Create your own Rube Goldberg Machine! (Level 3)

Description	Teach your learners the principles of engineering and the values of resilience, creativity, and attention to detail with this hands-on activity
Leading Question	How can we create a machine that helps us do something useful or fun in our house?
Total Time Required	50-80 minutes per day over 4 days.
Supplies Required	Pencil, color pens, paper/notebook, household items to create the machine (ball, toy car, Legos, tape, straws, cards, dominoes, strings, etc. - any items found at home)
Learning Outcomes	1. Understanding of motion and force. 2. Understanding of an example of aa machine that uses force to work. 3. Design and execution of a machine.
Previous Learning	Basic understanding of force and motion strand (G1 science)

DAY 1

Today you will learn about what makes things move, and watch videos of a Rube Goldberg machine.

Suggested Duration	Activity and Description

10-20 minutes	Discussion:
	• What is a machine? What are the different types of machines?
	  ○ Let the learner reflect and answer
	  ○ A machine is something that is designed to make our work easier. Examples: there are simple machines and more complex ones called compound machines.
	  ○ Simple machines: there are 6 types of simple machines: levers, pulleys, wheels and axles, screws, wedges, and inclined planes
	  ○ Compound machines are made up of two or more simple machines
	• How do you think a machine, like a bicycle, for example, works?
	  ○ Let the learner reflect and answer

- Explain that a bicycle works to move us from one point to another by applying force to the pedals
- What are Newton's three laws of motion? What state is a wheel that has not been turned in? what happens when we apply force?
  - Inertia, acceleration, action/reaction
  - An unturned wheel is in the state of inertia
- If force is applied, the wheel's motion will be accelerated in a way that is proportional to the force applied.

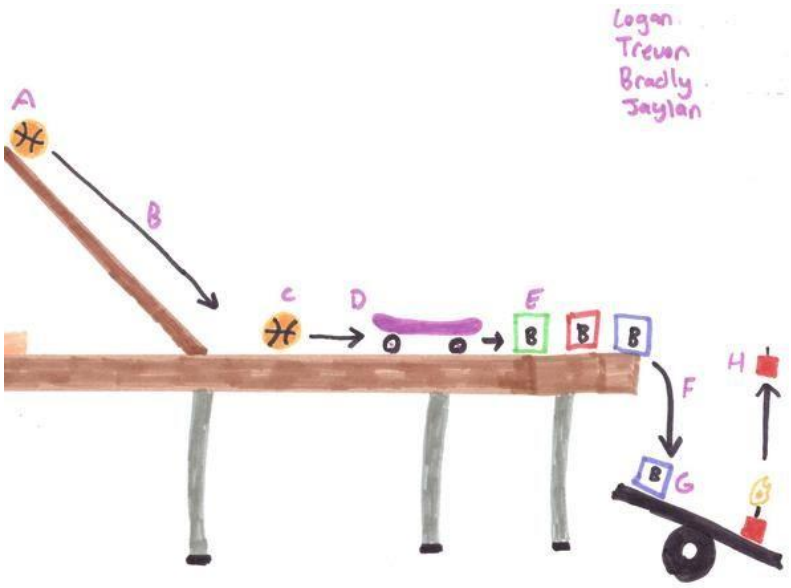
5-10 minutes

- Watch some videos Rube Goldberg machines online to get the learner excited about building their own. If you do not have access to the internet, you can show them one of the images below:

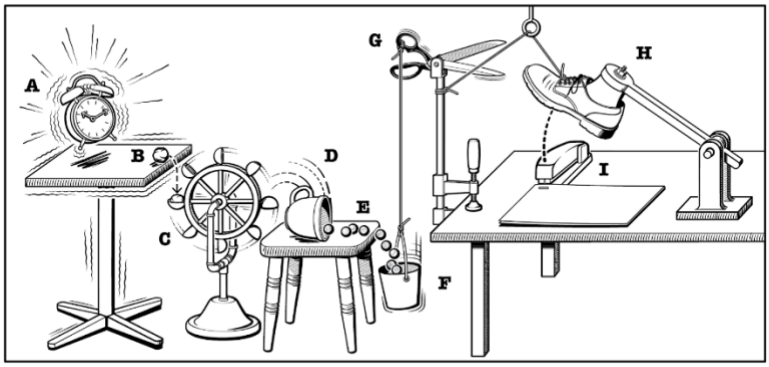
To secure coins:

Source:

To put out a candle:



To staple paper:



To spray a piece of cloth:

5 minutes	• Discussion What type of machine the Rube Goldberg one from the video you just watched/image you have just seen is? Simple or compound? A Rube Goldberg machine is a compound machine that is designed to "solve a problem" (such as pressing a button), and is composed of several simple and compound machines that are connected to each other such that exerting force on the first component to "start" the machine results in the exertion of force on the next component and so on until the last component is struck. You may provide this explanation after the next activity (discussion about machines)
15 minutes	The learner will discover some machines at home! Tell them to spend some time walking around the house collecting 5-10 machines and to place them on a table
20-30 minutes	• After all the machines are placed on the table, ask him or her to write down in a notebook or piece of paper: Name of machine Why they think this is a machine What work does it make easier for us to do How it works If it is a simple or compound machine.

