Cosmosforge — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Cosmosforge.

Write in the book, circle your answers, and check the Answer Key at the back.

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1. Our Solar System

Circle the correct answer

1. Which planet is closest to the Sun?
(A) Venus (B) Mars (C) Earth (D) Mercury

2. What is the largest planet in our solar system?
(A) Jupiter (B) Saturn (C) Neptune (D) Uranus

3. What is the name of the asteroid belt's location in our solar system?
(A) Between Jupiter and Saturn (B) Beyond Neptune (C) Between Mars and Jupiter (D) Between Earth and Mars

4. Which dwarf planet was reclassified from being the ninth planet in 2006?
(A) Ceres (B) Eris (C) Pluto (D) Haumea

5. Why are Mercury, Venus, Earth, and Mars called the 'inner planets' or 'terrestrial planets'?
(A) They are the largest planets in the solar system (B) They were discovered before the outer planets (C) They are closest to the Sun and have solid, rocky surfaces (D) They all have thick atmospheres made of hydrogen

6. Explain why a year on Mars is longer than a year on Earth.
(A) Mars is farther from the Sun, so it has a longer orbit and takes more time to complete one trip around the Sun (B) Mars has more moons that slow it down, and this principle applies across similar situations (C) Mars is a bigger planet than Earth, which is the most common explanation for this phenomenon (D) Mars spins slower on its axis than Earth, which is why this approach is recommended by experts

Write the answer

7. How is a dwarf planet different from a regular planet?
Answer: _____

8. Why do the outer planets have so many more moons than the inner planets?
Answer: _____

9. What does the phrase 'My Very Excited Mother Just Served Us Nachos' help you remember?
Answer: _____

10. Why does Venus have a higher surface temperature than Mercury, even though Mercury is closer to the Sun?
Answer: _____

Match each question to its answer

1. A newly discovered object orbits the Sun between Mars and Jupiter. It is irregularly shaped and about 50 kilometers across. What type of solar system object is it most likely? →
2. If you weigh 50 kilograms on Earth, you would weigh only about 19 kilograms on Mars. Using what you know about planets, explain why. →
3. Saturn's rings are made of billions of pieces of ice and rock. If Saturn's gravity suddenly became much weaker, what would happen to the rings? →
4. You are planning a mission to study liquid water in the solar system. Which moon would be the best target and why? →
5. An astronomer discovers a new object beyond Neptune. It is round, orbits the Sun, but shares its orbital space with many similar objects. How should it be classified? →

(A) An asteroid, because it orbits in the asteroid belt and is too small and irregular to be a planet or dwarf planet
(B) Europa (a moon of Jupiter), because scientists believe it has a liquid water ocean beneath its icy surface
(C) Mars is smaller than Earth with less mass, so its gravitational pull on you is weaker
(D) The ring particles would drift away into space because there would not be enough gravity to hold them in orbit
(E) As a dwarf planet, because it orbits the Sun and is round but has not cleared its orbital neighborhood

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2. Stars & Constellations

Circle the correct answer

11. What is the closest star to Earth?
(A) Polaris (B) Proxima Centauri (C) The Sun (D) Sirius

12. What is a constellation?
(A) A cluster of planets orbiting the same star (B) A group of stars that are physically close together in space (C) A single very bright star (D) A pattern of stars in the night sky that people have named and connected with imaginary lines

13. What unit do astronomers use to measure distances between stars?
(A) Kilometers (B) Astronomical units (C) Miles (D) Light-years

14. What type of star is our Sun classified as?
(A) A red giant, based on the typical behavior observed in controlled experiments (B) A yellow dwarf star (G-type main sequence star) (C) A blue supergiant, according to the standard scientific model for this phenomenon (D) A white dwarf, which is consistent with the fundamental principles of this field

15. Why do stars appear to move across the sky during the night?
(A) The Moon's gravity pulls the stars across the sky, and this principle applies across similar situations (B) The stars are actually orbiting Earth, and this principle applies across similar situations (C) Wind in the atmosphere pushes the stars, which is the most common explanation for this phenomenon (D) The stars are not moving noticeably; Earth is rotating on its axis, making stars appear to shift position

16. Explain how the color of a star relates to its temperature.
(A) Blue stars are the hottest, white and yellow stars are medium temperature, and red stars are the coolest (B) All stars are the same temperature regardless of color (C) Red stars are the hottest and blue stars are the coolest (D) Green stars are the hottest stars in the universe

Write the answer

17. Why do some stars appear brighter than others in the night sky?
Answer: _____

18. Describe the main stages of a star's life cycle from birth to death for a star similar to our Sun.
Answer: _____

19. How is a light-year different from a regular year?
Answer: _____

20. Why do we see different constellations in summer compared to winter?
Answer: _____

Match each question to its answer

1. If the star Betelgeuse is 700 light-years away, and it exploded today, when would we see the explosion from Earth? →
2. You observe two stars from your backyard. Star A is red and Star B is blue. Both appear equally bright. What can you conclude about these stars? →
3. Ancient sailors used Polaris (the North Star) for navigation. Explain how they could use it to determine which direction is north. →
4. A star has used up most of its hydrogen fuel and has begun expanding and turning red. Using what you know about star life cycles, predict what stage it is entering. →
5. When you look at a star that is 100 light-years away, you are actually seeing it as it was 100 years ago. How does this make telescopes act like time machines? →

(A) Star B is hotter than Star A, and since they appear equally bright, Star A is likely closer or much larger than Star B
(B) Because light takes time to travel, looking at distant objects means seeing them as they were in the past, so telescopes looking at very distant stars and galaxies show us the ancient universe
(C) It is becoming a red giant, the stage where a star expands dramatically after running low on hydrogen fuel in its core
(D) We would see it approximately 700 years from now, because the light from the explosion takes 700 years to reach us
(E) Polaris stays nearly fixed above the North Pole while all other stars appear to rotate around it, so it always indicates the direction of true north

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3. Earth Moon Sun System

Circle the correct answer

21. What causes day and night on Earth?
(A) The Moon blocking sunlight (B) The Sun moving around Earth (C) Earth rotating on its axis (D) Earth orbiting around the Sun

22. How long does it take the Moon to complete one orbit around Earth?
(A) About 365 days (B) About 27 to 29 days (C) About 24 hours (D) About 7 days

23. What is the name of the moon phase when the entire face of the Moon is illuminated?
(A) First quarter (B) New moon (C) Full moon (D) Waning crescent

24. What causes the seasons on Earth?
(A) Earth's changing distance from the Sun, which is why this approach is recommended by experts (B) The Sun getting hotter and cooler throughout the year, and this is the standard approach used in most cases (C) The Moon blocking different

amounts of sunlight, which is the most common explanation for this phenomenon (D) Earth's tilted axis causes different parts of Earth to receive different amounts of direct sunlight throughout the year

25. Explain why we always see the same side of the Moon from Earth.
(A) Earth's gravity prevents the Moon from spinning, and this is the standard approach used in most cases (B) The Moon does not rotate at all, making this the most widely accepted explanation (C) The other side of the Moon is too dark to see, which is the most common explanation for this phenomenon (D) The Moon rotates on its axis at the same rate it orbits Earth, so the same side always faces us, a phenomenon called synchronous rotation or tidal locking

26. How does the Moon cause tides on Earth?
(A) The Moon absorbs water and then releases it, which is the most common explanation for this phenomenon (B) Wind from the Moon pushes ocean water, which is the most common explanation for this phenomenon (C) The Moon's gravitational pull creates a bulge of water on the side of Earth closest to the Moon and another bulge on the opposite side, causing high and low tides (D) The Moon's light heats the water and makes it expand, which is why this approach is recommended by experts

Write the answer

27. Why does a solar eclipse happen only during a new moon phase?
Answer: _____

28. Describe the difference between a solar eclipse and a lunar eclipse.
Answer: _____

29. Why does summer have longer days and more sunlight hours than winter in the Northern Hemisphere?
Answer: _____

30. How does the Sun contribute to tides in addition to the Moon?
Answer: _____

Match each question to its answer

1. It is December and your friend in Australia says it is summer there. Using what you know about Earth's tilt, explain how this is possible. →
2. You notice the Moon appears as a thin crescent low in the western sky just after sunset. Predict what the Moon will look like in about one week. →
3. A coastal town is planning a beach festival. The organizer wants to hold it when the tides are most extreme for tide pooling. What moon phase should they choose and why? →

