SIEMENS STEM DAY | Science Technology Engineering Math

GRADES 9–12

SIEMENS STEM DAY ACTIVITY

MEDICATION IN THE BODY

OBJECTIVES

Students will be able to:

- **Create** equations to represent real-world situations by fitting functions to data.
- **Summarize** the results of an experiment based on a function created to fit data.

THIS LESSON FOCUSES ON

Engineering Design Cycle

- Defining the Problem

21st Century Skills

- Critical Thinking

OVERVIEW

Students model how a medication is filtered from the blood using colored water. They make predictions about how much medicine remains in a person's system over time by comparing their predictions to observed data and identifying the relationship between time and milligrams.

STEM incorporates Science, Technology, Engineering, and Mathematics to focus on real-world issues and problems guided by the engineering design process. This type of instruction supports students in developing critical thinking, collaboration, reasoning, and creative skills to be competitive in the 21st-century workforce.

Each Siemens STEM Day classroom activity highlights one or more components of the engineering design cycle and an essential 21st-century skill.

MATERIALS

- **Medicine Half Life** handout—one per student
- 8 oz Measuring cup—one per group
- food coloring—one .25 oz bottle per group
- water—one gallon per group
- **Analyze the Results** handout—one per group

HAVE YOU EVER WONDERED . . .

How your body process medication you take?

MAKE CONNECTIONS!

How does this connect to students?	**How does this connect to careers?**	**How does this connect to our world?**
When we take medication, it is essential to know how long it stays in our system. Taking another dose of medicine before the first dose has had time to metabolize in our system can be dangerous.	An **FDA Pharmaceutical Scientist** works in a lab determining how different compounds interact with cells and organisms in the body. He/she is responsible for testing medications to make sure they are safe for the population. They may find themselves analyzing test results and techniques provided by pharmaceutical companies. An FDA Pharmaceutical Scientist works for the Federal Drug Administration.	**Extended-Release (ER)** medication is designed to take a longer time to release into the body thus slowing the time it takes for the medicine to come out of the body. ER improves the stability of the medication in the body vs. taking multiple doses a day.

BLUEPRINT FOR DISCOVERY

1. Introduce students to how medications are metabolized in the body by showing the following video: https://youtu.be/uOcpsXMJcJk
2. Reinforce how medication breaks down in the stomach then travels into the bloodstream and that "metabolization" is when the drug is broken down by the liver or the kidney. The rate at which the body can break down a medication is called the **half-life**. Half-life refers to how long it takes for half of the dose to be metabolized and eliminated from the bloodstream.
3. Divide the students into groups of 3–4 and distribute the **Medicine Half-Life** handouts and activity supplies to each group. Challenge the groups to follow the procedure listed visually demonstrate half-life.
4. As each group completes their demonstration, instruct them to complete the **Analyze the Results** handout as a group.
    - *Note:* Groups may require assistance choosing the correct function or writing an equation.

[1] Explore Health careers, Pharmaceutical Scientist, On the internet https://explorehealthcareers.org/career/pharmacology/pharmaceutical-scientist/ (visited August 23, 2019)
[2] Live Science, Medicine's Journey Through the Body: 4 Stages Alison Davis, (April 30, 2014), On the internet https://www.livescience.com/45241-medicine-journey-trough-body-nigms.html (visited August 23, 2019)
[3] Verywell Mind, Overview of Your Medication's Half-Life, Marcia Purse (June 15, 2019),On the internet https://www.verywellmind.com/medication-half-life-380031 (visited August 23, 2019)

5. To summarize their learning, work together as a whole group to answer the following question: Given a medication volume of .25 oz has a half-life of 1 hour, after how many hours would the medication be less than .0001 of an oz?

TAKE ACTION!

- Students can research the half life of plastics and apply their learning to a public action campaign about the importance of recycling.

NATIONAL STANDARDS

Mathematical Practice	Common Core Standards for Mathematical Practice MP4: Model with mathematics. MP5: Use appropriate tools strategically. Common Core State Standards for Math HSS-ID.B.6a: Fit a function to the data; use functions fitted to data to solve problems in the context of the data. HSF-IF.B.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. HSF-IF.B.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. HSF-IF.C.7e: Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. HSF-LE.A.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

MEDICATION HALF-LIFE

Today we are going to explore how medication metabolizes in the body. It breaks down by half-life. Half-life refers to how long it takes for half of the dose to be metabolized and eliminated from the bloodstream.

Materials

- Water—1 gallon
- A measuring cup—8 oz
- Food coloring—.25 oz

Procedure

1. Fill the measuring cup with water up to the 1 cup (8oz) measuring line.
2. Place all the .25 oz bottle of food coloring into the water
3. Next, you are going to demonstrate Half-Life by repeating the following steps over and over until the liquid is significantly more transparent or you run out of water.
    a. Dump out half of the water in measuring cup. There should be 4oz or half a cup left.
    b. Fill the cup back up with fresh water
    c. Record a mark to indicate the time through this process
    d. Repeat.
4. Complete the table below.

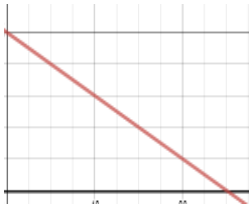
Volume of food coloring	.25															
Half-life number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Volume of food coloring															
Half-life number	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

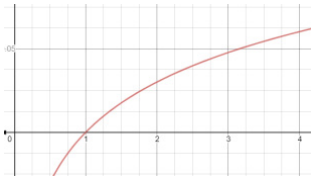
ANALYZE THE RESULTS

1. Use the graph paper to plot your results.
2. Look at the sketches below and determine which of the following best matches your plot.

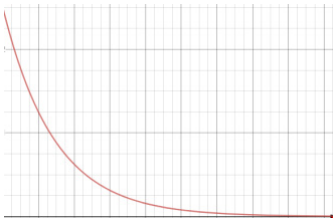
Linear
y=mx+b



Logarithmic
y=a log(x)



Exponential
y=b(a)x



3. Use your data and your function that matches your graph and create an equation for your plot.

ANALYZE THE RESULTS