EARTH AND SPACE SCIENCES

One of the best ways for you to become familiar with and improve on the performance expectations of Earth and Space Sciences is to test your knowledge and understanding by answering practice questions. That is the purpose of this booklet. Within it are four exams, each containing 50 questions. Some questions will challenge you and force you to "think outside the box" by analyzing and interpreting reading passages, graphs and charts. These are critical thinking skills that are expected of you in today's world. Other questions are more content-oriented, dealing with learned facts. Still other questions will test whether you have a working knowledge of the 2026 Edition Reference Tables for Earth and Space Sciences, which are provided in the back of this book.

After you have completed an exam, check how well you have done. The answers and explanations for all questions are provided. Your teacher can assist you if you need additional instruction.

As its author, I hope that this book will improve your grade. But I truly hope that your knowledge of our Earth and Space continues to grow, for there is much for all of us to discover about these topics. When you have time, check the NASA website, especially the images sent back from the Hubble and the James Webb Space telescopes, for every image is a new discovery. Our understanding of our planet and our universe is constantly evolving. It's an exciting journey.

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Published by

TOPICAL REVIEW BOOK COMPANY

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Test 1

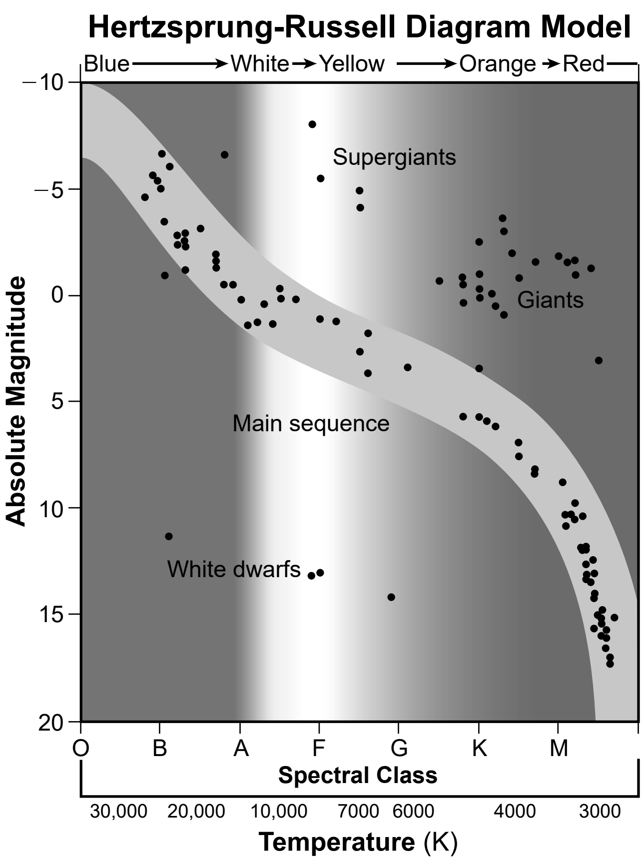
Answer all questions in this part.

***Directions*: Use your knowledge of Earth and Space Sciences to answer all questions in this examination. Throughout this exam, some questions may require the use of the *2026 Edition Reference Tables for Earth and Space Sciences.* This is provided in the back of this test book.**

Base your answers to questions 1 through 8 on the information below.

Our Sun – A Star

The Hertzsprung-Russell (H-R) diagram was developed from star charts by two scientists in different countries independently of each other in 1911. It classified stars based on their surface temperatures, observable color, and magnitude. Absolute magnitude is a measurement of how bright a star would appear if all stars are the same distance from Earth. The brighter the star, the lower the absolute magnitude value.



1. Our Sun is classified as a spectral class G star with a surface temperature between 5000 to 6000 K and an absolute magnitude of about five. Based on this information, complete the H-R diagram model by placing **one X** to indicate where the Sun is located. Also, identify the relative temperature and relative absolute magnitude of the Sun as it transitions to a red giant.

