|  |
| --- |
| True / False |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. The ocean holds more than 97% of Earth's water.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2. The average land elevation on Earth is greater than the average depth of the ocean.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. Marine science draws on information from disciplines of geology, biology, chemistry, physics, and engineering.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4. Scientific hypotheses are never revised or updated.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5. Gravity was important in the formation of our planet because it pulled dense metals such as iron and nickel inward, forming Earth's core.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 6. ​The ocean provides a variety of resources ranging from food and water to energy, construction materials, and life-saving pharmaceuticals.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7. ​The materials that formed the Earth and the ocean were formed within starts billions of years ago.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8. ​Atoms that make up Earth, its ocean, and its inhabitants were formed within stars billions of years ago.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. ​Nuclear fusion is the changing of hydrogen and helium into heavier elements of carbon, oxygen, silicon, and iron in stars.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10. ​The ancestors of invertebrates produced enough oxygen to oxidize minerals dissolved in the ocean and surface sediments through a process called respiration.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11. ​Humanity did not spread to nearly all of the inhabitable areas of Earth until after the European voyages of discovery in the late 1400s and early 1500s.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12. ​The Library of Alexandria was an important gathering place for intellectuals and a warehouse for written knowledge relating to trade, natural wonders, artistic achievements, and other items of interest to seafarers.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. ​Eratosthenes was a scientist who was interested in the size of Earth and used methods of geometry to determine the circumference of our planet.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | True |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14. ​Latitude is a measurement that uses the prime meridian (Greenwich, England) as a reference point to help determine the exact location of a specific point on Earth.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15. ​Captain Cook was the first scientist to drift in the Arctic ice pack and proved no Arctic continent existed.

|  |  |  |
| --- | --- | --- |
|   | a.  | True |
|   | b.  | False |

|  |  |
| --- | --- |
| *ANSWER:* | False |

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|  |
| --- |
| Multiple Choice |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 16. About \_\_\_\_% of Earth's water is found in the ocean.

|  |  |  |
| --- | --- | --- |
|   | a.  | 97 |
|   | b.  | 71 |
|   | c.  | 67 |
|   | d.  | 30 |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 17. The average land elevation is approximately \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | 760 meters (2,500 feet) |
|   | b.  | 3,700 meters (12,000 feet) |
|   | c.  | 200 meters (650 feet) |
|   | d.  | 840 meters (2,756 feet) |

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| --- | --- |
| *ANSWER:* | d |

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| 18. The world ocean \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | plays a minor role in the weather and shape of landmasses of Earth |
|   | b.  | does not influence the way organisms live on land |
|   | c.  | dramatically influences weather, nurtures life, and provides crucial natural resources |
|   | d.  | has an average depth that represents over half of Earth's radius |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 19. On a planetary scale, the ocean comprises about \_\_\_\_% of Earth’s mass.

|  |  |  |
| --- | --- | --- |
|   | a.  | 71 |
|   | b.  | 20 |
|   | c.  | 8 |
|   | d.  | 0.02 |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20. ​The field of marine science involves \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | the building of oil platforms, ships, harbors, and other structures that enable us to use the ocean wisely |
|   | b.  | the process of making observations, asking questions, and forming hypotheses |
|   | c.  | the scientific study of the ocean, its associated life-forms, and its bordering lands |
|   | d.  | testing hypotheses by controlled experiments |

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| --- | --- |
| *ANSWER:* | c |

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| 21. Which statement is most consistent with the scientific method?

|  |  |  |
| --- | --- | --- |
|   | a.  | Hypotheses cannot be revised after they are proposed. |
|   | b.  | Hypotheses are tested through observations and controlled experiments. |
|   | c.  | Scientific laws always arise fully formed and in correlating groups. |
|   | d.  | Theories cannot be modified after they are tested. |

|  |  |
| --- | --- |
| *ANSWER:* | b |

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| 22. What comprises the most abundant form of matter in the universe?

