PRACTICE EXAM 56: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. Most stars, including the Sun, are observed to give off most of their light at certain wavelengths that depend strongly on their temperature. What does the color of a star most directly tell scientists about that star?

A. Its exact distance from Earth, measured in light-years, because the color of a star changes systematically with its distance from the observer on Earth

B. Its surface temperature, because hotter stars peak at shorter, bluer wavelengths and cooler stars peak at longer, redder wavelengths

C. Its total chemical composition, because the color of a star is determined only by the precise mix of elements found inside the star and not its temperature

D. Its rotation rate, because faster-spinning stars are always seen as blue while slower-spinning stars are always seen as red, regardless of their actual temperature

2. Scientists conclude that the universe is roughly 13.8 billion years old. Which line of evidence most directly supports this estimate?

A. The orbital period of Earth around the Sun, which can be carefully measured from year to year and used to determine the total age of the universe

B. The number of stars in the Milky Way galaxy, which can be counted using powerful telescopes and used to calculate the total age of the universe

C. The temperature of Earth's interior, which is measured by drilling into the crust and used to calculate the total age of the entire universe

D. The expansion rate of the universe combined with the cosmic microwave background, which together allow scientists to estimate how long ago expansion began

3. As a massive star runs out of hydrogen in its core, it can eventually undergo a violent supernova explosion. Which of the following is the primary cause of this kind of supernova?

A. A small comet from the outer reaches of the solar system happening to crash directly into the star, which suddenly triggers a violent explosion of the star

B. A nearby planet falling into the star and immediately depositing its mass, which suddenly causes the entire star to explode violently in a supernova event

C. The star's iron core collapses under gravity once fusion can no longer produce energy, and the rebounding material blasts the star's outer layers into space

D. The star slowly cools and then quietly fades away over many millions of years, which is what produces the very small supernova explosions observed in space

4. The planets, asteroids, and comets in our solar system all orbit the Sun in nearly the same plane and in the same direction. Which idea best explains this observation?

A. The solar system formed from a single rotating disk of gas and dust, and all of its objects inherited the same plane and direction of motion from that original disk

B. Each of the planets, asteroids, and comets was independently captured from completely different directions in space and only coincidentally ended up in the same plane

C. The Sun's magnetic field gradually pulled all of the planets, asteroids, and comets into the same plane and direction of motion over many billions of years of orbiting

D. Collisions between solar system objects randomly happened to organize all of the planets, asteroids, and comets into the same plane and direction by complete chance

5. An asteroid orbits the Sun with an orbital period of 27 years. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is its approximate average distance from the Sun?

A. About 27 AU, because the orbital period in years is always equal to the average distance from the Sun in AU, no matter what the actual length of the orbit

B. About 5.2 AU, because the average distance from the Sun is always equal to the square root of the orbital period in years, which is the case for every object

C. About 81 AU, because the average distance from the Sun is always equal to exactly three times the orbital period in years, regardless of the size of the orbit

D. About 9 AU, because 27 squared is 729, and the cube root of 729 is 9 AU

6. A scientist explains that the seasons in Earth's two hemispheres are opposite to each other and that this is caused by the tilt of Earth's rotational axis. Which of the following correctly describes this tilt and its effect?

A. Earth's axis is tilted by about 90 degrees, so the Sun's rays strike one hemisphere directly from above while never reaching the other hemisphere at all

B. Earth's axis is tilted by about 23.5 degrees, so one hemisphere leans toward the Sun while the other leans away, producing opposite seasons in the two hemispheres

C. Earth's axis is completely vertical with no tilt at all, so the Sun's rays strike the equator most directly all year long, with no seasons in either hemisphere

D. Earth's axis flips back and forth between two extreme tilts every six months, which is the actual cause of the opposite seasons observed in the two hemispheres

7. A waning crescent Moon, with a thin sliver lit on its left side, can be seen low in the eastern sky just before sunrise. About one week later, which Moon phase will be visible?

A. A waxing crescent, the thin sliver phase of the Moon that appears just after the new moon, with the lit portion growing on the right side in the evening sky

B. A waning gibbous, the phase of the Moon that appears just after the full moon, with more than half lit and the bright portion shrinking each night

C. 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 each day

D. A last quarter, the phase of the Moon during which exactly the left half of the visible disk is illuminated in the early morning sky just before sunrise each day

8. The Sun has been steadily fusing hydrogen into helium for about 4.6 billion years and is expected to continue doing so for about another 5 billion years. About how old is the Sun considered to be right now, and what stage of its life is it in?

