Designing the Drip

Trace how a model produces data for design decisions.

MS-ETS1-4 "Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each part that tells what the team tested or changed. Circle each number that is data or a design goal, then number the tests 1 and 2 to show how evidence guided the next design.

A Garden Watering Model

1. At a school garden, a team wanted a simple system that would keep young plants watered during a three-day weekend. Their proposed design used a raised bottle with a tiny hole in its cap. Water would drip through a tube into the soil. Before building several systems, the team made a model. The model included a drawing of the parts and a table for predicting and recording how much water reached the soil each day. It let them test ideas safely and quickly.

2. For the first test, the model predicted that a 1-millimeter hole would deliver 300 milliliters per day. The team filled the bottle, placed it above a container, and measured the collected water after one day. The result was 450 milliliters, too much for the seedlings and outside their goal of 250 to 350 milliliters. This data showed that the hole size affected the flow. The team changed only the hole size to 0.7 millimeter for the next model test, so they could connect a new result to one clear change.

3. On the second test, the 0.7-millimeter hole delivered 330 milliliters. That result met the water goal, but the team also checked a constraint: after three days, at least 100 milliliters had to remain in the bottle. A model calculation using its 1,000-milliliter starting amount showed that 330 milliliters per day would leave only 10 milliliters after three days. The team planned another test with a larger bottle while keeping the successful hole size. Repeating tests, using data, and changing one feature at a time helped the team move toward an optimal system.

2 ANSWER WITH EVIDENCE

Use the passage

1. What two things did the team's model include, and what information could it help the team collect?

2. How did the first test result compare with the team's daily water goal?

3. Why did the team change only the hole size before the second test?

4. What did the second test and three-day calculation cause the team to plan next?

3 YOUR TURN

Your own words

Develop and run a numerical model for a lunchbox that must keep an apple at 10°C or colder after 4 hours with an ice pack at most 200 g. For this simplified classroom model only, use a fixed 180 g pack and $T = 16 - 0.8t$, where T is the 4-hour temperature in °C and t is foam thickness in mm. Valid thicknesses are whole numbers from 5 to 10 mm; the goal is the least foam that meets the temperature requirement. Draw a labeled lunchbox and an input → rule → output model. Run $t = 5$ first, calculate T, and use that result to choose and run a thicker design. Then test another thickness to improve the design toward the goal. Record each test, thickness, calculation, T and pack mass; use extra paper for additional rows. State the best allowed thickness and justify why one mm less fails. Explain one real condition the rule omits; these outputs are simulated, not measured food-safety results.

TEST	FEATURE CHANGED	TEMPERATURE AFTER 4 HOURS	ICE PACK MASS

ANSWER KEY

Designing the Drip

GRADES 6-8 · MS-ETS1-4

PART 1 · READ AND MARK

Underline each part that tells what the team tested or changed. Circle each number that is data or a design goal, then number the tests 1 and 2 to show how evidence guided the next design. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What two things did the team's model include, and what information could it help the team collect?	**It included a drawing of the parts and a table. The table helped predict and record how much water reached the soil each day.**
2	How did the first test result compare with the team's daily water goal?	**The first test delivered 450 milliliters, which was above the goal range of 250 to 350 milliliters per day.**
3	Why did the team change only the hole size before the second test?	**Changing one feature at a time let the team connect the new result to the hole size.**
4	What did the second test and three-day calculation cause the team to plan next?	**The 0.7-millimeter hole met the daily water goal, but only 10 milliliters would remain after three days. The team planned to test a larger bottle while keeping the 0.7-millimeter hole.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Model diagram: foam thickness t → calculate 16 − 0.8t → predicted temperature T after 4 hours, with ice pack fixed at 180 g. Test 1: 5 mm gives 12°C, so it fails. Test 2: 10 mm gives 8°C and passes, but uses more foam. Test 3: 8 mm gives 9.6°C and passes. Check 7 mm: 10.4°C fails. Thus 8 mm is the least permitted whole-number thickness meeting the model criterion; 180 g is within the 200 g limit. The rule omits actual ambient conditions and heat leaks, so physical testing is needed before trusting a real lunchbox.

For the own task, require a developed diagram and runnable input/rule/output model, at least three documented iterations using the supplied rule, and a justified minimum of 8 mm (7 mm fails). The supplied rule gives: 5 mm → 12°C and 10 mm → 8°C with 180 g. Accept alternate testing sequences after the first test when subsequent choices use results. Do not accept invented measured temperatures. This intentionally simplified engineering model is not an empirical law or a food-storage recommendation; students must identify its limits.