



ACCELERATION

Grade: 2-4

Prep Time: 10 minutes

Lesson Time: 60 minutes

WHAT STUDENTS DO: Sequence Marble Run Setups to Maximize Speed.

Students will sequence marble run setups and time each of them to understand the physics concept of Acceleration. Marble Genius marble run pieces will be used. Students will be asked to observe which pieces enable the marble to achieve maximum acceleration and adjust their setup to maximize speed.

STEM CORE & COMPONENT QUESTIONS

WHAT IS ACCELERATION AND HOW DOES IT RELATE TO PHYSICS?

INSTRUCTIONAL OBJECTIVES

Students will be able...
to model a series of marble runs using basic building techniques to understand how different pieces/setups accelerate the speed of the marble.

Marble Genius STEM Lesson Plan – Acceleration



1.0 Materials

Required Materials

Please supply:

For marble run building (per group of students)

- **Marble Genius Starter Set, Super Set or Extreme Set Pieces:**
 - 20 tubes (minimum)
 - 3 bases (minimum)
 - 5 different action pieces (wheel, ladder, squiggly, etc.)
 - 1 top entry piece

For observing, designing, and capturing results (per group of students)

- Paper and pencil
- Colored pencil (green, yellow, purple, red, blue)
- 2 metric rulers
- Wall clock/stop watch/timing device (seconds - ideally hundredths)

Please print:

From Student Guide Below:

- | | |
|-------------------------------------|-----------------|
| (A): Factors Impacting Acceleration | - 1 Per Student |
| (B): Time Sheet | - 1 Per Group |

Marble Genius STEM Lesson Plan – Acceleration



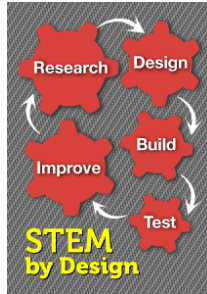
2.0 Teacher Vocabulary

Rube Goldberg Machine	A Rube Goldberg machine is a contraption, invention, device, or apparatus that is deliberately over-engineered to perform a simple task in a complicated fashion, generally including a chain reaction. The expression is named after American cartoonist and inventor Rube Goldberg (1883–1970).
Marble Run	Typically made of wood or plastic and features small, interlocking pieces that can generate a large number of track configurations for a marble to run down. More complicated add-ons, such as jumps, loops, trampolines, xylophone ramps, and electronic triggers are also typical with more complex sets. A type of Rube Goldberg Machine.
Acceleration	Increase of speed or velocity
Slope	Incline or slant, especially downward or upward
Prediction	A declaration about what will happen based on reason and knowledge
Design	A plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is built or made
Impediment	A hindrance or obstruction in doing something
Experiment	A scientific procedure undertaken to make a discovery, test a hypothesis, or demonstrate a known fact.
STEM by Design	Research, design, build, test, improve

Marble Genius STEM Lesson Plan – Acceleration



3.0 Procedures



The purpose of this lesson is to use the Stem by Design process to help students learn about **Acceleration** and to see if the order of the pieces impacts the time it takes for the marble to make it to the bottom.

Step 1: Engage - The first part of the lesson will highlight basic definitions and introduce the lesson.

Step 2: Explore – The students will spend time designing and experimenting as part of groups of 5-6 students during this part of the lesson. Using the Stem by Design process, they will use what they learn and order the pieces in fastest accelerating to slowest accelerating.

Step 3: Explain – While the students are still in groups, take 5 minutes to remind the students of several important concepts (slope, impediment, etc.) and answer any questions they have before the students finish.

Step 4: Evaluate/Review – Once students return to their desks, take time to review the concepts and ask the students what they learned and any observations that they have.

Step 1: Engage (~15 minutes)

Marble Run Scientific Exploration

Read the following to the students:

- A.) **Fiction Story:** Pretend that we're stepping into a time machine and going back over 100 years to help inventor Rube Goldberg. Rube invented a contraption that is deliberately complex to perform a simple task and today we're going to work with one of these contraptions, the **Marble Run**. Rube needs help identifying the marble run pieces that have the fastest acceleration and to know if order matters for getting the marble to the

bottom as fast as possible. If you succeed, you will have learned the key concepts of **Acceleration** and Rube will thank you for your efforts!

B.) Let the students know that **Acceleration** means the *increase in speed or velocity*. One common example is a car that goes from very slow to very fast. Question for the students: If a car goes from very slow to very fast in a short amount of time, is that FAST or SLOW **Acceleration (A: Fast)?**

Key Concept: What impacts the **Acceleration** of a marble?