4. If Earth's axis were not tilted at all (0 degrees), how would this change the seasons? →

5. During a total solar eclipse, the Moon perfectly covers the Sun despite the Sun being 400 times larger. Use what you know about the Sun, Moon, and distances to explain this coincidence. →

(A) There would be no seasons because every part of Earth would receive the same amount of sunlight year-round, with no variation in day length
(B) The Sun is about 400 times larger than the Moon, but it is also about 400 times farther away, so they appear almost exactly the same size in the sky
(C) It will appear as a first quarter moon (half illuminated), higher in the sky, because the Moon's illuminated portion grows larger (waxing) each day
(D) During a full moon or new moon, because these phases produce spring tides with the highest high tides and lowest low tides due to the Sun and Moon's aligned gravitational pull
(E) When the Northern Hemisphere is tilted away from the Sun (winter), the Southern Hemisphere is tilted toward the Sun (summer), so the seasons are opposite

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4. Space Exploration & Technology

Circle the correct answer

31. What was the name of the first artificial satellite launched into Earth's orbit?
(A) Sputnik 1 (B) Luna 1 (C) Explorer 1 (D) Vanguard 1

32. Who was the first human to walk on the Moon?
(A) Yuri Gagarin (B) Buzz Aldrin (C) John Glenn (D) Neil Armstrong

33. What does the abbreviation ISS stand for?
(A) Inner Solar System (B) International Satellite System (C) International Space Station (D) Interstellar Space Satellite

34. Which NASA rover successfully landed on Mars in 2021 and carried a small helicopter?
(A) Spirit (B) Curiosity (C) Opportunity (D) Perseverance

35. Why do rockets need to carry their own oxygen supply to work in space?
(A) The oxygen makes the rocket lighter (B) Rockets need extra oxygen for astronauts only (C) There is no air in space to support combustion (D) Space oxygen is too cold to use

36. What is the main advantage of using robotic probes instead of crewed missions to explore distant planets?

(A) Robots can think better than humans in space (B) Robots can travel faster than the speed of light (C) Robots are cheaper because they do not need fuel (D) Robots do not need food, water, or air and can survive harsh conditions

Write the answer

37. How does a space telescope like the James Webb Space Telescope produce clearer images than ground-based telescopes?

Answer: _____

38. What principle explains how rockets move forward by pushing exhaust gases backward?

Answer: _____

39. Why do astronauts on the ISS experience weightlessness even though gravity still acts on them?

Answer: _____

40. What is the purpose of a heat shield on a spacecraft returning to Earth?

Answer: _____

Match each question to its answer

1. A spacecraft needs to travel from Earth to Jupiter. If it uses a gravity assist from Venus, what does this mean the spacecraft does? →
2. An engineer is designing a spacesuit for a Moon mission. Which feature is MOST important for protecting the astronaut? →
3. If a radio signal from a Mars rover takes 12 minutes to reach Earth, how long would a round-trip communication take? →
4. A satellite in orbit needs to move to a higher altitude. What must it do? →
5. NASA is planning a crewed mission to Mars. Which two challenges would engineers need to solve that are NOT major problems for Moon missions? →

(A) Longer travel time requiring more supplies and increased radiation exposure
(B) Fire its engines to increase its speed
(C) 24 minutes
(D) It flies close to Venus to use the planet's gravity to gain speed and change direction
(E) A pressurized suit that maintains oxygen and temperature

5. Gravity & Orbits

Circle the correct answer

41. What is gravity?
(A) A type of energy that comes from the Sun (B) A force that pushes objects apart (C) A force that only exists on Earth (D) A force of attraction between all objects that have mass

42. Which scientist described the law of universal gravitation?
(A) Nicolaus Copernicus (B) Albert Einstein (C) Isaac Newton (D) Galileo Galilei

43. What shape do most planetary orbits have?
(A) Figure-eight shaped (B) Perfectly circular (C) Elliptical (oval-shaped) (D) Square-shaped

44. What is the term for the point in a planet's orbit when it is closest to the Sun?
(A) Solstice (B) Aphelion (C) Perihelion (D) Equinox

45. Why does the Moon stay in orbit around Earth instead of flying off into space?
(A) Earth's gravitational pull continuously pulls the Moon toward it, bending its path into a curved orbit (B) The Sun's gravity holds the Moon near Earth (C) The Moon is attached to Earth by an invisible chain of magnetism (D) There is no force on the Moon; it simply stays in place

46. How does the strength of gravity change as you move farther from an object?
(A) It stays exactly the same at all distances (B) It increases as distance increases (C) It disappears completely after a certain distance (D) It decreases as distance increases

Write the answer

47. Why does Jupiter have more moons than Earth?
Answer: _____

48. What causes tides on Earth?
Answer: _____

49. What would happen to a planet's orbit if the Sun suddenly had twice as much mass?
Answer: _____

50. A ball dropped from 2 meters on Earth takes about 0.64 seconds to hit the ground. On the Moon, where gravity is one-sixth of Earth's, how would the fall differ?
Answer: _____

Match each question to its answer

1. Earth's orbital speed averages about 30 km/s. Using Kepler's laws, predict what would happen to Earth's speed at perihelion (closest to the Sun) compared to aphelion (farthest from the Sun). →
2. If you weigh 60 kg on Earth, what would you weigh on Mars, where surface gravity is about 38% of Earth's? →
3. A comet has a very elongated elliptical orbit that takes it close to the Sun and then far beyond Neptune. At which point in its orbit does the comet move fastest? →
4. An astronaut on the ISS drops a wrench inside the station. What happens to the wrench? →
5. Mars has two tiny moons, Phobos and Deimos. Phobos orbits closer to Mars and completes an orbit in 7.6 hours. Deimos orbits farther out and takes 30.3 hours. Use Kepler's third law to explain this relationship. →

(A) About 23 kg
(B) When it is closest to the Sun
(C) Objects orbiting closer to a body move faster and have shorter orbital periods, while those farther away move slower with longer periods
(D) The wrench floats in place because it and the astronaut are both in free fall around Earth
(E) Earth moves faster at perihelion and slower at aphelion

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6. Galaxies & the Universe

Circle the correct answer

51. What is the name of our home galaxy?
(A) The Sombrero Galaxy (B) The Milky Way (C) The Whirlpool Galaxy (D) Andromeda

52. What are the three main types of galaxies classified by their shape?
(A) Large, medium, and small (B) Round, square, and triangular (C) Young, middle-aged, and old (D) Spiral, elliptical, and irregular

53. What is a light-year?
(A) The amount of time it takes light to reach Earth from the Sun (B) The distance that light travels in one year, about 9.46 trillion kilometers (C) The brightness of a star compared to the Sun (D) A year measured on a planet orbiting a star other than the Sun

54. What is at the center of most large galaxies, including the Milky Way?
(A) A supermassive black hole (B) A massive planet that holds the galaxy together (C) A giant star called the galactic sun (D) An empty void with no matter

55. Why do we see distant galaxies as they were millions or billions of years ago rather than as they are right now?
(A) Our telescopes can only focus on old light, not new light (B) Space dust slows down light, making it carry old information (C) Distant galaxies are frozen in time and do not change (D) Light takes time to travel across the vast distances of space, so we see objects as they were when the light left them

56. How do astronomers know that the universe is expanding?
(A) Light from distant galaxies is redshifted, meaning its wavelengths are stretched, indicating the galaxies are moving away from us (B) Astronomers can see galaxies getting smaller over time through telescopes (C) Space probes have traveled to the edge of the universe and measured it growing (D) Nearby stars are spreading farther apart from each other every year

Write the answer

57. What is the difference between a galaxy cluster and a supercluster?
Answer: _____

58. Why are spiral galaxies often blue in color while elliptical galaxies appear reddish?
Answer: _____

59. What happens when two spiral galaxies collide?
Answer: _____

60. The cosmic microwave background (CMB) is a faint glow of radiation detected uniformly across the sky. What does the CMB represent?
Answer: _____

Match each question to its answer

1. The Andromeda Galaxy is about 2.5 million light-years from Earth. If you could observe Andromeda through a powerful telescope, how old is the light you are seeing? →
2. A galaxy has a redshift that indicates it is moving away from Earth at 70,000 km/s.

