

Reading Explorer 5 Unit 10 Lesson B

DIRECTIONS: Choose the best answer for each question.

Element Hunters

All the elements found in nature - the different kinds of atoms - were found long ago. To find a new one these days, you need to create it.

[A] Everything you know and love on Earth, and everything you don't, is built of elements - the different types of atoms. Most of them are billions of years old, scattered into space by the Big Bang¹ or by exploding stars. They were then incorporated into the newly born Earth, endlessly recycled as they moved from rock to bacteria, president, or mouse.

[B] In the late 1800s, the Russian chemist and inventor Dmitry Mendeleyev tried to make sense of Earth's elements, grouping them by mass - the scientific term for weight - and other attributes in his periodic table of the elements. Later, scientists connected the order of elements in the periodic table to the structure of atoms. Each element got a number: its atomic number - the number of protons in its atomic nucleus.

[C] By 1940, researchers had discovered every element on Earth, right up to uranium (element 92). They had filled in every gap Mendeleyev had left in his table, but they weren't finished. Beyond uranium lay a world of possibilities - elements too radioactive and unstable to have survived billions of years. To explore that world, you have to create it first.

[D] The first steps of creation not only extended the periodic table, but played a fateful² role in world history. It was 1940, the year after World War II began, and U.S. scientists led the race to create new elements. Element 93, neptunium, was created in a laboratory at the University of California, Berkeley. The next year, Glenn Seaborg and his colleagues at the same university produced element 94, plutonium. Seaborg was promptly recruited to the Manhattan Project³ to create an atomic bomb for the U.S. military.

[E] The intensified level of nuclear research in the United States did not go unnoticed by the world's other superpower at the time - the Soviet Union. Georgy Flerov was a prominent physicist who had helped launch that country's nuclear weapons research. Early in World War II, Flerov had noticed that the flow of articles about radioactive elements from U.S. and German scientists had suddenly stopped. This heightened secrecy led him to suspect that they were building atomic bombs, and in April 1942, he wrote to Soviet leader Joseph Stalin explaining his fears. Flerov's suspicions were confirmed, and Stalin asked Russian physicists to build a bomb, too.

[F] For his part in the war effort, Flerov was rewarded with a car, a house, and, most significantly, a laboratory in the town of Dubna, north of Moscow. There, Flerov focused his attention on the hunt for new elements. His American counterpart, Glenn Seaborg, returned to Berkeley after helping to engineer the bomb that the U.S. military dropped on Nagasaki at the end of the war. He continued to make new elements, with less fateful applications - smoke detectors, for instance - or no applications at all. By 1955, his team had gotten as far as element 101 - he named it mendelevium.

[G] For a time it seemed Mendeleyev's table might end there, with his namesake.⁴ The protons in an atomic nucleus are always trying to tear it apart; their positive electric charges repel⁵ one another. Neutrons - electrically neutral particles that outnumber the protons - help bind the nucleus together. But that binding force works only at extremely close range, and it weakens sharply as the size of the nucleus increases. So there has to be a final box on the periodic table, a maximum size beyond which an atom won't be stable even for an instant. With mendelevium, which has a half-life⁶ of 51.5 days, researchers seemed to be getting close to the final box.

Beyond Mendelevium

[H] The Berkeley team continued its research regardless, rivaled by Flerov's team in Dubna. From 1965 to 1974, Berkeley claimed to have produced elements 102-106 - but so did the Dubna lab. Although those short-lived elements died within hours, the tense disputes over who made them first were fueled by the competitive atmosphere of the Cold War.⁷ In the end, a spirit of compromise prevailed: Element 105 was named dubnium and element 106 seaborgium.

[I] Meanwhile, theorists had given a new purpose to the quest for elements. They calculated that a very large nucleus might be surprisingly stable if it had "magic numbers" of protons and neutrons. That insight, if correct, would change everything. It would mean that there could be an "island of stability" where extremely heavy elements might last minutes, weeks, or even thousands of years.

