Clues in Motion

Evaluate evidence for the solar system's origin

ESS.1B "Students will develop an understanding of Earth, the solar system, and the laws that predict the motion of celestial bodies. Read and evaluate scientific information for mechanisms/results (e.g...."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB As you read, underline two observations that support the solar nebular model, circle two mechanisms that explain those observations, and number one limitation of the model. Use your marks to connect evidence with an explanation.

How Do We Test an Origin Story?

1. Imagine testing a model for how our solar system began, using only rocks and motion as clues. Some primitive meteorites contain minerals that formed about 4.56 billion years ago. Their ages suggest when solid material first appeared in the young solar system, but an age alone does not show how that material gathered. Astronomers also find that most planets orbit the Sun in the same direction and nearly the same plane. A successful origin model should explain both the ancient solids and this shared pattern of motion, rather than treating either clue as proof by itself.

2. The solar nebular model begins with a slowly rotating cloud of gas and dust. Gravity pulled the cloud inward. As it shrank, it spun faster, and collisions among particles helped flatten much of the material into a disk around the growing Sun. In the hot inner disk, heat prevented common ices from remaining solid, so rocky material built the inner planets. Farther out, ices could join rock to make larger cores, some of which captured thick gas envelopes. Leftover rocky pieces include many asteroids, while icy leftovers include many comet nuclei.

3. Gravity also explains why these objects still move. A planet's forward motion keeps it from falling straight into the Sun, while the Sun's gravity bends its path into an orbit. Many asteroids orbit between Mars and Jupiter; some comets travel on long, steeply tilted paths and spend most of their time far from the Sun. The disk model accounts for the planets' broadly aligned orbits, but not every orbit remains unchanged. Encounters with massive planets can redirect smaller bodies. Scientists compare several clues and consider later changes before deciding how strongly today's patterns support an origin model.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why are meteorite ages useful but insufficient evidence for the solar nebular model?

2. Use the model to explain why inner planets became rocky while some outer planets gained thick gas envelopes.

3. How does the shared direction and plane of most planetary orbits support a rotating disk origin?

4. A comet has a steeply tilted orbit. Does that observation alone disprove the disk model? Explain using a mechanism from the passage.

3 YOUR TURN

Your own words

Astronomers find another star system where most planets orbit in one direction and nearly one plane, but a gas giant orbits close to the star and several rocky bodies orbit farther out. Write a five-sentence argument evaluating how well the solar nebular model explains this system. Cite two specific details from the passage and identify a pattern the model does not explain on its own.

ANSWER KEY

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PART 1 · READ AND MARK

As you read, underline two observations that support the solar nebular model, circle two mechanisms that explain those observations, and number one limitation of the model. Use your marks to connect evidence with an explanation. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why are meteorite ages useful but insufficient evidence for the solar nebular model?	**They indicate when some of the first solid material formed, but their ages do not show how that material gathered.**
2	Use the model to explain why inner planets became rocky while some outer planets gained thick gas envelopes.	**Heat kept common ices from remaining solid in the inner disk, leaving rocky material to build planets. Farther out, ices helped form larger cores that could capture gas.**
3	How does the shared direction and plane of most planetary orbits support a rotating disk origin?	**A rotating cloud flattened into a disk, so planets formed from that disk would be expected to orbit in broadly aligned paths.**
4	A comet has a steeply tilted orbit. Does that observation alone disprove the disk model? Explain using a mechanism from the passage.	**No. An encounter with a massive planet can redirect a smaller body, so the comet's present orbit may differ from its earlier path.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The shared direction and plane of most orbits support an origin in a rotating disk. Gravity can pull a rotating cloud inward, while collisions help flatten its material. The model also predicts that heat favors rocky material near the star and lets icy material help build gas-collecting cores farther out. A nearby gas giant and more distant rocky bodies do not fit that simple formation pattern. I would look for evidence of later orbital changes before deciding whether this pattern rules out the disk model.

Accept arguments that distinguish support for a disk origin from the unexplained arrangement of bodies. Students should not claim that the unusual arrangement alone disproves the model.