|  |  |  |
| --- | --- | --- |
|   | a.  | water molecules |
|   | b.  | planets and planet-like bodies |
|   | c.  | dust and debris |
|   | d.  | hydrogen and helium |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. New planets formed in a cloud of dust and debris surrounding our young sun through a process known as \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | supernova |
|   | b.  | oxygen revolution |
|   | c.  | accretion |
|   | d.  | cataclysmic expansion of energy and matter |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24. The death of a star is characterized by a massive release of energy called a \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | nebula |
|   | b.  | protostar |
|   | c.  | supernova |
|   | d.  | comet |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. ​Stars spend their lives changing its hydrogen and helium to \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | carbon, oxygen, silicon, and iron |
|   | b.  | nitrogen and oxygen |
|   | c.  | water and carbon dioxide |
|   | d.  | ammonia and methane |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26. What process allows the sun to generate light and heat?

|  |  |  |
| --- | --- | --- |
|   | a.  | accretion |
|   | b.  | oxygen revolution |
|   | c.  | density stratification |
|   | d.  | nuclear fusion |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| 27. What is the clumping of smaller particles into large masses?

|  |  |  |
| --- | --- | --- |
|   | a.  | accretion |
|   | b.  | nuclear fusion |
|   | c.  | density stratification |
|   | d.  | oxygen revolution |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 28. What are the abundant elements that make up the composition of Earth’s present-day atmosphere?

|  |  |  |
| --- | --- | --- |
|   | a.  | oxygen and carbon dioxide |
|   | b.  | nitrogen and oxygen |
|   | c.  | carbon dioxide, nitrogen, and hydrogen |
|   | d.  | hydrogen and oxygen |

|  |  |
| --- | --- |
| *ANSWER:* | b |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. Oxygen first began to accumulate in Earth’s atmosphere as a result of \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | biosynthesis |
|   | b.  | cellular respiration |
|   | c.  | methane synthesis |
|   | d.  | photosynthesis |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30. Earth’s inner core is primarily made of \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | magnesium |
|   | b.  | water |
|   | c.  | iron |
|   | d.  | silicates |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 31. What would a visitor approaching Earth from space see 4.4 billion years ago?

|  |  |  |
| --- | --- | --- |
|   | a.  | a blue planet due to 71% of its surface being covered by water |
|   | b.  | a hot, vapor-shrouded sphere blanketed by lightning-stroked clouds |
|   | c.  | a supercontinent breaking apart into smaller pieces |
|   | d.  | a landscape dominated by continents with small bodies of water dispersed throughout |

|  |  |
| --- | --- |
| *ANSWER:* | b |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 32. The ocean originated from \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | water vapor produced by cellular respiration in early living organisms |
|   | b.  | radioactive heating of Earth's interior, and the heating of the surface by meteorites striking and melting the outer layers of Earth |
|   | c.  | capture of water molecules in space by Earth's gravity |
|   | d.  | volcanic gases, radioactive heating of Earth's interior, and a barrage of icy comets or asteroids striking and melting the outer layers of Earth |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 33. During its initial formation by the accretion of particles, the young Earth was \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | shrouded in a thick atmosphere |
|   | b.  | density stratified with a core, mantle, and crust |
|   | c.  | likely chemically homogenous throughout |
|   | d.  | completely covered by an ocean |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 34. The primary physical process responsible for the formation of Earth’s layers, the inner and outer core, mantle, and crust is \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | density stratification |
|   | b.  | radioactive decay |
|   | c.  | outgassing |
|   | d.  | mass layering |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 35. A(n) \_\_\_\_ is a graphic representation that depicts information about the ocean and ocean features.

|  |  |  |
| --- | --- | --- |
|   | a.  | seismograph |
|   | b.  | echo sounder |
|   | c.  | chart |
|   | d.  | atlas |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 36. Although the first regular ocean traders were probably the Cretans or the Phoenicians, the first direct evidence of voyaging, traveling the ocean for a specific purpose, comes from  \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | ancient maps left by Polynesian people |
|   | b.  | Eratosthenes’s latitudinal and longitudinal maps |
|   | c.  | records of trade in the Mediterranean Sea |
|   | d.  | James Cook’s accurate charts of New Zealand, Australia, and the Great Barrier Reef |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 37. Who was the first person to estimate the size of the Earth within approximately 8% of its true size based on the geometric observations of travelers?

