

PRACTICE EXAM 58: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. The light reaching us from a galaxy 10 billion light-years away took 10 billion years to arrive. What does this tell scientists about the universe and about astronomy itself?

A. Observing very distant objects is a way of looking back in time, since the light we see now was emitted long before it reached the Earth

B. The light from any galaxy reaches Earth the instant it is emitted, so distant galaxies show us the universe exactly as it appears at the current moment

C. The light from any galaxy is constantly absorbed before it reaches Earth, so the distance to a galaxy has no measurable effect on the age of the light we observe

D. The light from any galaxy travels backwards in time as it crosses space, so observing distant galaxies shows us the universe long after we observed nearby objects in space

2. Astronomers classify stars by their luminosity and surface temperature on a graph called the Hertzsprung-Russell diagram. Which of the following best describes what this diagram reveals about stars?

A. The diagram reveals only the chemical composition of stars and nothing else about their physical properties or stages of stellar evolution that occur during their lifetimes

B. The diagram has no real scientific use and is no longer considered helpful for the modern study of any aspect of star formation, structure, or stellar evolution at all

C. The diagram reveals only the rotation rate of stars and nothing else about their physical properties or stages of stellar evolution that occur during their lifetimes

D. The diagram organizes stars into groups such as the main sequence, giants, and white dwarfs, revealing patterns linked to a star's mass, age, and evolutionary stage

3. The Sun is classified as a main-sequence star. Which of the following best describes what this classification means?

A. The Sun is a small, cool, dim, post-main-sequence star that is steadily fading and cooling as it nears the very end of its long, multi-stage evolutionary lifetime as a small star

B. The Sun is a stable, middle-aged star fusing hydrogen into helium in its core, where outward pressure from fusion balances the inward pull of gravity, keeping it stable over time

C. The Sun is a very massive, hot, blue, young star that has only just begun fusing the first elements in its core and is rapidly approaching its eventual violent supernova explosion

D. The Sun is the leftover dense, hot core of a dead massive star, with no nuclear fusion at all taking place anywhere within its interior at any point in its current stage of life

4. A scientist explains that during the Big Bang, only the lightest elements—hydrogen, helium, and a small amount of lithium—were produced. Where, then, did the heavier elements in the universe come from?

A. The heavier elements were all manufactured by chemical reactions in Earth's atmosphere shortly after the Earth itself first formed, with no role at all played by any stars

B. The heavier elements have always existed in their current amounts since the universe first began, since the Big Bang produced every element in exactly the same proportions

C. Heavier elements up to iron form by fusion inside stars, and elements heavier than iron form in supernova explosions and other extreme stellar events, then scatter into space

D. The heavier elements are all produced by ongoing chemical reactions taking place inside the Sun right now, with no role at all played by any other stars anywhere in the universe

5. Kepler's First Law states that planetary orbits are ellipses with the Sun at one focus, not perfect circles with the Sun at the center. Which of the following best describes one practical consequence of this elliptical shape?

A. A planet's distance from the Sun remains exactly constant throughout its entire orbit, regardless of where the planet happens to be located in its orbit around the Sun at any time

B. A planet's distance from the Sun is greatest exactly halfway between the planet's closest and farthest points, regardless of where the planet is located in its orbit around the Sun

C. A planet's distance from the Sun is exactly the same at every point along its orbit, since elliptical orbits do not actually affect how far the planet is from the Sun at any time

D. A planet's distance from the Sun changes throughout its orbit, with a closest point called perihelion and a farthest point called aphelion at opposite ends of the ellipse

6. Earth's orbit is only slightly elliptical, with the Earth slightly closer to the Sun in January and slightly farther from the Sun in July. Which of the following best explains why this small difference in distance is not what causes the seasons?

A. Earth's distance to the Sun changes dramatically through the year by many millions of kilometers, with closer distances causing summer and farther distances causing winter at any latitude

B. Earth's distance to the Sun has never been measured by scientists, which is the main reason that the changing seasons cannot ever be explained by the changing distance to the Sun

C. The change in Earth's distance to the Sun is small compared with the effect of the axial tilt, and the Northern Hemisphere actually has winter when Earth is closest to the Sun

D. The change in Earth's distance to the Sun is exactly the same in the Northern Hemisphere and the Southern Hemisphere at any given time of year, so it cannot cause any seasons at all

7. A waxing crescent Moon, with a thin sliver lit on its right side, can be seen low in the western sky just after sunset. About one week later, which Moon phase will be visible?

A. A first quarter, the phase of the Moon during which exactly the right half of the visible disk is illuminated in the early evening sky just after sunset

B. A full moon, the phase of the Moon during which the entire side of the Moon facing Earth is brightly lit throughout the entire night for many hours after sunset

C. A waning crescent, the phase of the Moon during which a thin sliver appears lit on the left side of the Moon in the early morning sky just before sunrise

D. A new moon, the phase during which the side of the Moon facing us is dark, so the Moon cannot be easily seen anywhere in the sky at any time of day for many hours

8. The Sun and the Moon appear roughly the same size in Earth's sky, even though the Sun is far larger than the Moon in reality. Which of the following best explains this apparent coincidence?

- A. The Sun and Moon are exactly the same actual size, which is the only reason they appear to be the same size in Earth's sky as seen by observers across the surface of the planet
- B. The Sun is about 400 times the Moon's diameter but also about 400 times farther away, so the two objects happen to span about the same angular size in Earth's sky
- C. The Sun and Moon are at exactly the same actual distance from Earth, which is the only reason they appear to be the same size in Earth's sky as seen by observers on the surface
- D. The Sun and Moon physically grow and shrink throughout the day, which is the only reason they appear to be the same size in Earth's sky as seen by observers on the surface

9. Spring tides have the largest tidal range during the lunar month, while neap tides have the smallest tidal range. Which of the following correctly explains the difference between these two kinds of tides?