[J] Around the time that this new theory appeared, a brilliant physicist named Yuri Oganessian joined Flerov's lab in Dubna. The island of stability had captured his imagination. However, reaching it seemed to him an impossible task at that point. The Berkeley and Dubna labs had gotten only as far as element 106 by shooting light atoms against heavy ones with such force that they joined to create a single superheavy nucleus. But beyond 106, the collisions were so energetic that they were ripping the new nucleus apart before it even formed. To overcome this problem, Oganessian proposed that shooting slightly heavier atoms at lighter targets might create gentler collisions that were more likely to create new elements. Unfortunately, before he could put his proposal into action, a lab in Darmstadt, Germany, used the idea to make elements 107 through 112. Oganessian's historic moment would have to wait another quarter century.

[K] In the coming years, the Dubna lab went through hard times. Flerov died in 1990; the Soviet Union collapsed in 1991. The lab went months without being able to pay its researchers. Scientists gathered mushrooms in the forests and fished in the Volga River. Oganessian, now in charge of the lab, could have directed it toward more practical goals and made some money for himself and his staff, but he decided instead to continue toward element 114 and the promised island of stability.

Achieving the Dream

[L] To make element 114, Oganessian would shoot calcium at plutonium. He persuaded U.S. physicists at the Lawrence Livermore National Laboratory in California - who just a few years earlier had been his rivals - to give him a small amount of plutonium. The plan was to use a cyclotron⁸ to shoot a beam of calcium atoms at high speed into a thin sheet of metal covered with the precious plutonium atoms. Among the trillions of atoms spraying out the other side - the metal sheet was thinner than hair - Oganessian expected at most one atom of element 114. His team - along with Livermore's - invented a new device to detect it.

[M] They turned the cyclotron on in November 1998. It wasn't a very trustworthy piece of machinery, and it required constant attention. Nevertheless, in late November, the cyclotron managed to produce a single atom of element 114. It lasted only a few seconds - but that was thousands of times longer than would be expected if there were no island of stability. It also proved that the calcium method worked. Dubna and other labs have since made elements 115-118, and isotopes⁹ with different numbers of neutrons. They are still nowhere near the island's peak, where an element might last years, but the creation of element 114 was the great breakthrough that Oganessian had been dreaming about for decades.

[N] It wasn't until 2011, however, that element 114 was officially admitted to the periodic table. This is because no newly discovered element is officially recognized until another laboratory can duplicate the experiment, which sometimes takes years. Element 114 was given the name *flerovium*. This belated¹⁰ but welcome recognition came when Oganessian was 78 years old. After such a triumph, other scientists might have decided it was time to retire to a quiet and grateful life - but not Yuri Oganessian.

[O] The island of stability still captures his imagination, inspiring him on to further discoveries. As Oganessian put it, "We have discovered the island. Now it is time to explore it, to walk along its western beach." Techniques must be developed to shoot the magic number of neutrons into flerovium to reach its peak of stability. Scientists need to discover if there are peaks at other elements. Although at the moment those goals seem almost impossible, Oganessian has no intention of giving up the hunt for new elements.

¹ The **Big Bang** refers to the cosmic explosion that marked the beginning of the universe.

² If an action is **fateful**, it is considered to have an important and often disastrous effect on future events.

³ The **Manhattan Project** was the name of the U.S. government project that developed the first atomic bombs during World War II.

⁴ Someone's or something's **namesake** has the same name as that person or thing.

⁵ When two charged particles **repel** each other, they push each other away.

⁶ **Half-life** is the time needed for half the atoms in a radioactive substance to disintegrate.

⁷ The **Cold War** was a period of hostility between the United States and the Soviet Union from 1945 until 1991.

⁸ A **cyclotron** is a device that can accelerate charged atoms, protons, or other particles, direct them into a beam, and "shoot" them at a target.

⁹ **Isotopes** are elements that have the same number of protons and electrons, but a different number of neutrons.

¹⁰ A **belated** action happens later than it should have.

- _____ 1. What is the main purpose of paragraph B?
- to describe what elements are and introduce the periodic table
 - to explain that Mendeleyev was a Russian inventor
 - to suggest that most elements are ancient
 - to explain that each element has an atomic number
- _____ 2. According to the following sentence from paragraph B, how did Mendeleyev make sense of the elements?

In the late 1800s, the Russian chemist and inventor Dmitry Mendeleyev tried to make sense of Earth's elements, grouping them by mass - the scientific term for weight - and other attributes in his periodic table of the elements.