|  |  |  |
| --- | --- | --- |
|   | a.  | Captain James Cook of the British Royal Navy |
|   | b.  | Eratosthenes of Cyrene |
|   | c.  | U.S. naval officer Matthew Maury |
|   | d.  | The Polynesians |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 38. Which statement is true with regard to latitude and longitude?

|  |  |  |
| --- | --- | --- |
|   | a.  | Longitudinal lines are drawn parallel to the equator, while latitudinal lines are drawn from pole to pole. |
|   | b.  | Latitude and longitude comprise a system of imaginary lines dividing Earth's surface into a grid. |
|   | c.  | Greenwich, England was the original location of “zero longitude.” |
|   | d.  | Zero degrees latitude is the prime meridian and zero degrees longitude is the equator. |

|  |  |
| --- | --- |
| *ANSWER:* | b |

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| 39. ​Scientists believe that answers to questions are \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | ​always questionable |
|   | b.  | ​sometimes correct, but mostly wrong |
|   | c.  | ​ultimately knowable |
|   | d.  | ​extremely simple if you look in the right places |

|  |  |
| --- | --- |
| *ANSWER:* | c |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40. ​When using the scientific method, scientific theories must be \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | ​tested and consistently supported by observations or experiments |
|   | b.  | ​​verified by the leading authorities in the field |
|   | c.  | ​consistent with previous, universally accepted scientific concepts |
|   | d.  | ​consistent with the fact that the ocean is of great age |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 41. ​Volcanic venting of substances including water vapor is called \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | ​outgassing |
|   | b.  | ​fissure |
|   | c.  | ​fusion |
|   | d.  | ​condensation |

|  |  |
| --- | --- |
| *ANSWER:* | a |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 42. ​What did the Polynesians use to navigate between the islands in the Pacific Ocean?

|  |  |  |
| --- | --- | --- |
|   | a.  | ​the compass invented by the Chinese |
|   | b.  | ​detailed maps with latitude and longitude lines |
|   | c.  | ​maritime records obtained from the Library of Alexandria |
|   | d.  | ​subtle directional clues based off of wind and wave patterns, the sun, moon, and stars, and marine organisms |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| 43. ​The cousin of which scientist worked out the first rough chart of the Gulf Stream?

|  |  |  |
| --- | --- | --- |
|   | a.  | ​Charles Darwin |
|   | b.  | ​Edward Forbes |
|   | c.  | ​John Murray |
|   | d.  | ​Benjamin Franklin |

|  |  |
| --- | --- |
| *ANSWER:* | d |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 44. ​The word "oceanography" was first coined in association with \_\_\_\_.

|  |  |  |
| --- | --- | --- |
|   | a.  | ​Cook's third voyage |
|   | b.  | ​the *Challenger* expedition |
|   | c.  | ​the founding of the Library of Alexandria |
|   | d.  | ​Captain James Cook's first voyage |

|  |  |
| --- | --- |
| *ANSWER:* | b |

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| 45. ​Which voyage was the first expedition devoted purely to marine science?

|  |  |  |
| --- | --- | --- |
|   | a.  | ​Matthew Maury’s oceanographic work as a U.S. naval officer |
|   | b.  | ​the *Challenger* expedition |
|   | c.  | ​Benjamin Franklin's first voyage across the Atlantic to take up his post as American Ambassador to France |
|   | d.  | ​Captain Cook's voyage to Tahiti in the ship *Endeavour* |

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| *ANSWER:* | b |

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| 46. ​Who is considered to be the father of physical oceanography?

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|   | a.  | ​Eratosthenes  |
|   | b.  | ​Ptolemy |
|   | c.  | ​Matthew Maury |
|   | d.  | ​Captain James Cook |

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| *ANSWER:* | c |

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| 47. ​Who was the first person to compile a picture of the large-scale wind and current systems?

