

Stars Make Elements

Communicate how mass and life stage change element production.

HS-ESS1-3 "Communicate scientific ideas about the way stars, over their life cycle, produce elements. Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Underline each element example. Circle the star mass and life stage linked to that example. Use these notes to build your own comparison model.

Two stellar paths

- ① Stars form when gravity pulls gas together. During their main-sequence lives, Sun-like and massive stars fuse hydrogen into helium in their cores. Fusion joins light nuclei to make heavier nuclei. The nuclei change; this is not a chemical reaction. A star does not make every element at every stage. Its initial mass affects the core conditions it can reach and the later fusion stages it can undergo.
- ② A Sun-like star later becomes a red giant. It can fuse helium into carbon and oxygen, but its core never reaches the conditions for the sequence of fusion stages that builds an iron core. It sheds outer layers, returning some enriched material to space, and leaves a carbon-oxygen white dwarf. A white dwarf is a remnant, not a new main-sequence star. These notes describe a Sun-like star, not every possible low-mass star.
- ③ A sufficiently massive star reaches later fusion stages, making elements such as neon, magnesium and silicon and eventually building an iron-rich core. Fusion involving iron does not provide the energy needed to keep supporting that core. Core collapse can produce a supernova that ejects enriched material and leaves a neutron star or black hole. Ejected gas can contribute to later stars and planets. Many elements heavier than iron involve other processes, including neutron capture; detailed pathways are outside this model.

2 ANSWER WITH EVIDENCE _____ Use the passage

1 What element do both kinds of star produce during core hydrogen fusion? Why is this a nuclear change?

2 Compare a Sun-like red giant with a massive star near core collapse. Name one element example for each and explain the role of mass.

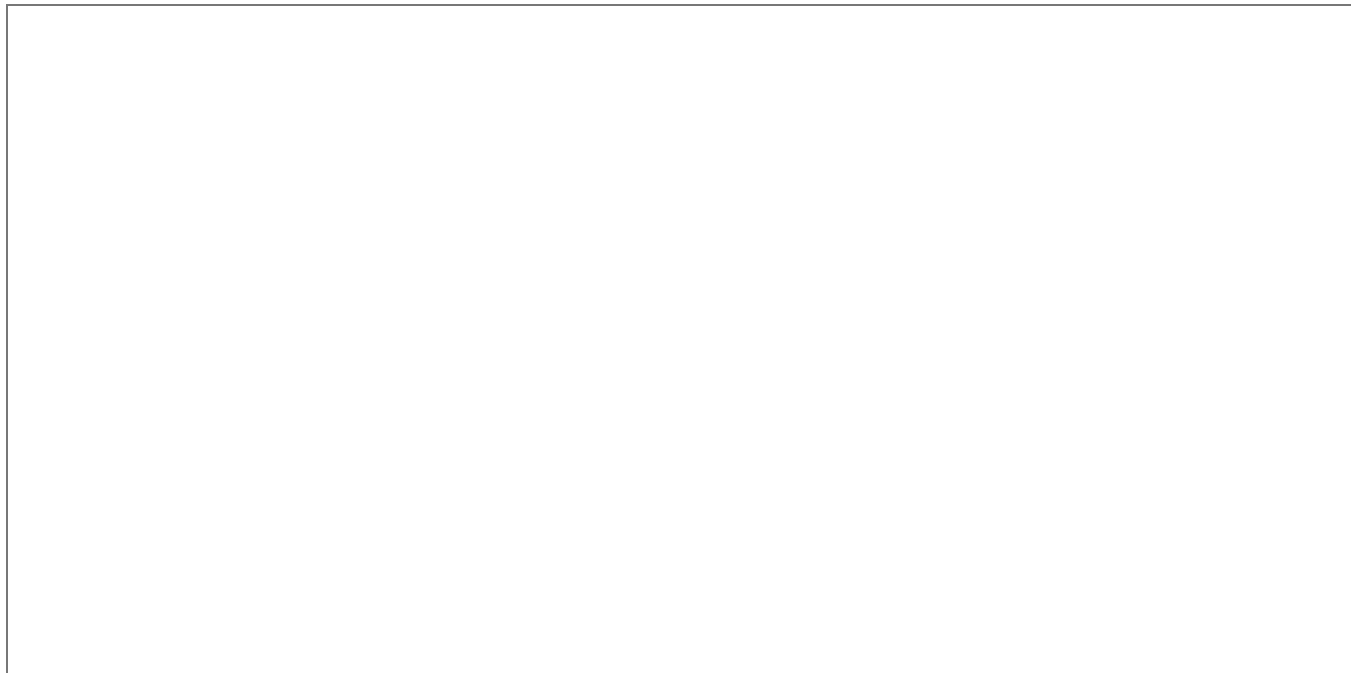
3 Correct this statement: Every star produces an iron core, then its supernova becomes the same star again.