DAY 2

Today you will design your own Rube Goldberg machine!

Suggested Duration	Activity and Description

2 minutes	• Explain that the learner will be creating their own Rube Goldberg machine at home! Tell him or her that a Rube Goldberg machine must meet the following criteria: It must include at least 3 types of simple machines: levers or pulleys, wheels, inclined planes It must have at least 10 parts It must solve a problem at the end – like ring a bell, push a button etc. •
20-30 minutes	• The learner will reflect on the type and purpose of the machine they want to make. They can watch more videos if needed to get inspiration. Ask him or her to draw the machine they want to build in their notebook or on a piece of paper using a pencil. A machine to put sugar in tea, made of a small pall, a few wooden popsicle sticks and a cup with tea at the end. • A machine to pop a balloon made of a small ball, toy car/light stone with a pin attached, a wooden plan or popsicle sticks and a balloon at the end.
20 minutes	• Using a similar list to the template below, the learner will gather all their toys or objects found in the house and write down what they think they can use in each category. Examples: balls, sticks, paper, ruler, bottles, bottle caps, cards, stones, candles, threads, pins, balloons etc. You can use any items you have at home or create ones out of paper or other easily adaptable material. The learner will then divide the items based on whether they roll, slide, pull etc. • Template:

Item	Machine type	Energy transfer
Ruler	Inclined plane	
Ball	Wheel	Cards
Cards		Lever

DAY 3

Today you will assemble and create your own Rube Goldberg machine, and then refine your machine so that it works perfectly!

Suggested Duration	Activity and Description
10-20 minutes	• Time to test our design! The learner will assemble all the items, allow her or him to set up and test the machine.

	• You can also create some items using paper or other adaptable material, if some items are unavailable After the setup is complete, ask them to get the machine going and observe what happens together
10-20 minutes	• Discussion: What do you think worked? What did not work? • What can you change?
5-10 minutes	• Give them feedback and ask them to refine their design and items list either to fix errors or expand the machine (by adding just one or two additional parts. Do not complicate the design) • If the learner did not get it right this time, explain that designing a machine is a process and making mistakes is a part of it. Explain that this is the purpose of testing, so we can learn from our mistakes and make things work better.
5-10 minutes	• The learner will assemble all the items necessary and set up the modified machine for another testing round of the final design presented to the rest of the family!
5 minutes	• Discussion: What do you think of your final design? What do you think worked? What didn't work? • What can you change?
10 minutes	• The learner will make the necessary adjustments (if any) and set up the machine again to show their siblings/rest of the family! They will first explain the purpose of the machine, its different parts, and finally set it off!
5 minutes	• The learner will present the set up and start the machine again in front of the rest of the family!

DAY 4

Today you will document what you created and produce a final report!

Suggested Duration	Activity and Description

30-60 minutes	• The learner will use the documentation of the process of creating the machine to produce a final report with the following sections: **Purpose of machine** **Simple machines used:** ○ Type of simple machine: e.g.: a wooden stick was used as an inclined plane **Newton's three laws of motion and where they were observed:** list the laws and describe where in the process you observed them. E.g.: before I started the machine, the first object was in a state of inertia (first law) **Observations of kinetic energy transfer:** e.g.: when I started the machine by releasing a thread and paper cup pulley attached to a stone, the energy from the falling stone was transferred onto a wooden stick lever, causing the load on the other end of the lever to fly upwards **First design description:** setup and result **Second or final design:** modifications to first design, set up and result **Conclusion:** do you think the way you engineered the machine was successful? What would you change, if anything? The learner can refer to his or her science textbook or perform a quick desktop search of the laws of motion or other information needed to complete the report.

ASSESSMENT CRITERIA

- Successful creation of a Rube Goldberg machine that consists of 5 or more simple and/or compound machines, and that solves some problem/serves some purpose.
- Reiteration of design based on feedback.
- Presentation of final design.
- Reporting on experience

ADDITIONAL ENRICHMENT ACTIVITIES

- There is always room for extending the complexity of the final design by adding more items and simple machines to the design.
- Additional topics that can be covered in discussion and final report:
  - Potential energy
  - Kinetic energy
  - Speed
  - Velocity
- Example of questions that can be asked: if you have a scale, timer/stopwatch and ruler, ask the learner to calculate the kinetic energy of the ball by using KE = ½ (mv^2), where
  KE = kinetic energy
  m =mass in kg

v = velocity in meters per second