Change in relative temperature: ____________________________________

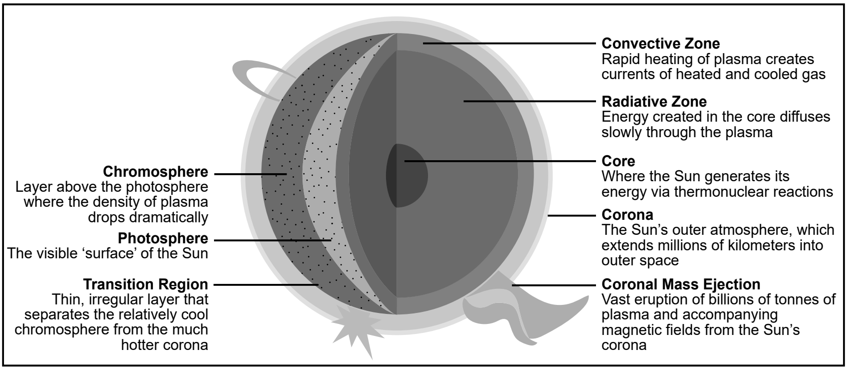
Change in relative absolute magnitude: ______________________________

2. Astronomers are certain that our Sun will never transition to a supergiant. What is the criteria about our Sun for making this statement?

____

The model below shows the layers of the Sun and information about some features of each layer.

Model of Sun's Layers



3. Based on the information in the model, which list of five of the Sun's layers are in the correct sequence to allow energy generated by fusion to eventually reach the Sun's surface as radiation?

(1) core → chromosphere → photosphere → transition region → corona
(2) core → radiative zone → transition region → photosphere → corona
(3) core → photosphere → corona → transition region → chromosphere
(4) core → radiative zone → convective zone → photosphere → chromosphere

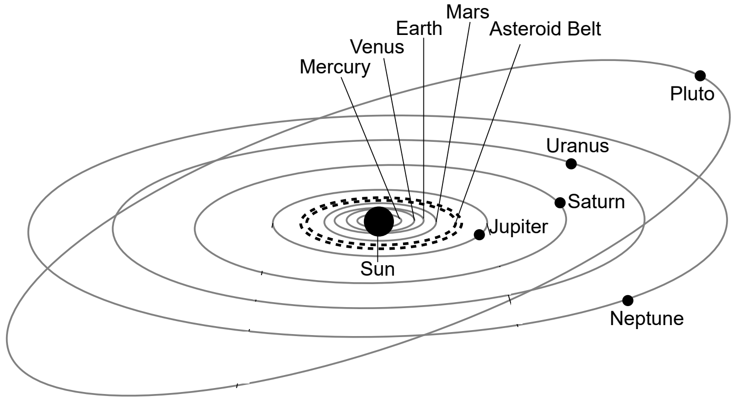
3____

4. Our Sun's average distance from Earth is 150 million km. The electromagnetic energy that is radiated from the photosphere travels at a speed of 300,000 km/sec. How long, in minutes, would it take for this radiated energy to travel from the photosphere to Earth? __________________minutes

5. Which layer of the Sun would have rising and sinking plasma due to density differences? ____________________________________

The model below represents the orbits of celestial bodies around our Sun.

Our Solar System Model



6. The table shows the eccentricity of the orbits of Mercury and Venus around the Sun.

Planet	Eccentricity
Mercury	0.206
Venus	0.007

Place a check mark (√) in the boxes to indicate the **two** statements that are correctly predicted by Kepler's Laws.

☐ Venus orbits the Sun at a constant speed.

☐ Mercury travels faster in its orbit when it is closer to the Sun.

☐ Venus's orbit is less elliptical than Mercury's orbit.

☐ The orbital speeds of both planets are affected by their masses.

☐ Unlike Venus, the eccentricity of Mercury's orbit prevents Mercury from having a moon.

