

## CHAIN REACTION I

Duration: Open-ended and self-determined; 20 minutes to an hour plus

Institution: Explora

Skill level/Age Level: 3<sup>rd</sup> Grade - Adult

Group size: Variable, scalable. Works well with individuals, small groups, and even many individuals working together on interconnected parts of a large chain reaction. The biggest factors are the size of the space, the amount of material, and number of staff available to facilitate. Recommend ratio of one facilitator for every seven students.

## INTRODUCTION

The objective of My Chain Reaction is to see if a little input energy can be continued through a system in either a single event or a variety of ways. Users build sequences of events such that one action triggers another action, which triggers another action and so on. Falling dominoes are a basic form of this. Rube Goldberg inventions are the most intricate. There are multiple beginning and end point for chain reactions each depends on the actions of the individuals builders, and all are made meaningful by what happens in the middle, especially the process of building and problem solving. Users are invited to try out an idea; build toward it, test it, redesign, build and test again, and again. Things fall apart. Things fall over. Working with My Chain Reaction often means figuring out how to make something do what you want it to do through multiple attempts and arrangements, or thinking of ways to use a specific item to continue a sequence of action.



**KEY CONCEPTS AND/OR SUBJECT AREA**

- Construction
- Building
- Potential and kinetic energy
- Simple machines
- Testing of ideas
- Trial, error, and correction

**MATERIALS AND TOOLS**

Include some items from each of the categories below in your activity kit. You do not need to have everything in the list, and you can swap out things that you don't have on-hand with something that will do the same job; for example, paper towel tubes or hot wheels track make great ramp and recycled plastic containers make great buckets. What is most important is to have a mix of different types of materials that can be used to test ideas for My Chain Reaction and promote long engagement time.

*Essential Materials:*

- Pipe cleaners
- Tape
- Straws
- Zip ties
- Twist ties
- String
- Dixie cups
- Twistable wire
- Binder clips
- Paper clips

- Rubber bands
- Stops ( $\frac{1}{2}$ " sections of cut  $\frac{1}{4}$ " pex tubing)
- Popsicle sticks
- Jingle bells
- Dominoes
- Large and small weights (washers, nuts)
- Springs
- Clothes pins
- Misc. clips
- Lego assortment
- Tinker toy assortment
- K'nex assortment
- Small wood dowels
- Balls (marbles, steel balls, wooden balls, golf balls, etc.)
- Large, medium, and small parts storage containers
- Funnels
- Chemistry Stands (to add height)
- Containers (yogurt tubs, cans, plastic bottles, etc.)
- Assorted PVC pipe cut to 4"-12" lengths
- Cardboard tubes cut to 4"-12" lengths
- Scraps of flat wood
- Scraps of wood blocks
- Wood and plastic discs
- Large dowels, misc. sizes
- Misc. small wood cut-offs
- Misc. tubes cut in half to make tracks
- Cardboard pieces and scraps
- Pencils
- Rulers
- Scissors
- Screws and screwdrivers



#### *Optional Materials:*

- Teeter-totters
- Switchbacks
- Linked levers
- Lifters
- Elevated tracks

- Ramps
- Starting gates

### SET UP



Stage My Chain Reaction to make it inviting and to provide a hint about what might go on there. Space tables and stools so they can be navigated, add a few pieces that go well together, such as a funnel, a chemistry stand, and a ramp, to spark ideas and encourage experimentation.

What we call archaeology—evidence of previous use—is also important. Leaving the efforts of other visitors in place can be a suggestion for newcomers, and let them know we want them to experiment.

- Put in- and out-blocks on all tables. These are used to start chain reactions and can also be used to link together sets of events.
- Take apart a completed project, but leave the pieces for someone else to use.
- Have a chain reaction made up to a halfway point and leave some pieces that could be added scattered nearby.
- Have a simple example chain reaction set up and working to show participants what the activity is about.
- A few tables with different materials on them that can be used to start a chain reaction from scratch.
- Starting simple is an effective way to get users comfortable and involved.

Keeping My Chain Reaction “messy enough” so the set-up itself gives a hint about its use, and so people feel comfortable contributing to the activity is important. There is a delicate balance to be struck between sending the message that this is a shared work in progress and engendering a space too chaotic to be navigated. Things we regularly do when staffing the space to keep it just right are: sort bins

of supplies and small pieces (re-usable plastic food storage containers are great for this); remove tape from materials and tables. Sweep, set up examples, pick up hazards—such as balls—on the floor, make sure a couple of the tables are clear, remove excess materials from those tables that are too cluttered, and regularly wipe down larger items and surfaces.

### HOW TO OR STEP-BY-STEP



1. Start by setting up a simple example chain reaction for participants to try. This helps trigger conversation about the activity and motivates visitors to build their own.
  - a. Many facilitators intentionally set up the example so it doesn't work on the first try, to show that many chain reactions need to be adjusted to run to completion.
  - b. Others demonstrate by doing, and will work on building their own chain reactions—that they quickly abandon when a visitor either approaches or wants to find out what she can do to keep it going.