- A. Spring tides occur at first and last quarter when the Sun and Moon pull at right angles, while neap tides occur at new and full moon when their pulls combine in a single straight line of action
- B. Spring tides occur only in the season of spring, while neap tides occur only in the season of fall, with no relationship at all to the position of the Sun or the Moon in the sky at any time
- C. Spring tides occur only on Earth's largest lakes, while neap tides occur only on the open oceans, with no relationship at all to the position of the Sun or the Moon in the sky at any time of year
- D. Spring tides occur at new and full moon when the Sun, Earth, and Moon align, while neap tides occur at first and last quarter when the Sun and Moon pull at right angles to each other

10. A scientist explains that all of the planets in the solar system, plus most of the asteroids and comets, orbit the Sun in the same direction. Which of the following best explains why this is the case?

- A. The solar system formed from a single rotating cloud of gas and dust, and the objects within it inherited the same direction of motion from that original spinning cloud
- B. Each planet, asteroid, and comet was captured independently from completely different regions of space and only coincidentally ended up orbiting the Sun in the same direction
- C. The Sun's gravitational pull always forces all of the objects orbiting it into the same direction of motion, regardless of the direction in which they happen to be moving before they enter the solar system
- D. The Moon's gravitational pull on the planets forces all of them to orbit the Sun in the same direction, regardless of the direction in which they happen to be moving before they enter the system

11. Mars has a thin atmosphere and surface features that suggest it once had liquid water flowing across its surface. Which of the following best describes what these features reveal about Mars's history?

A. Mars has always been exactly as it is today, with no liquid water flowing across its surface at any time in its history, regardless of any features that may be observed on its surface

B. Mars currently has large open oceans of liquid water flowing across its surface, which is the main reason that scientists have observed water-related features on the surface of the planet

C. Mars's climate was likely once warmer and wetter, with liquid water flowing across its surface in the distant past before the climate changed and the planet became cold and dry

D. Mars's surface features were all created within the last few hundred years by liquid water that briefly flowed across its surface, with no connection to any earlier history of the planet

12. A geologist studies a thick sequence of horizontal sedimentary rock layers that has remained undisturbed since deposition. According to the principle of superposition, where is the oldest rock layer located in this sequence?

A. At the very bottom of the sequence, since the lowest undisturbed layer was deposited first and is therefore the oldest layer in the entire sequence by the principle of superposition

B. At the very top of the sequence, since the highest undisturbed layer was deposited first and is therefore the oldest layer in the entire sequence by the principle of superposition

C. Exactly in the middle of the sequence, since deposition always begins in the middle of any sedimentary sequence and then builds outward in both directions over time afterwards

D. The oldest layer cannot be identified, since the layers in any undisturbed sedimentary sequence are always randomly ordered with no relationship between position and age at all

13. A volcanic ash bed deposited between two sedimentary layers is dated by radiometric methods to about 50 million years old. Which of the following statements best describes what this date allows the geologist to conclude?

A. Every layer in the entire sequence above and below the ash bed must be exactly 50 million years old, even though they are all very far from the dated ash bed at this single point

B. The layers above the ash bed are older than 50 million years and the layers below the ash bed are younger than 50 million years, by the principle of superposition over deposition

C. The layers below the ash bed are older than 50 million years and the layers above the ash bed are younger than 50 million years, by the principle of superposition combined with absolute dating

D. The date of the ash bed cannot be used to determine the age of any other layers in the sequence, since the ages of other layers cannot ever be related to the dated age of the ash bed itself

14. A radioactive isotope has a half-life of 1,500 years. A sample now contains one-eighth of the original amount of this isotope. About how much time has passed since the sample formed?

A. About 1,500 years, because reducing the original amount of a radioactive isotope to one-eighth of its original amount requires only one full half-life of decay of the isotope

B. About 3,000 years, because reducing the original amount of the radioactive isotope to one-eighth of its original amount requires only two full half-lives of decay of the isotope

C. About 12,000 years, because reducing the original amount of the radioactive isotope to one-eighth of its original amount requires exactly eight full half-lives of decay of the isotope

D. About 4,500 years, because three half-lives are needed to reduce the isotope to one-eighth of its original amount

15. Earth's geologic history is divided into eons, eras, periods, and epochs. Which of the following correctly orders these divisions from longest to shortest?

A. Eons are the longest, followed by eras, periods, and then epochs as the shortest of all the divisions used to organize Earth's geologic history into time intervals

B. Epochs are the longest, followed by periods, eras, and then eons as the shortest of all the divisions used to organize Earth's geologic history into time intervals

C. Periods are the longest, followed by eons, eras, and then epochs as the shortest of all the divisions used to organize Earth's geologic history into time intervals

D. Eras are the longest, followed by epochs, eons, and then periods as the shortest of all the divisions used to organize Earth's geologic history into time intervals

16. A geologist studies a sequence of rock layers that includes evidence of widespread glaciation, followed by a period of warm climates and abundant tropical fossils, followed by another period of glaciation. What does this pattern most directly suggest about Earth's history?

- A. Earth's climate has always been exactly as it is today, with no measurable changes ever taking place in any region during any period of geologic history, no matter what the rocks may show
- B. Earth's climate has changed significantly over geologic time, alternating between cooler and warmer periods that are recorded in the rocks and fossils of different parts of the geologic past
- C. Earth's climate has only been cold during human history, with no warm or tropical periods ever taking place anywhere on the planet during any earlier part of geologic history at any time
- D. Earth's climate has only been warm during human history, with no cold or glacial periods ever taking place anywhere on the planet during any earlier part of geologic history at any time

17. Mass extinctions punctuate Earth's history and often correspond with major environmental disruptions. Which of the following best describes the likely role of large-scale volcanic eruptions in past mass extinctions?

- A. Large-scale volcanic eruptions have always made the global climate cooler over short periods, but they have never had any role at all in any mass extinction event in Earth's geologic history
- B. Large-scale volcanic eruptions are now considered to have had no role at all in any mass extinction event in Earth's history, since their effects have never reached far from the actual eruption sites
- C. Large-scale volcanic eruptions have always made the global climate warmer over short periods, but they have never had any role at all in any mass extinction event in Earth's geologic history
- D. Major volcanic events can release enormous amounts of gas and ash that alter the climate and the chemistry of the atmosphere and oceans, contributing to mass extinction events on Earth

18. Wegener noticed that the coastlines of South America and Africa appeared to fit together like puzzle pieces, suggesting that the two continents were once joined. Which of the following best explains why this single observation was not enough to convince other scientists to accept his idea?