- Slope – angle of a piece (the steeper the angle the faster the acceleration)
- Impediments – an obstruction that causes the marble to slow down.

Today we'll divide into groups to help Rube with the two goals I mentioned earlier:

- 1.) Identify the pieces that cause the marble to accelerate the fastest.
- 2.) Determine if the order of the pieces impacts the speed at which the marble gets from the top of the run to the bottom.

Hand out the worksheet: **Factors Impacting Acceleration** to all of the students. Have the students spend 5 minutes completing this sheet and then divide them into groups of 5-6 and proceed to step 2.

Step 2: Explore (~30 minutes)

Hand out one timesheet to each group and make sure each group has access to a clock with seconds on it (wall clock or timer). Also, hand out the marble run pieces as described in the materials section. Give the students up to 30 minutes to complete the time sheet.

Step 3: Explain (~5 minutes)

After about 10-15 minutes of Explore, have the students pause for a minute to remind them about some important concepts: Slope, Impediment, etc. Remind them that what they are doing is conducting an Experiment and it's important that they work together as a team and keep testing. See if they have any questions you can answer before they finish.

Step 4: Evaluate (~5 minutes)

Once everything is put away and the students return from their desks, ask them what they observed and learned.

Factors Impacting Acceleration

Name _____

SLOPE:

(Connect 1 dot on left to 1 dot on right, making the steepest slope possible)

* *
* *
* *
* *

(Connect 1 dot on left to 1 dot on right with NO slope)

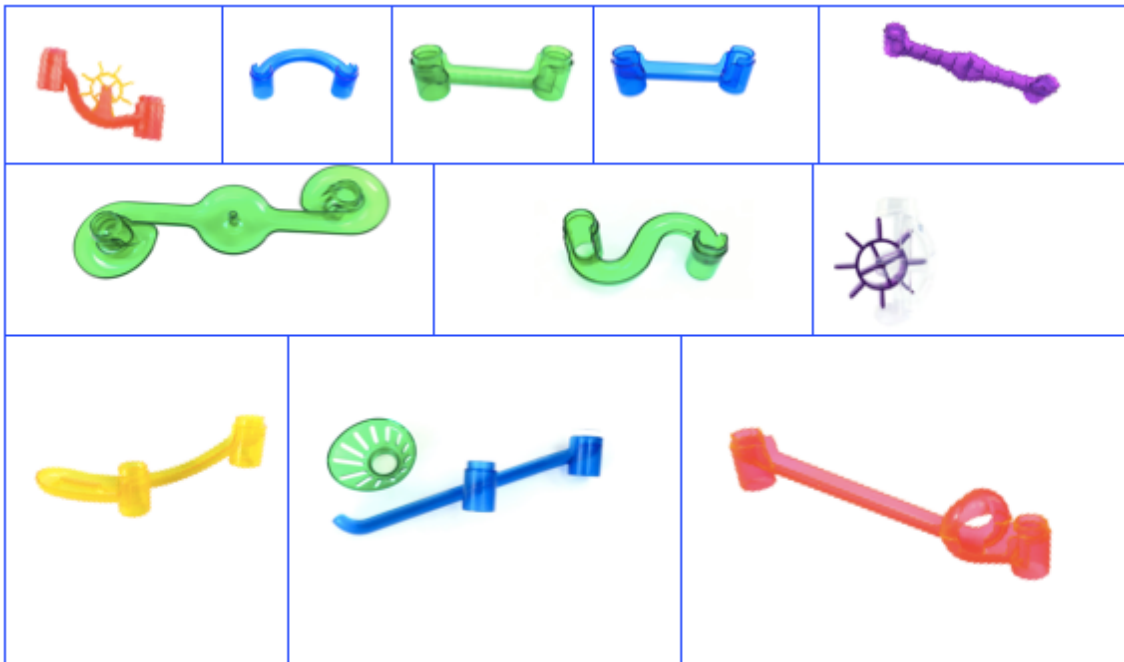
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IMPEDIMENT

Draw an example of an Impediment that would slow down or prevent the smiley face from reaching the star.



