Clues to Origins

Evaluate evidence for the solar system's formation

ESS.1B.1 "Read and evaluate scientific information for mechanisms/results (e.g., the solar nebular theory) to explain how the solar system was formed. Cite evidence and develop a logical argument."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline three observations that support the solar nebular model. Number the steps in the model's formation sequence, then circle one limit of the evidence.

Reconstructing a Solar System

1. Imagine trying to reconstruct a fire from ashes rather than watching it burn. Scientists face a similar challenge with the solar system, which formed about 4.6 billion years ago. In the solar nebular model, a cloud of gas and dust collapsed under gravity. As it shrank, its rotation sped up, and material spread into a flattened disk around a growing Sun. Within that disk, dust grains collided and stuck, forming larger bodies called planetesimals. Gravity helped planetesimals merge into planets. This sequence predicts that planets should mostly orbit in the same direction and nearly the same plane.

2. Those shared orbits are one clue, but a matching pattern alone does not prove a story. Telescopes observe disks of gas and dust around some young stars, showing that disks can exist during star formation. In our system, rocky planets lie closer to the Sun, while planets rich in gas or ice are farther out. Near the young Sun, heat kept many substances from freezing into solids; farther away, water and other compounds could freeze, supplying more solid building material. In the cooler outer disk, large cores could grow and attract gas. These observations connect conditions in the disk to different planetary materials.

3. Ancient meteorites provide another test. Scientists measure radioactive elements and their decay products in some meteorites to estimate when the earliest solid grains formed, roughly 4.56 billion years ago. That age fits a system assembled long before life appeared on Earth. Yet no one observed our solar system forming, and today's young-star disks are not recordings of our own past. Planetary migration may also have changed planets' original distances from the Sun. A strong explanation links several independent clues to a mechanism while naming what each clue cannot establish by itself. The nebular model gains strength from this combined evidence, not from a single perfect match.

2 ANSWER WITH EVIDENCE

Use the passage

1. How does the model's spinning disk explain the direction and plane of most planetary orbits?

2. How do disks around young stars support the solar nebular model? What can they not establish?

3. Use the passage's explanation of temperature to account for the difference between inner and outer planets.

4. What does the meteorite age help establish, and why does it not prove the entire formation model?

3 YOUR TURN

Your own words

A classmate claims, "The Sun captured fully formed planets from different stars, so the nebular model is unnecessary." Write a 75 to 100 word argument evaluating this claim. Connect at least three distinct pieces of passage evidence to the nebular model, and explain one limit of that evidence.

ANSWER KEY

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PART 1 · READ AND MARK

Underline three observations that support the solar nebular model. Number the steps in the model's formation sequence, then circle one limit of the evidence. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How does the model's spinning disk explain the direction and plane of most planetary orbits?	**The planets formed from material in one rotating, flattened disk, so they mostly orbit in its direction and plane.**
2	How do disks around young stars support the solar nebular model? What can they not establish?	**They show that gas-and-dust disks exist during star formation. They do not show that our own solar system formed in a disk.**
3	Use the passage's explanation of temperature to account for the difference between inner and outer planets.	**Heat near the Sun kept many substances from freezing into solids. Farther out, frozen compounds supplied more solid material, allowing large cores to grow and attract gas.**
4	What does the meteorite age help establish, and why does it not prove the entire formation model?	**It dates some of the earliest solids to about 4.56 billion years ago. An age does not establish every step by which those solids became planets.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The capture claim does not readily explain why most planets orbit in the same direction and nearly the same plane. A rotating disk offers a shared origin for those orbits. Disks around young stars show that such environments exist, although they do not show our system forming. The rocky inner planets and gas-rich or ice-rich outer planets also fit a disk with hotter inner regions and cooler outer regions. Meteorite ages place early solid formation about 4.56 billion years ago, consistent with ancient assembly. Together, these clues support the nebular model, but none alone proves every step.

Accept arguments that accurately connect three distinct observations to formation mechanisms and identify a genuine limit, such as the lack of direct observation or possible planetary migration. Students need not claim that capture is impossible.