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|   | a.  | ​Benjamin Franklin |
|   | b.  | ​Matthew Maury |
|   | c.  | ​Eratosthenes of Cyrene |
|   | d.  | ​Wyville Thomson |

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| *ANSWER:* | b |

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| 48. ​Which individual was the first to provide a rough chart of an ocean current, specifically, the Gulf Stream?

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|   | a.  | ​Edward Forbes |
|   | b.  | ​Tim Folger |
|   | c.  | ​Benjamin Franklin |
|   | d.  | ​Captain James Cook |

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| *ANSWER:* | d |

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| 49. ​Which individual would be most likely to receive the title of "first marine scientist"?

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|   | a.  | ​Matthew Maury |
|   | b.  | ​Captain James Cook |
|   | c.  | ​Christopher Columbus |
|   | d.  | ​Wyville Thompson (of the *Challenger* expedition) |

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| *ANSWER:* | b |

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| 50. ​What was one accomplishment of Captain James Cook?

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|   | a.  | ​He was the first to circumnavigate the world. |
|   | b.  | ​He was the first to land on the coast of Antarctica. |
|   | c.  | ​He was the first European to explore the South Pacific. |
|   | d.  | ​He mapped the coasts of Australia and New Zealand. |

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| *ANSWER:* | d |

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| 51. ​What was the most important outcome of Matthew Maury's work?

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|   | a.  | ​the discovery of the Hawai'ian Islands |
|   | b.  | ​the formulation of a working hypothesis for the formation of coral reefs |
|   | c.  | ​the invention of a chronometer for the determination of longitude |
|   | d.  | ​the charting of ocean currents to significantly shorten the travel time of sailors |

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| *ANSWER:* | d |

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| 52. ​The *Challenger* expedition (1872–1876) was a unique and historic voyage. Why?

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|   | a.  | ​It is the longest continuous scientific oceanographic expedition on record. |
|   | b.  | ​Its scientists developed the first reliable navigational charts to indicate current and wind patterns. |
|   | c.  | ​It was the first expedition to use an echo sounder to study the seafloor. |
|   | d.  | ​It proved the hypothesis that life could not exist in the deep sea. |

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| *ANSWER:* | a |

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| 53. ​Edward Forbes was an Edinburgh professor who thought that \_\_\_\_.

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|   | a.  | ​life was plentiful in the deep sea |
|   | b.  | ​there was an easy route to the orient from Europe |
|   | c.  | ​no life existed in the deep sea because of high pressure and lack of light |
|   | d.  | ​the Pacific Ocean was much smaller than it truly is |

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| *ANSWER:* | c |

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| 54. ​What did the German Meteor expedition discover during their 1925 crisscross across the South Atlantic for 2 years?

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|   | a.  | ​a completely flat ocean floor |
|   | b.  | ​the deepest part of the ocean’s deepest trench |
|   | c.  | ​a varied and often extremely rugged bottom profile |
|   | d.  | ​evidence for seafloor spreading and plate tectonics |

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| *ANSWER:* | c |

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| 55. ​What information did NASA’s Earth-observing satellite, *AQUA*, collect to learn about Earth’s water cycle?

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|   | a.  | ​amount of phytoplankton and dissolved organic matter in the oceans |
|   | b.  | ​samples of seafloor sediments |
|   | c.  | ​changes in sea surface elevation |
|   | d.  | ​ocean floor topography |

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| 56. ​*Glomar Challenger* is known mainly for \_\_\_\_.

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|   | a.  | ​being the first modern scientific survey ship to circumnavigate the globe |
|   | b.  | ​being the first nuclear powered scientific research vessel |
|   | c.  | ​being owned and operated simultaneously by four governmental agencies |
|   | d.  | ​taking the first complete cores of seafloor sediments |

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| *ANSWER:* | d |

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| 57. ​The first scientific expedition to use an echo sounder was the \_\_\_\_.