7. Based on the *Our Solar System Model*, if a new planet was identified that orbited the Sun at an average orbital distance greater than that of Mercury but less than that of Venus, the average speed of this planet would be
(1) greater than the average speed of Mercury, but less than the average speed of Venus
(2) less than the average speed of Mercury, but greater than the average speed of Venus
(3) greater than the average speed of Venus, but less than the average speed of Earth
(4) less than the average speed of Venus, but greater than the average speed of Earth

7____

An observer on Earth sees phases of the Moon, but the Moon isn't the only solar system body to exhibit phases. Venus also has observable phases as viewed from Earth. Venus's orbit around the Sun is approximately 225 Earth days.

The photograph shows a Moon phase and Venus viewed with unaided eyes in the night sky. The inset box shows Venus observed using a telescope. Both the Moon and Venus are in crescent phase.

Observed Phases of the Moon and Venus

8. Using *Our Solar System Model,* construct an explanation for why an observer on Earth can see a cycle of phases for the planet Venus. In the spaces below, write the terms for choices *A*, *B*, and *C* that correctly complete the passage.

Choices A:	**Choices B:**	**Choices C:**
• inside	• closer to	• Moon
• outside	• farther from	• Sun

Venus orbits the Sun, circling _*A*_ Earth's orbit in about 225 Earth days. This means that Venus is sometimes _*B*_ Earth, while at other times it is positioned on the other side of the _*C*_ . It is this change in relative positions of Venus that causes an observer on Earth to see phases of Venus.

Choice *A*:________________________

Choice *B*: ________________________

Choice *C*: ________________________

Answer all questions in this part.

***Directions*: Use your knowledge of Earth and Space Sciences to answer all questions in this examination. Some questions may require the use of the *2026 Earth and Space Sciences Reference Tables*.**

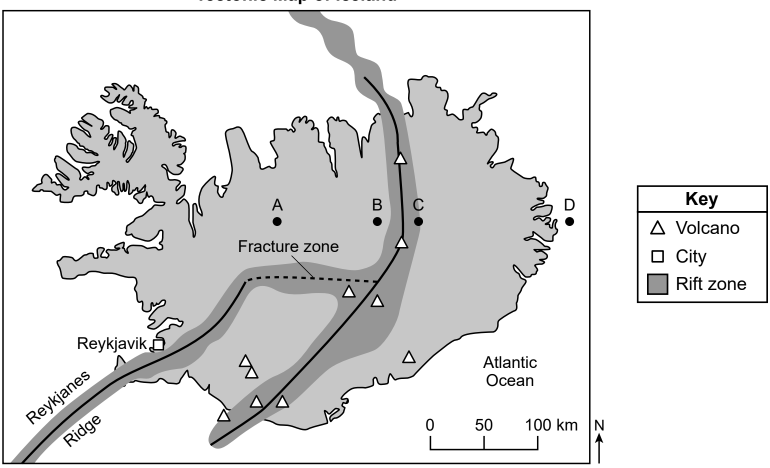
Base your answers to questions 1 through 4 on the information below and on your knowledge of Earth and Space Sciences.

Iceland Hotspot

Iceland is one of the most active volcanic regions on Earth. It is a hotspot in the north Atlantic Ocean near the Reykjanes Ridge. The island formed by a combination of seafloor spreading and volcanism.

The map below shows some information about the tectonic setting of Iceland. Points *A* through *D* represent locations on Earth's surface.

Tectonic Map of Iceland



1. Place the letters representing locations *A*, *B*, *C*, and *D* in the spaces below to show the pattern in the ages of rock from youngest to oldest.

________ → ________ → ________ → ________

(youngest) (oldest)

2. Which statement correctly compares the rate of seafloor spreading at the ridge in Iceland to the rate of seafloor spreading at another plate boundary?

(1) Iceland's approximate rate of spreading is faster than the Southeast Indian Ocean Ridge.

(2) Iceland's approximate rate of spreading is slower than the East Pacific Rise.

