

# Worksheet: Fusion Reactions in Stars



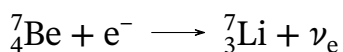
**Q1:** In the P–P III branch of the proton–proton chain reaction, a boron-8 nucleus becomes a beryllium-8 nucleus, releasing a positron and an electron neutrino in the process. This is shown in the following nuclear equation.



What is the name of this process?

- A  $\beta^-$  decay
- B Pair production
- C  $\alpha$  decay
- D  $\beta^+$  decay
- E Electron capture

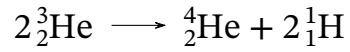
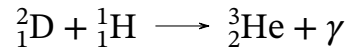
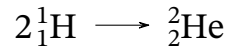
**Q2:** In the P–P II branch of the proton–proton chain reaction, a beryllium-7 nucleus and an electron combine to produce a lithium-7 nucleus and an electron neutrino. This is shown in the following nuclear equation.



What is the name of this process?

- A Beta decay
- B Pair production
- C Inverse beta decay
- D Alpha decay
- E Electron capture

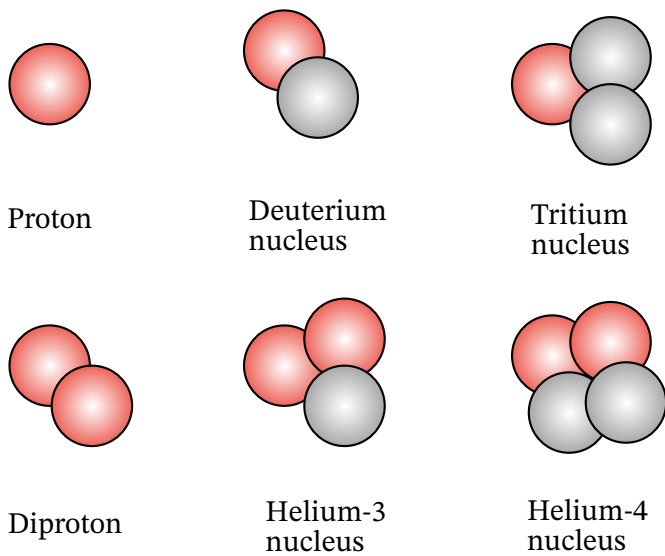
**Q3:** The following set of nuclear equations shows one way that helium-4 can be produced through the proton–proton fusion chain.



How many protons are needed in total to produce one helium-4 nucleus using this chain reaction only?

- A 6
- B 2
- C 4
- D 8
- E 10

**Q4:** The diagram shows six combinations of protons and neutrons.



► Which of the following combinations is stable?

A The proton, the deuterium nucleus, the helium-3 nucleus, and the helium-4 nucleus

B The tritium nucleus, the diproton, the helium-3 nucleus, and the helium-4 nucleus

C The tritium nucleus, the helium-3 nucleus, the deuterium nucleus, and the proton

D The diproton, the deuterium nucleus, the helium-4 nucleus, and the tritium nucleus

E The proton, the helium-4 nucleus, the diproton, and the tritium nucleus

► Which of the following combinations is unstable?

A The diproton and the tritium nucleus

B The helium-3 nucleus and the proton

C The diproton and the helium-4 nucleus

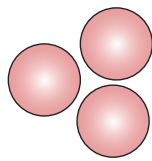
D Tritium nucleus and the helium-3 nucleus

E The deuterium nucleus and the helium-4 nucleus

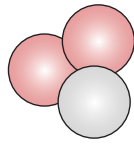
► Which of the following has the shortest half-life?

- A The diproton
- B The tritium nucleus
- C The deuterium nucleus
- D The helium-3 nucleus
- E The proton

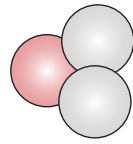
**Q5:** The diagram shows four combinations of protons and neutrons, where some form stable bound states, some form unstable bound states, and some cannot form bound states. Protons are represented by red circles and neutrons are represented by gray circles.



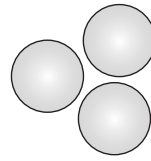
Trip proton



Helium-3  
nucleus



Tritium  
nucleus



Trineutron

► Which of the four combinations forms a bound state that is stable?

