WATER CLOCK INVESTIGATION

Observe • Identify Patterns • Predict • Apply • Design

Name: ________________________________	**Class Period:** __________	**Date:** __________________

THE CHALLENGE Investigate how a hydraulic clock uses repeating motions and liquid transfers to measure time. Use evidence from the model to predict its future display, then design a way people could keep time accurately on Mars. You may redesign the water clock or propose a different timekeeping system.

Driving Question

How do repeating events allow clocks to measure time, and how could people keep time accurately under different gravity?

1 Read and Think

Read the short introduction before opening the model.

MEASURING TIME

Humans keep track of time by counting repeating patterns. Earth's rotation creates the daily cycle, while clocks divide a day into hours, minutes, and seconds. A water clock does not create time; it counts repeated motions and liquid transfers. In the VariableVista model, a pendulum, scoop, siphons, minute discs, and hour globes work together. When a clock is calibrated, each repeated event is synchronized with a known unit of time. If the environment changes the mechanism's motion, the clock may keep moving but no longer keep accurate time.

1. According to the reading, what does a clock count?

2. In this investigation, what does synchronized mean?

3. Which part do you predict most directly regulates the clock's repeated motion? ☐ Pendulum ☐ Siphons ☐ Hour globes ☐ Digital display

Explain your prediction.

2 Observe and Notice

Use Live mode first. Then use Observe Fast to see a longer sequence.

Write three observations that describe only what you can directly see. Avoid explaining why it happens yet.

1. I observe that…

2. I observe that…

3. I observe that…

3 Map the System

Identify how the visible parts work together as a counting system.

Component	What I see it doing	How it helps count time
Top reservoir and feed		
Scoop and pendulum		
Four siphons		
Minute discs		
Hour globes		
Lower return reservoir		

Which part appears to regulate or pace the system? Use one observation as evidence.

NUMBER THE NORMAL SEQUENCE Write 1–5 to show the order in which the events occur.

_____	The full minute column transfers liquid to the next hour globe.
_____	The reservoir feeds the scoop.
_____	The siphons fill and then drain rapidly.
_____	The pendulum regulates the movement of the scoop.
_____	The fourth siphon adds liquid to the minute-disc column.

MODEL PATTERN Four siphons divide a two-minute interval. After the fourth siphon, one disc is added. Thirty discs represent sixty minutes. At the hour, the minute column transfers liquid to an hour globe. At noon and midnight, the hour display resets.

4 Read the Clock

Record the clock display exactly as shown before making a prediction.

Measurement	Model reading	Measurement	Model reading
Selected time zone		Digital time	
Filled hour globes		Filled minute discs	

Explain how the visible liquid display represents the digital time.

5 Predict Two Hours Later

Use the repeating pattern and the twelve-hour reset to predict the future display.

Prediction	Your answer
Current digital time	
Digital time two hours from now	
Number of new hour-globe filling events during the next two hours	
Number of complete minute-column cycles during the next two hours	

Will the clock cross noon or midnight during the next two hours? ☐ Yes ☐ No

Show how you determined your two-hour prediction.

How many hour globes do you predict will appear filled at the end of the two hours? Account for the reset if needed.

IMPORTANT Count filling events separately from the number of globes visible at the end. Two hour events can occur even if the clock resets during the interval.

CHECK THE PREDICTION

Use Observe Fast. You may also open How It Works and select Preview an hour change or Preview the twelve-hour reset. Return to Live mode when finished.

Evidence check	Prediction	Model result
Hour-globe filling events		
Complete minute-column cycles		
Filled globes at the end		

Did the model support your prediction? ☐ Yes ☐ Partly ☐ No

Use one piece of model evidence to explain your answer.

SCIENTIFIC THINKING A prediction is useful even when it is not correct. Strong scientific reasoning means comparing the prediction with evidence and revising the explanation when necessary.

6 Apply the Idea to Mars

Separate the length of a planetary day from the calibration of a clock mechanism.

KEY IDEA Mars has a day that is close to an Earth day, but its surface gravity is much weaker. Day length describes planetary rotation. Gravity affects how a physical pendulum moves. These are different measurements.

Comparison	Earth	Mars
Length of one day	About 24 hours	24 hours, 39 minutes, 35 seconds
Surface gravity	100% of Earth gravity	About 38% of Earth gravity
Same-length pendulum	Calibrated for Earth	Each swing takes about 1.6 times as long

A clock does not become inaccurate because “time is different.” It becomes inaccurate when its repeated motion is no longer synchronized with the unit it is supposed to count. On Mars, the unchanged pendulum would swing more slowly. Gravity-driven liquid flow would also likely change, but the amount would need to be tested.

1. Which Mars measurement is most similar to Earth? ☐ Day length ☐ Surface gravity ☐ Pendulum period

2. Which measurement most directly affects the swing rate of a pendulum? ☐ Day length ☐ Gravity ☐ Number of hours on a clock

3. An unchanged Earth pendulum on Mars would swing: ☐ Faster ☐ Slower ☐ At the same rate

4. Explain why a similar day length does not keep the pendulum synchronized.

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5. Complete the cause-and-effect chain.

Weaker gravity	→	**Pendulum swings ___________**	→	**The clock runs ___________ because each counted cycle takes longer.**

6. A student claims, “Mars has nearly a 24-hour day, so an Earth pendulum clock should remain accurate.” Write a response using at least two numbers from the table.

MODEL LIMITATION The VariableVista model follows a selected Earth time zone. It does not change gravity or simulate the behavior of real liquid on Mars. The model can show the clock’s counting pattern, but Mars performance must be predicted from scientific information and tested with a physical or computational timekeeping system.

7 Design a Way to Keep Time on Mars

Redesign the water clock or propose a different timekeeping system.

MARS TIMEKEEPING CHALLENGE People living in a Mars habitat need a dependable way to keep track of time. You may adapt the water clock or choose another method. Explain what repeating event or process your idea counts, how it communicates time, and how Mars gravity might affect it.

Design choice	Your response
Approach	☐ Redesign the water clock ☐ Propose another way to keep time
Name or brief description	
Repeating event or process it counts	
How the design shows or communicates time	
How Mars gravity might affect it	

DEVELOP YOUR IDEA

Design question	Your explanation
How does your idea keep track of time?	
How could Mars gravity affect your idea?	
What evidence would show that it keeps accurate time?	

DESIGN SKETCH *Draw and label your idea. Show the repeating event or process used to keep time.*

8 Final Explanation

Use evidence from the model, the Earth-Mars comparison, and your timekeeping design.

Why would an unchanged Earth pendulum water clock lose accuracy on Mars even though a Martian day is close to an Earth day? Describe one way people could keep time accurately on Mars.

CLAIM

EVIDENCE - Include the model pattern and at least two numerical facts.

REASONING - Connect gravity, synchronization, and your proposed timekeeping method.

NGSS alignment: Supporting MS-ETS1-1 through defining a Mars timekeeping problem and proposing a solution; Science and Engineering Practices include Developing and Using Models, Analyzing and Interpreting Data, Using Mathematics and Computational Thinking, and Constructing Explanations and Designing Solutions. Crosscutting concepts: Patterns; Cause and Effect; Systems and System Models.

Science sources: NASA Science, “Mars Facts”; OpenStax University Physics, “Pendulums”; Next Generation Science Standards, MS-ETS1 Engineering Design.