

**READING REVIEW EXERCISE (SKILLS 1–4):** Read the passage and choose the best answers to the questions that follow.

Paragraph

### Pulsars

- 1▶ There is still much for astronomers to learn about pulsars. Based on what is known, the term *pulsar* is used to describe the phenomenon of short, precisely timed radio bursts that are emitted from somewhere in space. Though all is not known about pulsars, they are now believed in reality to emanate from spinning neutron stars, which are highly reduced cores of collapsed stars that are theorized to exist.
- 2▶ Pulsars were discovered in 1967, when Jocelyn Bell, a graduate student at Cambridge University, noticed an unusual pattern on a chart from a radio telescope. What made this pattern unusual was that, unlike other radio signals from celestial objects, this series of pulses had a highly regular period of 1.33730119 seconds. Because day after day the pulses came from the same place among the stars, Cambridge researchers came to the conclusion that they could not have come from a local source such as an Earth satellite.
- 3▶ **5A** A name was needed for this newly discovered phenomenon. **5B** The possibility that the signals were coming from a distant civilization was considered, and at that point the idea of naming the phenomenon *L.G.M.* (short for Little Green Men) was raised. **5C** However, after researchers had found three more regularly pulsing objects in other parts of the sky over the next few weeks, the name *pulsar* was selected instead of *L.G.M.* **5D**
- 4▶ As more and more pulsars were found, astronomers engaged in debates over their nature. It was determined that a pulsar could not be a star inasmuch as a normal star is too big to pulse so fast. The question was also raised as to whether a pulsar might be a white dwarf star, a dying star that has collapsed to approximately the size of the Earth and is slowly cooling off. However, this idea was also rejected because the fastest pulsar known at the time pulsed around 30 times per second and a white dwarf, which is the smallest known type of star, would not hold together if it were to spin that fast.
- 5▶ The final conclusion among astronomers was that only a neutron star, which is theorized to be the remaining core of a collapsed star that has been reduced to a highly



dense radius of only around 10 kilometers, was small enough to be a pulsar. Further evidence of the link between pulsars and neutron stars was found in 1968, when a pulsar was found in the middle of the Crab Nebula. The Crab Nebula is what remains of the supernova<sup>1</sup> of the year 1054. Several hypotheses have been developed around the concept that neutron stars are what form after a supernova explosion, which results in a subsequent implosion of the remaining matter. This intense implosion brings about an inward contraction of neutrons packed so densely together that they no longer resemble normal matter, and are thus referred to as neutron stars. A neutron star is believed to be what formed and survived after the Crab Nebula supernova explosion.

- 6► The generally accepted theory for pulsars is the lighthouse theory, which is based upon a consideration of the theoretical properties of neutron stars and the observed properties of pulsars. According to the lighthouse theory, a spinning neutron star emits beams of radiation that sweep through the sky, and when one of the beams passes over the Earth, it is detectable on Earth. The radiation is contained within a field of radio waves created by the immensely powerful magnetic field of a neutron star, a magnetic field said to be about one trillion times the strength of the Earth's magnetic field. The radio waves are dispersed through the north and south poles of the pulsar. In order for the beam to pass over the Earth, the pulsar has to be aligned in such a way that these poles face the direction of the Earth. It is known as the lighthouse theory because the emissions from neutron stars are similar to the pulses of light emitted from lighthouses as they sweep over the ocean. For this reason, some believe that the name *lighthouse* is actually more appropriate than the name *pulsar*.

## GLOSSARY

1. *supernova*—a star that explodes due to the intense nuclear energy contained within

- The phrase "emanate from" in paragraph 1 is closest in meaning to
  - develop from
  - revolve around
  - wander away from
  - receive directions from
- Which of the sentences below best expresses the essential information in the highlighted sentence in paragraph 2? *Incorrect* choices change the meaning in important ways or leave out essential information.
  - It was unusual for researchers to hear patterns from space.
  - It was unusual for celestial objects to emit radio signals.
  - It was unusual that the pattern of the pulsars was so regular.
  - It was unusual that the period of pulses was only slightly more than a second in length.
- The word "they" in paragraph 2 refers to
  - day after day
  - the pulses
  - the stars
  - Cambridge researchers
- The word "raised" in paragraph 3 could best be replaced by
  - lifted
  - suggested
  - discovered
  - elevated
- Look at the four squares [■] that indicate where the following sentence could be added to paragraph 3.  
**This name was selected because it indicates a regularly pulsing radio source.**  
 Where would the sentence best fit? Click on a square [■] to add the sentence to the passage.
- The phrase "engaged in" in paragraph 4 could best be replaced by
  - became attached to
  - were disappointed in
  - made promises about
  - took part in
- The word "their" in paragraph 4 refers to
  - weeks
  - pulsars
  - astronomers
  - nature



8. Which of the sentences below best expresses the essential information in the highlighted sentence in paragraph 4? *Incorrect* choices change the meaning in important ways or leave out essential information.
- (A) Pulsars could not be white dwarfs because the frequency of the pulsars is too high.
  - (B) Pulsars cannot spin very fast because they will fall apart if they spin fast.
  - (C) White dwarfs cannot be dying stars because they cannot pulse at around 30 times per second.
  - (D) White dwarfs cannot contain pulsars because white dwarfs spin much faster than pulsars.
9. The word "Further" in paragraph 5 is closest in meaning to
- (A) distant
  - (B) irrelevant
  - (C) additional
  - (D) unreliable
10. Which of the sentences below best expresses the essential information in the highlighted sentence in paragraph 5? *Incorrect* choices change the meaning in important ways or leave out essential information.
- (A) Several theories suggest that a supernova explodes and then collapses inward, creating a neutron star.
  - (B) It is believed that a neutron star explodes, creating a supernova that subsequently implodes.
  - (C) Most hypotheses have proven that a supernova explosion produces several neutron stars.
  - (D) A supernova explodes and then collapses outward, which forms the hypotheses that explain neutron stars.
11. The word "properties" in paragraph 6 is closest in meaning to
- (A) lands
  - (B) characteristics
  - (C) masses
  - (D) surroundings