

Four and a Half Meters of Time: a String Model of Earth's History

Investigation question: If all 4.54 billion years of Earth's history were stretched along a 4.54-meter string, where would the first animals, the last non-bird dinosaurs and the first modern humans sit, and what does the spacing reveal that a textbook chart hides?

Physical model

Groups of 4

1 session

Setup 8 · Activity 35 · Cleanup 5 min

MS-ESS1-4 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Calculator:** Converts each event's age in millions of years to centimeters from the 'today' end (divide by 10) and reads the result aloud; shows the work on the sheet.
- ☐ **Measurer:** Measures each distance from the 'today' end with the tape or meter sticks and marks the spot with a small piece of masking tape.
- ☐ **Card placer:** Clips the correct event card at each mark, checks that the cards read in order along the string, and keeps the string straight.
- ☐ **Checker and recorder:** Recomputes every third conversion independently, records the group's predictions and measurements, and reports to the class.

Safety

- Strings on the floor are a tripping hazard; keep lanes clear, walk only alongside the string, and have the card placer call out before anyone crosses a lane.
- Scissors only for cutting string and cards; pass them handle first and keep them closed on the desk when not in use.
- No chemicals or heat are used. If the activity is run outdoors, keep groups away from stairs and traffic.

Procedure

1. Lay the string straight along your lane with the TODAY loop at one end. Before measuring anything, place a sticky note where the group guesses the first animals belong and another where the non-bird dinosaurs end. Record both guesses in centimeters from TODAY on the recording sheet.
2. Measure 454 cm from TODAY and clip the 'Earth forms (4,540 Ma)' card there. Check with the tape that the distance is 454 cm, not the full string length.
3. For each event on the recording sheet, the calculator divides the age in millions of years by 10 to get centimeters from TODAY, says the result aloud, and the checker records it. Work in the order listed, oldest first.
4. The measurer measures each distance from the TODAY loop, never from the previous card, and marks it with a small piece of masking tape. The card placer clips the card at the mark.

5. When you reach the events younger than 10 million years, switch to millimeters (1 mm = 1 million years) and use the hand lens. Decide as a group whether the last three cards can be placed at separate spots or must share one clip, and record what you decided.
6. Walk the finished string from the Earth end to TODAY. Measure and record the length of the Precambrian stretch (from 'Earth forms' to 'Cambrian explosion') and the length from 'Cambrian explosion' to TODAY.
7. Compare your two guesses from step 1 with the measured positions and write one sentence about each.
8. Measure the gap between 'Chicxulub impact' and 'modern humans appear' and record it, then answer the analysis questions individually before discussing them as a group.

Record your observations

Lab 1 recording sheet: Four and a half meters of time

Scale: **1 cm = 10 million years**, so centimeters from TODAY = age in millions of years $\div$ 10. One millimeter is one million years. Fill in the guesses before you measure anything.

Guesses before measuring

Event	Our guess (cm from TODAY)	Measured position (cm)	How far off were we? (cm)
First animals appear (Cambrian explosion)			
Non-bird dinosaurs die out (Chicxulub impact)			

Event positions (dates rounded from the current international chart and USGS, NASA and Smithsonian sources)

Event	Age (millions of years ago)	Centimeters from TODAY (age $\div$ 10)	Placed? (check)
Earth has assembled	4,540		
Giant impact forms the moon	4,500		
Oldest surviving zircon grains	4,400		
Oldest surviving whole rocks	4,000		
Oldest stromatolites (microbial mats)	3,500		
Oxygen starts building up in the air	2,400		
Cambrian explosion: first animals with hard parts	539		
Burgess Shale animals buried	508		

Event	Age (millions of years ago)	Centimeters from TODAY (age ÷ 10)	Placed? (check)
End-Ordovician mass extinction	443		
Late Devonian mass extinction	372		
Pangaea fully assembled	300		
End-Permian mass extinction	252		
First dinosaurs	230		
End-Triassic mass extinction	201		
Pangaea begins to split	180		
Chicxulub impact; non-bird dinosaurs die out	66		
India collides with Eurasia	50		
Antarctic ice sheet forms	34		
Quaternary begins: northern ice sheets start their cycles	2.58		
Modern humans appear	0.3		

Measured stretches

Stretch	Measured length (cm)	Share of the whole string (length ÷ 454 × 100)
Earth forms to Cambrian explosion (the Precambrian)		
Cambrian explosion to TODAY (the Phanerozoic)		
Chicxulub impact to modern humans		

- How did your two guesses compare with the measured positions? Which one surprised you more, and why?

2. What did your group decide to do with the last three cards (Quaternary, modern humans, and the present interglacial, which began 0.0117 million years ago)? Explain the problem they caused.

Analysis questions

3. Use your measured stretches to calculate what percent of Earth's history is Precambrian and what percent is Phanerozoic. Show the division.

4. The Chicxulub card sits 6.6 cm from TODAY and the modern-humans card 0.03 cm. How many times longer is the gap between the end of the non-bird dinosaurs and today than the whole existence of modern humans? Show the calculation.

5. Your textbook's time-scale chart gives the Phanerozoic Eon far more space than the Precambrian. Using your string, explain why the chart is not to scale and why geologists draw it that way anyway.

6. Suppose you wanted a model on which the present interglacial (11,700 years) is a full centimeter long. How long would the whole-Earth string have to be? Show your work and comment on whether the model would be usable.

- 7.** Which events on your list could be placed in order by rock layers and fossils alone, and which needed an age measured in years from materials such as meteorites or volcanic ash? Give two examples of each.

- 8.** Every model shows some things well and others badly. Name one thing the string shows well and two things about Earth's history it cannot show.
