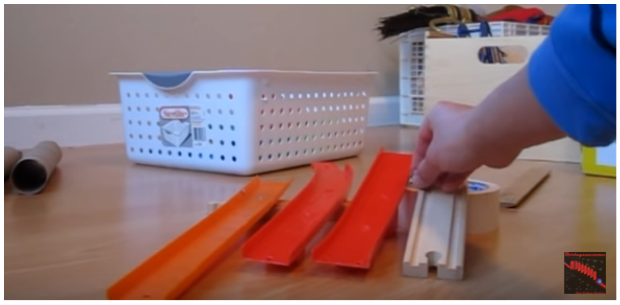
Create your own Rube Goldberg Machine! (Level 3)

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 a 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? ● What are simple machines? What are examples of simple machines? ● What are compound machines? What are some of the examples of compound machines? ● 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 are devices with few or no moving parts that are used to change the direction of motion and/or the: magnitude of a force in

	order to perform a task. 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. Examples of compound machines include bicycle, wheelbarrow, scissors etc • How do you think a machine, like a bicycle, for example, works? • 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? Newton's three laws of motion • Newton's first law: A body remains in its state of rest or uniform motion in a straight line unless and until an external force acts on it. Newton's first law of motion is also known as the Law of inertia. • Newton's second law: The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction of the applied force or force = mass x acceleration • Newton's third law: Action and reaction are equal but opposite • 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 the following videos of Rube Goldberg machines:  How to Make a SIMPLE Rube Goldberg Machine - Become a Beginner https://www.youtube.com/watch?v=PK2_gA2OeMI

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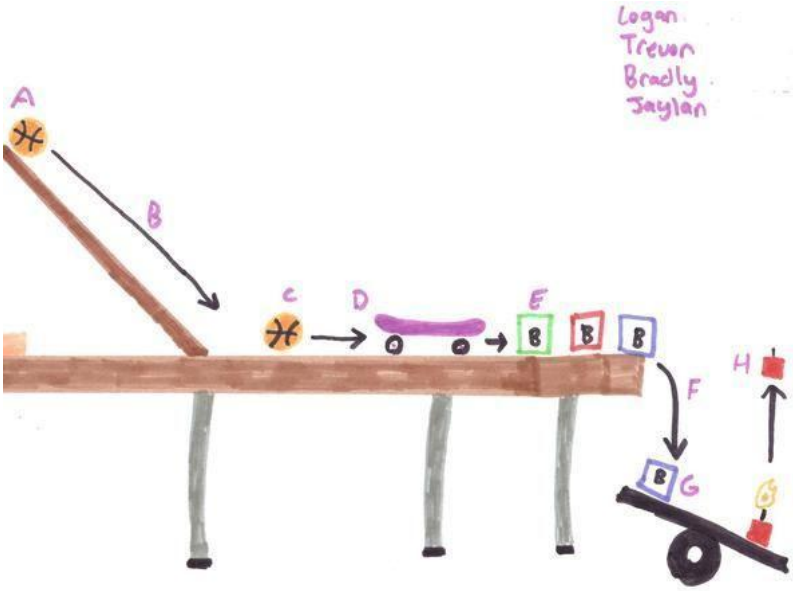
Physics -Rube Goldberg

https://www.youtube.com/watch?v=Z5oZqPlkbT0

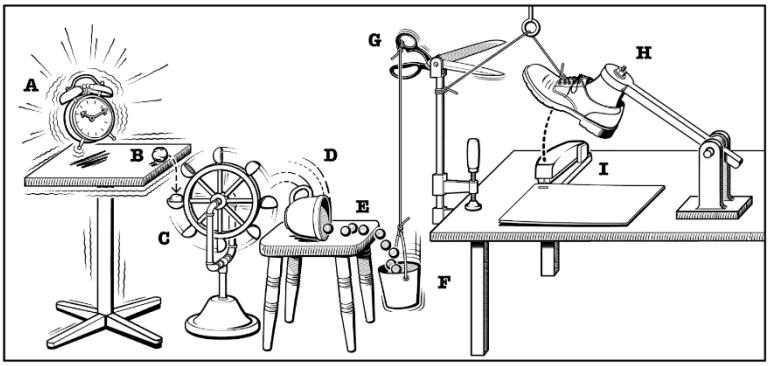
If you do not have access to the internet, look at one of the images included here To secure coins:

