Contents

Unit 2

Reading Section　Astronomy

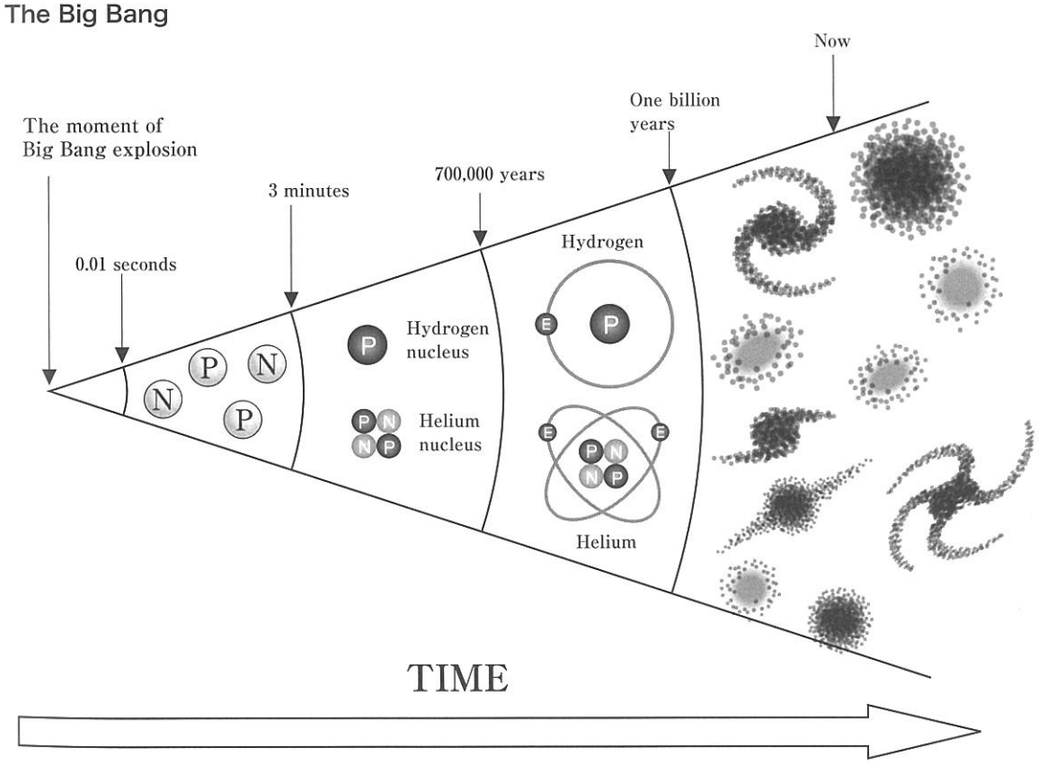
天文学はTOEFLで最も出題される分野の一つです。実際の試験ではその中でも焦点を絞ったトピックが出題されますが、解答に必要な事柄は全てパッセージ中で説明されるため、そのトピック自体について熟知している必要はありません。しかしながら同分野の話題を理解するための語彙や基礎知識はある程度必要です。例えばstarは日本語と異なり、恒星のみを指す語で惑星や衛星等は含みません。このユニットでは現代天文学の土台とも言えるビッグバン理論を理解することで、その語彙と基礎知識の一部を習得できるよう目指します。しかし本文に現れる語彙は天文学の重要語句のほんの一部に過ぎないので、それ以外の語彙は次のVocabulary for the genreを初めとして更に強化する必要があります。Unit 8で扱う物理用語も天文学の理解に欠かせないので合わせて覚えましょう。