- A. The fit of the coastlines was the only evidence Wegener ever assembled to support his idea of continental drift, which is the main reason that his idea was rejected by other scientists
- B. Other scientists did not accept Wegener's idea because the puzzle-piece fit of the coastlines was not by itself sufficient evidence, and Wegener could not propose a mechanism for moving the continents
- C. The fit of the coastlines was eventually shown to be a complete coincidence with no relationship at all to any past geological history of either continent or to any process operating today
- D. Other scientists rejected Wegener's idea simply because they could not see the puzzle-piece fit of the coastlines for themselves, even though Wegener pointed it out to them many times

19. A subduction zone is a region where one tectonic plate descends beneath another. Which of the following best describes a typical geologic feature found in a subduction zone where an oceanic plate descends beneath a continental plate?

A. A deep ocean trench at the boundary and a chain of volcanic mountains on the overriding continental plate, fed by melt rising from the descending plate

B. A long mid-ocean ridge running along the boundary and chains of low volcanic islands rising from the deep ocean floor near the descending plate as it moves into the mantle

C. A long mid-ocean ridge running along the boundary and chains of high snow-capped mountains rising along the coastline of the overriding plate as it moves into the mantle below

D. A flat continental shelf running along the boundary and chains of volcanic islands rising near the descending plate as it moves into the mantle on its long journey downward through the crust

20. Earth's crust is divided into oceanic crust and continental crust, which differ in density, thickness, and composition. Which of the following correctly compares these two types of crust?

A. Oceanic crust is much thicker than continental crust and is composed of less dense, lighter-colored rock such as granite, while continental crust is composed of denser, darker rock such as basalt

B. Oceanic crust is thinner and denser than continental crust, composed mostly of dark basalt, while continental crust is thicker and less dense, composed mostly of lighter-colored rock such as granite

C. Oceanic crust and continental crust have exactly the same density, thickness, and composition as each other, which is the main reason scientists treat them as the same kind of crust everywhere

D. Oceanic crust is thinner than continental crust but is composed of much less dense rock, such as light-colored granite, while continental crust is composed of denser, darker rock such as basalt

21. A geologist describes a sedimentary rock as "well sorted" when most of its grains are of similar size. Which of the following environments most likely produces well-sorted sedimentary rock?

A. A glacial environment, where ice carries unsorted rock fragments of all sizes from boulders down to clay and deposits them together in a single chaotic mixture as the ice melts away

B. A landslide environment, where a sudden collapse carries unsorted rock fragments of all sizes from boulders down to clay and deposits them together in a single chaotic mixture

C. A windswept desert, where wind blows away the lighter, finer dust while leaving sand grains of a similar size to pile up into well-sorted dunes shaped by the wind

D. A volcanic eruption that throws unsorted rock and ash of all sizes into the air and deposits them together in a single chaotic mixture, with no sorting of any kind by size or weight

22. A scientist examines a metamorphic rock and notices that its minerals are aligned into parallel bands rather than scattered in random directions. Which of the following best describes this kind of texture?

A. A vesicular texture, which is the texture seen in lava flows that trap small pockets of gas as they cool, leaving cavities that fill the rock with many small visible holes throughout

B. A clastic texture, which is the texture seen in sedimentary rocks formed from broken fragments of older rocks cemented together, with each fragment retaining its original shape and size

C. A pyroclastic texture, which is the texture seen in volcanic rocks formed from fragments of solid rock and frozen droplets of lava thrown out by an erupting volcano onto the surface

D. A foliated texture, in which platy minerals such as mica are aligned by directed pressure into parallel layers or bands, typical of metamorphic rocks such as gneiss and schist

23. A rock layer that is composed primarily of the fossilized shells of marine organisms cemented together is most likely to be which kind of rock?

A. A biological sedimentary rock such as limestone, formed from the accumulation of marine organism shells and skeletons that are cemented together over time at or near the seafloor

B. An intrusive igneous rock such as granite, formed from molten rock cooling slowly underground over millions of years to produce coarse, interlocking crystals of feldspar and quartz

C. A metamorphic rock such as schist, formed from older rocks subjected to high heat and pressure deep underground, which recrystallized the original minerals into wavy parallel bands

D. An extrusive igneous rock such as basalt, formed from molten rock cooling rapidly at the surface to produce a fine-grained dark rock with very small, barely visible crystals throughout

24. A region's groundwater is held in an aquifer, a layer of rock that can store and transmit water. Which of the following best describes the difference between an unconfined aquifer and a confined aquifer?

- A. An unconfined aquifer is always completely empty and contains no water at any time, while a confined aquifer always overflows the surface and floods the surrounding ground above
- B. An unconfined aquifer is bounded above by a permeable layer and connected to the surface, while a confined aquifer is bounded above by an impermeable layer that traps water under pressure
- C. An unconfined aquifer always contains salty water, while a confined aquifer always contains fresh water, with no relationship at all to the rocks or sediments that store the water
- D. An unconfined aquifer and a confined aquifer are exactly the same kind of aquifer, with no measurable difference in how they store water or how they connect to the surface above

25. A river enters a flat plain and slows down, dropping much of its sediment. Which of the following landforms is most likely to develop where this river slows and deposits its load?

- A. A glacial moraine, a ridge or pile of unsorted rock and sediment dropped along the sides or end of a glacier as the ice melts and the rocks frozen inside the ice are released to the ground
- B. A volcanic cinder cone, a steep, cone-shaped hill that forms around a volcanic vent from the accumulation of small, lightweight fragments of solidified lava thrown into the air during an eruption
- C. A coral reef, a structure built by colonies of marine animals that secrete calcium carbonate skeletons in warm, shallow seawater near tropical coastlines around the world's oceans
- D. A floodplain or delta, a flat area formed by the deposition of sand, silt, and clay where a river slows on a plain or as it enters a standing body of water, building up over time

26. Earth's atmosphere is divided into layers based on how temperature changes with altitude. Which of the following best describes the lowest layer of the atmosphere, where almost all weather occurs?

