions. **Stability and Change:** For designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

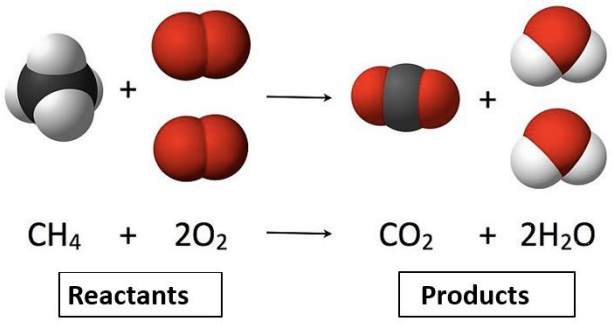
STEM Challenge Overview:

In this STEM Challenge, your task is to design, creates and test a model of a chemical chain reaction.

Ask	Ask students if they know what happens during a chemical reaction. Discuss their ideas including what are some common signs that a chemical reaction is occurring. If possible, use some molecular models to show how the reactants combine, break bonds between them, and then form new bonds to form the products (you can also use a Powerpoint slide to slow this as a diagram).

	Ask students if they have heard about chain reactions and have them share ideas about them. In simple terms, a chain reaction is a series of events where one event starts the next event until everything is done. Here is cool 2 minute video of a chain reaction. https://www.youtube.com/watch?v=HULgdt_vnVU
Imagine/Brainstorm	Students **brainstorm** ideas for how they could design a simple chain reaction that keeps going until the end once it is started. After brainstorming, they should consider the strengths and weaknesses of each idea.
Plan/Design	In order to learn more about these strange fixtures, let students read***, Chemical Changes and Chain Reactions***. After researching the chain reactions, have students **plan** and **design** a model of a chain reaction. Once the reaction is started, it should be able to keep going until it is completed.
Create/Test	Students follow their plan, and **create** their chain reaction. Once it is created, students **test** their chain reaction in a measureable way to evaluate its effectiveness. Their results should be recorded, organized, and analyzed.
Improve	After discussing and evaluating their results, students should **improve** their solution, redesign their chain reaction and find at least one additional thing to make it particularly excellent.

Teacher Notes:
For this STEM Challenge, we emphasize the basic changes that happen during a chemical reaction. A **chemical reaction**, or chemical change, occurs when two or more **substances** combine to form new substances. During this process, the **bonds** between atoms in the **reactants** (starting substances) are broken. The atoms then rearrange and new bonds between the atoms are formed to make the **products** (final substances). It really helps to have some molecular models available so that you can show then a reaction like the burning of methane diagrammed below.



During a chemical reaction, other changes often occur. Common signs that a chemical reaction has occurred include changes in color, smell, and temperature. In addition, the formation of gas bubbles (without boiling) and the formation of a solid from the mixing of two liquids are often indications that a chemical change has occurred.

Chemical reactions can sometimes occur as a chain reaction. In simple terms, a chain reaction is a series of events where one event starts the next event until everything is done. A Rube Goldberg machine (like

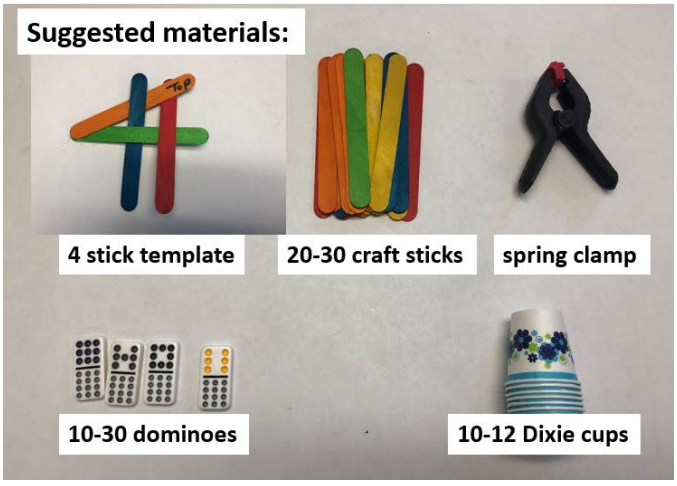
the one showed in the video) is a device that performs a series of tasks as part of an interesting chain reaction. In a **chemical chain reaction**, the products of the reaction themselves promote and spread the reaction. This speeds up the reaction so that it can happen very quickly. Some chain reactions are so fast that they can lead to an explosion.