Vocabulary for the genre

Cosmology [kɑzmálədʒi]　宇宙学
space exploration [spéis èksplәréiʃәn]　宇宙探査
spacecraft [spéiskræft]　宇宙船
astronomer [әstránәmәr]　天文学者
astronaut [æstrәnɔ̀:t]　宇宙飛行士
probe [próub]　探査機、探査する
launch pad [lɔ́:ntʃ pǽd]　発射台
light year [láit jíәr]　光年
orbit [ɔ́:rbit]　軌道
rotation [routéiʃәn]　自転
revolution [rèvәlú:ʃәn]　公転
axis [ǽksis]　回転軸
manned flight [mænd fláit]　有人飛行（無人飛行はunmanned flight）
artificial satellite [à:rtәfíʃәl sætәlàit]　人工衛星
solar system [sóulәr sístәm]　太陽系
zenith [zí:niθ]　天頂
magnitude [mægnәtju:d]　等級
luminosity [lù:mәnásәti]　明るさ
asteroid [æstәrɔ̀id]　小惑星
galaxy [gǽləksi]　銀河
Milky Way (galaxy) [mílki wéi]　天の川
nebula / nebulae (pl.) [nébjulә / -lì:]　星雲
comet [kámit]　彗星
nova [nóuvә]　新星
supernova [sù:pәrnóuvә]　超新星
white dwarf [hwáit dwɔ́:rf]　白色矮星
red giant [réd dʒáiәnt]　赤色巨星
binary star [báinәri stá:r]　連星
neutron star [njú:trɑn stá:r]　中性子星
quasar [kwéizɑ:r]　準星
pulsar [pʌ́lsɑ:r]　電波天体

sunspot [sʌ́nspɑ̀t]　太陽の黒点
solar eclipse / lunar eclipse [sóulәr iklíps / lú:nәr —]　日食 / 月食
velocity [vәlásәti]　速度
meteor [mí:tiәr]　流星＝shooting star
meteorite [mí:tiәràit]　隕石
celestial body [sәléstʃәl bádi]　天体
celestial globe [sәléstʃәl glóub]　天球（見かけ上の仮想の球体）
constellation [kànstәléiʃәn]　星座
zodiac [zóudi`æk]　十二宮（天の川を構成する12星座の総称）
cosmic ray [kázmik réi]　宇宙線
stellar [stélәr]　星の、星に関する
interstellar [intәrstélәr]　星間の
wavelength [wéivlèŋkθ]　波長
frequency [frí:kwәnsi]　周波数
Polaris [pәléәris]　北極星
the Big Dipper [ðә bíg dípәr]　北斗七星
theory of relativity [θí:әri әv rèlәtívәti]　相対性理論
geocentric theory [dʒì:ouséntrik θí:әri]　天動説
heliocentric theory [hì:iouséntrik θí:әri]　地動説
Doppler effect [dáplәr ifékt]　ドップラー効果

The Big Bang



N＝中性子（neutron）　P＝陽子（proton）　E＝電子（electron）

Read the passage and answer the questions that follow.

CD 8

The Big Bang Theory

1 Before the 20th century, astronomers could only assume that the universe had existed forever without change, or that it was created in its present condition by divine action at some arbitrary time. Evidence that the universe was evolving did not begin to accumulate until the 1920s. The theory that all matter in the universe was created from a gigantic explosion called the "big bang" is widely accepted by students of cosmology.

2 It was German-American physicist Albert Einstein's theory of relativity, published in 1915, that set the stage for the development of the concept of an expanding universe. In 1919, a Dutch astronomer, Willem de Sitter, showed Einstein's theory could also describe an expanding universe. Mathematically, De Sitter's solution for Einstein's equations was sound, but observational evidence of expansion was lacking, and Einstein was skeptical.

3 In 1929, American astronomer Edwin Powell Hubble made what has been called the most significant astronomical discovery of the century. He observed large red shifts in the spectra of the galaxies he was studying. Red shifts are the result of the Doppler effect, which should be observed when some object is moving away from the point of view. The red shifts Hubble observed indicated that the galaxies are continually moving apart at tremendous velocities.