A. The Sun is only a few thousand years old and is currently still in its very early protostar stage of formation, before any kind of nuclear fusion has begun in its core

B. The Sun is more than 20 billion years old and is currently in its red giant stage, fusing helium into carbon in its core after having used up its original hydrogen

C. The Sun is about 4.6 billion years old and is currently a middle-aged main-sequence star, with about half of its expected hydrogen-fusing lifetime still ahead of it

D. The Sun is only 100 years old and is currently a brand-new star that has just begun its main-sequence stage of fusing hydrogen into helium in its central core region

9. Solar wind is a stream of charged particles continuously flowing outward from the Sun. Which of the following best describes one effect of the solar wind on Earth?

A. The solar wind directly powers all weather systems on Earth, including hurricanes, blizzards, and thunderstorms, by transferring its energy to Earth's lower atmosphere

B. The solar wind interacts with Earth's magnetic field and atmosphere to produce auroras near the polar regions, where charged particles excite atoms in the upper atmosphere

C. The solar wind is permanently blocked from ever reaching the Earth by the gravitational pull of the Moon, which deflects every single charged particle far away from the Earth

D. The solar wind delivers all of the heat that Earth receives, so it is the main reason that the surface of the Earth is warm enough for liquid water and life to exist

10. A scientist explains that the gravitational pull of the Sun and Moon together produce ocean tides on Earth. Which of the following best summarizes how the Sun and Moon together influence the tides?

A. The Sun has no role at all in producing tides, since only the Moon can ever exert any gravitational pull on Earth's water, regardless of the Sun's mass or distance

B. The Moon has no role at all in producing tides, since only the Sun can ever exert any gravitational pull on Earth's water, regardless of how close the Moon ever gets

C. The Sun and Moon both pull on Earth's water, but the Sun's effect is so weak and the Moon's effect is so strong that they only ever produce a single tide each year

D. The Moon's gravity is the main driver of Earth's tides, while the Sun's gravity modifies the tides depending on the alignment of the three bodies in space

11. Mercury and the Moon are both rocky, airless worlds covered with impact craters of many sizes. What does the heavy cratering of these surfaces reveal about their geologic history?

A. They have surfaces that have not been significantly modified by erosion or active geologic processes for a very long time, allowing the impact craters to remain visible

B. They have surfaces that are constantly being remade by very active volcanoes, which is the only reason that so many large impact craters are visible on their surfaces

C. They have surfaces that are completely covered by liquid water and active rivers, which is the only reason that so many large impact craters are visible on their surfaces

D. They have surfaces that have been completely repaved by plate tectonics, which is the only reason that so many large impact craters are visible on their surfaces today

12. A geologist describes one rock layer as "older" than another rock layer, without saying exactly how many years old either layer is. This kind of age comparison is best described as which of the following?

A. Absolute dating, which gives the exact numerical age of a rock or fossil sample in years, using methods such as radiometric dating of certain unstable isotopes

B. Carbon dating, which uses the decay of carbon-14 to give the exact numerical age of a rock or fossil sample in years for samples that contain organic material

C. Relative dating, which compares the ages of rocks and other features in order and identifies which is older or younger without giving any exact number of years

D. Index fossil dating, which compares the ages of rocks using only the fossils preserved within them, in order to give the exact numerical age of each layer in years

13. A volcanic ash layer found within a thick sedimentary sequence is dated by radiometric methods to about 75 million years old. Which of the following statements best describes what this date tells the geologist about the surrounding sedimentary layers?

A. The layers just below the ash bed are older than 75 million years, and the layers just above the ash bed are younger than 75 million years, by the principle of superposition

B. Every single layer in the entire sequence above and below the ash bed must be exactly 75 million years old, because they all happen to be near the dated ash bed

C. The layers above the ash bed are older than 75 million years, while the layers below the ash bed are younger than 75 million years, by the principle of superposition

D. The dated age of the ash bed has no relationship at all to the ages of any of the other layers above or below it within the same overall sedimentary sequence

14. A radioactive isotope has a half-life of 2,000 years. A sample contains one-quarter of the original amount of this isotope. About how much time has passed since the sample formed?

