

Six Seconds and Sixty Years: A Glacier's Two Clocks

Learning target: I can record what I notice about a glacier that changes its valley in seconds and in centuries, connect it to what I already know, and write a first explanation of how one process can work on two very different time scales.

Phenomenon exploration

About 25 min

Individual

MS-ESS2-2 · supports

discussion

writing

Name _____

Date _____

Period _____

Directions

Read the field notebook and study the figure and the table. The glacier and the numbers are a teaching scenario, invented to be realistic. Do not look anything up yet. Part A asks for what you notice and wonder; use only facts that are given. Part B asks what you already know and what you think right now; there is no penalty for being wrong. Part C asks for your first explanation. Write in complete sentences. You will come back to this page at the end of the chapter to see how your thinking changed.

You will need: This worksheet, Pencil, Calculator (optional)

Field notebook: one day at Marrow Glacier

Ms. Alvarez's class is standing on a rocky ridge above the front of Marrow Glacier, a river of ice that flows out of the mountains and ends in a fjord. For most of the morning nothing seems to happen. Then there is a crack like a gunshot. A slab of ice about 40 meters tall, the height of a twelve-story building, leans away from the glacier and crashes into the water. From the first crack to the splash takes about six seconds. The wave it makes rocks the boats in the fjord for several minutes. Then the glacier looks as still as it did before.

Afterward the class looks around. A survey stake that a ranger hammered into the ice yesterday has moved about 0.5 meters toward the fjord in 24 hours. Beside the glacier, the bare bedrock is covered with long, straight scratches a few millimeters deep and many meters long, all pointing down the valley. A boulder 3 meters across sits alone on the ridge; it is made of a dark rock that does not match the pale rock under it, and the nearest cliff of that dark rock is 12 kilometers up the valley. The whole valley is shaped like the letter U, about 1.5 kilometers from rim to rim. The stream that pours out from under the ice is milky gray, as if someone had stirred flour into it.

Same glacier, two clocks

The ice slab that fell (what we watched)

About 40 m tall

Fell in about 6 seconds

Wave lasted a few minutes

Happened once while we watched

The valley around us (what we found)

U-shaped valley 1.5 km wide

Scratches on bedrock, mm deep, m long

Boulder 3 m across, 12 km from its source rock

Stake moved 0.5 m in one day

Teaching scenario: Marrow Glacier and every number on this page are invented to be realistic, not measured at a real glacier.

Measured changes from the notebook (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

What changed	How big	How long it took
Ice slab broke off the front	about 40 m tall	about 6 seconds
Survey stake on the ice moved toward the fjord	0.5 m	24 hours
Scratches cut into bedrock beside the ice	a few mm deep, many m long	unknown
Dark boulder carried from its source cliff	3 m across, moved 12 km	unknown
Valley carved into a U shape	1.5 km wide	unknown

Simulated values for a classroom scenario; they are realistic for a valley glacier that ends in the sea.

Part A: Notice and wonder

1. List three things you **notice** in the notebook, the figure or the table. Use only facts that were observed or given, not explanations. Number them 1, 2, 3.
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2. Write two questions you **wonder** about. At least one must be a question that could be answered by measuring something at the glacier.

Part B: What you already know and what you think now

3. Write two things you already know or believe about ice, glaciers or how rock gets broken and moved. It is fine if you are not sure; label anything you are unsure about with a question mark.

4. The stake moved 0.5 m in one day. If the ice kept moving at that rate, how far would it move in one year (365 days)? Then estimate how many years it would take ice to travel the 12 km from the dark cliff to the ridge where the boulder sits. Show your work with units.

5. Which explanation for the straight scratches on the bedrock fits the facts on this page best? Circle one, then write one fact from the page that supports your choice.

- ☐ **A.** Ice is hard enough to scratch rock by itself.
- ☐ **B.** Rock fragments frozen into the bottom of the ice were dragged across the bedrock as the ice moved.
- ☐ **C.** Rain running down the valley wore the grooves.
- ☐ **D.** The scratches were already there before the glacier existed.

Part C: Your first explanation

6. The slab fell in six seconds. The U-shaped valley, the scratches and the far-traveled boulder look like the work of the same glacier, but none of them happened while the class watched. Write your first explanation of how one glacier can be responsible for a change that takes seconds and a change that takes far longer than a human life. Use at least two numbers from the page.

7. **Predict.** Suppose the climate warms and the front of Marrow Glacier melts back 60 m every year for the next ten years. Describe two things you expect to find on the newly uncovered valley floor, and say why.

8. Write one question you would want answered before you could be sure that the valley was carved by ice and not by the stream. Say what measurement or observation would answer it.

Sentence starters for Part C

If you are not sure how to begin q6, try: 'The slab falling was fast because _____. The valley took much longer because _____. Both are caused by the glacier because _____.' For q4, write the multiplication on one line and the division on the next so you can check each step: $0.5 \text{ m per day} \times 365 \text{ days} = \text{_____ m per year}$; $12,000 \text{ m} \div \text{_____ m per year} = \text{_____ years}$.

Two more clocks

The notebook lists three changes with 'unknown' for how long they took. For each one, propose a way a scientist could put a number on the time: what would they measure, and what would they have to assume about the past to turn the measurement into an age? Then rank the three from the easiest to the hardest to date and explain your ranking in two or three sentences.