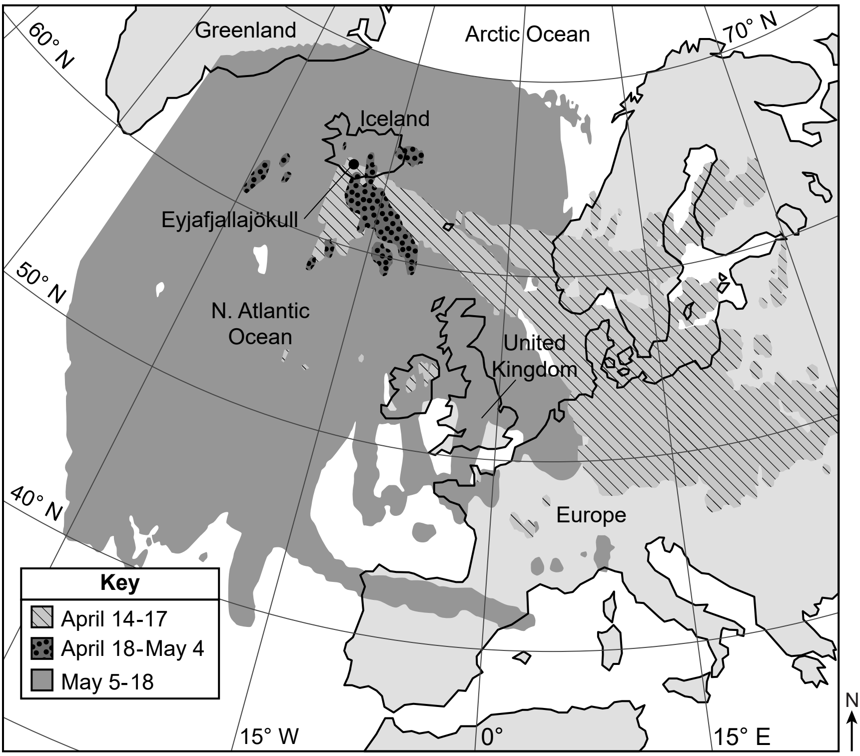
(3) Iceland's approximate rate of spreading is faster than the boundary between the Cocos Plate and the Nazca Plate.

(4) Iceland's approximate rate of spreading is slower than the Southwest Indian Ocean Ridge. 2 ____

Eyjafjallajökull Volcano is located on the south coast of Iceland. On April 14, 2010, an explosive eruption occurred in the ice-covered crater. The mixing of the glacial water and magma resulted in a massive ash cloud that went approximately 11 km into the atmosphere. The cloud consisted of large amounts of microscopic particles of hard volcanic rock.

The map below shows some information about the movement of the ash cloud during the Eyjafjallajökull Volcano eruption in 2010. The key indicates the distribution of the ash cloud over time as a result of the eruption event.

Eyjafjallajökull Volcanic Ash Cloud



3. Which statement, based on evidence found on the map, describes how the movement of the Eyjafjallajökull ash cloud influenced humans?

(1) Between May 5 and May 18, all of Iceland was most likely experiencing poor air quality.

(2) By April 18, the southern tip of Greenland was most likely experiencing poor air quality.

(3) On April 23, residents within southern Europe experienced total darkness due to the ash cloud.

(4) On April 15, residents in the United Kingdom experienced increased atmospheric visibility due to the ash cloud. 3 ____

Managing and mitigating lava flows from volcanic eruptions is a challenge due to the intense heat and fluid dynamics of lava. In Iceland, several solutions have been applied or proposed to address the impacts of lava flows.

The table below lists different methods that all require equipment to address the impact of lava flows on communities.