- by grouping them in a table by their attributes
- by weighing them scientifically
- by gathering a large amount of each
- by laying them out on his table to study

- _____ 3. In paragraph G, a *neutron* is described as _____.
a. the nucleus of heavy atoms
b. a positively charged proton
c. a neutral particle that keeps the nucleus together
d. the half-life of mendelevium
- _____ 4. According to the passage, we can infer that elements are named _____.
a. when a famous scientist turns 65 years old
b. after the country where they were discovered
c. according to the date when they were found
d. by the scientists who discovered them
- _____ 5. What does *it* refer to in the third sentence of paragraph J?
a. Oganessian's imagination
b. the island of stability
c. Flerov's lab in Dubna
d. the collision for element 106
- _____ 6. Which statement best describes Oganessian's attitude in the early 1990s?
a. He was determined to carry on research to find element 11.
b. He was angry at not being paid and having to forage for food.
c. He was depressed at the loss of his colleague Flerov.
d. He was ambitious as he turned to money-making projects.
- _____ 7. What is another way to express *they are still nowhere near the island's peak* in paragraph M?
a. The laboratory is located on the wrong side of the island.
b. The scientists worked at lower altitudes to successfully create the elements.
c. They had not yet managed to create elements that could last years.
d. The scientists could not go near the elements they created because it was dangerous.
- _____ 8. What does Oganessian mean when he says, "*it's time ... to walk along its western beach*"?
a. It is best to locate laboratories on remote islands where collision experiments won't bother people.
b. Now that some experiments based on the theory have worked, it needs to be researched more thoroughly.
c. Researchers tend to spend too much time at work and would benefit from walking on a western beach.
d. While conducting research on elements, scientists discovered a beautiful island with great beaches.
- _____ 9. According to the following sentence from paragraph L, what was Oganessian hoping to achieve?
Among the trillions of atoms spraying out the other side - the metal sheet was thinner than hair - Oganessian expected at most one atom of element 114.
a. spraying trillions of atoms at a sheet
b. getting atoms to pass through a metal sheet
c. slicing a metal sheet thinner than hair
d. creating an atom of element 114

10. Which of the following is NOT mentioned in the reading passage?
- a. making nuclear bombs
 - b. creating synthetic elements
 - c. collaboration between physicists
 - d. nuclear power plants

DIRECTIONS: Choose the best answer for each question.

Black Holes

[A] A black hole is certainly among the most amazing things in the universe. Born when a star collapses, it is so dense that even light cannot escape the pull of its gravity. That such a thing can even exist challenges our imagination. It is a notion that Albert Einstein himself thought too preposterous to be real. But Einstein was wrong.

The Death of a Star

[B] Our sun is only an average-size star. After it burns up the last of its fuel, the outer layers will float away and the center will become much smaller, pulled in by the force of gravity. What will remain is a dead star known as a white dwarf. This dead star will be a million times smaller than the current size of the sun - about the size of the Earth.

[C] For a star ten times as heavy as our sun, death is much more dramatic. The outer layers are thrown far into space in an explosion that creates a supernova, one of the brightest objects in the universe. The center, meanwhile, is squashed by gravity into a spinning ball several kilometers wide called a neutron star. A neutron star is so dense that a sugar-cube-size piece of a neutron star would weigh a billion tons on Earth.

[D] But this is nothing compared to the death of a star 20 times the weight of our sun. The star's center collapses. Temperatures reach 100 billion degrees. Nothing can resist the force of its gravity. Pieces of iron bigger than Mount Everest are easily squeezed into little bits of sand. Even atoms are destroyed. Everything is squashed with overwhelming force, becoming tinier and tinier, denser and denser, until the star becomes a black hole.

The Power of Gravity

[E] The force of gravity inside black holes is stronger than anything in the universe. Not even light can escape their gravity - and this causes the blackness. At the same time, it's impossible to see inside one. A black hole is a place completely cut off from the rest of the universe by a boundary called an event horizon. Nothing inside can be observed from the outside and vice versa. Anything entering a black hole - a star, a planet, a person - is lost forever.

[F] Although it was his own theory of relativity that first predicted their existence, Albert Einstein never believed black holes were real. He felt nature would not permit such objects. It seemed impossible to him that the force of gravity could become powerful enough to cause the center of an enormous star to disappear from the universe.

[G] Later, in the 1960s, there was a radical shift in the way science thought about black holes. This was largely due to the fact that powerful new telescopes began to be widely used. These allowed astronomers to see more than ever before.