4 Like de Sitter, Georges Lemaître, who worked with Hubble in 1924, developed a simple solution to Einstein's equations that described a universe in expansion. Hubble's stunning observation provided the evidence Lemaître was seeking for his theory. In 1933, Lemaître clearly described the expansion of the universe. Projecting back in time, he suggested that the universe had originated as a great "cosmic egg," expanding outward from a central point. He did not, however, consider whether an explosion actually took place to initiate this expansion.

5 George Gamow further investigated the origin of the universe in 1948. Because the universe is expanding outward, he reasoned, it should be possible to calculate backward in time to its beginning. If all the mass of the universe was compressed into a small volume 10 to 15 billion years ago, its density and temperature must have been phenomenal. A tremendous explosion would have caused the start of the expansion, left a "halo" of background radiation, and formed the atomic elements that are heavier than the abundant hydrogen and helium.

6 Gamow's theory implied there was a specific beginning and end to the universe. However, a number of other scientists, including Fred Hoyle, Thomas Gold, and Hermann Bondi, felt that the theory of expansion required no beginning or end. Their model, called the steady-state theory, suggested that matter was being continuously created throughout the universe. As galaxies drifted apart, matter would "condense" to form new ones in the void left behind. For nearly two decades, supporters of the competing theories seemed to be on equal footing.

7 In 1965, Robert H. Dicke made calculations relative to the cooling-off period after the initial big bang explosion. His results indicated that Gamow's residual radiation should be detectable. Unknown to him, radio engineers Arno Penzias and Robert W. Wilson had already detected such radiation at 3 K in 1964 while looking for sources of satellite communication interference. This was the most convincing evidence yet gathered in support of the big bang theory, and it sent the steady-state theory into decline.

8 No theory exists today that can account for the extreme conditions that existed at the moment of the big bang. ■ **(A)** The theory of relativity does not apply to objects as dense and small as the universe must have been prior to the big bang. ■ **(B)** Cosmologists can project only as far back as 0.01 seconds after the explosion, when the cosmos was a seething mass of protons and neutrons. ■ **(C)** Protons and neutrons began to form atomic nuclei about three minutes and 46 seconds after the explosion, when the temperature was a mere 900 million K. After 700,000 years, hydrogen and helium formed. ■ **(D)** About one billion years after the big bang, stars and galaxies began to appear from the expanding mass. Countless stars would condense from swirling nebulae, evolve and die before our sun and its planets could form in the Milky Way galaxy.

Questions

1. According to the passage, why did some astronomers start to think that the universe was expanding?
   - Ⓐ Einstein's theory proved that the universe is expanding.
   - Ⓑ Both the theoretical and observational grounds had suggested that possibility.
   - Ⓒ Scientists thought that a universe created by god was impossible.
   - Ⓓ Lemaître found evidence that the universe had originated as an egg.

2. The word "arbitrary" in paragraph 1 is closest in meaning to
   - Ⓐ critical
   - Ⓑ adequate
   - Ⓒ random
   - Ⓓ primitive

3. Which of the following can be inferred from paragraph 2?

Ⓐ Einstein was the first to advocate that the universe was expanding.
Ⓑ De Sitter found a conclusive evidence to support an expanding universe.
Ⓒ Without the theory of relativity, the big bang theory would not have developed.
Ⓓ Einstein's equation was mathematically sound and proven.