Possible Lava Flow Solutions

	Solution	Description	Constraint
A	Lava diversion	Construct channels to redirect lava	– Costly – Time-consuming – Lava may breach – Redirects flows instead of stopping them
B	Seawater cooling	Use pumps to draw seawater to spray lava to cool and harden	– Need constant water supply – Demand for energy to run multiple costly pumps
C	Lava flow barrier	Build earthen barriers to dam the lava and stop its flow	– Need machinery/equipment to build barrier – Lava could breach the barrier
D	Explosions	Detonate explosives to disrupt the lava flow and redirect its path	– Could cause further damage and loss of life – Not precise and lava returns to its original path

4. Which proposed solution would best protect an Icelandic community from a lava flow when considering constraints such as costs and equipment?

(1) Solution *A*, lava diversion (3) Solution *C*, lava flow barrier
(2) Solution *B*, seawater cooling (4) Solution *D*, explosions 4 ____

Base your answers to questions 5 through 8 on the information below and on your knowledge of Earth and Space Sciences.

Stars and Stellar Evolution

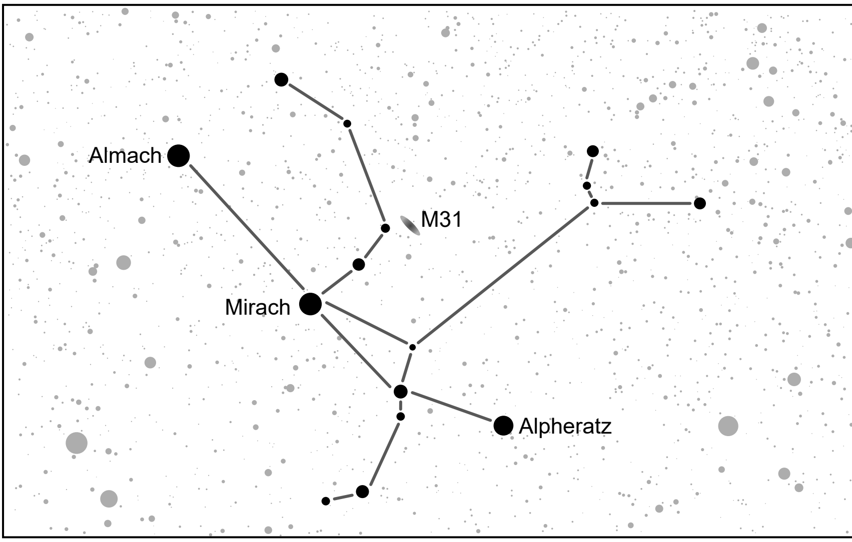
The Andromeda constellation contains several stars including three of the brightest stars in the sky: Almach, Mirach, and Alpheratz. Almach is a multiple-star system located 350 light years (ly) from Earth. A light year is defined as the distance that light travels in one year, about 6 trillion miles or 9.5×10^{12} km. The Almach system is the third brightest object in the constellation. Mirach is a red giant star located 200 ly from Earth, and it is approximately 2000 times brighter than the Sun. Alpheratz is a sub-giant star located 97 ly from Earth, and it is approximately 200 times brighter than the Sun.

The Andromeda Galaxy, known as M31, is also within the Andromeda constellation. It is 2.5 million ly away from Earth.

The Andromeda constellation is visible in both the northern and southern hemispheres of Earth, but is not visible at latitudes greater than 40° S. In the northern hemisphere, this constellation is best observed from August to February. In the southern hemisphere, it is only visible from October to December.

The model below shows some information about a constellation.

Model of the Andromeda Constellation



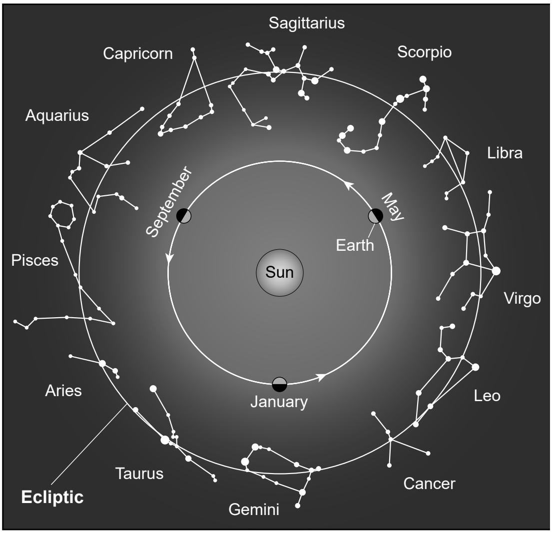
5. Which row correctly lists the factors that influence nuclear reactions in stars and lists the types of elements in the core of some of the stars named in the Andromeda constellation?