A. About 2,000 years, because only one half-life is needed to reduce the original amount of a radioactive isotope to one-quarter of the value it had when it formed

B. About 8,000 years, because four half-lives are needed to reduce the original amount of a radioactive isotope to one-quarter of the value it had when it formed

C. About 1,000 years, because only half of one half-life is needed to reduce the original amount of a radioactive isotope to one-quarter of the value it had when it formed

D. About 4,000 years, because two half-lives are needed to reduce the original amount of the isotope to one-quarter of its starting value

15. A geologist studies the fossil record and notes that many groups of organisms first appear suddenly in the rocks, persist for some time, and then disappear from the record. The disappearance of an entire species from Earth is best described as which of the following?

A. A radiation event, during which a single species rapidly diversifies into many new species that fill empty roles in the environment over a relatively short period of time

B. Extinction, the permanent disappearance of a species from Earth, which occurs when no individuals of that species remain alive anywhere on the planet at any time

C. A migration event, during which a species moves from one region to another in response to a change in its environment, without disappearing from the planet entirely

D. Speciation, the formation of a new species from an existing one as populations become reproductively isolated over time, with no relationship to disappearance

16. Wegener proposed that today's continents were once joined together in a single supercontinent that later broke apart and drifted into their current positions. Which of the following pieces of evidence supports this idea?

A. The fact that all of today's continents have completely different rock formations, different fossils, and different mountain belts, with no similarities at all between any of them

B. The fact that every continent currently sits at the exact same elevation above sea level, which has been used as the main evidence for the breakup of a former supercontinent

C. Matching coastlines, rock formations, mountain belts, and fossils on continents that are now separated by wide oceans, which together align when the continents are reassembled

D. The fact that the continents are currently all moving directly toward one another at high speed, which has been used as the main evidence for a former supercontinent's existence

17. A scientist uses ice cores from Antarctica to study Earth's past climate over hundreds of thousands of years. Which of the following best describes how the ice cores reveal information about ancient climate?

A. Tiny bubbles of ancient air trapped in the ice contain samples of the atmosphere from each time the ice was deposited, allowing past gas levels and temperatures to be reconstructed

B. The ice cores show the exact age of the entire Earth, because Antarctic ice has been preserved continuously since the Earth itself was first formed billions of years ago

C. The ice cores contain fossils of land plants and large animals from the very earliest periods of life on Earth, which can be used to reconstruct climate from those early times

D. The ice cores are not actually used in climate science at all, since polar ice contains no useful information whatsoever about past climate or atmospheric composition

18. Volcanic ash layers and lava flows are sometimes used as time markers within a thick sequence of sedimentary rocks. Which of the following best explains why a volcanic ash layer makes a useful time marker?

A. A volcanic ash layer always shows the exact moment when the Earth itself first formed, since all volcanic activity on the planet has occurred during this single instant in time

B. A volcanic ash layer always grows thicker over millions of years, so the present thickness of any ash bed reveals the exact numerical age of the rocks it is found within

C. A volcanic ash layer always contains exactly the same fossils as the surrounding sedimentary rocks, since volcanic ash and sediment are deposited at very different times in geology

D. A single eruption deposits volcanic ash across a wide area in a very short time, so the same ash bed in different places represents the same instant in geologic time

19. A subduction zone is a region where one tectonic plate sinks beneath another, often producing both deep ocean trenches and chains of volcanoes inland. Which combination of plates most typically produces a subduction zone at a coastal volcanic mountain range?

A. Two continental plates colliding head-on, which slowly crumple the crust upward into a high mountain range but never form any subduction zone or any volcanic activity at all

B. Two oceanic plates pulling away from each other at a mid-ocean ridge, which forms only new oceanic crust between the plates and never any subduction zone or volcano of any kind

C. An oceanic plate descending beneath a continental plate, which produces a deep trench at the coast and feeds melt to a chain of volcanoes inland behind the trench

D. Two plates sliding horizontally past each other along a transform boundary, which produces only earthquakes and never produces any subduction zones or any active volcanoes at all

20. The Hawaiian Islands lie far from any tectonic plate boundary, yet they are the site of active volcanism. Which of the following best explains the origin of this island chain?