3 YOUR TURN _____ Your own words

Create a labeled comparison model for a science display. A viewer must be able to follow both paths and understand why the same element list does not fit every star.

Compare mass and lifetime

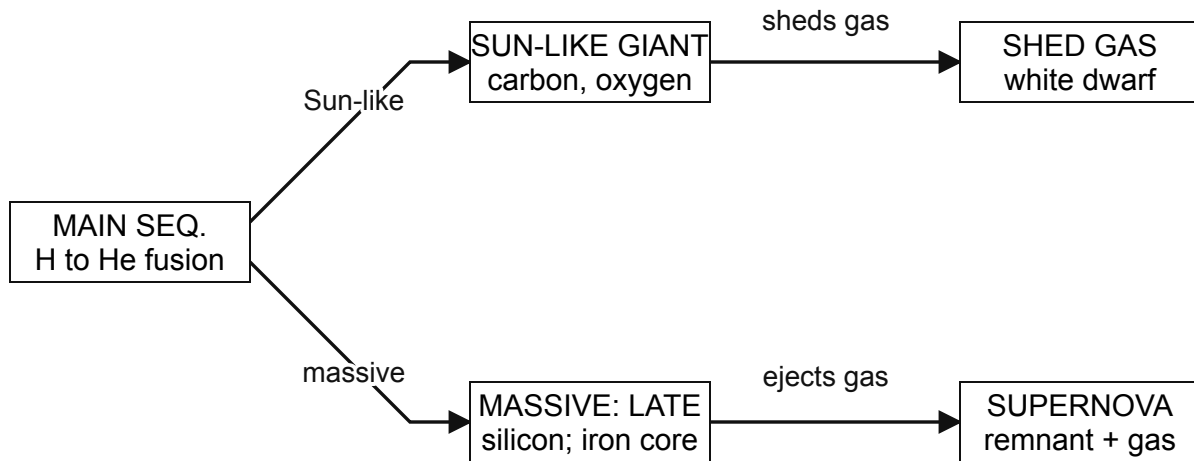
Draw separate Sun-like and massive-star paths. Label the common main-sequence process; later fusion stages and element examples; and each ending. Add a note explaining where ejected material can go. Do not draw the remnant turning back into the same star.



Explain how mass and life stage affect which elements form. Point to both paths and at least two element examples.

Compare mass and lifetime · example model

Simplified model



Sun-like: hydrogen to helium; later helium fusion makes carbon and oxygen, followed by outer-layer loss and a white dwarf. Massive: hydrogen to helium, later stages leading to silicon and an iron-rich core, followed by core collapse, possible supernova and remnant. Shed/ejected material can enrich later gas clouds. The arrows show successive stages, not the same star repeating its life.

1. Helium. Light nuclei join to form heavier nuclei; the atomic nuclei change rather than simply forming new chemical combinations.
2. A Sun-like red giant produces carbon or oxygen from helium fusion. A massive star undergoes later stages producing examples such as silicon and an iron-rich core. Its mass allows more extreme core conditions.
3. A Sun-like star does not build an iron core or undergo core-collapse supernova. Ejected material can contribute to a different, later generation of stars; the original star ends as a remnant.

PART 3 · YOUR TURN (SAMPLE ANSWER)

Both paths begin with hydrogen fusion making helium. Later, a Sun-like star makes carbon and oxygen but ends as a white dwarf; a massive star reaches further fusion stages and builds an iron-rich core. Both return some enriched material to space through different processes, and this material can enter later generations.

Require initial-mass labels, ordered life stages, actual element examples tied to stages, different endings and a correct enrichment pathway. A clear alternative arrangement is acceptable. Do not require detailed reaction chains, neutron-capture pathways or exact mass thresholds. Stars in interacting binaries are outside this simplified comparison. Scientific reference: NASA Stars, science.nasa.gov/universe/stars/.