- A. The stratosphere, the second layer of the atmosphere above the surface, where temperature gradually increases with altitude due to the absorption of ultraviolet radiation by the ozone layer
- B. The mesosphere, the third layer of the atmosphere above the surface, where temperature decreases sharply with altitude and where many meteors burn up as they enter the atmosphere of Earth
- C. The troposphere, the lowest layer of the atmosphere, where temperature generally decreases with altitude and where almost all weather phenomena occur
- D. The thermosphere, the fourth layer of the atmosphere above the surface, where temperature increases sharply with altitude due to the absorption of high-energy radiation from the Sun by gases

27. A scientist explains that the lower atmosphere is warmed primarily by infrared radiation released from Earth's surface rather than directly by sunlight passing through the air. Which of the following best explains this pattern?

- A. Earth's surface absorbs incoming sunlight and re-emits the energy as infrared radiation, which is then absorbed by greenhouse gases in the lower atmosphere, warming the air near the surface
- B. Earth's surface is heated directly by the absorption of all incoming sunlight by the lower atmosphere, with no role at all played by infrared radiation re-emitted from the surface back into the air
- C. Earth's atmosphere is heated only by the absorption of all incoming sunlight at the top of the atmosphere, with no role at all played by infrared radiation re-emitted from the surface back into the air
- D. Earth's atmosphere is heated only by internal heat from deep within the planet, with no role at all played by the Sun or by any infrared radiation re-emitted from the surface back into the air

28. A meteorologist sees a region of low atmospheric pressure on a weather map. Which of the following kinds of weather is most likely to be associated with this low-pressure system?

- A. Clear skies and generally fair weather, since air sinks in a low-pressure system, which warms and dries the air as it descends, suppressing the formation of clouds and discouraging precipitation
- B. Rising air, cloud formation, and a higher chance of precipitation, since air converges toward a low-pressure center at the surface and rises and cools as it moves upward through the atmosphere
- C. Strong winds blowing outward from the low-pressure center, since air always flows outward from any low-pressure system at the surface and never inward toward the center of the system
- D. No measurable effect on the weather, since the air pressure measured by a barometer has no actual connection to the weather conditions that develop over the region in the following hours

29. A meteorologist explains that hurricanes weaken rapidly once they make landfall, even before they reach inland regions. Which of the following best explains this rapid weakening?

- A. The Coriolis effect immediately stops acting on a hurricane the moment it crosses any coastline, which immediately disorganizes the storm and stops its rotation within just a few hours
- B. The air pressure inside the eye of the hurricane immediately becomes equal to the surrounding air pressure once the storm crosses any coastline, which stops all rotation within just a few hours

C. The hurricane loses its supply of warm ocean water, which had been providing the heat and moisture needed to power the storm out at sea

D. The hurricane is immediately repelled by the magnetic field of the Earth once the storm crosses any coastline, which slows its winds and quickly weakens its overall structure within hours

30. A scientist explains that climate change is supported by many lines of evidence collected over many decades. Which of the following best describes one such line of evidence?

A. A single day of unusually warm weather in one city, which by itself definitively proves that the global climate is warming, regardless of any other long-term data trends or evidence

B. A single hurricane making landfall in one region, which by itself definitively proves that the global climate is warming, regardless of any other long-term data trends or other evidence

C. A single day of unusually cold weather in one city, which by itself definitively proves that the global climate is cooling, regardless of any other long-term data trends or evidence

D. Long-term temperature records, melting of glaciers and polar ice, and rising global sea level, all of which show consistent trends linked to a warming planet over many decades

31. A meteorologist explains that the Coriolis effect deflects winds and ocean currents in the Northern Hemisphere to the right of their direction of motion. Which of the following best describes the cause of the Coriolis effect?

A. The gravitational pull of the Moon directly drags winds and ocean currents to the right of their direction of motion in the Northern Hemisphere, with no role at all played by any other body

B. The rotation of the Earth on its axis causes objects moving across its surface to appear to curve, deflecting winds and currents to the right in the Northern Hemisphere and to the left in the Southern

C. The Sun's gravitational pull directly drags winds and ocean currents to the right of their direction of motion in the Northern Hemisphere, with no role at all played by any other body in space

D. The Earth's magnetic field directly drags winds and ocean currents to the right of their direction of motion in the Northern Hemisphere, with no role at all played by the rotation of the Earth on its axis

32. A meteorologist looks at a weather map showing a cold front advancing toward a warm, humid region. Which of the following sequences of weather is most likely as the cold front passes?

- A. A narrow band of heavy showers and thunderstorms, followed by clearing skies and a sharp drop in temperature behind the front, as the cold air wedges beneath the warm air ahead
- B. A long period of light, steady rain or drizzle that lasts many hours, followed by gradually warming temperatures and increasing humidity once the front has finally passed across the region
- C. Several days of motionless dense fog that simply hangs over the same area, with no precipitation and no real change in temperature of any kind for the entire period that the front sits over the region
- D. Completely clear skies and rising temperatures throughout the entire passage of the front, with no clouds or precipitation developing at any point during the day or evening hours

33. A scientist explains that one important contributor to current climate change is the burning of fossil fuels. Which of the following best describes how burning fossil fuels affects Earth's climate?

- A. Burning fossil fuels has no measurable effect on Earth's climate, since the carbon dioxide released by the burning of fossil fuels is far too small in quantity to matter for the climate of the planet
- B. Burning fossil fuels removes carbon dioxide from the atmosphere over many years, which gradually cools the surface of the Earth and slows down the changes that occur in the global climate
- C. Burning fossil fuels permanently and instantly reverses all of the climate change that has already occurred over recent centuries, with no further action needed in any other sector of the economy
- D. Burning fossil fuels releases carbon dioxide into the atmosphere, increasing the concentration of this greenhouse gas and adding to the warming caused by the greenhouse effect

34. A meteorologist explains that warm air can hold more water vapor than cold air. Which of the following best describes one consequence of this fact for the formation of clouds and precipitation?