- A The triproton
- B The tritium nucleus
- C The helium-3 nucleus
- D The trineutron

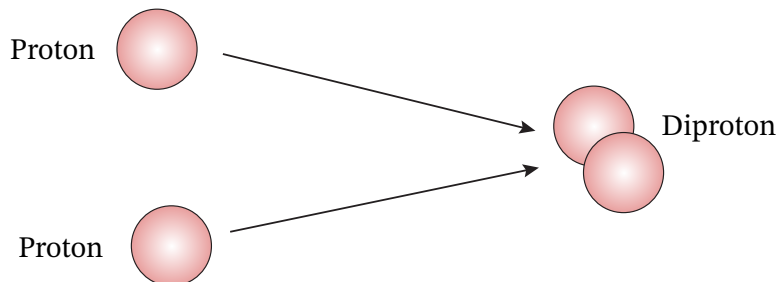
► Which of the four combinations forms a bound state that is unstable?

- A The helium-3 nucleus
- B The trineutron
- C The tritium nucleus
- D The triproton

► Which of the four combinations cannot form bound states of particles?

- A The helium-3 nucleus
- B The tritium nucleus and the triproton
- C The triproton and the trineutron
- D The triproton and the helium-3 nucleus
- E The tritium nucleus and the trineutron

**Q6:** In the first part of the proton–proton fusion chain, two protons must fuse together to form a diproton, as shown in the diagram.



► What repulsive force acts between the two particles within the diproton?

A The weak nuclear force

B Gravity

C Electrostatic repulsion

D The strong nuclear force

► What non-negligible attractive force acts between the two particles within the diproton?

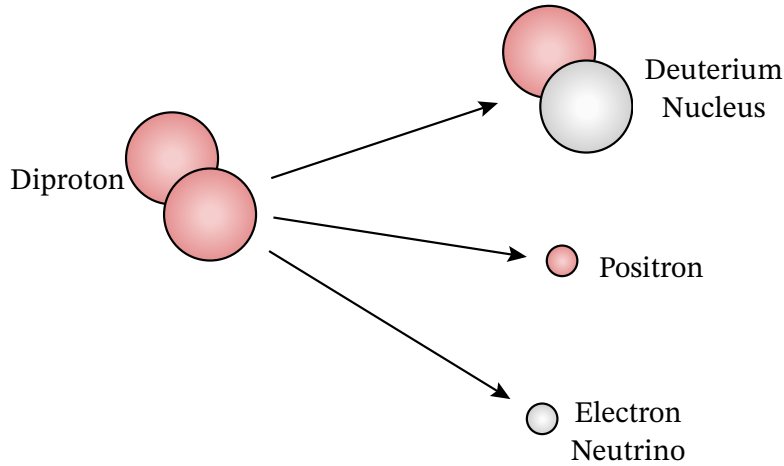
A Gravity

B Electrostatic attraction

C The strong nuclear force

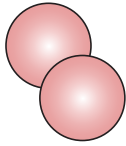
D The weak nuclear force

**Q7:** In the first part of the proton–proton fusion chain, two protons fuse to form a bound state called a diproton. Diprotons, however, are unstable. The diagram shows one way in which diprotons can decay, producing a deuterium nucleus, a positron, and an electron neutrino. What name is given to this type of decay?

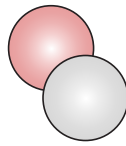


- A Alpha decay
- B  $\beta^+$  decay
- C  $\beta^-$  decay
- D Electron capture
- E Nuclear fission

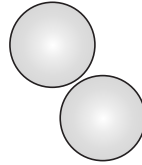
**Q8:** The diagram shows three pairs of protons and neutrons, where one forms a stable bound state, one forms an unstable bound state, and one does not form a bound state. Protons are represented by red circles and neutrons are represented by gray circles.



Diproton



Deuterium nucleus



Dineutron

► Which of the three pairs forms a bound state that is stable?

A The deuterium nucleus

B The diproton

C The dineutron

► Which of the three pairs forms a bound state that is unstable?

A The diproton

B The dineutron

C The deuterium nucleus



► Which of the three pairs does **not** form a bound state?

A The dineutron

B The diproton

C The deuterium nucleus