A. The Hawaiian Islands lie directly on top of a plate boundary that has been incorrectly mapped, since active volcanism can occur only along true tectonic plate boundaries

B. A hotspot, a region of unusually hot rising mantle material, melts through the moving Pacific Plate from below, producing a chain of volcanic islands as the plate slides over it

C. The Hawaiian Islands are formed by the steady accumulation of coral and shell fragments deposited by ocean currents, with no underlying volcanic or tectonic activity involved at all

D. The Hawaiian Islands were originally formed by repeated meteor impacts in the central Pacific Ocean, with no connection at all to volcanic or tectonic activity in the region

21. A geologist describes a region's bedrock as "made mostly of basalt," a dark, fine-grained volcanic rock. What does the fine-grained texture of basalt indicate about how it formed?

A. The rock was originally a sandy sediment that was buried and slowly compacted over millions of years, eventually turning into a fine-grained sedimentary rock at depth

B. The rock was formed deep underground from slowly cooling magma that took millions of years to crystallize, allowing time for very large, clearly visible crystals to grow

C. The rock was originally a clay sediment that was heated and squeezed by intense pressure deep underground, recrystallizing into a fine-grained metamorphic rock at depth

D. The rock was formed at or near the surface from rapidly cooling lava, which left little time for crystals to grow before the lava solidified into solid rock

22. Two minerals have very similar appearances and surface colors, but they leave streaks of different colors when rubbed against an unglazed ceramic tile. Why is the streak color often more reliable than surface color for identifying minerals?

A. The streak color depends only on the temperature of the room where the mineral is tested, which is the most carefully controlled feature in any mineral identification test

B. The streak color is determined by the powdered form of the mineral, which is much more consistent for a given mineral than the surface color, which can vary considerably

C. The streak color always exactly matches the surface color of any mineral, which is why both properties are equally reliable for use in any mineral identification test

D. The streak color depends only on how recently the mineral was mined, which is the main feature used to identify minerals in any laboratory test of any natural sample

23. A river leaves the mountains and enters a broad, flat plain, where its slope decreases sharply and the river slows down. Which of the following most likely happens to the river's load of sediment as it slows on the plain?

A. The river begins to drop its heaviest particles first, while continuing to carry the finer particles farther downstream, gradually depositing sand, gravel, and silt across the plain

B. The river begins to pick up additional sediment from the surrounding plain instead of depositing any sediment at all, even though the slope of the river has just decreased

C. The river suddenly evaporates entirely as soon as it leaves the mountains, leaving its sediment behind in a single thick layer at the edge of the steep slope above the plain

D. The river permanently stops moving entirely as soon as it leaves the mountains, even though the slope of the river has only just decreased and water keeps flowing in

24. A confined aquifer holds groundwater under pressure between two impermeable layers. A well drilled into such an aquifer can sometimes spurt water above the ground without pumping. What is this kind of well called?

A. A dry well, which is a well that contains no water at all because the underground rock layers surrounding it have no pore spaces and cannot hold or release any groundwater

B. A drainage well, which is a well drilled specifically to remove excess water from the surface of the ground and direct it downward into the soil for storage in the aquifer

C. An artesian well, in which pressure in the confined aquifer drives the water upward through the well casing, sometimes high enough to flow out at the surface without a pump

D. A pumped well, which is the standard kind of well that requires an electric or hand-powered pump to lift the groundwater from the aquifer up to the surface above

25. Water in Earth's atmosphere can be found as a gas (water vapor), a liquid (droplets), or a solid (ice crystals). Which of the following processes most directly transforms liquid water at Earth's surface into water vapor in the atmosphere?

A. Sublimation, the process in which a solid changes directly into a gas without ever passing through the liquid stage, used to describe ice changing directly into vapor in the air

B. Condensation, the process in which water vapor changes into the tiny liquid droplets that gather together to form clouds and the dew that forms on grass and other surfaces

C. Precipitation, the process in which water droplets and ice crystals in clouds grow heavy enough to fall back to the surface as rain, snow, sleet, or hail across a wide region

D. Evaporation, the process in which liquid water at the surface absorbs energy from the Sun and changes into invisible water vapor that joins the atmosphere

26. A geologist studies the size of mineral particles in a sedimentary rock and finds that the rock is made of grains roughly the size of fine sand, all nicely rounded and well sorted by size. Which of the following statements best describes how this rock most likely formed?