- A. Clouds and precipitation form only when warm, dry air sinks through the atmosphere and warms further as it descends, which is the only way clouds can ever form anywhere in the atmosphere
- B. Clouds and precipitation form only when cold, dry air sinks through the atmosphere and warms as it descends, which is the only way clouds can ever form anywhere in the atmosphere
- C. As warm, humid air rises and cools, it can hold less water vapor, so the excess vapor condenses into tiny droplets that form clouds and may eventually fall as precipitation
- D. Clouds and precipitation form only when the wind stops blowing entirely, which is the only condition under which water vapor in the air is able to condense into clouds anywhere

35. A weather forecaster explains that meteorologists use weather satellites, surface weather stations, weather balloons, and computer models to make predictions. Which of the following best describes one important advantage of using all of these tools together?

- A. Using only one tool would always be much more accurate than using multiple tools together, which is the main reason that modern weather forecasting always relies on a single tool at a time
- B. Combining many sources of data and using computer models lets forecasters build a more complete picture of the atmosphere and produce more reliable predictions than any single tool could on its own
- C. Using multiple tools together always increases the chance of producing a poor forecast, since any disagreement between tools always reduces the reliability of the resulting weather prediction
- D. Using multiple tools together has no real benefit over using a single tool, since meteorologists are never able to combine information from many different sources into a single weather forecast

36. A scientist explains that some regions are likely to experience longer and more intense droughts as the climate warms. Which of the following best describes how climate change can contribute to more severe droughts?

- A. Higher temperatures increase evaporation from soils and surface water, and shifts in rainfall patterns can reduce precipitation in some regions, both of which make droughts more severe
- B. Higher temperatures have no effect on evaporation rates from soils or surface water, so droughts in the future will be no more severe than droughts that have already occurred in the past
- C. Higher temperatures cause all rainfall to fall in exactly the same pattern across the planet, which would make every region of the world experience exactly the same amount of drought every year
- D. Higher temperatures cause the atmosphere to retain exactly the same amount of water vapor at all times, with no measurable effect on how much rain falls in any single region around the world

37. A community is considering several different sources of electricity for its new neighborhood. Which of the following would be the most sustainable, lowest-emission choice over the long term?

- A. A new coal-fired power plant that burns large quantities of coal to generate electricity, releasing significant carbon dioxide and other air pollutants into the atmosphere during operation
- B. A new natural gas power plant that burns large quantities of natural gas to generate electricity, releasing significant carbon dioxide and methane into the atmosphere during operation

C. A new oil-fired power plant that burns large quantities of oil to generate electricity, releasing significant carbon dioxide and other air pollutants into the atmosphere during operation

D. A new wind farm that uses turbines to convert energy from moving air into electricity, with little or no direct greenhouse gas emissions during operation over its lifetime

38. A scientist explains that many natural ecosystems provide services such as flood control, water filtration, pollination, and carbon storage. Which of the following best describes the term "ecosystem services"?

A. Ecosystem services are the benefits that people receive from natural ecosystems, including the production of food, clean water, climate regulation, and many other supporting and cultural benefits

B. Ecosystem services are paid services provided by environmental consulting firms to private clients, with no relationship to the natural benefits that ecosystems provide to people around the world

C. Ecosystem services are recreational activities that take place outdoors in natural areas, with no relationship to the natural benefits that ecosystems provide to people around the world

D. Ecosystem services are computer programs used to track environmental data, with no relationship to the natural benefits that ecosystems provide to people around the world

39. A river that flows through a region is heavily polluted by runoff from many farms, none of which discharges directly into the river through any single pipe or outlet. Which of the following best describes this kind of pollution?

A. Point-source pollution, in which a pollutant enters the river from a single identifiable location, such as the end of a specific pipe coming directly from a single factory or wastewater treatment plant

B. Nonpoint-source pollution, in which a pollutant comes from many scattered sources spread across the land, such as agricultural runoff carrying fertilizer and pesticide from many farms in the region

C. Thermal pollution, in which heated water is released from a single industrial plant directly into a river, raising the river's temperature and harming the organisms that live in the river

D. Atmospheric pollution, in which a pollutant enters the river only from the air after being released from a single industrial smokestack and then settles into the water over a period of time

40. A community is concerned about the loss of native species in its region. Which of the following best describes one important benefit of protecting biodiversity?

- A. Protecting biodiversity has no measurable effect on the long-term health of any ecosystem, since native species play no role at all in maintaining the natural functioning of any ecosystem anywhere
- B. Protecting biodiversity reduces the long-term productivity and stability of every ecosystem, which is the main reason that biodiversity is widely considered harmful to ecosystems by scientists today
- C. A more diverse community of species supports ecosystem stability, resilience, and the continued provision of ecosystem services such as pollination, decomposition, and nutrient recycling
- D. Protecting biodiversity always permanently and instantly reverses all of the climate change that has already occurred, with no further effort of any kind needed in any other sector of the global economy

41. A coastal community is preparing for future climate change by elevating critical infrastructure, building flood barriers, and restoring coastal wetlands. Which of the following best describes this combination of actions?

- A. Mitigation, since the community is reducing the greenhouse gas emissions that are the underlying cause of climate change by adjusting its physical infrastructure to better cope with future climate impacts
- B. Restoration, since the community is rebuilding ecosystems that have already been damaged or destroyed by previous human activity in the region, with no relationship to any future climate impacts
- C. Acidification, since the community is taking steps to lower the rising acidity of the nearby ocean by removing carbon dioxide from the seawater near its shoreline, with no relationship to climate impacts
- D. Adaptation, since the community is adjusting its infrastructure and ecosystems to better cope with climate impacts that are already starting to occur in the region

42. A factory installs scrubbers on its smokestacks to remove sulfur dioxide and other pollutants before the exhaust enters the atmosphere. Which of the following best describes one environmental benefit of using scrubbers on industrial smokestacks?