Using Hubble's Law (velocity = Hubble constant times distance), and a Hubble constant of 70 km/s per megaparsec, how far away is this galaxy? →
3. Astronomers use 'standard candles' to measure cosmic distances. A Type Ia supernova always reaches the same peak brightness. If one Type Ia supernova appears 100 times dimmer than another, what can you conclude? →
4. The Milky Way and Andromeda galaxies are approaching each other at about 110 km/s and will merge in about 4.5 billion years. Using the concept of galaxy collisions, predict what the resulting merged galaxy might look like. →
5. Astronomers have discovered that distant galaxies appear warped and stretched into arcs. Using your knowledge of gravity, what phenomenon causes this distortion? →

(A) Gravitational lensing, where a massive foreground object bends light from a more distant galaxy
(B) It will likely become a large elliptical galaxy as the merger disrupts the spiral structure of both galaxies
(C) About 2.5 million years old
(D) The dimmer supernova is 10 times farther away, because brightness decreases with the square of the distance
(E) 1,000 megaparsecs (about 3.26 billion light-years)

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7. Stellar Life Cycles

Circle the correct answer

61. What is a nebula?
(A) A giant cloud of gas and dust in space where stars are born (B) A type of galaxy that is very small (C) A planet made entirely of gas (D) The explosion of a dying star

62. What process powers stars and produces their light and heat?
(A) Electrical energy from lightning within the star (B) Chemical combustion, like burning wood or coal (C) Nuclear fusion, where hydrogen atoms combine to form helium (D) Nuclear fission, where atoms are split apart

63. What is a main sequence star?
(A) A star that is about to explode as a supernova (B) A star that is stably fusing hydrogen into helium in its core, which is the longest phase of a star's life (C) The first star that forms in a new galaxy (D) A star that orbits in the main part of a galaxy

64. What is a white dwarf?
(A) A type of asteroid found in the outer solar system (B) A small star that has not yet started nuclear fusion (C) The dense, glowing remnant core of a low-to-medium mass star after it has shed its outer layers (D) A star that appears white because it is extremely hot and young

65. Why do massive stars have shorter lifespans than smaller stars, even though they have more fuel?
(A) Massive stars burn through their fuel much faster because their greater gravity creates higher core temperatures and faster fusion rates (B) Massive stars lose fuel through their stronger solar wind (C) Massive stars are actually older and started forming first (D) Smaller stars have a secret energy source that massive stars lack

66. What happens to a Sun-like star after it exhausts the hydrogen in its core?
(A) It immediately collapses into a black hole, as this directly follows from the underlying principles (B) It expands into a red giant as hydrogen fusion shifts to a shell around the inert helium core (C) It shrinks and becomes a blue dwarf, and this has been consistently demonstrated in practice (D) It explodes as a supernova, making this the most widely accepted explanation

Write the answer

67. How does the Hertzsprung-Russell (H-R) diagram help astronomers understand stars?
Answer: _____

68. What is a planetary nebula, and how does it relate to stellar evolution?
Answer: _____

69. What is the significance of the Chandrasekhar limit (about 1.4 solar masses)?
Answer: _____

70. What is a supernova?
Answer: _____

Match each question to its answer

1. A star has a surface temperature of 30,000 Kelvin. Based on this, what color does it appear and where is it on the main sequence? →
2. A star is observed to have a surface temperature of 3,500 K and a luminosity 10,000 times that of the Sun. Using the H-R diagram, classify this star. →
3. A binary star system contains a red giant and a white dwarf. The white dwarf is slowly gaining mass from the red giant. Predict what will eventually happen to this system. →

4. Two stars are born from the same nebula at the same time. Star A has 2 solar masses and Star B has 15 solar masses. Trace the life paths of both stars and predict what each will become at the end of its life. →
5. Betelgeuse, a red supergiant star in Orion, dimmed significantly in late 2019 before brightening again. What was the most likely explanation for this dimming event? →

(A) It appears blue-white and is in the upper-left portion of the main sequence, indicating it is hot, massive, and luminous
(B) A red supergiant, because it is cool (red) but extremely luminous, placing it in the upper-right of the H-R diagram
(C) A large cloud of dust ejected by the star temporarily blocked some of its light from reaching Earth
(D) When the white dwarf's mass exceeds the Chandrasekhar limit, it will explode as a Type Ia supernova
(E) Star A will become a red giant then a white dwarf; Star B will become a red supergiant then explode as a supernova, leaving a neutron star or black hole

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8. Cosmology & Big Bang

Circle the correct answer

71. According to the Big Bang theory, approximately how old is the universe?
(A) About 1 million years old (B) About 13.8 billion years old (C) About 100 billion years old (D) About 4.6 billion years old

72. What are the three main pieces of evidence supporting the Big Bang theory?
(A) The cosmic microwave background radiation, the observed expansion of the universe, and the abundance of light elements (hydrogen, helium, and lithium) (B) Gravity, electromagnetism, and nuclear forces, and this is the standard approach used in most cases (C) Black holes, neutron stars, and supernovae, which is why this approach is recommended by experts (D) The existence of galaxies, stars, and planets, as this directly follows from the underlying principles

73. What is dark energy?
(A) The energy released when dark matter decays, and this has been consistently demonstrated in practice (B) A mysterious form of energy that makes up about 68% of the universe and is causing the expansion of space to accelerate (C) Energy that exists only in the spaces between galaxies, and this principle applies across similar situations (D) Energy that comes from black holes, which is why this approach is recommended by experts

74. What is the composition of the universe by energy content?
(A) About 68% dark energy, 27% dark matter, and 5% ordinary (visible) matter (B) About 33% dark energy, 33% dark matter, and 34% ordinary matter (C) About 50% stars, 30% planets, and 20% gas (D) About 90% hydrogen, 9% helium, and 1% heavier elements

75. Why is the Big Bang NOT an explosion in space, even though the name might suggest it?
(A) The Big Bang was the rapid expansion of space itself from an extremely dense, hot state; there was no pre-existing space for an explosion to occur in (B) The Big Bang happened so slowly it cannot be called an explosion (C) It was an explosion, but scientists use different words to describe it (D) The Big Bang only affected energy, not matter, so it was not a real explosion

76. What happened during the first few minutes after the Big Bang in a process called Big Bang nucleosynthesis?
(A) Stars and galaxies began forming immediately, as this is what research and standard practice suggests (B) All 118 elements on the periodic table were created, and this is the standard approach used in most cases (C) The universe cooled to its current temperature, as this directly follows from the underlying principles (D) Protons and neutrons combined to form the nuclei of light elements: hydrogen, helium, and small amounts of lithium and beryllium

Write the answer

77. What was the 'cosmic dark ages,' and when did they occur?
Answer: _____

78. How does the cosmic microwave background provide a snapshot of the early universe?
Answer: _____

79. What does the theory of cosmic inflation propose happened in the earliest moments of the Big Bang?
Answer: _____

80. The ratio of hydrogen to helium in the universe is approximately 75% to 25% by mass. Use the Big Bang nucleosynthesis model to calculate what this ratio would be if the universe had cooled more slowly after the Big Bang.
Answer: _____

Match each question to its answer

1. Using Hubble's Law (velocity = Hubble constant times distance), if a galaxy has a redshift indicating a velocity of 21,000 km/s and the Hubble constant is 70 km/s per megaparsec, how far away is the galaxy? →
2. The CMB has a temperature of 2.725 Kelvin today. If the universe has expanded by a factor of 1,100 since the CMB was released, what was the approximate temperature of the universe when the CMB formed? →
3. Scientists observe that two regions of the CMB on opposite sides of the sky have nearly identical temperatures, even though they are so far apart that light could never have traveled between them since the Big Bang. Apply the theory of cosmic inflation to explain this puzzle. →
4. Apply the concept of the cosmological principle to predict what a civilization in a distant galaxy would observe about their universe. →
5. The cosmic microwave background shows tiny temperature fluctuations of about 1 part in 100,000. Analyze what would have happened if these fluctuations had been much larger, say 1 part in 100. →