Row	Factors That Influence Nuclear Reactions in Stars	Elements of Giant Stars in Andromeda
(1)	• Mass of star • Stage in lifetime	He and C
(2)	• Brightness of star • Stage in lifetime	H and He
(3)	• Mass of star • Distance from Earth	He and C
(4)	• Brightness of star • Distance from Earth	H and He

5 ____

The model shows some information about the zodiac constellations visible from Earth. The ecliptic is the Sun's apparent path among the constellations as viewed from Earth.

Model of Some Constellations Visible from Earth



6. Identify the name and motion of the celestial object shown in the model that is responsible for the pattern of different constellations that are visible to an observer in the northern hemisphere. Then, identify the name of **one** constellation that would most likely be highest in the night sky at the same time that the Andromeda constellation would also be visible in the night sky at midnight in January in New York State. [1]

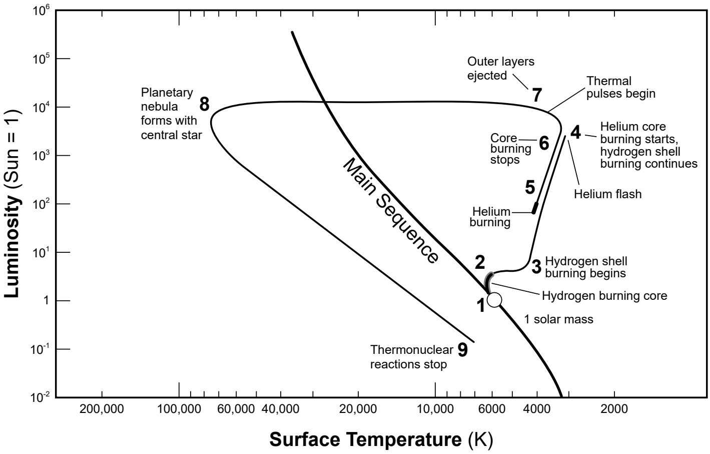
Name and description of motion:________________________________

____

Constellation name: ________________________________

The graph below shows the evolution of a Sun-like star. Numbers 1 through 9 represent the steps in the sequence of a star's evolution and its position on a H-R Diagram. Luminosity is the total amount of energy radiated by a star, compared to our Sun. The term "burning" refers to fusion.

Evolution of a Sun-like Star

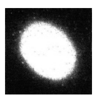
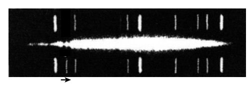
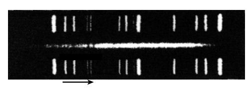
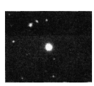
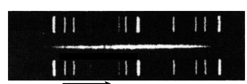


7. Which piece of evidence in the *Evolution of a Sun-like Star* graph could be used to support the claim that nuclear fusion is the process responsible for energy generation in stars like our Sun and Mirach?
(1) In Step 4, helium burns in the core, then helium burns in the shell.
(2) In Step 7, outer layers of the star are ejected and become a planetary nebula in Step 8.
(3) From Step 2 to Step 5, hydrogen burning changes to helium burning in the core.
(4) From Step 1 to Step 3, hydrogen core burning stops and thermal pulses begin. 7 ____

In 1924, Edwin Hubble studied the Andromeda Galaxy, along with many other galaxies, and found that there is a pattern in the speeds that galaxies arereceding from Earth. Hubble's finding had important implications for theories related to understanding the universe.