[H] What astronomers found was that at the center of most galaxies - and there are more than 100 billion galaxies in the universe - is a large collection of stars and gas and dust. At the very center of this collection is an object so heavy and so dense, with a force of gravity so strong, that there is only one possible explanation: It's a black hole.

[I] These holes are truly immense. The one at the center of our galaxy, the Milky Way, is 4.3 million times heavier than the sun. A nearby galaxy, Andromeda, has one that weighs as much as 100 million suns. Other galaxies are thought to contain billion-sun black holes, while some are as heavy as ten billion suns. The holes didn't begin life this large. They gained weight by consuming entire stars, planets, and gas clouds. Black holes, it turns out, are a lot more common than you might think. In fact, there are likely trillions of them in the universe.

Viewing the Invisible

[J] A black hole is invisible. It's just a blank spot in space, but scientists are able to deduce its existence by the effect it has on things around it. For example, if a planet or sun comes close to a black hole, it should be possible to see the enormous gravity of the black hole trying to pull the object in.

[K] The black hole at the center of the Milky Way galaxy is currently a peaceful one. But it is currently pulling a gas cloud toward itself at about 2,900 kilometers a second. As the gas cloud begins to enter the black hole, telescopes around the world will be able to take a picture of a black hole in action.

[L] A black hole is a messy eater. As objects get nearer and nearer to it, they get hotter and hotter. Black holes also spin, and the extreme heat and spinning break up and throw off large amounts of matter at extremely high temperatures. This heated matter flies through space, away from the hole with unbelievable speed. It can travel millions of light-years straight through a galaxy. The material then cools, comes together, and eventually forms new stars around the galaxy.

Birth of a Universe

[M] In recent years, it has become increasingly accepted that our universe is not everything that exists. We may live, rather, in what's known as the multiverse - a vast collection of separate universes. This is only a theory, but it seems that to give birth to a new universe, you first need to take a bunch of material from an existing universe, crunch it down, and seal it off in a black hole.

[N] According to this theory, our universe might have been the product of a black hole in another, older universe. 13.8 billion years ago, our universe began when a black hole abruptly exploded. The moment before, everything was packed into a small, massively dense speck - a singularity. Perhaps the multiverse theory can be explained using the example of an oak tree. Once in a while, an acorn is dropped, falls into the soil, and abruptly sprouts. So, too, with a singularity - the seed of a new universe.

- _____ 11. In the second last sentence of paragraph A, what does the word *It* refer to?
- a. light
 - b. a black hole
 - c. a collapsed star
 - d. the idea that black holes exist

_____ 12. Where would the following sentence be best placed in paragraph B?

It will die in about five billion years.

- a. after the first sentence
- b. after the second sentence
- c. after the third sentence
- d. after the fourth sentence

_____ 13. Which statement about black holes is NOT true?

- a. They are black because light cannot escape their gravity.
- b. Anything that enters a black hole is lost forever.
- c. Black holes gain weight by eating stars and planets.
- d. The black hole at the center of our galaxy does not currently have an impact on anything.

_____ 14. Will our sun become a black hole?

- a. Yes. Every star eventually becomes a black hole.
- b. Perhaps, but not for another 5 billion years.
- c. Perhaps, but only if our sun collapses.
- d. No. Our sun is too small.

_____ 15. Which of the following is NOT used to describe the life cycle of a star or black hole?

- a. be born
- b. eat
- c. push
- d. die

_____ 16. What caused people in the scientific community to start to think about black holes in a new way?

- a. Albert Einstein presented his theory of relativity.
- b. New telescopes began to be widely used.
- c. Astronauts brought back new information from space.
- d. The theory of the multiverse became common.

_____ 17. How do scientists locate black holes?

- a. by building more telescopes around the world
- b. by observing how a planet or sun is pulled toward a black hole
- c. by tracking heated matter in space
- d. by tracking cooling matter in space

_____ 18. Based on the information in paragraph K, what can we infer about black holes?

- a. that they are made of gas
- b. that they can be violent
- c. that they are easy to spot
- d. that they do not move very fast

_____ 19. Which statement is a theory, and not a fact?

- a. Black holes are extremely common.
- b. There are more than 100 billion galaxies in the universe.
- c. The black hole in our galaxy is pulling a gas cloud toward itself.
- d. Our universe is the product of a black hole in another, older universe.