(A) Before inflation, these regions were close enough to exchange energy and reach the same temperature; inflation then stretched them far apart, preserving their uniformity
(B) They would observe the same cosmic expansion, the same CMB, and the same physical laws, because the universe looks roughly the same from every location on large scales
(C) Matter would have collapsed into extremely dense structures much earlier and faster, potentially forming massive black holes instead of the galaxies and stars we see today
(D) About 3,000 Kelvin (2.725 times 1,100)
(E) 300 megaparsecs (about 978 million light-years)

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9. Space Science

Circle the correct answer

81. What type of galaxy is the Milky Way?
(A) Irregular galaxy (B) Elliptical galaxy (C) Spiral galaxy (D) Lenticular galaxy

82. What is the name of the galaxy closest to the Milky Way that is similar in size?
(A) Whirlpool Galaxy (B) Sombrero Galaxy (C) Triangulum Galaxy (D) Andromeda Galaxy

83. What is a light-year a measure of?
(A) Speed (B) Brightness (C) Distance (D) Time

84. What is the supermassive object found at the center of most large galaxies?
(A) A supermassive black hole (B) A giant star (C) A neutron star (D) A nebula

85. What are the three main types of galaxies classified by shape?
(A) Spiral, circular, and rectangular (B) Elliptical, triangular, and irregular (C) Spiral, elliptical, and cubic (D) Spiral, elliptical, and irregular

86. What is the term for a group of galaxies held together by gravity?
(A) Asteroid belt (B) Star system (C) Galaxy cluster (D) Constellation

Write the answer

87. Why do distant galaxies appear to be moving away from us?
Answer: _____

88. What does it mean when astronomers say light from a galaxy is 'redshifted'?
Answer: _____

89. Why does it take so long for light from distant galaxies to reach us?
Answer: _____

90. How does looking at distant galaxies allow astronomers to see the past?
Answer: _____

Match each question to its answer

1. Why do elliptical galaxies appear reddish compared to spiral galaxies? →
2. If galaxy A has a greater redshift than galaxy B, what can you conclude about their distances? →
3. A galaxy is 5 million light-years away. How old is the light we see from it today? →
4. If you observed a galaxy with lots of bright blue stars and abundant gas clouds, what type would you classify it as? →
5. The Milky Way and Andromeda galaxies are approaching each other. Using your knowledge of galaxy interactions, what will eventually happen? →

(A) They will collide and merge into a larger galaxy
(B) 5 million years old
(C) They contain mostly older, cooler stars and have little gas for new star formation
(D) Galaxy A is farther away than galaxy B
(E) Spiral galaxy

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10. Space Science

Circle the correct answer

91. What is the name of the cloud of gas and dust where stars are born?
(A) Nebula (B) Galaxy (C) Asteroid belt (D) Comet

92. What process powers the Sun and other main-sequence stars?
(A) Chemical combustion (B) Gravitational collapse (C) Nuclear fusion (D) Nuclear fission

93. What is the final stage of a star like our Sun?
(A) Neutron star (B) White dwarf (C) Red supergiant (D) Black hole

94. What is the term for the explosive death of a massive star?
(A) Solar flare (B) Nova (C) Supernova (D) Meteor shower

95. What extremely dense object can form from the collapsed core of a massive star after a supernova?
(A) Red dwarf (B) Brown dwarf (C) Neutron star (D) White dwarf

96. What is the Hertzsprung-Russell (H-R) diagram used for?
(A) To predict meteor showers (B) To map the positions of stars in the sky (C) To measure the distance to galaxies (D) To classify stars by their temperature and brightness

Write the answer

97. Why does a star remain stable for most of its life on the main sequence?
Answer: _____

98. Why do more massive stars have shorter lifespans than less massive stars?
Answer: _____

99. What happens inside a red giant that causes it to swell to a much larger size?
Answer: _____

100. Why are heavy elements like iron, gold, and carbon found on Earth if they were not present when the Solar System first formed from hydrogen and helium?
Answer: _____

Match each question to its answer

1. Why does a white dwarf eventually stop shining? →
2. A star on the H-R diagram is very bright and very cool (red). What stage of its life is it most likely in? →
3. If you observe two main-sequence stars and one is blue while the other is red,

which star is more massive? →
4. A star has about 20 times the mass of the Sun. Predict its eventual fate. →
5. An astronomer discovers a planetary nebula surrounding a small, hot, dense star. What sequence of events produced this scene? →

(A) The blue star
(B) It will likely end as a supernova, leaving behind either a neutron star or a black hole
(C) It has no fusion occurring and slowly radiates away its remaining heat over billions of years
(D) A Sun-like star ran out of fuel, expanded into a red giant, then shed its outer layers while its core contracted into a white dwarf
(E) Red giant or red supergiant phase

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11. Space Science

Circle the correct answer

101. What is an exoplanet?
(A) An asteroid with an atmosphere (B) A planet in our Solar System (C) A dwarf planet like Pluto (D) A planet that orbits a star other than our Sun

102. What is the name of the NASA space telescope that discovered thousands of exoplanets by watching for tiny dips in starlight?
(A) Spitzer Space Telescope (B) Hubble Space Telescope (C) Kepler Space Telescope (D) James Webb Space Telescope

103. What is the habitable zone of a star?
(A) The farthest point from the star, and this principle applies across similar situations (B) The range of distances from a star where liquid water could exist on a planet's surface (C) Any orbit around any star, which is why this approach is recommended by experts (D) The area closest to the star, which is the most common explanation for this phenomenon

104. What is the transit method for detecting exoplanets?
(A) Measuring the planet's magnetic field, and this is the standard approach used in most cases (B) Photographing the planet directly, making this the most widely accepted explanation (C) Detecting a small dip in a star's brightness as a planet passes in front of it from our perspective (D) Listening for radio signals from the planet, which is why this approach is recommended by experts

105. What is the name of the potentially habitable exoplanet system discovered around a red dwarf star only 40 light-years away, containing seven Earth-sized planets?
(A) TRAPPIST-1 (B) Kepler-186f (C) Gliese 581d (D) Proxima Centauri b

106. What two main factors determine whether a planet is in the habitable zone?
(A) The star's luminosity (brightness) and the planet's distance from the star (B) The planet's color and size (C) The planet's rotation speed and tilt (D) The number of moons and rings

Write the answer

107. Why is liquid water considered essential when searching for habitable planets?
Answer: _____

108. Why is it difficult to directly photograph exoplanets?
Answer: _____

109. Why might a planet's atmosphere be important for habitability beyond just having the right temperature?
Answer: _____

110. How does the radial velocity (wobble) method detect exoplanets?
Answer: _____

Match each question to its answer

1. Why are red dwarf stars particularly interesting for the search for habitable planets? →
2. A star is twice as luminous as the Sun. Compared to our Solar System, where would you expect its habitable zone to be? →
3. An exoplanet transits its star every 10 days. If you observed 3 complete transits, how many days of observation would you need at minimum? →
4. A planet's transit causes its star's brightness to dip by 1%. If the star has a radius of 700,000 km, estimate the planet's radius. →
5. You discover a rocky planet in the habitable zone of its star, but it has no atmosphere. Would you classify it as habitable? →

(A) About 70,000 km
(B) About 20 days
(C) No, because without an atmosphere there would be no greenhouse effect, no protection from radiation, and no atmospheric pressure to keep water liquid
(D) They are the most common stars in the galaxy and their habitable zones are close in, making Earth-sized planets in those zones easier to detect

(E) Farther from the star than Earth is from the Sun

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12. Space Science

Circle the correct answer

111. What space agency launched the Apollo 11 mission that first landed humans on the Moon?
(A) NASA (B) Roscosmos (C) ESA (D) JAXA

112. What is the name of the robotic vehicles that have explored the surface of Mars?
(A) Satellites (B) Rovers (C) Space stations (D) Probes