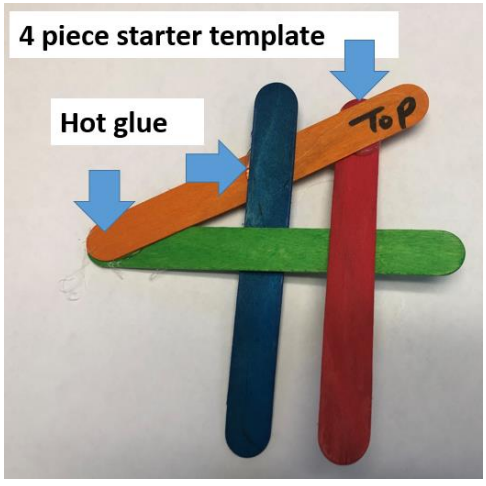
This STEM Challenge provides students with the opportunity to build a working model of the chain reaction. Students can start their chain reaction dominoes, craft sticks, wooden blocks, or other items. They should use the energy of the starting object to initiate the movement of the next object thus beginning the chain reaction. While they'll understand many of the opportunities provided by the blocks and dominoes, you'll probably need to help them with the craft stick creations. A starting template, or pattern, is very helpful (see pictures and video). While we use this primarily as a chemical change activity, it also works super well when you're talking about changes in kinetic and potential energy. See the Converting Potential Energy STEM Challenge if this seems like a better content fit. If you teach at the high school level, it is also a great lesson to discuss how systems naturally tend toward low energy and high entropy.

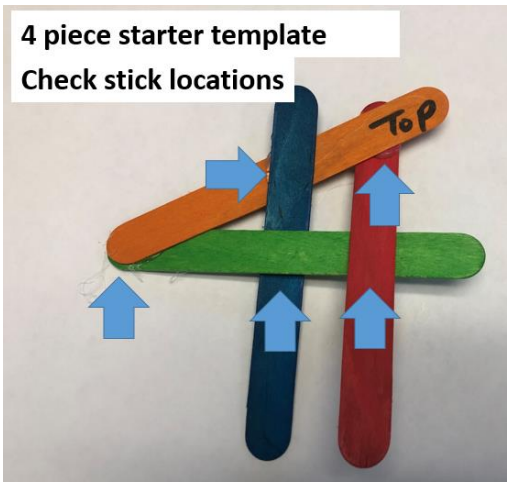
While releasing the chain reaction is super fun and exciting, it is even better when students can see and hear it again in slow motion video. The slow motion video is super easy to do with almost any type of device and it helps kids to realize how fast some things actually happen in real time.

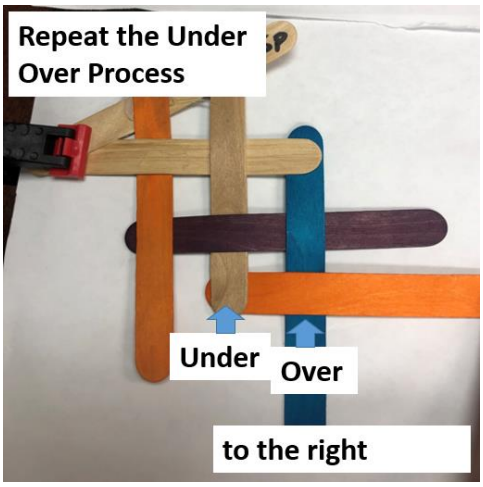
When students are constructing their chain, it really helps if you hot glue a 4 stick template for them to help get them started (see pictures and videos). This keeps the first sticks stable and it is much easier to build the chain using the template. Secondly, it helps if each group can use a spring clamp to clamp down the template to the table or desk when they begin to build. The clamp also stabilizes the chain and makes it much easier to build.

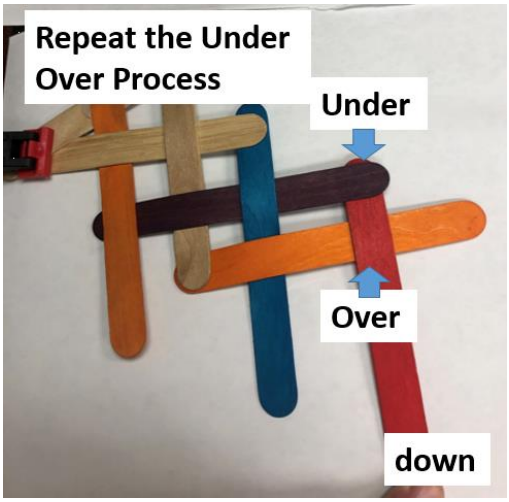
While we focus primarily on the craft stick chain, it is also good to have students use dominoes (or wood blocks) and paper cups to design a more complex chain reaction. If time permits, they can combine the sticks, dominoes, and cups to make a colossal chain reaction.