2. From there, ask some questions about what just happened, what the student saw, and invite them to build their own

## FACILITATION TIPS



Analogies can help make connections for students. Ask if they have experience with every day, popular examples of actions used in My Chain Reaction to help build interest and spark ideas. Some favorite analogs:

- The game Mouse Trap
- Lining up dominoes up one after the other, and then knocking them down.
- Refer to Rube Goldberg devices: making the simple complex; making something random have purpose
- A sliding funnel, a string that pulls an item, a construction pulley
- A playground see-saw



Focusing work with My Chain Reaction in a group around a shared challenge or single motion or component can be helpful in organizing the activity. Here are some playful examples from Explora's Chain Reaction Scientists Club about how to scaffold the activity.

- *Balance*: investigate how changing an object's balance can cause a domino effect. Balance an object ever so carefully, so that when the moment comes, it can release its full potential!
- *Ramps, balls, and wheels*: begin an investigation of simple machines by exploring how a ramp influences motion
- *Levers*: “give me a lever long enough and a fulcrum on which to place it, and I shall move the world.”—Archimedes. Begin to understand the lever and its power to amplify or reduce force



- *Pulleys*: more powerful in numbers. Redirects tension with a single spindle. Lifts heavy items with less force, even a locomotive. Super Pulleys! They are part of our everyday lives and pirate movies.
- *Gears*: Now for a subject with teeth! Speed p, slow down, power up, or power down; gears will make your chain reaction run like clockwork
- *Repeatability*: measure, mark, record, secure. Do it once, twice...maybe thrice? Remove the wobbles and fasten your components so your reaction acts the same way every time!
- *Precision*: randomness has a habit of creeping into reactiondom. How can you achieve control so precise that your reaction behaves correctly for each and every turn?
- *Energy transfer*: sometimes the energy you use is made when you need it, and sometimes it is build up over time and stored until set free. How can you use those behaviors in your chain reaction?
- *Build custom components*: need a lift? Build it. Want to reverse directions? Design it. Use tools to create your own reaction components from basic materials.

#### FACILITATION PROMPTS AND QUESTIONS



Guide exploration with inquiry questions. Ask visitors questions that get them thinking, invite them to try their ideas, encourage them to keep going, and challenge them to experiment. This is a selection of our favorites:

- What do you think will happen when you push the block down?
- Have you seen something like that happen somewhere else?
- How can we make our own chain reaction?
- What would you like to build?
- What can you use to begin or extend your chain reaction?
- What are the steps to your chain reaction?
- Does one piece work better than the other?
- Can you add another piece to continue your reaction?

- What do you think would happen if you add/take out this piece?
- Do you think you could find a way to make the ball go through the funnel?
- How would you get your chain reaction to go a different direction?
- Can you make a chain reaction in a “U” shape?
- What do you notice about the weight of the ball and how it goes down ramp?
- What keeps the ball from going into the container every time?
- Can you make this action set off another action?
- Can you make your chain reaction higher/lower?
- Can two ball be used to balance the lever?
- What will happen if a heavy ball is used on the shorter side of a lever and a smaller and lighter one used on the longer side? Or reversed?
- How should this Chain Reaction end?
- What happened when you knocked the block down?
- How many things happened between the first stet and the last?
- What could we use to continue this Chain Reaction?

### GENERAL FACILITATION TIPS



- “Sometime, if the child is unsure, I like to help them start with something very simple. Then I step back and engage if they seem stuck somewhere or need help with putting something together. Give them the freedom to build something that is not a chain reaction.”
- “Showing visitors the example, encouraging them to put the example back together. Helping with suggestions as needed: ‘This might work better,’ ‘Try this size ball.’”
- “Sometimes the example is the extent of this exploration (4 and under). Sometimes it serves as a demonstration and that suffices. Most times it serves to whet their appetite and they begin to make their own projects.”
- “Challenge the visitors to include a feature in their chain reaction projects.”
- “They like challenges! Encourage the visitors to test what work and what doesn’t. Making mistakes is part of the learning process!”

### MATERIALS SOURCES

Just about everything you need to build a My Chain Reaction kit can be found at big box stores like Wal-Mart or Target, and supplemented with recycled items like paper towel tubes, cleaned food containers, boxes, and more. Here are a few sources for some of the more specialized materials and items:



- Chemistry Stands, Flinn Scientific, part numbers AP8 232, AP4550
- PCV pipe, home Improvement stores
- Woodworks Ltd. (<http://www.craftparts.com/>) is a good source for dowel rods
- Rubber bands can be found though various sources (3 ½" x ¼" work well)

#### **MORE INFORMATION**

PIE Network Chain Reaction workshop:

[http://www.pienetwork.org/workshops/chain\\_reaction\\_workshop](http://www.pienetwork.org/workshops/chain_reaction_workshop)

Annual Rube Goldberg Machine competition:

<http://www.rubegoldberg.com>

#### **KEYWORDS**

- Building
- Trial-and-error
- Needs free flat space for working
- Requires facilitation
- Simple machines
- Construction
- Engineering