- ____ 20. According to the multiverse theory, which of these events happened last in the birth of our universe?
- a. Everything was packed into a singularity.
 - b. A black hole abruptly exploded.
 - c. Our universe was created.
 - d. Material was sealed off in a black hole.

DIRECTIONS: Complete the sentences. Choose the correct word.

- a. attribute
- b. bind
- c. charges
- d. collision
- e. counterpart
- f. dispute
- g. duplicate
- h. prevail
- i. quest
- j. trustworthy

- ____ 21. If you ____ something to an event or situation, you think that it was caused by that event or situation.
- ____ 22. A(n) ____ is a person or thing that has a similar function or position in a different place.
- ____ 23. I made a(n) ____ of my house key and gave it to my neighbor.
- ____ 24. The positive ____ in the nucleus of an atom repel one another.
- ____ 25. The two companies decided to settle their ____ out of court.
- ____ 26. In her ____ to gain success, she was willing to sacrifice her time, her family, and her friends.
- ____ 27. A(n) ____ occurs when a moving object crashes into something.
- ____ 28. She insisted she received the news from a very reliable and ____ source.
- ____ 29. He was confident that justice would ____ and the murderer would be punished.
- ____ 30. He used a complicated knot to ____ the packages together.

Reading Explorer 5 Unit 10 Lesson B

Answer Section

1. ANS: A PTS: 1 REF: Pages 213-216
OBJ: Purpose TOP: New Discoveries
2. ANS: A PTS: 1 REF: Page 219 OBJ: Understanding Long Sentences
TOP: New Discoveries
3. ANS: C PTS: 1 REF: Pages 213-216
OBJ: Unfamiliar Vocabulary TOP: New Discoveries
4. ANS: D PTS: 1 REF: Pages 213-216
OBJ: Inference TOP: New Discoveries
5. ANS: B PTS: 1 REF: Pages 213-216
OBJ: Anaphoric Reference TOP: New Discoveries
6. ANS: A PTS: 1 REF: Pages 213-216
OBJ: Inference TOP: New Discoveries
7. ANS: C PTS: 1 REF: Pages 213-216
OBJ: Paraphrase TOP: New Discoveries
8. ANS: B PTS: 1 REF: Pages 213-216
OBJ: Figurative Language TOP: New Discoveries
9. ANS: D PTS: 1 REF: Page 219 OBJ: Understanding Long Sentences
TOP: New Discoveries
10. ANS: D PTS: 1 REF: Pages 213-216
OBJ: Negative Detail TOP: New Discoveries
11. ANS: D PTS: 1 REF: Unit 10 OBJ: Anaphoric Reference
TOP: New Discoveries
12. ANS: B PTS: 1 REF: Unit 10 OBJ: Cohesion
TOP: New Discoveries
13. ANS: D PTS: 1 REF: Unit 10 OBJ: Negative Detail
TOP: New Discoveries
14. ANS: D PTS: 1 REF: Unit 10 OBJ: Inference
TOP: New Discoveries
15. ANS: C PTS: 1 REF: Unit 10 OBJ: Figurative Language
TOP: New Discoveries
16. ANS: B PTS: 1 REF: Unit 10 OBJ: Cause and Effect
TOP: New Discoveries
17. ANS: B PTS: 1 REF: Unit 10 OBJ: Supporting Detail
TOP: New Discoveries
18. ANS: B PTS: 1 REF: Unit 10 OBJ: Inference
TOP: New Discoveries
19. ANS: D PTS: 1 REF: Unit 10 OBJ: Fact or Theory
TOP: New Discoveries
20. ANS: C PTS: 1 REF: Unit 10 OBJ: Sequence
TOP: New Discoveries
21. ANS: A PTS: 1 REF: Page 220 OBJ: Vocabulary
TOP: New Discoveries
22. ANS: E PTS: 1 REF: Page 220 OBJ: Vocabulary
TOP: New Discoveries

23.	ANS: G	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
24.	ANS: C	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
25.	ANS: F	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
26.	ANS: I	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
27.	ANS: D	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
28.	ANS: J	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
29.	ANS: H	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			
30.	ANS: B	PTS: 1	REF: Page 220	OBJ: Vocabulary
	TOP: New Discoveries			