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|   | a.  | ​*Challenger* expedition |
|   | b.  | ​*Meteor* expedition |
|   | c.  | ​United States *Exploring* expedition |
|   | d.  | ​voyage of *Trieste* |

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| *ANSWER:* | b |

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| 58. ​Modern oceanography began with the efforts of \_\_\_\_, who trapped his ship in pack ice to explore the Arctic.

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|   | a.  | ​Forbes |
|   | b.  | ​Wilkes |
|   | c.  | ​Thomson |
|   | d.  | ​Nansen |

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| *ANSWER:* | d |

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| 59. What device bounces sound waves off the ocean bottom to study the depth and contours of the seafloor?​

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|   | a.  | ​echo sounder |
|   | b.  | ​satellite |
|   | c.  | ​bathyscaphe |
|   | d.  | ​submersible |

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| *ANSWER:* | a |

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| 60. ​What type of information about the ocean are satellites most likely to provide to scientists?

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|   | a.  | ​amount of phytoplankton and dissolved organic matter |
|   | b.  | ​pH of the ocean in different locations |
|   | c.  | ​sea floor bathymetry |
|   | d.  | ​sea floor sedimentation rate |

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| *ANSWER:* | a |

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| 61. What is meant by a “single world ocean"?

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| *ANSWER:* | The Ocean comprises about 71% of the surface of Earth and exists as a single large continuous mass of water. The ocean has very few dependable, natural, and permanent divisions. The artificial compartments we generally refer to as oceans (i.e., Pacific, Atlantic, or Indian Ocean) or seas are based on either the position of the continents or on imaginary boundaries or lines such as the equator. |

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| 62. Describe the general steps involved in the scientific method.

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| *ANSWER:* | The scientific method starts with a question, or a desire to understand something that has been observed or measured. A working hypothesis is formed to tentatively explain the observation. The hypothesis is tested with controlled experiments and further observations to be either verified or disproved. A hypothesis that is consistently supported by observation or experiment is advanced to the status of theory, a statement that explains the observations. Theories can evolve into larger constructs, known as laws, which summarize the observations. |

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| 63. Describe the basic processes and timeline that led to the formation of Earth and its ocean and atmosphere.

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| *ANSWER:* | Earth formed about 4.6 billion years ago through the accretion of particles orbiting in our solar system. Earth was initially molten and layers only formed once planet began to cool. Density stratification allowed the least dense elements to escape to Earth’s surface and atmosphere, while the denser elements sunk to form the internal layers of Earth, the mantle and core. The ocean and the atmosphere formed together as the planet cooled sometime between 4.4 and 3.8 billion years ago. The ocean formed as water vapor trapped in Earth’s outer layers escaped to the surface via volcanic activity, a process called outgassing. This vapor cooled and condensed to form an ocean. |

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| 64. Discuss the early atmosphere and how it could have led to the evolution of life on Earth.

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| *ANSWER:* | Earth’s atmosphere formed as hot gases escaped from deep within the planet. This early atmosphere included gases such as carbon dioxide, methane, and ammonia (note that molecular oxygen was absent in the atmosphere until about 2.2 billion years ago). Experiments have shown that organic molecules necessary for life could have formed as the dissolved compounds in the atmosphere were exposed to light, heat, and electrical sparks. These energized mixtures can produce simple sugars and amino acids, proteins and nucleotides—all biologically important molecules. |

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| 65. ​Briefly describe the formation of our density stratified Earth.

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| *ANSWER:* | ​The planet grew by the aggregation of particles. Meteors and asteroids bombarded the surface, heating the new planet and adding to its growing mass. At the time, Earth was composed of a homogenous mixture of materials. Earth lost volume because of gravitational compression. High temperatures in the interior turned the inner Earth into a semisolid mass; dense iron and nickel fell toward the center to form the core, while less dense silicates moved outward. Friction generated by this movement heated the Earth even more. The result of density stratification is evident in the formation of the inner and outer core, the mantle, and the crust. |

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| 66. Using specific examples, describe how advances in navigation and voyaging relate to the advent of marine science.​