To secure coins:

To put out a candle:



To staple paper:



To spray a piece of cloth:

	
5 minutes	Discussion: ● What type of machine is the Rube Goldberg one from the video you just watched/image you have just seen is? ● Is a Rube Goldberg machine a simple or compound machine? A Rube Goldberg machine is a chain-reaction type of compound machine that is intentionally designed to “solve a seemingly simple problem” (such as pressing a button, closing a door, dropping a bottle in a recycling bin etc), 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	Discover some machines at home! 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, 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 Share and present the work to the rest of the family.

Day 2

Today you will design your own Rube Goldberg machine!

<table>
<tr><th>Suggested Duration</th><th>Activity and Description</th></tr>
<tr><td>2 minutes</td><td>

You create your own Rube Goldberg machine at home! 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.

</td></tr>
<tr><td>20-30 minutes</td><td>

Reflect on the type and purpose of the machine they want to make. You can watch more videos if needed to get inspiration. Draw the machine you want to build in your 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.

</td></tr>
<tr><td>5 - 10 minutes</td><td>Discussion:

What is the purpose of your machine? What is making it easier for you to do? What problem is it solving?
What items do you think you can use to create your Rube Goldberg machine you have drawn?

</td></tr>
<tr><td>20 minutes</td><td>

Using a similar list to the template below, gather all their toys or objects found in the house and write down what you think you 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:
<table>
<tr><th>Item</th><th>Machine type</th><th>Energy transfer</th></tr>
<tr><td>Ruler</td><td>Inclined plane</td><td></td></tr>
<tr><td>Ball</td><td>Wheel</td><td>Cards</td></tr>
<tr><td>Cards</td><td></td><td>Lever</td></tr>
</table>
</td></tr>
</table>

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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 minutes	• Time to test the first design! Assemble all the items and set up and test the machine. When assembling the different parts, it is important to test each part before moving to the next. • You can also create some items using paper or other material if some items are unavailable. • After the setup is complete, get the machine going and observe what happens together.
10-20 minutes	Reflection: • What do you think worked? • What didn't work? • What can you change? (if it worked, ask them if they can expand the machine and add more parts)
10 minutes	• Ask for feedback and refine your design and write a list either to fix errors or expand the machine (by adding just one or two additional parts. Do not complicate the design) • If you did not get it right this time, know that designing a machine is a process and making mistakes is a part of it. That is the purpose of testing, so we can learn from our mistakes and make things work better.
5 minutes	• Record your observations from the first trial and refine the design of the machine based on the feedback by either expanding or refining it. You can draw the final design in color pens! • Set up and start the machine for another testing round of the final design.
10-20 minutes	Discussion: • What do you think worked? • What didn't work? • What can you change?
10 minutes	• Make the necessary adjustments (if any) and set up the machine again to present and show their siblings/rest of the family! They will first explain the purpose of the machine, its different parts, and finally set it off!

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5 minutes	Present the set up and start the machine again in front of the rest of the family! Family feedback will include: ● What did they love about the machine? ● Any additional questions they may have? ● Any suggestions for improvement? Use the feedback to revise the design of the machine

DAY 4

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

Suggested Duration	Activity and Description
30-60 minutes	● 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:** o 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? You can refer to your science textbook or perform a quick desktop search of the laws of motion or other information needed to complete the report. Share and present the report with the family for feedback. Family feedback should include: ● What they love about the report? ● Any questions they have for the learner ● Any suggestions for improvement?

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	Use the feedback to revise 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