4. According to paragraph 3, red shifts are

Ⓐ proof that something is moving away quickly
Ⓑ spectra of galaxies Hubble discovered
Ⓒ the cause of the Doppler effect
Ⓓ necessary light when moving in an apartment

5. The author mentions the "cosmic egg" in paragraph 4 in order to

Ⓐ show that eggs are a great source of nutrition
Ⓑ liken the universe to a familiar concept to illustrate his explanation
Ⓒ demonstrate that he is a humorous person
Ⓓ convey the idea that the universe is a type of organism born from an egg

6. The word "phenomenal" in paragraph 5 is closest in meaning to

Ⓐ corporeal
Ⓑ observable
Ⓒ superficial
Ⓓ extraordinary

7. It can be inferred from paragraph 6 that Gamow's theory

Ⓐ did not have sufficient observational evidence
Ⓑ soon replaced the steady-state model
Ⓒ explained well how matter was being created
Ⓓ did not require the beginning or end of the universe

8. The word "ones" in paragraph 6 refers to

Ⓐ scientists
Ⓑ competing theories
Ⓒ galaxies
Ⓓ beginning and end of the universe

9. The phrase "on equal footing" in paragraph 6 is closest in meaning to

Ⓐ by the same reason
Ⓑ convincing to a similar degree
Ⓒ compatible with each other
Ⓓ open to the public

10. According to paragraph 7, what made the steady-state theory less convincing than the big bang theory?

Ⓐ Dicke's calculations proved the existence of the initial big bang explosion.
Ⓑ Satellite communication interference turned out to be the most convincing evidence for it.
Ⓒ Penzias and Wilson's experiment gathered evidence in favor of the steady-state theory.
Ⓓ Residual radiation supporting the idea of the cooling-off period had been found.

11. All of the following are mentioned as having been created shortly after big bang EXCEPT

Ⓐ neutrons
Ⓑ nebulae
Ⓒ protons
Ⓓ atomic nuclei

12. Which of the sentences below best expresses the essential information in the highlighted sentence? Incorrect choices change the meaning in important ways or leave out essential information.

Ⓐ A very large explosion completed the expansion process, and radiation and heavy elements were left behind.
Ⓑ The universe started with such a large explosion that it left background radiation and heavy elements such as hydrogen and helium.
Ⓒ The expansion of the universe was caused by a large explosion, and its radiation created heavier elements than hydrogen and helium.
Ⓓ When the universe started to expand with a large explosion, the explosion left behind radiation and created heavy elements.

13. Look at the four squares [■] that indicate where the following sentence could be added to the passage.

Other subatomic particles, such as neutrinos, were also thought to form within the first second.

Where would the sentence best fit? Select a square to add the sentence to the passage.

14. Directions: An introductory sentence for a brief summary of the passage is provided below: Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some answer choices do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. ***This question is worth 2 points***.

Before the 20th century, the universe was thought to have existed forever, or created by divinity.

-
-
-

Answer Choices

Ⓐ Dicke's calculations indicated that the steady-state theory was incorrect.
Ⓑ The big bang theory explains what the universe must have been prior to the big bang.
Ⓒ Hubble discovered that galaxies appeared to be moving away from the earth.
Ⓓ Gamow's theory of an expanding universe required a specific beginning and end to the universe.
Ⓔ The big bang theory attempts to explain how matter was created and evolved after the explosion.
Ⓕ Einstein's theory laid the foundation for the concept of an expanding universe.

Listening Section | Conversation

CD 9 Listen to a conversation between a student and an advisor.

Questions

1. Why does the student go to see the advisor?
Ⓐ To discuss what his major should be
Ⓑ To change his class to a more advanced one
Ⓒ To choose the best course for his interests
Ⓓ To complain about the difficulty of biology

CD 10 **2.** What is the student's problem?
Ⓐ There are two similar courses which he needs to distinguish between.
Ⓑ There are two majors in which he is currently interested.
Ⓒ He does not understand why he needs to study biology.
Ⓓ He wants to change to a more basic-level course.

CD 11 **3.** What are some differences between *Introduction to Biology* and *General Biology*? Select two answers.
[A] *Introduction to Biology* does not lead to any other course.
[B] Only *Introduction to Biology* is required for all science students.
[C] *General Biology* does not have a laboratory component.
[D] *General Biology* is more difficult than *Introduction to Biology*.

CD 12 **4.** Listen again to part of the conversation Then answer the question.