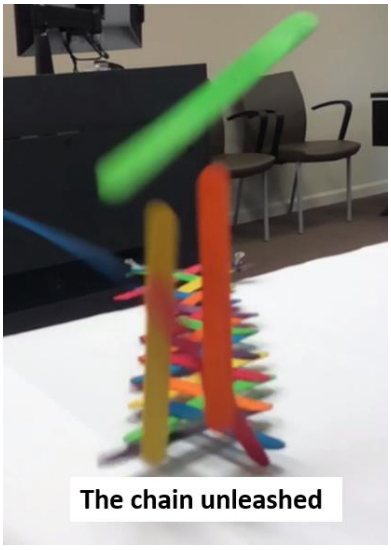

4 piece starter template
Check stick locations
TOP


Repeat the Under
Over Process
Under
Over
to the right


Repeat the Under
Over Process
Under
Over
down


Dominoes and falling cups can also be used to model a chain reaction

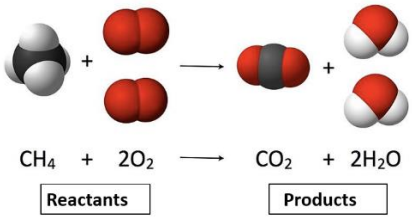

Ready to launch


The chain unleashed

Vocabulary Cards:

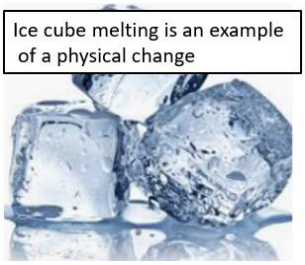
chemical change

a change where new substances are produced



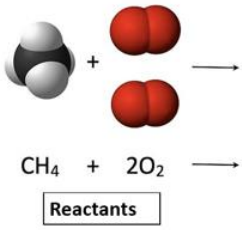
physical change

change in form of a substance but not its composition



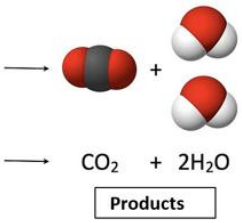
reactants

the starting substances before a chemical reaction



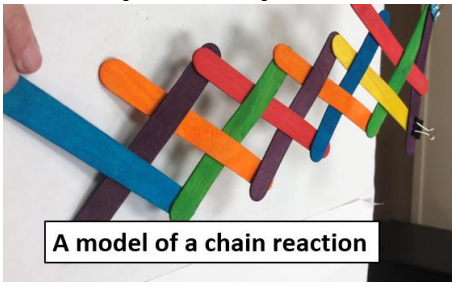
products

the final substances after a chemical reaction



chain reaction

when the first products of the reaction speeds up the reaction



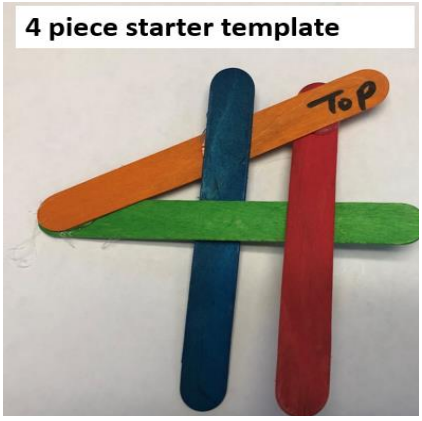
engineer

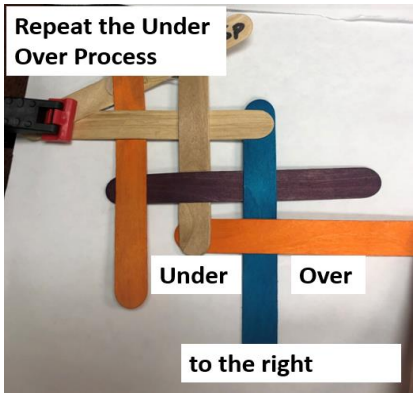
to design, build, and improve things

Chain Reaction STEM Challenge:

Can you design, create and test a model of a chemical chain reaction.

Designing and constructing your model:





1. After learning about potential and kinetic energy, **plan** and **design** a model of a chain reaction.
2. Using the materials provided and your plan, **construct** your system. You can use a starter template for your sticks to get going or build your own.
3. If possible, use a clamp to hold down your template to a desk or table.
4. The first stick that you add goes across, the next stick goes down.
5. Each stick that you add should go **under** the first stick and **over** the second. Repeat the **over-under** process for each stick that you add.
6. You should be able to feel the potential energy in your system as you bend each stick into position.
7. Make sure to push and hold down on the last stick that you add each time. Otherwise, you will start the reaction.
8. You can place a weight on the end of the chain to keep it from releasing while you complete other parts of your system.
9. Try to add other things to your system could be involved in the chain reaction. For example, dominoes in a line or a paper cup pyramid can both be used in this manner. Be creative with your ideas. See if you can get all parts of your reaction to work together.
10. When you're ready, release the last stick or topple your first domino and observe carefully what happens.
11. If possible, **videotape** the reaction in **slow motion**. This is very cool and it allows you to observe what happens in detail.

Evaluating and Improving:

As a group, **evaluate** the effectiveness of your design and discuss how you would change your design moving forward to **improve** the chain reaction. If time permits, make these improvements and re-test.