- A. Scrubbers reduce the release of pollutants that contribute to acid rain and respiratory illness, improving air quality in the surrounding region and reducing damage to forests, lakes, and human health
- B. Scrubbers have no measurable effect on any pollutant released into the atmosphere, since the gases released by any industrial smokestack cannot be removed by any kind of treatment system at all
- C. Scrubbers always permanently and instantly reverse all of the climate change that has already occurred over recent centuries, with no further effort of any kind needed in any other sector of the economy
- D. Scrubbers always increase the release of pollutants from any industrial smokestack, since adding any treatment system to a smokestack always makes the pollution from the smokestack significantly worse

43. A city is considering ways to reduce its contribution to climate change. Which of the following actions would most directly reduce the city's greenhouse gas emissions?

- A. Expanding parking lots and highways to encourage more residents to drive personal cars for many of their daily trips, regardless of the resulting increase in fuel use and carbon dioxide emissions
- B. Removing all of the trees and other vegetation from the city's parks and street medians, regardless of the resulting decrease in carbon storage by plants and the increase in urban temperatures
- C. Investing in public transportation, supporting energy-efficient buildings, and shifting electricity supply to renewable sources such as wind and solar to reduce fossil fuel use
- D. Encouraging residents to leave all lights, appliances, and electronics turned on at all times throughout their homes, regardless of the resulting increase in energy use and carbon dioxide emissions

44. A scientist explains that a region's water supply depends on its precipitation, its evaporation, the size of its rivers and aquifers, and the amount of water that people withdraw. Which of the following best describes the meaning of "water scarcity" for a region?

- A. Water scarcity is the condition in which a region's water supply is unlimited and is far greater than the demand from the people, agriculture, and industry that depend on the water of the region
- B. Water scarcity is the condition in which a region's water supply is always perfectly matched to the demand from the people, agriculture, and industry that depend on the water of the region
- C. Water scarcity is the condition in which a region's water supply is always greater than the demand and continues to grow each year, regardless of the demand from people, agriculture, and industry
- D. Water scarcity is the condition in which the demand for fresh water in a region exceeds the available supply, making it difficult to meet the needs of people, agriculture, and natural ecosystems

45. A homeowner is considering installing solar panels on the roof. Which of the following best describes one major environmental benefit of using solar panels to supply household electricity?

- A. Solar panels permanently and instantly reverse all of the climate change that has already occurred over recent centuries, with no further effort of any kind needed in any other sector of the economy
- B. Solar panels generate electricity directly from sunlight, reducing the household's demand for electricity from fossil-fuel power plants and lowering its share of greenhouse gas emissions from the grid

C. Solar panels always increase the household's demand for electricity from fossil-fuel power plants, since installing solar panels always raises the total energy use of any household over its lifetime

D. Solar panels have no measurable effect on any household's greenhouse gas emissions, since the electricity generated by any household solar installation cannot be used to replace electricity from the grid

46. A community is concerned about the rising amount of waste sent to landfills. Which of the following actions, taken at the individual or household level, would most directly reduce the amount of waste sent to local landfills?

A. Reducing, reusing, and recycling materials whenever possible, and composting food scraps and yard waste, all of which divert materials away from landfills and return them to use or to the soil

B. Discarding all materials, including paper, glass, metal, food scraps, and yard waste, directly into ordinary household trash without sorting any items for recycling, composting, or repair at any point

C. Burning all household waste in an open pile in the backyard, which has been shown to be the cleanest and most environmentally friendly way to handle the waste from any household, ever

D. Storing all household waste indefinitely in the attic or basement, with no recycling, composting, or disposal at all, which has been shown to be the safest way to handle waste from any household

47. A community installs LED streetlights and replaces older buildings' heating systems with high-efficiency models. Which of the following best describes the most direct environmental benefit of these actions?

A. The community's average rainfall is permanently changed, since changes to the community's streetlights and heating systems have been shown to directly alter long-term precipitation patterns over the surrounding region

B. The community's residents no longer need to use any source of energy of any kind in any of their daily lives, since changes to the community's streetlights and heating systems fully replace every other source of energy demand

C. The community's energy use is reduced, lowering demand for electricity and fuel, and reducing the greenhouse gas emissions associated with generating that energy from fossil-fuel sources

D. The community's average temperature falls sharply in the summer, since changes to the community's streetlights and heating systems have been shown to directly cool the climate of the surrounding region of the country

48. An engineering team is designing a new water filtration system for a remote community. The team must balance cost, ease of use, and reliability. The team gathers data about the local water sources, the available materials, the skills of local technicians, and the budget the community can afford. Which step of the engineering design process is the team performing by gathering this information?

- A. Building a prototype, since gathering information about a problem is the same step as constructing an early working model of the design that the team plans to test in a real environment later on
- B. Testing the design, since gathering information about a problem is the same step as evaluating the performance of a finished design under real conditions over a period of time before it is finalized
- C. Releasing the final product, since gathering information about a problem is the same step as delivering the finished design to the people who will actually use it daily for many years without any further changes
- D. Defining the problem, since gathering information about the situation and identifying the criteria and constraints the solution must address is a key part of the early problem-definition phase

49. An engineering team has built and tested a prototype of a new bridge support. The test has revealed that the support fails under certain loading conditions that the team did not originally anticipate. Which of the following best describes the team's most appropriate next action?

- A. Use the test data to analyze why the support failed, modify the design to address the weakness, and then test the modified support again to determine whether the change has been effective
- B. Conceal the failure of the support from the public and proceed to build the full-sized version of the bridge using the original plans, since revealing flaws found in any prototype is never an acceptable practice
- C. Abandon the entire project immediately, since the discovery of any unanticipated weakness in any prototype always proves that the underlying design can never be made to work safely under any conditions
- D. Open the full-sized version of the bridge to vehicle and pedestrian traffic without making any changes, since the first version of any design is always the final version, regardless of the test results

50. An engineering team has developed three different designs for a new wind turbine, each of which has different strengths in cost, power output, and noise. Which of the following best describes how the team should choose among these three designs?

