

Passage V

An astronomy class is given the following facts about stellar evolution.

1. A star's evolution can be divided into 3 stages: *pre-main sequence* (pre-MS), *main sequence* (MS), and *post-main sequence* (post-MS).
2. Gravity causes part of a cloud of gas and dust to collapse and heat up, creating a pre-MS star. The star's hot dust and gas emit its energy.
3. A pre-MS star becomes an MS star when the star produces the majority of its energy by fusing hydrogen nuclei (protons) at its center to make helium nuclei.
4. An MS star becomes a post-MS star when the star expands in volume and produces the majority of its energy by fusing hydrogen to make helium in a shell surrounding its center.
5. The more massive a star, the more rapidly the star passes through each of the 3 stages of its evolution.

Two students discuss the evolution of the *Algol system*—Algol A, a 3.6-solar-mass MS star; Algol B, a 0.8-solar-mass post-MS star; and Algol C, a 1.7-solar-mass MS star. (One solar mass = the Sun's mass.) The 3 stars orbit a mutual center of mass, with Algol A and Algol B much closer to each other and to the center of mass than to Algol C.

Student 1

The 3 stars of the Algol system formed at the same time from the same cloud of gas and dust. Algol B, originally the most massive of the 3 stars, became a post-MS star and expanded in volume while Algol A remained an MS star. Because the matter in the outer parts of Algol B was more strongly attracted to Algol A than to the matter in the inner parts of Algol B, this matter flowed from Algol B to Algol A, and, over time, Algol A became more massive than Algol B.

Student 2

Algol B was not part of the original Algol system (Algol A and Algol C). Algol B and the original Algol system formed in different clouds of gas and dust at different times and moved in 2 different but intersecting orbits around the center of the galaxy. During a particular orbit, Algol B encountered the original Algol system at the intersection of the 2 orbits and became part of the Algol system.

Algol B became a post-MS star while Algol A and Algol C remained MS stars. Algol B never lost mass to Algol A. Algol B was always less massive than Algol A.

24. Based on Student 2's discussion, Algol B is part of the present Algol system because of which of the following forces exerted on Algol B by the original Algol system?
 - F. Electric force
 - G. Magnetic force
 - H. Gravitational force
 - J. Nuclear force
25. Based on Student 1's discussion and Fact 4, while matter flowed between Algol A and Algol B, Algol B produced the majority of its energy by fusing:
 - A. hydrogen nuclei to make helium nuclei at its center.
 - B. hydrogen nuclei to make helium nuclei in a shell surrounding its center.
 - C. helium nuclei to make hydrogen nuclei at its center.
 - D. helium nuclei to make hydrogen nuclei in a shell surrounding its center.
26. Suppose that chemical composition is uniform among stars formed from the same cloud of gas and dust, but that chemical composition varies among stars formed from different clouds of gas and dust. Student 2 would most likely agree with which of the following statements comparing the chemical compositions of the stars in the present-day Algol system at the time they formed?
 - F. Algol A and Algol B had the most similar compositions.
 - G. Algol A and Algol C had the most similar compositions.
 - H. Algol B and Algol C had the most similar compositions.
 - J. Algol A, Algol B, and Algol C had the same composition.
27. If the mass of the Sun is 2.0×10^{30} kg, what is the mass of Algol C?
 - A. 1.6×10^{30} kg
 - B. 2.0×10^{30} kg
 - C. 3.4×10^{30} kg
 - D. 7.2×10^{30} kg
28. Which of the following statements best explains why the reaction described in Fact 3 requires a high temperature and pressure?
 - F. All protons are positively charged, and like charges attract each other.
 - G. All protons are positively charged, and like charges repel each other.
 - H. All electrons are negatively charged, and like charges attract each other.
 - J. All electrons are negatively charged, and like charges repel each other.

29. Based on Fact 5 and Student 1's discussion, which of the 3 stars in the Algol system, if any, was most likely the first to become an MS star?
- A. Algol A
 - B. Algol B
 - C. Algol C
 - D. The 3 stars became MS stars at the same time.
30. Based on Fact 5, would Student 2 agree that by the time Algol A stops being an MS star, Algol A will have spent as much time being an MS star as Algol B spent being an MS star?
- F. Yes, because according to Student 2, Algol A has always been more massive than Algol B.
 - G. Yes, because according to Student 2, Algol A has always been less massive than Algol B.
 - H. No, because according to Student 2, Algol A has always been more massive than Algol B.
 - J. No, because according to Student 2, Algol A has always been less massive than Algol B.