Stellar evolution: two pathways

Student activity • observation and reasoning

YEAR 11 / LESSON 107 / PHYSICS + SCIENCE (DOUBLE AWARD)

The question

Why does initial stellar mass affect the later stages of a star's life?

Arrange labelled stages into two simplified pathways and justify the points at which they diverge.

Equipment

• Booklet and original labelled stage cards

Desk-based sequencing only. No heat sources, balloons, bright lamps or solar viewing are used.

Course coverage: Shared Physics / Double Award: 8.9–8.10. Evolution of Sun-like and more massive stars.

Plan, model or apparatus sketch

Draw clearly labelled astronomical axes, spectra or orbital/pathway diagrams as appropriate.

Method and reasoning

Read the whole sequence before starting

YEAR 11 / LESSON 107 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. Begin both pathways with a gas-and-dust cloud and gravitational collapse to a protostar. Explain how sustained hydrogen fusion marks entry to the main sequence.

2. For a Sun-like star, place main sequence, red giant, loss of outer layers and white dwarf in order. Label the white dwarf as a hot remnant that cools, not a continuing hydrogen-fusing main-sequence star.

3. For a sufficiently massive star, place main sequence, red supergiant, core-collapse supernova and compact remnant in order. Show a neutron star or black hole as possible outcomes depending on the remnant and progenitor conditions.

4. Explain that the two pathways are alternatives, not one sequence through which every star passes. In particular, the Sun is not expected to become a core-collapse supernova or black hole.

5. Compare main-sequence lifetimes qualitatively: more massive stars generally consume their fuel much more rapidly despite having more of it.

6. Add a limitation to each model. Real evolution depends on mass, composition, mass loss and companions; the simplified pathway does not predict every observed star.

Cleanup

- Collect cards and retain corrected pathway diagrams.

Record your evidence

Blank spaces are for your own work

YEAR 11 / LESSON 107 / PHYSICS + SCIENCE (DOUBLE AWARD)

Reference and task data

Original ordering task. A planetary nebula is expelled stellar gas, not a newly forming planetary system. A white dwarf, neutron star and black hole are distinct outcomes and should not be placed in one universal sequence.

Stage / comparison	Sun-like pathway	Massive-star pathway
Main sequence		
Expanded stage		
Outer layers / explosion		
Remnant		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 11 / LESSON 107 / PHYSICS + SCIENCE (DOUBLE AWARD)

1. What begins the main sequence?

2. What comes after the Sun-like main sequence?

3. What is a white dwarf?

4. What may a massive core-collapse remnant become?

5. Will the Sun follow the massive-star pathway?

6. Why can a more massive star live less long?