A Star's Forking Path

Model how mass shapes a star's life.

ESS.1.a "Utilize models to explain the process of stellar evolution from star birth to star death."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each change from one stage to another, circle what causes each change, and number the point where a star's path splits.

From Cloud to Remnant

1 Imagine drawing a star's life as a path that splits. The path begins inside a cold, dense cloud of gas and dust called a nebula. Gravity pulls material together into a protostar. As the center contracts, it heats up. When the core becomes hot enough for hydrogen fusion, the object becomes a main-sequence star. Fusion releases energy, and the outward pressure it creates balances gravity pulling inward. That balance can last millions to billions of years. A useful model shows each stage with an arrow for the change and a label for its cause, rather than just listing names.

2 The first major fork in the model depends on a star's initial mass. A star about as massive as the Sun uses its core hydrogen slowly. When core hydrogen runs low, the core contracts while outer layers expand and cool, making a red giant. The star later sheds its outer gas, which glows as a planetary nebula. The exposed core remains as a white dwarf, a dense object no longer powered by fusion. Over immense spans of time, it cools. This route does not include a supernova, and the word “planetary” does not mean planets form there.

3 A star born with much more mass burns through its core fuel faster, despite having more of it. After its main-sequence stage, it expands into a red supergiant and fuses heavier elements in its core. Eventually, an iron-rich core cannot gain energy by further fusion. Gravity overwhelms the core's support, and the core collapses. The resulting supernova blasts the outer layers into space. The collapsed core may remain as a neutron star or, if massive enough, become a black hole. In a branching model, initial mass changes the later path, while gravity and fusion explain the transitions.

2 ANSWER WITH EVIDENCE

Use the passage

1. In a model of star birth, what stages would you connect from a nebula to a main-sequence star? Label each arrow with the change that causes it.

2. Complete the Sun-like branch of a model from red giant to white dwarf. What happens to the star's material along this path?

3. A massive-star model shows an arrow from red supergiant to supernova. What core change should label that arrow, and why does it happen?

4. A model splits after a massive star's supernova. What two possible remnants belong at the ends of those arrows, and what determines which one forms?

3 YOUR TURN

Your own words

Write two arrow models for stars born in the same nebula, one Sun-like and one much more massive. Show each path from birth to a remnant, label at least two arrows with physical causes, and add one sentence explaining why the paths differ.

ANSWER KEY

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PART 1 · READ AND MARK

Underline each change from one stage to another, circle what causes each change, and number the point where a star's path splits. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In a model of star birth, what stages would you connect from a nebula to a main-sequence star? Label each arrow with the change that causes it.	**Nebula → protostar, as gravity pulls material together; protostar → main-sequence star, as the core heats enough for hydrogen fusion to begin.**
2	Complete the Sun-like branch of a model from red giant to white dwarf. What happens to the star's material along this path?	**Red giant → planetary nebula → white dwarf. The star sheds its outer gas, leaving its exposed core as a white dwarf.**
3	A massive-star model shows an arrow from red supergiant to supernova. What core change should label that arrow, and why does it happen?	**The iron-rich core collapses because further fusion cannot supply energy to support it against gravity.**
4	A model splits after a massive star's supernova. What two possible remnants belong at the ends of those arrows, and what determines which one forms?	**The remnant can be a neutron star or, if the collapsed core is massive enough, a black hole.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sun-like: nebula → (gravity pulls gas together) protostar → (hydrogen fusion begins) main-sequence star → red giant → planetary nebula → white dwarf.
Much more massive: nebula → protostar → main-sequence star → red supergiant → (iron-rich core collapses) supernova → neutron star.
The stars follow different paths because their initial masses differ.

Accept other accurate arrow labels for the same physical changes. For the massive-star path, either a neutron star or a black hole is a valid remnant.