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| *ANSWER:* | ​Early exploration of the ocean was primarily for economic and political reasons.The Polynesians and Europeans quickly discovered that the ocean was a vast expanse that was both wondrous and plentiful. Advances in navigation, such as the compass or the chronometer, allowed explorers to travel around the ocean with much greater efficiency. In the mid to late 1700s, Captain James Cook was the first to use the knowledge the voyagers before him had compiled and applied this information to the study of the ocean. Cook was both an explorer and scientists and within 100 years of his first voyage in 1768, the first fully organized, scientific expedition was launched (*Challenger* expedition in 1872). Economists, traders, explorers, and scientists learned very early on that an understanding of the ocean could better all of their interests. Governments quickly realized there were great profits to be had from the natural resources in the ocean and started investing in oceanographic exploration. |

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| 67. ​Examine “The World” chart from the third century B.C.E. where Eratosthenes drew latitude and longitude lines through important places rather than spacing them at regular intervals as we do today. Briefly describe the misconceptions the Alexandrians had of the world.

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| *ANSWER:* | ​The Alexandrian perception of the world is reflected in the size of the continents and oceans on the chart. Continents comprise a large percentage of the world, whereas the ocean is only a small percentage. Today, we know that the ocean covers approximately 71% of Earth’s surface. Alexandrians also placed themselves at the center of the world as evidenced by the longitude line that Eratosthenes drew through as one of the important places. It’s difficult to consider Alexandria the center of the world when many continents (North America, South America, Africa, etc.) are missing. |

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| 68. ​Describe the contributions made by Matthew Maury that improved our understanding of ocean science.

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| *ANSWER:* | ​Matthew Maury was, perhaps, the first person to be engaged in full-time oceanographic work and is considered by many to be the father of physical oceanography. A U.S. naval officer, he was interested in exploiting winds and currents for commercial and naval purposes. Working in the Navy’s Depot of Charts and Instruments, he was able to study ships’ logs with their many regular readings of temperature and wind direction, and compile this information into coherent wind and current charts. Maury issued these charts to mariners in exchange for logs of their new voyages, and began to assemble a picture of the worldwide pattern of surface winds and currents. These analyses allowed him to produce a set of directions for sailing great distances more efficiently. |

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| 69. ​Modern technologies enable scientists to acquire information about the ocean relatively rapidly. How have satellites changed the way we perceive, navigate, and study the ocean?

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| *ANSWER:* | ​In 1958, the National Aeronautics and Space Administration (NASA) was organized. Its satellites have contributed greatly to our understanding of the ocean and ocean processes. The first oceanographic satellite, SEASAT, was launched in 1978 sending information about the ocean such as temperature, wave height, and variation in sea surface contours. Modern satellites such as the TOPEX/Poseidon, the Jason-3,and the AQUA are capable of sending large amount of scientific date back to Earth very quickly. The type of information that is gathered includes data about the water cycle, evaporation, temperature, phytoplankton, and dissolved organic matter at the surface of the ocean. In terms of navigation, the U.S. Department of Defense has developed a Global Positioning System (GPS) composed of 24 satellites equipped with a computer, an atomic clock, and a radio transmitter. Any GPS receiver on the ground can calculate its own geographic location. Longitude and latitude are accurate with 1 meter. Overall, the use of satellites for studying the ocean has allowed scientists to see the “big picture” and watch how it changes over time—satellites can collect immense quantities of data, spanning the entire ocean, in a very short period of time. This was virtually impossible when we were limited strictly to shipboard methods. Conquering the spatial and temporal challenges of studying the ocean is one of the biggest accomplishments in oceanography to date. |

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| 70. How do echo sounders work and what kind of information can they provide about the ocean floor?​

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| *ANSWER:* | ​Echo sounders changed the way scientists study the ocean floor. Echo sounders bounce sound waves off the ocean floor gathering information about depth and contour. Sound waves are emitted from a ship and travel to the ocean floor and then they are reflected back to the ship. The depth is calculated by taking the sound wave velocity and multiplying it by the round-trip time, then divided by 2 (D=V(T/2)). Initially, this technique was very popular in measuring depths but was further applied to defining ocean floor contours and features. |

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