A. It formed in an environment with steady, moving water or wind that transported the sand far enough to round and sort the grains before they were deposited and cemented

B. It formed in a region with no transport at all, since well-rounded, well-sorted sand grains can only form when sediment is left completely undisturbed in one place for a long time

C. It formed only by the freezing of water within the sediment, since freezing is the only natural process that is able to round and sort sand grains by size in the natural world

D. It formed only by the chemical evaporation of a desert salt lake, since evaporation is the only natural process that is able to round and sort sand grains by size in nature

27. Soil that has lost its topsoil through erosion is often much less fertile than soil that retains its topsoil. Which of the following best explains why topsoil is the most fertile layer of a soil profile?

A. The topsoil layer is the only layer of soil that contains any water, while all of the other layers of soil are completely dry and unable to support the growth of any plants

B. The topsoil layer contains the most organic matter and the most nutrients needed by plant roots, because dead plants and animals decompose at or near the soil's surface

C. The topsoil layer is the only layer of soil that contains any air, while all of the other layers of soil are completely airless and cannot support the growth of any plants

D. The topsoil layer is always the deepest layer of soil, where the longest exposure to underground heat has produced the highest fertility of any of the soil layers above

28. A river system carries dissolved chemicals and suspended sediment from the land into the ocean over millions of years. Which of the following is one major long-term consequence of this process?

A. Rivers cause the global average temperature of the surface of the Earth to fall sharply over very short periods of time, which is the main consequence of rivers entering the oceans

B. Rivers permanently remove all dissolved oxygen from the surface of the oceans, which is the main long-term consequence of any river entering the ocean from the continental surface

C. Rivers contribute to making the oceans salty over geologic time and continuously add new sediment that builds up along continental margins to form thick layers of rock

D. Rivers cause the oceans to gradually shrink in volume by removing water from them, which is the main long-term consequence of any river entering the ocean from the land surface

29. A coastline of soft cliffs is steadily worn back by the action of ocean waves striking the base of the cliff. Which of the following best describes this process?

A. Coastal erosion by wave action, in which the energy of breaking waves repeatedly pounds and undermines the base of the cliff, causing the cliff face to retreat landward over time

B. Glacial scouring, in which a thick, slow-moving sheet of ice carves out broad U-shaped valleys and pulverizes solid bedrock as it advances across the land surface of a region

C. Wind abrasion, in which strong winds carrying loose sand grains grind away the surface of exposed rock, slowly wearing away the rock and changing its overall shape over time

D. Frost wedging, in which water that has seeped into cracks in the rock freezes and expands, gradually prying the rock apart into many smaller pieces over many freeze-thaw cycles

30. A weather forecaster examines a surface weather map and identifies a region where warm air is rising over slowly retreating cooler air, with broad layers of clouds covering the area for many hours. What type of weather front is most likely involved?

A. A cold front, in which a fast-moving mass of cold air aggressively pushes underneath a warmer air mass and forces it to rise sharply, producing a narrow band of brief storms

B. An occluded front, in which a fast cold front catches up to and overtakes a slower warm front, lifting the warm air completely off the ground and producing complex weather

C. A warm front, in which a mass of warm air slowly slides up and over a retreating mass of cooler air, often producing broad layers of clouds and long periods of steady precipitation

D. A stationary front, in which two opposing air masses meet but neither one is able to advance, so the boundary between them stalls over the same area for several days at a time

31. A high-pressure system is settled over a region for several days, and the area enjoys generally clear skies and calm weather. Which of the following best explains the link between high pressure and fair weather?

A. Air sinks in a high-pressure system, which warms and dries the air as it descends, suppressing the formation of clouds and discouraging precipitation across the region

B. Air rises strongly in a high-pressure system, which cools the air and produces widespread clouds and steady rain across the entire region for many days at a time

C. The Sun gives off more energy whenever a high-pressure system is over a region, which is the main reason that high pressure is associated with clear skies and fair weather

D. High-pressure systems force water vapor in the atmosphere to freeze into ice crystals very high in the sky, which is the main reason they are associated with clear, sunny weather

32. A meteorologist explains that surface winds in the Northern Hemisphere are deflected to the right of their original direction as they move across Earth's surface. What is this deflection of moving air and water called?