- A. The team should always choose the most expensive of the three designs, since a higher cost is a guarantee that a design will perform better than any of the less expensive options under all conditions

- B. The team should evaluate each design against the criteria and constraints, weighing the trade-offs and selecting the design that best balances cost, power output, noise, and other relevant factors
- C. The team should always choose the least expensive of the three designs, since a lower cost is a guarantee that a design will perform better than any of the more expensive options under all conditions
- D. The team should select one of the three designs completely at random, since there is no reliable way to compare competing engineering designs to one another in any kind of meaningful or systematic way

Practice Exam 58: Answer Key with Explanations

1. A — Observing very distant objects is a way of looking back in time, since the light we see now was emitted long before it reached Earth. Light's finite speed turns distance into a window onto earlier times. This is why astronomy is partly the study of cosmic history.
2. D — The Hertzsprung-Russell diagram organizes stars into groups such as the main sequence, giants, and white dwarfs, revealing patterns linked to a star's mass, age, and evolutionary stage. Plotting luminosity against temperature exposes these natural groupings. It is one of the most important tools in stellar astronomy.
3. B — A main-sequence star is a stable, middle-aged star fusing hydrogen into helium in its core, with outward pressure from fusion balancing the inward pull of gravity. This hydrostatic equilibrium keeps the star steady. The Sun spends about 90 percent of its life in this stage.
4. C — Elements up to iron form by fusion inside stars, while elements heavier than iron form in supernovae and other extreme stellar events, then scatter into space. The Big Bang produced only the lightest elements. Stellar nucleosynthesis is the origin of nearly every heavier element.
5. D — Kepler's First Law means a planet's distance from the Sun changes throughout its orbit, with a closest point called perihelion and a farthest point called aphelion. The Sun sits at one focus of the ellipse, not at the center. This variable distance shapes how speed changes along the orbit.
6. C — The change in Earth's distance to the Sun is small compared with the effect of axial tilt, and the Northern Hemisphere has winter when Earth is closest to the Sun. The tilt, not the small distance change, drives the seasons. This is why January perihelion does not warm northern winters.
7. A — A waxing crescent grows into a first quarter Moon about a week later, with exactly the right half of the visible disk illuminated. "Waxing" means the lit fraction is increasing. The next stages would be waxing gibbous and then full.
8. B — The Sun is about 400 times the Moon's diameter but also about 400 times farther away, so the two objects span about the same angular size in Earth's sky. Angular size depends on both real size and distance. This coincidence is what makes total solar eclipses possible.
9. D — Spring tides occur at new and full moon when the Sun, Earth, and Moon align and their pulls combine, while neap tides occur at first and last quarter when the Sun and Moon pull at right angles and partly cancel. Alignment governs tidal strength. This is why tide range varies through the lunar month.
10. A — The solar system formed from a single rotating cloud of gas and dust, and the objects within it inherited the same direction of motion from that original spinning cloud. Conservation of angular momentum preserved that direction. This is the nebular hypothesis.

11. C — Mars's surface features suggest its climate was once warmer and wetter, with liquid water flowing across its surface in the distant past before the climate changed and the planet became cold and dry. Riverbeds, lake basins, and minerals formed in water provide the evidence. Mars's history of water is a key target of exploration.
12. A — By superposition, the oldest rock layer in an undisturbed sequence lies at the very bottom, since the lowest layer was deposited first. Layers accumulate from the bottom upward over time. This rule is the foundation of relative dating in horizontal strata.
13. C — By superposition combined with the absolute date of the ash bed, layers below the ash are older than 50 million years and layers above it are younger. A dated ash bed acts as a fixed time marker within the surrounding sequence. This is how absolute and relative dating combine to constrain ages.
14. D — One-eighth remaining means three half-lives have passed, since $1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8$. Three half-lives \times 1,500 years equals 4,500 years. Counting halvings is the key to radiometric age problems.
15. A — Eons are the longest divisions of the geologic time scale, followed by eras, periods, and then epochs as the shortest. The hierarchy nests shorter divisions inside longer ones. This structure organizes 4.6 billion years of history into manageable intervals.
16. B — A rock record alternating between glaciation and warm tropical climates shows that Earth's climate has changed significantly over geologic time, with cooler and warmer periods preserved in rocks and fossils. The geologic record is one of continual change. This is why climate is studied as a dynamic system.
17. D — Major volcanic events can release enormous amounts of gas and ash that alter the climate and the chemistry of the atmosphere and oceans, contributing to mass extinctions. The end-Permian extinction is linked to the Siberian Traps eruptions. Volcanism is one of the recognized triggers of mass extinction.
18. C — Other scientists did not accept Wegener's idea because the puzzle-piece fit alone was not sufficient evidence, and he could not propose a mechanism for moving continents. Without a plausible driver, drift seemed implausible to many. Mantle convection later supplied that missing mechanism.
19. A — A subduction zone with an oceanic plate descending beneath a continental plate typically shows a deep ocean trench at the boundary and a chain of volcanic mountains on the overriding continental plate. The descending plate creates the trench, and melting above it feeds the volcanoes. The Andes are a classic example.
20. B — Oceanic crust is thinner and denser than continental crust, composed mostly of dark basalt, while continental crust is thicker and less dense, composed mostly of lighter rock such as granite. These differences explain why oceanic plates subduct under continental ones. Density controls who goes down at convergent boundaries.
21. C — A windswept desert produces well-sorted sediment because wind blows away lighter, finer dust and leaves sand grains of similar size to pile into dunes. Wind transport sorts grains efficiently by size. Glaciers and landslides, by contrast, deposit poorly sorted material.
22. D — A foliated texture has platy minerals such as mica aligned by directed pressure into parallel layers or bands, typical of metamorphic rocks like gneiss and schist. The alignment forms perpendicular to the direction of compression. Foliation is a hallmark of regional metamorphism.
23. A — Limestone made primarily of fossilized marine organism shells cemented together is a biological sedimentary rock, formed from the accumulation of shells and skeletons on or near the

seafloor. Calcium carbonate from marine life builds the rock over time. This composition distinguishes it from igneous and metamorphic rocks.

