Stardust Comes Around

Connect gravity, mass and fusion using a source-informed model.

ESS.1 "Obtain, evaluate, and communicate information about the connections among mass, gravity, and fusion in the life cycle of stars. a. Utilize models to explain the process of stellar evolution from star birth to star death. b..."

NAME _____ DATE _____

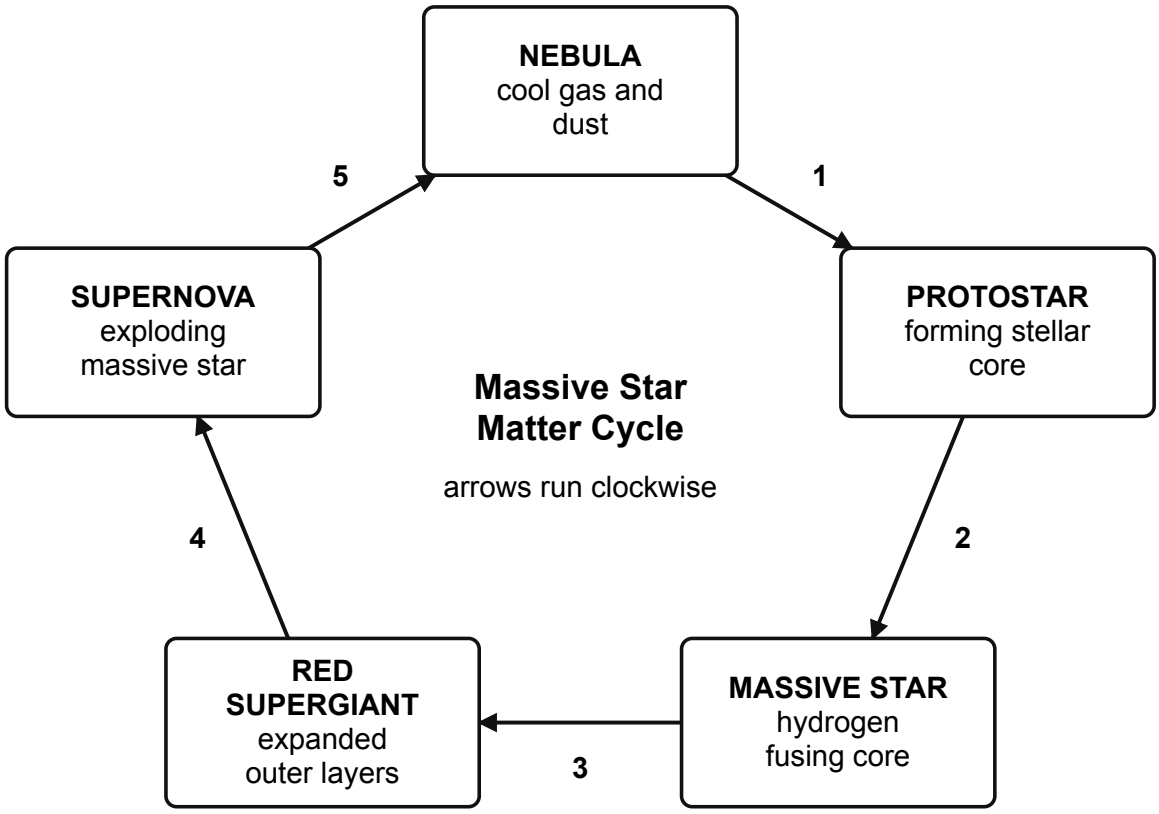
1 LABEL THE MODEL

Word bank below

NASA source summary: gravity compresses gas; core fusion releases energy that supports a star against collapse. More massive stars use fuel faster. Lower-mass stars can leave white dwarfs; a massive-star explosion can leave a neutron star or black hole. Fill the arrows and evaluate this model using those facts. Source: science.nasa.gov/universe/stars.

WORD BANK

- Core fusion begins
- Core hydrogen runs low
- Debris cools and gathers
- Gravity collapses gas
- Iron core collapses



Arrow numbers match the response boxes on the next student section.

Label the arrows

Use the word bank to write the process for each numbered arrow.

Arrow 1	Arrow 2	Arrow 3

Arrow 4	Arrow 5

2 RUN THE MODEL

Use your finished diagram

1. Use the NASA source summary and two model arrows to explain how gravity and fusion play different roles in stellar evolution.

2. A hypothetical star converts 4×10^9 kg of mass into energy each second. With $E=mc^2$ and $c=3\times10^8$ m/s, calculate the energy released per second. Is this mass produced or converted?

3. A student claims the loop shows that every star explodes and then becomes the same star again. Use the source summary to evaluate both parts.

3 CHECK IT

Before you turn it in

- [ ] I used a source fact to support my explanation.
- [ ] I connected gravity with fusion and mass.
- [ ] I distinguished recycled matter from a repeated individual life.

TEST THE MODEL

What part of a real star's life or death does this model leave out?

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PART 1 · COMPLETED MODEL

ARROW	FROM	TO	PROCESS
1	NEBULA cool gas and dust	PROTOSTAR forming stellar core	Gravity collapses gas
2	PROTOSTAR forming stellar core	MASSIVE STAR hydrogen fusing core	Core fusion begins
3	MASSIVE STAR hydrogen fusing core	RED SUPERGIANT expanded outer layers	Core hydrogen runs low
4	RED SUPERGIANT expanded outer layers	SUPERNOVA exploding massive star	Iron core collapses
5	SUPERNOVA exploding massive star	NEBULA cool gas and dust	Debris cools and gathers

PART 2 · RUN THE MODEL

1. **Gravity compresses a gas cloud toward a protostar. Once core fusion begins, its released energy supplies pressure support against gravity. Later loss of core support can lead to collapse.** (Use the NASA source summary and two model arrows to explain how gravity and fusion play different roles in stellar evolution.)
2. **$(4\times10^{9})(3\times10^{8})^{2} = 3.6\times10^{26}$ joules each second. Mass is converted to released energy; it is not newly produced by the fusion reaction.** (A hypothetical star converts 4×10^{9} kg of mass into energy each second. With $E=mc^{2}$ and $c=3\times10^{8}$ m/s, calculate the energy released per second. Is this mass produced or converted?)
3. **The source includes lower-mass white-dwarf outcomes, so this massive-star path is not universal. The loop recycles ejected matter into later clouds; it does not revive the same star. A compact remnant can remain.** (A student claims the loop shows that every star explodes and then becomes the same star again. Use the source summary to evaluate both parts.)

TEST THE MODEL (SAMPLE ANSWERS)

- Lower-mass stars can end as white dwarfs instead of supernovas.
- After a supernova, the collapsed core may become a neutron star.

This model shows one massive-star pathway and matter recycling, not every possible outcome. Accept explanations that distinguish collapse, fusion support and remnants. The energy calculation uses hypothetical supplied data and mass-energy equivalence; do not repeat the state source's erroneous wording that fusion produces mass. H-R diagram analysis and detailed nucleosynthesis remain outside this focused worksheet.