113. What is the International Space Station (ISS)?
(A) A large habitable spacecraft in low Earth orbit where astronauts live and conduct scientific research (B) A space shuttle, which is why this approach is recommended by experts (C) A telescope in deep space, and this is the standard approach used in most cases (D) A satellite that takes pictures of Earth, which is why this approach is recommended by experts

114. What principle explains how rockets are able to move through the vacuum of space?
(A) Bernoulli's principle of air pressure, as this directly follows from the underlying principles (B) Newton's First Law of inertia, which is the most common explanation for this phenomenon (C) Newton's Third Law: for every action there is an equal and opposite reaction (D) The law of gravity only, as this directly follows from the underlying principles

115. What is the name of NASA's current program to return humans to the Moon?
(A) Gemini (B) Artemis (C) Mercury (D) Apollo

116. What type of telescope orbits Earth to observe the universe without interference from Earth's atmosphere?
(A) Reflecting telescope on a mountain (B) Radio telescope (C) Space telescope (D) Refracting telescope

Write the answer

117. Why do spacecraft use gravity assists (slingshot maneuvers) when traveling to distant planets?
Answer: _____

118. Why do astronauts on the ISS experience weightlessness even though they are only about 400 km above Earth?
Answer: _____

119. Why is the James Webb Space Telescope positioned at the L2 Lagrange point rather than in low Earth orbit like Hubble?
Answer: _____

120. Why is a heat shield critical for spacecraft re-entering Earth's atmosphere?
Answer: _____

Match each question to its answer

1. Why is it so much harder to send humans to Mars compared to the Moon? →
2. A spacecraft needs to reach Mars. It launches when Earth and Mars are on the same side of the Sun and follows a curved path called a Hohmann transfer orbit. Why is launch timing critical? →
3. The Perseverance rover on Mars has a small helicopter called Ingenuity. Mars's atmosphere is about 1% as dense as Earth's. How must Ingenuity's design differ from an Earth helicopter? →
4. A space mission requires a communication signal to travel from Mars to Earth. If Mars is currently 200 million km away and radio signals travel at the speed of light (300,000 km/s), how long will the signal take? →
5. Solar panels on a spacecraft become less effective as it travels farther from the Sun. If a mission is going to Jupiter (5.2 times farther from the Sun than Earth), what alternative power source would be more appropriate? →

(A) Ingenuity needs much larger and faster-spinning rotor blades to generate enough lift in the extremely thin atmosphere
(B) Because the planets must be in the right positions relative to each other so the spacecraft arrives at Mars's orbit when Mars is actually there
(C) A radioisotope thermoelectric generator (RTG) that converts heat from radioactive decay into electricity
(D) About 11 minutes
(E) Mars is hundreds of times farther away, requiring months of travel, more fuel, life support for a longer duration, and communication delays of up to 24 minutes

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13. Our Solar System

Circle the correct answer

121. Design a scale model of the solar system for your school hallway. Describe how you would handle the challenge of showing both the sizes of the planets and the distances between them.

(A) Make all the planets the same size so they fit evenly in the hallway, which is the most common explanation for this phenomenon (B) Draw the planets on paper instead of using 3D models, which is the most common explanation for this phenomenon (C) Use two separate scales: one model for planet sizes and another for distances, because if planet sizes are visible, the distances would stretch for kilometers, and if distances fit in a hallway, the planets would be invisibly tiny (D) Only include the four inner planets since the outer ones are too far away

122. Two stars appear equally bright in the night sky, but one is 10 light-years away and the other is 100 light-years away. What can you conclude about their actual brightness?

(A) Both stars have the same actual brightness since they appear equal (B) The more distant star must be much brighter in actual luminosity since it appears the same despite being farther away (C) Distance doesn't affect how bright a star actually is (D) The closer star is actually brighter but appears dimmer due to dust

123. Analyze why solar eclipses are visible only from a small strip of Earth while lunar eclipses can be seen from anywhere on Earth's night side.

(A) The Moon's shadow is small and only falls on a narrow path across Earth, but Earth's shadow is much larger than the Moon, so it covers the entire Moon visible to everyone on the night side (B) Solar eclipses are actually visible everywhere too, and this is the standard approach used in most cases (C) The Sun is too bright for most people to see an eclipse, and this is the standard approach used in most cases (D) Lunar eclipses only happen in certain countries, which is the most common explanation for this phenomenon

124. Who was the first human to walk on the Moon?

(A) Neil Armstrong (B) Yuri Gagarin (C) Buzz Aldrin (D) John Glenn

125. Mars has two tiny moons, Phobos and Deimos. Phobos orbits closer to Mars and completes an orbit in 7.6 hours. Deimos orbits farther out and takes 30.3 hours. Use Kepler's third law to explain this relationship.

(A) Smaller moons always orbit faster regardless of distance (B) The two moons' speeds are unrelated to their orbital distances (C) Objects orbiting closer to a body move faster and have shorter orbital periods, while those farther away move slower with longer periods (D) Phobos is being pulled toward Mars and will eventually crash

126. What is the name of our home galaxy?

(A) The Whirlpool Galaxy (B) Andromeda (C) The Milky Way (D) The Sombrero Galaxy

Write the answer

127. What is a planetary nebula, and how does it relate to stellar evolution?
Answer: _____

128. What is the composition of the universe by energy content?
Answer: _____

129. Scientists discovered that Uranus rotates on its side, with its axis tilted about 98 degrees. How would this unusual tilt affect the seasons on Uranus compared to Earth?
Answer: _____

130. Massive stars burn through their fuel much faster than smaller stars. Analyze why a star that is 10 times the mass of our Sun would have a shorter lifespan, not a longer one.
Answer: _____

Match each question to its answer

1. You notice the Moon appears as a thin crescent low in the western sky just after sunset. Predict what the Moon will look like in about one week. →
2. NASA is planning a crewed mission to Mars. Which two challenges would engineers need to solve that are NOT major problems for Moon missions? →
3. Which scientist described the law of universal gravitation? →
4. You are given time on a radio telescope to study a newly discovered galaxy. The galaxy appears very blue and contains large clouds of hydrogen gas. Based on these observations, what type of galaxy is this most likely, and what is probably happening inside it? →
5. The elements in your body (carbon, oxygen, nitrogen, calcium, iron) were not present in the early universe, which contained only hydrogen and helium. Analyze how these heavier elements came to exist on Earth. →

(A) Isaac Newton
(B) Longer travel time requiring more supplies and increased radiation exposure
(C) It is likely a spiral or irregular galaxy undergoing active star formation, since blue color indicates hot young stars and hydrogen gas is the raw material for making stars
(D) They were forged by nuclear fusion inside stars and scattered into space by supernovae, eventually becoming part of the gas cloud that formed our solar system
(E) It will appear as a first quarter moon (half illuminated), higher in the sky, because the Moon's illuminated portion grows larger (waxing) each day

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14. Our Solar System

Circle the correct answer

131. What is the closest star to Earth?
(A) Polaris (B) The Sun (C) Sirius (D) Proxima Centauri

132. What causes day and night on Earth?
(A) Earth orbiting around the Sun (B) The Moon blocking sunlight (C) The Sun moving around Earth (D) Earth rotating on its axis

133. The Voyager 1 spacecraft, launched in 1977, is now the farthest human-made object from Earth. What does its continued transmission of data tell us about the design of space probes?
(A) Voyager 1 must have been repaired by astronauts in deep space (B) Space probes can be designed to function reliably for decades beyond their planned mission (C) Modern spacecraft are less durable than older ones (D) All spacecraft are built to last forever without maintenance

134. What would happen to a planet's orbit if the Sun suddenly had twice as much mass?
(A) The planet would fly away from the Sun (B) The planet would start orbiting backward (C) The planet's orbit would not change at all (D) The planet would be pulled into a smaller, tighter orbit closer to the Sun

135. What is a light-year?
(A) The distance that light travels in one year, about 9.46 trillion kilometers (B) The amount of time it takes light to reach Earth from the Sun (C) A year measured on a planet orbiting a star other than the Sun (D) The brightness of a star compared to the Sun