What does the advisor mean when she says this:
Ⓐ "It is too late to declare your major now."
Ⓑ "It is better if you declare your major soon."
Ⓒ "You should have declared your major before."
Ⓓ "You should not declare your major until the end of next year."

CD 13 **5.** What will the student likely do next?

Ⓐ Go to the registration office to change his major
Ⓑ Study biology so that he can change his course
Ⓒ Consult his parents about his future career
Ⓓ Enroll for a course he has decided to take

CD 14 **6.** What conclusion can be drawn from the conversation?

Ⓐ He has to decide his major before taking any biology courses.
Ⓑ Biology courses are demanding at this university.
Ⓒ The student is willing to study whatever required.
Ⓓ Chemistry major has more requirements than Education major.

Vocabulary for Unit 4 Listening section and biology

リスニングセクションが大学職員との会話の場合、学術用語が使われる機会はさほど多くありません。しかし同じ会話でも教授と話すときや、講義リスニングの場合は重要な学術用語がわからないと全体の要旨を把握する事さえ難しくなります。本書では未知語彙が比較的少ない会話リスニングの終了後に、２ユニット先のアカデミック・リスニングのための語彙を事前に学習します。Unit ４の講義リスニングの分野は生物学なので、該当音声を聞く前に以下の重要語彙を学習しましょう。もしUnit ４の設問に挑戦するまで時間がある場合、解答直前にまたこのページに戻って語彙を再確認してから解いてください。

botany [bátəni] 植物学
botanist [bátənist] 植物学者
zoology [zouálədʒi] 動物学
zoologist [zouálədʒist] 動物学者
taxonomy [tæksánəmi] 生物分類学
taxonomist [tæksánəmist] 生物分類学者
hierarchy [háiərà:rki] 階級制
domain [douméin] ドメイン（元は「領域」の意）
kingdom [kíŋdəm] 界（元は「王国」の意）
phylum / phyla (pl.) [fáiləm / -lə] 門（動物の場合）
division [divíʒən] 門（植物や菌類の場合）
class [klǽs] 綱（こう）
order [ɔ́:rdər] 目（もく）
family [fǽməli] 科
genus [dʒí:nəs] 属
species [spí:ʃi:z] 種
organism [ɔ́:rgənìzm] 生命体
carnivore [ká:rnəvɔ̀:r] 肉食動物
herbivore [ɔ́:rbəvɔ̀:r] 草食動物
omnivore [ámnivɔ̀:r] 雑食動物
fungus / fungi (pl.) [fʌ́ŋgəs / -gi:] 菌類
arthropod [á:rθrəpὰd] 節足動物
centipede [séntəpì:d] 百足（ムカデ）
crustacean [krʌstéiʃən] 甲殻類
mollusk [máləsk] 軟体動物
mammal [mǽməl] 哺乳類
amphibian [æmfíbiən] 両生類
reptile [réptil] 爬虫類
marsupial [ma:rsú:piəl] 有袋類
rodent [róudnt] げっ歯類 （ネズミやリス squirrel等）
echinoderm [ikáinədɔ:rm] 棘皮（きょくひ）動物（ヒトデ starfishやウニsea urchinなど）
primate [práimeit] 霊長類
canine [kéinain] イヌ科（の）

photosynthesis [fòutousínθəsis] 光合成
prokaryotic cells [proukæriátik sélz] 原核細胞
eukaryotic cells [ju:kærióutik sélz] 真核細胞
nucleus [njú:kliəs] 細胞核
vertebrate [vɔ́:rtəbrət] 脊椎動物
invertebrate [invɔ́:rtəbrət] 無脊椎動物
feline [fí:lain] ネコ科（の）
criterion / criteria (pl.) [kraitíəriən / -riə] 基準
ongoing [ángòuiŋ] 継続中の
pursuit [pərsú:t] 追及
undertake [ʌ̀ndərtéik] 引き受ける