The table shows some information about galaxies, including their distances and recessional velocities (speed relative to Earth). Black arrows below the spectra indicate how far the two darkest absorption lines have shifted in wavelength (λ).

Galaxy Data Table

Cluster Galaxy in	Approximate Distance in Light-Years from Earth	Spectra Recessional Velocities (blue Shorter λ — red Longer λ)
 Virgo	52 million	 1200 KM/SEC
 Ursa Major	60 million	 15,000 KM/SEC
 Corona Borealis	1 billion	 22,000 KM/SEC

Four statements about the universe, labeled *A*, *B*, *C*, and *D*, are shown in the table below.

A	The farther away a galaxy is from Earth, the more light is red-shifted, indicating an accelerating galaxy velocity.
B	The greater the distance a galaxy is from Earth, the more recessional velocities decrease (along with blue-shifted spectra data).
C	The closer galaxies are to Earth, the recessional velocity decreases, indicating the presence of cosmic microwave background radiation.
D	As distance of galaxies increases from Earth, the recessional velocity increases, shifting spectra to include longer wavelengths.

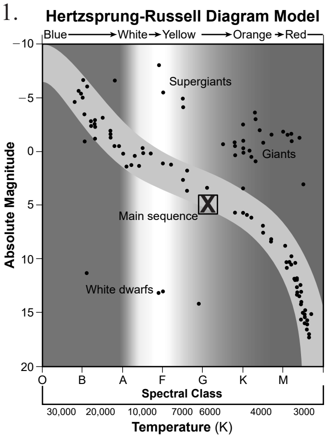
8. Which pair of statements supports the Big Bang theory, based on the given astronomical evidence of light spectra, galaxy distances, and galaxy velocities?
(1) *A* and *B* (2) *B* and *C* (3) *C* and *D* (4) *D* and *A* 8 ____

EARTH AND SPACE SCIENCES
ANSWERS AND EXPLANATIONS

An Earth and Space Sciences Reference Table is quoted throughout this section. The 2026 Earth and Space Sciences Reference Tables can be found in the back of this booklet.

TEST 1

1.



Explanation: On the temperature scale locate the area of 5,000 to 6,000 K. From this position move directly up stopping at the absolute magnitude value of 5. At this intersection position, place a **X**. The **X** should be positioned in the Main sequence section; this is where the Sun is presently located on the H-R diagram.

Change in relative temperature: cooler *or* lower temperature
Change in relative absolute magnitude: decreased *or* lower magnitude value

Explanation: Our Sun radiates in the 5,000 to 6,000 K range. When its fuel runs low, it will undergo expansion. This would cause the Sun's temperature to decrease and the Sun to be repositioned in the Giants' star area. The *H-R Diagram Model* shows that Giant stars are at a cooler temperature, around 3,500 K. When our Sun, with an absolute magnitude of 5, transitions (changes) to a red giant star, its size will greatly increase, and it will become brighter. This would decrease its absolute magnitude value to the Giants' value, in the range of 0 to –3.

2. Answer: mass

   Explanation: Our Sun is an average star; this classification is based on its mass. In its late stage of its life, the Sun will move off the Main Sequence and become a red giant star. Only massive stars become supergiant stars, for they contain the necessary mass to do so.

3. Answer: 4

   Nuclear fusion produces the energy of a star that occurs in the very dense *core*. This energy is then slowly emitted outward, entering the large *radiative zone*. The next level that the energy enters is the *convection zone*. At the *photosphere*, the Sun's energy is radiated out in space, which we see. The layer above the photosphere is the *chromosphere*.

4. Answer: 8.3 minutes

   Explanation: To arrive at this answer, one needs to divide the distance by the speed of light then convert the seconds to minutes.

   Solution: $\dfrac{150{,}000{,}000\text{ km}}{300{,}000\text{ km/sec}} = \dfrac{1500}{3} = 500\text{ sec}\ \dfrac{500\text{ sec}}{60\text{ sec/min}} = 8.3\text{ minutes}$

5. Answer: convection zone

   Explanation: In the *Model of Sun's Layers*—Convection zone—it states, "rapid heating of plasma creates currents of heated and cooled gas." The different temperatures of the plasma, produce different density values. This causes the hotter plasma to rise, while the cooler plasma sinks, setting off a convection current.