24. B — An unconfined aquifer is bounded above by a permeable layer and connected to the surface, while a confined aquifer is bounded above by an impermeable layer that traps water under pressure. The confining layer allows pressure to build in confined aquifers. Tapping a confined aquifer can produce an artesian well.
25. D — A floodplain or delta forms where a river slows on a plain or enters a standing body of water, depositing sand, silt, and clay over time. Reduced velocity drops the river's load. These landforms are classic features of low-gradient depositional environments.
26. C — The troposphere is the lowest layer of the atmosphere, where temperature generally decreases with altitude and where almost all weather phenomena occur. It contains most of the atmosphere's mass and water vapor. Weather, clouds, and storms develop within it.
27. A — Earth's surface absorbs incoming sunlight and re-emits the energy as infrared radiation, which is then absorbed by greenhouse gases in the lower atmosphere, warming the air near the surface. The atmosphere is mostly transparent to incoming sunlight but absorbs outgoing infrared. This explains why the lower atmosphere warms from below.
28. B — A low-pressure system features rising air, cloud formation, and a higher chance of precipitation, since air converges toward the low at the surface and rises and cools as it moves upward. Rising air drives the storms associated with low pressure. High-pressure systems, by contrast, bring fair weather.
29. C — A hurricane weakens over land because it loses its supply of warm ocean water, which had provided the heat and moisture powering the storm. Without that energy source, the storm rapidly decays. This is why hurricanes intensify over warm seas and weaken once ashore.
30. D — Climate warming is supported by long-term temperature records, melting of glaciers and polar ice, and rising global sea level, all showing consistent trends over many decades. The agreement across independent measurements is what makes the conclusion robust. Single events do not establish climate trends.
31. B — The Coriolis effect is caused by Earth's rotation on its axis, which makes objects moving across the surface appear to curve, deflecting winds and currents to the right in the Northern Hemisphere and to the left in the Southern. The deflection grows with latitude and speed. It shapes large-scale wind and ocean current patterns.
32. A — A fast cold front lifts warm, humid air steeply, producing a narrow band of heavy showers and thunderstorms, followed by clearing skies and a sharp drop in temperature behind the front. The steep frontal slope drives vigorous uplift. This abrupt change is characteristic of cold front passage.
33. D — Burning fossil fuels releases carbon dioxide into the atmosphere, increasing this greenhouse gas and adding to the warming caused by the greenhouse effect. CO₂ that was locked away for millions of years is returned in decades. This is the central mechanism of human-caused climate change.
34. C — As warm, humid air rises and cools, it holds less water vapor, so excess vapor condenses into tiny droplets that form clouds and may fall as precipitation. Cooling lowers the air's capacity for vapor. This is why rising air drives most cloud formation and rainfall.
35. B — Combining many data sources and using computer models lets forecasters build a more complete picture of the atmosphere and produce more reliable predictions than any single tool could on its own. Each tool fills different gaps and cross-checks the others. Modern forecasting depends on this integration.

36. A — Higher temperatures increase evaporation from soils and surface water, and shifts in rainfall patterns reduce precipitation in some regions, both of which make droughts more severe. The combination dries landscapes faster and refills them less. This is a recognized impact of climate change.
37. D — A wind farm uses turbines to convert energy from moving air into electricity, with little or no direct greenhouse gas emissions during operation. No fuel is burned to generate the power. This makes wind the most sustainable, lowest-emission choice among the options.
38. A — Ecosystem services are the benefits people receive from natural ecosystems, including production of food, clean water, climate regulation, and many supporting and cultural benefits. They are categorized as provisioning, regulating, supporting, and cultural. Recognizing them highlights the practical value of intact ecosystems.
39. B — Pollution coming from many scattered sources spread across the land, such as agricultural runoff from many farms, is nonpoint-source pollution. Its diffuse origin makes it hard to trace and control. This contrasts with point-source pollution from one identifiable outlet.
40. C — A more diverse community of species supports ecosystem stability, resilience, and the continued provision of ecosystem services such as pollination, decomposition, and nutrient recycling. Different species fill different roles, buffering ecosystems against disturbances. Biodiversity underpins the services people depend on.
41. D — Elevating infrastructure, building flood barriers, and restoring coastal wetlands to cope with climate impacts is adaptation, because the community is adjusting to changes already occurring. Adaptation manages effects, while mitigation cuts the emissions causing them. Coping with unavoidable impacts is the defining feature of adaptation.
42. A — Scrubbers reduce the release of pollutants that contribute to acid rain and respiratory illness, improving air quality and reducing damage to forests, lakes, and human health. They remove sulfur dioxide and other pollutants from exhaust gases. Their use is a core air-pollution control measure.
43. C — Investing in public transportation, supporting energy-efficient buildings, and shifting electricity to renewables most directly reduces a city's greenhouse gas emissions. Each measure cuts fossil-fuel use across a major sector. Together they target the largest urban emission sources.
44. D — Water scarcity is the condition in which the demand for fresh water in a region exceeds the available supply, making it difficult to meet the needs of people, agriculture, and ecosystems. It can arise from physical shortage or from poor distribution and management. It is a growing concern in many regions.
45. B — Solar panels generate electricity directly from sunlight, reducing a household's demand for electricity from fossil-fuel plants and lowering its share of grid greenhouse gas emissions. The sun supplies the energy without combustion. This makes rooftop solar a meaningful climate action at the household scale.
46. A — Reducing, reusing, and recycling materials, plus composting food and yard waste, divert materials away from landfills and return them to use or to the soil. These habits cut landfill volume at the source. They form the core of household waste reduction.
47. C — Installing LED streetlights and high-efficiency heating systems reduces the community's energy use, lowering demand for electricity and fuel and the greenhouse gas emissions associated with generating that energy from fossil sources. Less demand means less fuel burned. Efficiency upgrades are among the most cost-effective climate measures.
48. D — Gathering information about the situation and identifying the criteria and constraints the solution must address is part of defining the problem, the early phase of the engineering design

process. A well-defined problem guides all later steps. Skipping it leads to wasted effort on poorly aimed designs.

49. A — When a prototype reveals an unanticipated failure mode, the appropriate next step is to use the test data to analyze why it failed, modify the design, and then retest the modified version. Iteration—testing, refining, and retesting—is central to good engineering. A flaw found in testing is information, not a reason to abandon the project.
50. B — A team should evaluate each design against the criteria and constraints, weighing trade-offs and selecting the design that best balances cost, power output, noise, and other relevant factors. Structured evaluation supports better decisions than cost-only or random rules. Trade-off analysis is at the heart of engineering judgment.