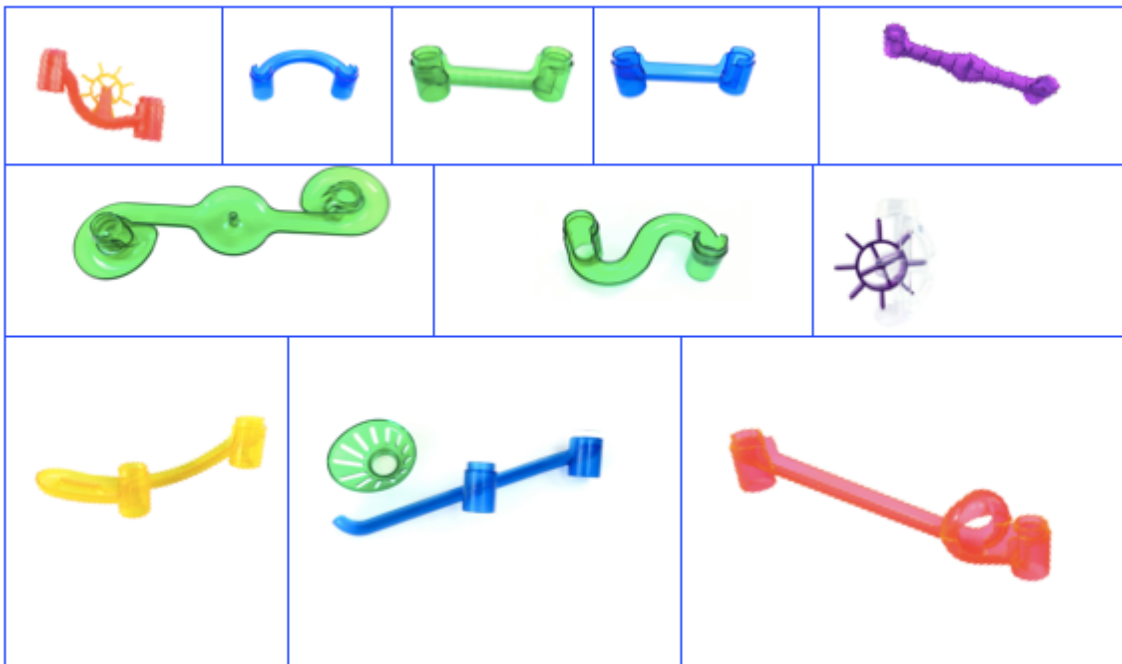
Circle 5 marble run pieces below that you think will have the fastest acceleration.



Time Sheet












Names: _____

- 1.) Cross out the pieces below that you don't have.
- 2.) Create a marble run with all the pieces you have. Put the pieces that you think will have the fastest acceleration at the bottom.
- 3.) In the upper left hand corner of each rectangle below, record the order of the pieces you used from top (#1) to the bottom of the run.
- 4.) Record the time it takes for the pieces to make it from the top to bottom. Time (seconds): _____
- 5.) Write the letter "I" in the rectangle of the pieces that have an impediment.
- 6.) Observe which pieces have the fastest acceleration. Rebuild your marble run with the fastest accelerating pieces starting at the top and the slowest accelerating pieces at the bottom.
- 7.) Record the time it takes for the pieces to make it from the top to bottom. Time (seconds): _____



Rubric

F = Fast Acceleration
M = Medium Acceleration
S = Slow Acceleration
i = Impediment

 <p>F i</p>	 <p>S</p>	 <p>S i</p>	 <p>S</p>	 <p>M i</p>
 <p>M i</p>		 <p>S i</p>		 <p>F i</p>
 <p>F i</p>	 <p>F</p>		 <p>F i</p>	



Lesson Plan for use with the following Marble Run Sets

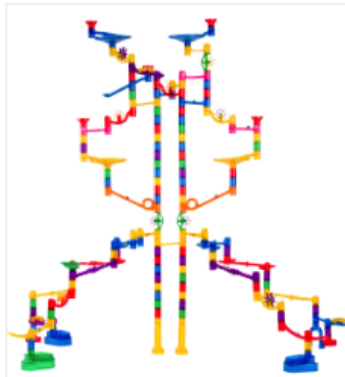
Available at
amazon



MARBLE GENIUS

Marble Run Super Set

On sale ~~\$44.99~~ \$39.99



MARBLE GENIUS

Marble Run Extreme Set

On sale ~~\$69.99~~ \$59.99



MARBLE GENIUS

Marble Run Starter Set

On sale ~~\$29.99~~ \$24.99

(Super Set or Extreme Set recommended for larger classes)