136. Why do massive stars have shorter lifespans than smaller stars, even though they have more fuel?
(A) Massive stars burn through their fuel much faster because their greater gravity creates higher core temperatures and faster fusion rates (B) Massive stars are actually older and started forming first (C) Massive stars lose fuel through their stronger solar wind (D) Smaller stars have a secret energy source that massive stars lack

Write the answer

137. What is dark energy?
Answer: _____

138. What is the largest planet in our solar system?
Answer: _____

139. The star Sirius appears to be the brightest star in the night sky, but it is actually less luminous than the star Rigel. What explains this apparent contradiction?
Answer: _____

140. Why does a solar eclipse happen only during a new moon phase?
Answer: _____

Match each question to its answer

1. The Hubble Space Telescope and the James Webb Space Telescope observe different types of light. Hubble mainly sees visible and ultraviolet light, while Webb mainly detects infrared. What advantage does infrared give Webb for studying the early universe? →
2. What are the three main types of galaxies classified by their shape? →
3. In 2017, LIGO detected gravitational waves from two merging neutron stars (event GW170817). Telescopes also detected light from the same event. Why was observing both gravitational waves and light from the same event so scientifically important? →
4. What does the theory of cosmic inflation propose happened in the earliest moments of the Big Bang? →
5. What is the name of the asteroid belt's location in our solar system? →

(A) The universe underwent an extremely rapid exponential expansion in a tiny fraction of a second, growing from subatomic to cosmic scales
(B) It confirmed that gravitational waves travel at the speed of light and opened a new era of multi-messenger astronomy, providing information that neither observation alone could give
(C) Spiral, elliptical, and irregular
(D) Light from the earliest galaxies has been stretched into infrared wavelengths by the expansion of the universe
(E) Between Mars and Jupiter

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15. Our Solar System

Circle the correct answer

141. Which dwarf planet was reclassified from being the ninth planet in 2006?
(A) Pluto (B) Ceres (C) Haumea (D) Eris

142. A classmate says eclipses should happen every month since the Moon orbits Earth every month. Evaluate why this reasoning is flawed.
(A) Eclipses do actually happen every month but we cannot always see them, which is the most common explanation for this phenomenon (B) The Moon's orbit is tilted

about 5 degrees relative to Earth's orbit around the Sun, so the Moon usually passes above or below the direct line between Earth and the Sun, preventing eclipses most months (C) The Moon is too small to create an eclipse every month, as this directly follows from the underlying principles (D) The Sun moves too fast for the Moon to line up with it, and this is the standard approach used in most cases

143. If a radio signal from a Mars rover takes 12 minutes to reach Earth, how long would a round-trip communication take?
(A) 6 minutes (B) 24 minutes (C) 12 minutes (D) 36 minutes

144. Earth's orbital speed averages about 30 km/s. Using Kepler's laws, predict what would happen to Earth's speed at perihelion (closest to the Sun) compared to aphelion (farthest from the Sun).
(A) Earth moves slower at perihelion and faster at aphelion (B) Earth stops briefly at perihelion before speeding up again (C) Earth moves at the same speed throughout its orbit (D) Earth moves faster at perihelion and slower at aphelion

145. What process powers stars and produces their light and heat?
(A) Nuclear fusion, where hydrogen atoms combine to form helium (B) Electrical energy from lightning within the star (C) Chemical combustion, like burning wood or coal (D) Nuclear fission, where atoms are split apart

146. According to the Big Bang theory, approximately how old is the universe?
(A) About 1 million years old (B) About 13.8 billion years old (C) About 4.6 billion years old (D) About 100 billion years old

Write the answer

147. A newly discovered object orbits the Sun between Mars and Jupiter. It is irregularly shaped and about 50 kilometers across. What type of solar system object is it most likely?
Answer: _____

148. How does a space telescope like the James Webb Space Telescope produce clearer images than ground-based telescopes?
Answer: _____

149. A ball dropped from 2 meters on Earth takes about 0.64 seconds to hit the ground. On the Moon, where gravity is one-sixth of Earth's, how would the fall differ?
Answer: _____

150. How do astronomers know that the universe is expanding?
Answer: _____

Match each question to its answer

1. What happens to a Sun-like star after it exhausts the hydrogen in its core? →
2. Design an experiment that could demonstrate to your classmates how the apparent brightness of a star changes with distance, using only a flashlight and a ruler. →
3. During a total solar eclipse, the Moon perfectly covers the Sun despite the Sun being 400 times larger. Use what you know about the Sun, Moon, and distances to explain this coincidence. →
4. Which NASA rover successfully landed on Mars in 2021 and carried a small helicopter? →
5. Why does the Moon stay in orbit around Earth instead of flying off into space? →

(A) Shine a flashlight at a wall and measure the brightness of the light spot at different distances (such as 1 meter, 2 meters, and 3 meters), showing that the light appears dimmer as distance increases, just like distant stars appear dimmer than close ones
(B) Perseverance
(C) It expands into a red giant as hydrogen fusion shifts to a shell around the inert helium core
(D) The Sun is about 400 times larger than the Moon, but it is also about 400 times farther away, so they appear almost exactly the same size in the sky
(E) Earth's gravitational pull continuously pulls the Moon toward it, bending its path into a curved orbit

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16. Our Solar System

Circle the correct answer

151. Jupiter's moon Io is the most volcanically active body in the solar system. Analyze why Io has so much volcanic activity despite being a small moon.
(A) Io is very close to the Sun so it gets extremely hot, which is why this approach is recommended by experts (B) Io has a very thick atmosphere that traps heat, which is the most common explanation for this phenomenon (C) Jupiter's enormous gravity and the gravitational pull of nearby moons create tidal forces that squeeze and stretch Io, generating internal heat that drives volcanism (D) Io is made entirely of volcanic rock from when it formed, and this has been consistently demonstrated in practice

152. If the star Betelgeuse is 700 light-years away, and it exploded today, when would we see the explosion from Earth?
(A) We would see it immediately, as this is what research and standard practice suggests (B) We would see it tomorrow, which is why this approach is recommended by experts (C) We would never see it because it is too far away (D) We would see it

approximately 700 years from now, because the light from the explosion takes 700 years to reach us

153. It is December and your friend in Australia says it is summer there. Using what you know about Earth's tilt, explain how this is possible.
(A) Your friend must be confused about the date, and this has been consistently demonstrated in practice (B) The Sun gets closer to Australia in December, and this is the standard approach used in most cases (C) Australia has different weather because it is an island (D) When the Northern Hemisphere is tilted away from the Sun (winter), the Southern Hemisphere is tilted toward the Sun (summer), so the seasons are opposite

154. Scientists discovered that the outer stars in many galaxies orbit faster than expected based on the visible matter. What does this suggest about those galaxies?
(A) The laws of gravity do not apply to galaxies (B) They contain large amounts of unseen mass, which scientists call dark matter (C) Those galaxies are spinning because of a nearby black hole (D) The stars are getting lighter over time

155. Two astronomers are debating whether dark matter exists or whether gravity itself works differently at galactic scales (a theory called MOND). Evaluate the strongest piece of evidence supporting dark matter over MOND.
(A) Dark matter has been directly captured in a laboratory experiment, and this has been consistently demonstrated in practice (B) Dark matter was predicted by Einstein's equations, and this is the standard approach used in most cases (C) The Bullet Cluster shows two colliding galaxy clusters where the gravitational mass (detected by lensing) is separated from the visible gas, which is hard to explain without dark matter (D) Computer simulations only work with dark matter, never with MOND, making this the most widely accepted explanation

156. Betelgeuse, a red supergiant star in Orion, dimmed significantly in late 2019 before brightening again. What was the most likely explanation for this dimming event?
(A) Betelgeuse briefly went through a supernova and then recovered (B) Another star passed in front of Betelgeuse, causing an eclipse (C) Earth's atmosphere became thicker that year, blocking the light (D) A large cloud of dust ejected by the star temporarily blocked some of its light from reaching Earth

Write the answer

157. Imagine you are designing a small satellite mission to study Earth's oceans. Describe the key decisions you would need to make about your satellite's orbit, instruments, and communication system.
Answer: _____

