

Design a Hallway Timeline That Tells the Truth About Time

Learning target: I can define the criteria and constraints of a scale-model design problem, calculate where events belong on a true-scale timeline, recognize when the criteria conflict, and choose and justify a design that meets them.

Transfer and design

About 50 min

Pairs

MS-ESS1-4 · practice

MS-ETS1-1 · practice

MS-ETS1-2 · practice

engineering design

data analysis

writing

Name _____

Date _____

Period _____

Directions

Read the design brief. Do the calculations in Part A first; they will show you a problem that the brief does not mention. In Part B, compare the three candidate layouts against every criterion and constraint, choose one (or improve one), sketch it, and justify your choice. Show all calculations with units. The event dates are real reference values.

You will need: This worksheet, Pencil, Calculator, Ruler, Scrap paper for the sketch

The design brief

Your school's science hallway is exactly 30.0 meters long. The principal has asked your class to build a timeline of Earth's history along one wall so that any visitor can walk from Earth's formation at the entrance to today at the far end. She wants it to be **honest about time**: the distance along the wall must be proportional to the number of years, with no cheating. There is one obstacle: a classroom door, 1.0 m wide, whose frame runs from 20.0 m to 21.0 m from the entrance, and nothing may be attached to the door or its frame.

Criteria and constraints — Criteria (what a good design does): C1: the wall is a true-scale model, so a visitor can measure a distance and convert it to years with one scale factor. C2: all four eons, the three eras of the current eon, and at least eight of the events in the table are shown. C3: every label is readable: no two labels may be closer than 3.0 cm along the wall. C4: a visitor can find where modern humans appear. **Constraints (limits you cannot change):** K1: total length 30.0 m. K2: nothing on the door or frame (20.0 to 21.0 m). K3: budget of 40 dollars for tape, card and markers. K4: the class has two build sessions of 50 minutes.

Events to place (real reference values)

Event	Age (millions of years ago)
Earth forms (start of the Hadean Eon)	4540
Start of the Archean Eon; oldest known Earth rock	4000

Event	Age (millions of years ago)
Oldest widely accepted fossils (microbial mounds)	3500
Start of the Proterozoic Eon	2500
Oxygen begins to build up in the air	2400
Start of the Phanerozoic Eon and Paleozoic Era (animal groups diversify)	539
End-Permian mass extinction; start of the Mesozoic Era	252
First dinosaurs	230
Asteroid impact; start of the Cenozoic Era	66
First primates	55
Current ice-age cycles begin	2.6
Modern humans appear	0.3
Current interglacial period begins	0.0117

Part A: Do the math before you design

- Calculate the scale factor: how many centimeters of wall represent one million years? (30.0 m = 3,000 cm stands for 4,540 million years.) Then state how many million years one meter of wall represents.

- Complete the table using your scale factor. Distance from the today end = age × scale factor. Distance from the entrance = 3,000 cm – distance from the today end. Round to 0.1 cm.

Age (million years)	Distance from TODAY end (cm)	Distance from ENTRANCE (cm)
Phanerozoic begins, 539		
End-Permian, 252		
Asteroid, 66		
First primates, 55		
Ice-age cycles, 2.6		
Modern humans, 0.3		
Interglacial, 0.0117		

3. Which labels break criterion C3 (closer than 3.0 cm to another label)? List the groups of labels that collide, with the distances between them.

4. What span of ages falls on the door and its frame (20.0 to 21.0 m from the entrance)? Show the calculation, then check the event table and say whether any listed event lands on the door.

5. Explain in your own words why criteria C1 and C3 cannot both be fully met by a single straight line at this scale. Which event is the clearest proof?

Part B: Compare, choose, sketch, justify

Three candidate layouts — Layout 1, one line: a single true-scale line for the whole wall; where labels collide, stack them on top of each other with leader lines pointing to the same spot. **Layout 2, line plus zoom panel:** a true-scale line for the whole wall, plus a separate 1.0-m 'zoom' panel at the today end that shows only the last 66 million years at a larger scale, with a bracket on the main line showing which tiny stretch it magnifies. **Layout 3, bent line:** one line with two scales: the first 4,474 million years at a reduced scale of about 0.58 cm per million years, then the last 66 million years at ten times that scale (about 5.8 cm per million years) so the recent labels spread out and the whole line still fits the 30.0-m wall, with a note at the bend.

6. Score each layout against each criterion and constraint: write 'meets', 'partly' or 'fails' and a few words of reason. Use your numbers from Part A.

Layout 1: one line	Layout 2: line + zoom panel	Layout 3: bent line
C1 true scale		
C2 eons, eras, 8+ events		
C3 labels 3 cm apart		
C4 humans findable		
K2 door		
K3 and K4 budget and time		

7. For Layout 2, calculate the scale of the 1.0-m zoom panel (100 cm for 66 million years), then the positions of first primates, the ice-age cycles and modern humans on the panel, measured from the today end. Does the panel fix every C3 collision? Show your work.

-  Sketch your chosen (or improved) layout as the wall seen from the hallway: mark the entrance, the door at 20.0 to 21.0 m, the today end, the four eon boundaries, and at least eight events at positions that match your calculations (not to scale on paper, but in the right order and with the distances written beside them). If you use a zoom panel or a bend, draw it and label its scale.



8. Justify your choice. Your justification must (1) name the layout and any improvement you made, (2) explain how it meets every criterion and constraint or admit which one it only partly meets, (3) explain what is **lost** in your design compared with a perfect single true-scale line, and (4) say why that loss is acceptable.

9. A visitor walking your timeline says, 'The last 66 million years must be the most important part of Earth's history, because it has the most labels.' Write what the timeline's builder should reply.

Keep the units straight

Write the scale factor with its units, cm per million years, and multiply every age in million years by it. For ages given in decimals (2.6, 0.3, 0.0117), the answers will be small; that is the point, not a mistake. To find distance from the entrance, subtract from 3,000 cm. A quick check: the Phanerozoic boundary should land about 3.6 m from the today end, which is about an eighth of the wall. For q6, fill one column at a time, and use the collision list from q3 to judge C3.

Add the engineering trade-off the brief left out

The principal adds a fifth criterion: 'A visitor should be able to see that the first three eons are most of Earth's history, without reading a single number.' Propose one design feature that meets it (think about color, width, texture or lighting rather than labels), explain how you would test whether it works on a sample of ten visitors, and describe one way the new feature could conflict with criterion C3 or constraint K3. Then rank all five criteria in order of importance and defend your top choice in two sentences.