6. Answer: Box 2 and 3 are checked.

   Explanation: In astronomy, the eccentricity value tells the shape of an orbiting celestial body. An eccentricity value of 0 is a perfect circle, for any number greater than 0, the orbiting path is elliptical (oval). The greater the eccentricity value is, the more elliptical the orbit will be. Venus' orbit, having a lower eccentricity value than Mercury, is less elliptical than Mercury's orbit. Having an eccentricity value greater than 0, the orbiting object at one time will be closer and at one time will be farther from the central object it is orbiting. This change of orbital distance produces different orbital speeds, being faster when closer and slower when farther from the orbiting object.

   Note, the revolution speed of all planets is fastest when the planets are closest to the Sun.

7. Answer: 2

   The closer an orbiting object is to the Sun, the faster is its orbital speed. This new planet would have a slower orbital speed than Mercury, but greater than that of Venus.

8. Choice A: inside Choice B: closer to Choice C: Sun

   Explanation: Venus' orbital path is closer to the Sun than Earth. When Venus' orbit takes it closer to the Earth, at a certain position, the reflected sunlight off the clouds of Venus will produce a crescent phase seen using a telescope.

9. Answer: 3

   During winter, the Earth's tilt of $23.5°$ causes the northern hemisphere to experience indirect sunlight, causing less heating ability of the radiant energy. If the tilt (obliquity) becomes less, to $22.1°$, the Sun's winter rays striking the northern hemisphere would be slightly stronger, producing more energy year-round. This would result in less formation of polar ice.

10. Answer: 2

    Diagram 2, *Influence of Fresh Water*, shows that the melting cold water of Greenland's glaciers makes the North Atlantic waters less salty, which lowers the density value of this water. This action restricts the southern warm water from moving north, resulting in a weakening of the ocean current circulation.

11. Answer: 1

    The *Ocean Currents Mode*l shows that a warm current flows by location *Y*. This produces warmer air temperatures in this location. Warmer air holds more water vapor than cold air, resulting in more precipitation to location *Y*.

12. Answer: 4

    Darker surfaces absorb more energy than lighter surfaces. When darker surfaces are exposed in glacial areas, more energy is absorbed causing more melting, decreasing the size of the glaciers.

EARTH AND SPACE SCIENCES REFERENCE TABLES
2026 EDITION

Contents

Solar System Objects Data Table

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=Earth days) (y=Earth years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Axial Tilt (°)
SUN	---	---	25.4 d	---	~1,391,400	7.25
MERCURY	57.9	88.0 d	58.7 d	0.206	4879	0.03
VENUS	108.2	224.7 d	243.7 d	0.007	12,104	177.36
EARTH	149.6	365.26 d	23 h 56 min	0.017	12,756	23.44
EARTH'S MOON	149.6 (0.384 from Earth)	27.3 d	27.3 d	0.055	3475	6.68
MARS	228.0	1.9 y	24 h 37 min	0.094	6792	25.19
CERES	414.0	4.6 y	9 h 5 min	0.079	~939	4.00
PALLAS	414.0	4.6 y	7 h 49 min	0.231	~513	84.00
JUPITER	778.5	11.9 y	9 h 54 min	0.049	142,976	3.13
SATURN	1432.0	29.4 y	10 h 39 min	0.054	120,536	26.73
URANUS	2867.0	84.0 y	17 h 15 min	0.047	51,118	97.77
NEPTUNE	4515.0	164.8 y	16 h 6 min	0.009	49,528	28.32
PLUTO	5906.4	248.0 y	6.4 d	0.244	2376	119.51
ERIS	~10,000.0	~557.6 y	1.1 d	0.436	2400	~78.30