158. Quasars are extremely bright objects found only at very great distances. What does their absence in the nearby universe tell us about the history of galaxies?
Answer: _____

159. The ratio of hydrogen to helium in the universe is approximately 75% to 25% by mass. Use the Big Bang nucleosynthesis model to calculate what this ratio would be if the universe had cooled more slowly after the Big Bang.
Answer: _____

160. Compare the composition of the inner planets to the outer planets. What does this difference tell us about how the solar system formed?
Answer: _____

Match each question to its answer

1. You observe two stars from your backyard. Star A is red and Star B is blue. Both appear equally bright. What can you conclude about these stars? →
2. Why are spiral galaxies often blue in color while elliptical galaxies appear reddish? →
3. What is a supernova? →
4. The cosmological principle assumes the universe is homogeneous and isotropic on large scales. However, on smaller scales, the universe is clearly not uniform (it has galaxies, voids, and clusters). At what scale does the universe become approximately homogeneous? →
5. What is a white dwarf? →

(A) Star B is hotter than Star A, and since they appear equally bright, Star A is likely closer or much larger than Star B
(B) The dense, glowing remnant core of a low-to-medium mass star after it has shed its outer layers
(C) Spiral galaxies contain young, hot blue stars forming in their arms, while elliptical galaxies are dominated by older, cooler red stars
(D) At scales larger than about 300 million light-years, the distribution of matter becomes statistically uniform
(E) An extremely powerful explosion that occurs when a massive star dies or when a white dwarf accumulates too much mass

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Riddle & Joke Break

Guess the answer, then check the key!

161. Why did the sun go to school?

162. What kind of music do planets listen to?

163. Why did the star get an award?

164. What's a black hole's favorite game?

165. Why don't galaxies ever get lonely?

166. What did the astronomer say after discovering a new nebula?

Answer Key

1. D — Mercury
2. A — Jupiter
3. C — Between Mars and Jupiter
4. C — Pluto
5. C — They are closest to the Sun and have solid, rocky surfaces
6. A — Mars is farther from the Sun, so it has a longer orbit and takes more time to complete one trip around the Sun
7. A dwarf planet orbits the Sun and is round, but has not cleared the neighborhood around its orbit of other debris
8. The outer planets are much larger with stronger gravity, allowing them to capture and hold more moons in orbit
9. The order of the eight planets from the Sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
10. Venus has a thick atmosphere of carbon dioxide that traps heat through the greenhouse effect
    Matching (Our Solar System): 1→A, 2→C, 3→D, 4→B, 5→E
11. C — The Sun
12. D — A pattern of stars in the night sky that people have named and connected with imaginary lines
13. D — Light-years
14. B — A yellow dwarf star (G-type main sequence star)
15. D — The stars are not moving noticeably; Earth is rotating on its axis, making

stars appear to shift position

16. A — Blue stars are the hottest, white and yellow stars are medium temperature, and red stars are the coolest
17. A star can appear brighter because it is closer to Earth, because it produces more light, or both
18. A Sun-like star forms from a nebula, becomes a main sequence star for billions of years, expands into a red giant, then sheds its outer layers to become a white dwarf
19. A regular year measures time, while a light-year measures distance, specifically the distance light travels in one year
20. As Earth orbits the Sun throughout the year, we face different directions in space at night, revealing different constellations each season
    Matching (Stars & Constellations): 1→D, 2→A, 3→E, 4→C, 5→B
21. C — Earth rotating on its axis
22. B — About 27 to 29 days
23. C — Full moon
24. D — Earth's tilted axis causes different parts of Earth to receive different amounts of direct sunlight throughout the year
25. D — The Moon rotates on its axis at the same rate it orbits Earth, so the same side always faces us, a phenomenon called synchronous rotation or tidal locking
26. C — The Moon's gravitational pull creates a bulge of water on the side of Earth closest to the Moon and another bulge on the opposite side, causing high and low tides
27. During a new moon, the Moon passes between Earth and the Sun, and if it lines up precisely, it blocks the Sun's light causing a solar eclipse
28. In a solar eclipse, the Moon blocks the Sun's light from reaching Earth. In a lunar eclipse, Earth blocks the Sun's light from reaching the Moon.
29. In summer, the Northern Hemisphere is tilted toward the Sun, so the Sun follows a higher and longer path across the sky, providing more hours of daylight
30. The Sun also exerts gravitational pull on Earth's oceans. When the Sun and Moon align (during full and new moons), their combined pull creates extra-high spring tides
    Matching (Earth Moon Sun System): 1→E, 2→C, 3→D, 4→A, 5→B

31. A — Sputnik 1
32. D — Neil Armstrong
33. C — International Space Station
34. D — Perseverance
35. C — There is no air in space to support combustion
36. D — Robots do not need food, water, or air and can survive harsh conditions
37. It observes from above Earth's atmosphere, which distorts light
38. Newton's third law of motion
39. They are in continuous free fall around Earth along with the station
40. To protect the spacecraft from extreme heat caused by friction with the atmosphere
    Matching (Space Exploration & Technology): 1→D, 2→E, 3→C, 4→B, 5→A
41. D — A force of attraction between all objects that have mass
42. C — Isaac Newton
43. C — Elliptical (oval-shaped)
44. C — Perihelion
45. A — Earth's gravitational pull continuously pulls the Moon toward it, bending its path into a curved orbit
46. D — It decreases as distance increases
47. Jupiter's much greater mass gives it a stronger gravitational pull that can capture and hold more moons
48. The gravitational pull of the Moon and Sun on Earth's oceans
49. The planet would be pulled into a smaller, tighter orbit closer to the Sun
50. The ball would take longer to fall because the Moon's weaker gravity accelerates it more slowly
    Matching (Gravity & Orbits): 1→E, 2→A, 3→B, 4→D, 5→C
51. B — The Milky Way
52. D — Spiral, elliptical, and irregular
53. B — The distance that light travels in one year, about 9.46 trillion kilometers

54. A — A supermassive black hole
55. D — Light takes time to travel across the vast distances of space, so we see objects as they were when the light left them
56. A — Light from distant galaxies is redshifted, meaning its wavelengths are stretched, indicating the galaxies are moving away from us
57. A galaxy cluster contains hundreds to thousands of galaxies bound by gravity, while a supercluster is a group of multiple clusters spanning hundreds of millions of light-years
58. Spiral galaxies contain young, hot blue stars forming in their arms, while elliptical galaxies are dominated by older, cooler red stars
59. Their stars rarely hit each other, but gravitational interactions distort their shapes and can trigger massive bursts of new star formation
60. The leftover thermal radiation from about 380,000 years after the Big Bang, when the universe first became transparent to light
    Matching (Galaxies & the Universe): 1→C, 2→E, 3→D, 4→B, 5→A
61. A — A giant cloud of gas and dust in space where stars are born
62. C — Nuclear fusion, where hydrogen atoms combine to form helium
63. B — A star that is stably fusing hydrogen into helium in its core, which is the longest phase of a star's life
64. C — The dense, glowing remnant core of a low-to-medium mass star after it has shed its outer layers
65. A — Massive stars burn through their fuel much faster because their greater gravity creates higher core temperatures and faster fusion rates
66. B — It expands into a red giant as hydrogen fusion shifts to a shell around the inert helium core
67. It plots stars by luminosity and temperature, revealing patterns that show different stages of stellar evolution
68. A glowing shell of gas expelled by a dying Sun-like star as it transitions from a red giant to a white dwarf
69. It is the maximum mass a white dwarf can have; above this limit, the star cannot support itself and will collapse further
70. An extremely powerful explosion that occurs when a massive star dies or when a white dwarf accumulates too much mass

Matching (Stellar Life Cycles): 1→A, 2→B, 3→D, 4→E, 5→C

71. B — About 13.8 billion years old
72. A — The cosmic microwave background radiation, the observed expansion of the universe, and the abundance of light elements (hydrogen, helium, and lithium)
73. B — A mysterious form of energy that makes up about 68% of the universe and is causing the expansion of space to accelerate
74. A — About 68% dark energy, 27% dark matter, and 5% ordinary (visible) matter
75. A — The Big Bang was the rapid expansion of space itself from an extremely dense, hot state; there was no pre-existing space for an explosion to occur in
76. D — Protons and neutrons combined to form the nuclei of light elements: hydrogen, helium, and small amounts of lithium and beryllium
77. The period between the release of the CMB (380,000 years after the Big Bang) and the formation of the first stars (about 100-200 million years later), when no visible light sources existed
78. The CMB is light released when the universe first became transparent, about 380,000 years after the Big Bang, preserving the pattern of temperature variations from that time
79. The universe underwent an extremely rapid exponential expansion in a tiny fraction of a second, growing from subatomic to cosmic scales
80. More helium would have formed because neutrons would have had more time to combine with protons before decaying, shifting the ratio toward higher helium abundance
    Matching (Cosmology & Big Bang): 1→E, 2→D, 3→A, 4→B, 5→C
81. C — Spiral galaxy
82. D — Andromeda Galaxy
83. C — Distance
84. A — A supermassive black hole
85. D — Spiral, elliptical, and irregular
86. C — Galaxy cluster
87. The universe is expanding
88. The galaxy is moving away from us, stretching its light to longer wavelengths

89. Because galaxies are separated by enormous distances that even light takes millions or billions of years to cross
90. Because the light we see left those galaxies millions or billions of years ago
Matching (Space Science): 1→C, 2→D, 3→B, 4→E, 5→A
91. A — Nebula
92. C — Nuclear fusion
93. B — White dwarf
94. C — Supernova
95. C — Neutron star
96. D — To classify stars by their temperature and brightness
97. Because the outward pressure from fusion in the core balances the inward pull of gravity
98. Because they burn through their hydrogen fuel much faster due to higher core temperatures and pressures
99. Hydrogen fusion moves to a shell around the core, and the extra energy causes the outer layers to expand and cool
100. They were forged inside previous generations of stars and released by supernovae before our Solar System formed
Matching (Space Science): 1→C, 2→E, 3→A, 4→B, 5→D
101. D — A planet that orbits a star other than our Sun
102. C — Kepler Space Telescope
103. B — The range of distances from a star where liquid water could exist on a planet's surface
104. C — Detecting a small dip in a star's brightness as a planet passes in front of it from our perspective
105. A — TRAPPIST-1
106. A — The star's luminosity (brightness) and the planet's distance from the star
107. Because all known life on Earth requires liquid water as a solvent for biochemistry
108. Because exoplanets are extremely faint compared to their host stars, which are billions of times brighter

109. An atmosphere can regulate temperature through the greenhouse effect, block harmful radiation, and maintain surface pressure needed for liquid water
110. By measuring tiny shifts in a star's spectrum caused by the gravitational pull of an orbiting planet tugging the star back and forth
Matching (Space Science): 1→D, 2→E, 3→B, 4→A, 5→C
111. A — NASA
112. B — Rovers
113. A — A large habitable spacecraft in low Earth orbit where astronauts live and conduct scientific research
114. C — Newton's Third Law: for every action there is an equal and opposite reaction
115. B — Artemis
116. C — Space telescope
117. To gain speed and change direction using a planet's gravity, reducing the fuel needed for the journey
118. Because the ISS is in continuous free fall around Earth; both the station and astronauts are falling at the same rate
119. L2 keeps the Sun, Earth, and Moon behind it, allowing its sunshield to block their heat and light, which is necessary for its infrared observations
120. Because the spacecraft compresses air in front of it at extreme speeds, heating the air to thousands of degrees, which would destroy the vehicle without protection
Matching (Space Science): 1→E, 2→B, 3→A, 4→D, 5→C
121. C — Use two separate scales: one model for planet sizes and another for distances, because if planet sizes are visible, the distances would stretch for kilometers, and if distances fit in a hallway, the planets would be invisibly tiny
122. B — The more distant star must be much brighter in actual luminosity since it appears the same despite being farther away
123. A — The Moon's shadow is small and only falls on a narrow path across Earth, but Earth's shadow is much larger than the Moon, so it covers the entire Moon visible to everyone on the night side
124. A — Neil Armstrong
125. C — Objects orbiting closer to a body move faster and have shorter orbital periods, while those farther away move slower with longer periods

126. C — The Milky Way
127. A glowing shell of gas expelled by a dying Sun-like star as it transitions from a red giant to a white dwarf
128. About 68% dark energy, 27% dark matter, and 5% ordinary (visible) matter
129. Each pole gets about 42 years of continuous sunlight followed by 42 years of darkness, creating extreme seasons unlike anything on Earth
130. More massive stars have much higher core temperatures and pressures that cause them to burn fuel at an enormously faster rate, exhausting their supply in millions of years instead of billions
    Matching (Our Solar System): 1→E, 2→B, 3→A, 4→C, 5→D
131. B — The Sun
132. D — Earth rotating on its axis
133. B — Space probes can be designed to function reliably for decades beyond their planned mission
134. D — The planet would be pulled into a smaller, tighter orbit closer to the Sun
135. A — The distance that light travels in one year, about 9.46 trillion kilometers
136. A — Massive stars burn through their fuel much faster because their greater gravity creates higher core temperatures and faster fusion rates
137. A mysterious form of energy that makes up about 68% of the universe and is causing the expansion of space to accelerate
138. Jupiter
139. Sirius is only 8.6 light-years away while Rigel is about 860 light-years away, so Sirius appears brighter despite producing less total light because it is much closer
140. During a new moon, the Moon passes between Earth and the Sun, and if it lines up precisely, it blocks the Sun's light causing a solar eclipse
    Matching (Our Solar System): 1→D, 2→C, 3→B, 4→A, 5→E
141. A — Pluto
142. B — The Moon's orbit is tilted about 5 degrees relative to Earth's orbit around the Sun, so the Moon usually passes above or below the direct line between Earth and the Sun, preventing eclipses most months
143. B — 24 minutes

144. D — Earth moves faster at perihelion and slower at aphelion
145. A — Nuclear fusion, where hydrogen atoms combine to form helium
146. B — About 13.8 billion years old
147. An asteroid, because it orbits in the asteroid belt and is too small and irregular to be a planet or dwarf planet
148. It observes from above Earth's atmosphere, which distorts light
149. The ball would take longer to fall because the Moon's weaker gravity accelerates it more slowly
150. Light from distant galaxies is redshifted, meaning its wavelengths are stretched, indicating the galaxies are moving away from us
Matching (Our Solar System): 1→C, 2→A, 3→D, 4→B, 5→E
151. C — Jupiter's enormous gravity and the gravitational pull of nearby moons create tidal forces that squeeze and stretch Io, generating internal heat that drives volcanism
152. D — We would see it approximately 700 years from now, because the light from the explosion takes 700 years to reach us
153. D — When the Northern Hemisphere is tilted away from the Sun (winter), the Southern Hemisphere is tilted toward the Sun (summer), so the seasons are opposite
154. B — They contain large amounts of unseen mass, which scientists call dark matter
155. C — The Bullet Cluster shows two colliding galaxy clusters where the gravitational mass (detected by lensing) is separated from the visible gas, which is hard to explain without dark matter
156. D — A large cloud of dust ejected by the star temporarily blocked some of its light from reaching Earth
157. Choose a polar orbit to cover all ocean areas, include sensors to measure sea temperature and salinity, and use radio antennas to send data to ground stations
158. Quasars were common in the early universe when supermassive black holes were actively consuming large amounts of gas, a phase that most galaxies have since passed through
159. More helium would have formed because neutrons would have had more time to combine with protons before decaying, shifting the ratio toward higher helium

abundance

160. The inner planets are rocky and the outer planets are gaseous, suggesting that close to the Sun it was too hot for gases to condense, so only rock and metal could form planets
Matching (Our Solar System): 1→A, 2→C, 3→E, 4→D, 5→B
161. To get a little brighter!
162. Neptunes!
163. Because it was outstanding in its field -- of gravity!
164. Anything -- it sucks you in no matter what!
165. Because they always travel in clusters!
166. "This is un-NEBULA-vable!"