A. The greenhouse effect, the warming of Earth's lower atmosphere caused by greenhouse gases absorbing outgoing infrared radiation from the surface and re-emitting it downward

B. The geostrophic balance, a condition in which winds blow exactly parallel to lines of equal pressure on a weather map and never accelerate in any direction across the region

C. The pressure gradient, the difference in atmospheric pressure between two locations on a weather map, which drives air to move from regions of high pressure to low pressure

D. The Coriolis effect, the apparent deflection of moving air and water caused by the rotation of the Earth, which curves winds to the right in the Northern Hemisphere

33. Hurricanes and other tropical cyclones lose strength rapidly when they move over cold ocean water, even before they reach land. Which of the following best explains why cold ocean water weakens these storms?

A. Cold ocean water somehow blocks the Coriolis effect from acting on the storm, which immediately disorganizes its rotation and weakens its winds within just a few hours

B. Cold ocean water increases the air pressure inside the eye of the storm to exactly match the air pressure of the surrounding ocean, which prevents any further rotation

C. Cold ocean water does not provide enough heat and moisture to power the storm, since the storm depends on warm seawater to supply the energy needed to maintain its winds

D. Cold ocean water immediately repels the storm with a strong magnetic force, which slows its winds and quickly weakens its overall structure in the absence of land

34. Forecasters use Doppler radar to detect precipitation and to estimate the speed of winds inside a storm. Which of the following best describes how Doppler radar works?

A. Doppler radar sends out radio waves and analyzes the change in frequency of the waves that are reflected back from raindrops, hailstones, and other particles in a storm

B. Doppler radar measures only the brightness of light emitted by a storm and uses that brightness to estimate how much rain is falling, with no information about wind speed at all

C. Doppler radar relies on satellites that physically lift water droplets out of clouds in order to measure the amount of precipitation in a storm, with no use of radio waves at all

D. Doppler radar measures only the temperature of air at ground level and uses that temperature alone to predict whether or not a storm is currently producing any precipitation

35. A region's climate is shaped by many factors, including its latitude, elevation, distance from large bodies of water, and prevailing winds. Which of the following best describes the effect of elevation on the climate of a mountain region?

A. Higher elevations are always considerably warmer than lower elevations at the same latitude, which is the main reason that mountain summits are usually warmer than valleys

B. Higher elevations tend to be cooler than lower elevations at the same latitude, because air temperature generally decreases with altitude in Earth's lower atmosphere

C. Higher elevations always have exactly the same temperature as nearby valleys at the same latitude, which is the main reason that mountains and lowlands are climatically identical

D. Higher elevations are always much warmer in winter and much cooler in summer than nearby valleys, which is the main reason mountains have no real seasonal climate variation

36. A scientist explains that recent global warming is changing the long-term average climate of many regions, even though daily weather still varies. Which of the following best illustrates this distinction between climate and weather?

A. A particularly cold week in a New England city is sufficient by itself to prove that the global climate is cooling, regardless of any other long-term data trends or scientific evidence

B. A single very warm afternoon in a New England city is enough by itself to prove that the global climate is warming, regardless of any other long-term data trends or scientific evidence

C. Daily weather variations make every individual day unpredictable, which by itself shows that the global climate cannot ever be changing in any consistent or measurable way over time

D. Average temperatures in a New England region have been rising over many decades, even though some individual days and weeks remain colder than usual from year to year

37. A coastal town wants to reduce its dependence on fossil fuels by generating much of its electricity locally from natural energy sources. Which of the following would be the best example of a sustainable, locally generated source of electricity for this town?

A. A new coal-fired power plant, which would supply a steady source of electricity but would also burn large amounts of imported coal and release significant air pollution into the area

B. A new oil-fired power plant, which would supply a steady source of electricity but would also burn large amounts of imported oil and release significant air pollution into the local area

C. A new offshore wind farm, which would convert energy from the steady ocean winds into electricity without burning fuel and without releasing greenhouse gases into the atmosphere

D. A new natural gas power plant, which would supply a steady source of electricity but would also burn large amounts of imported natural gas and release CO_2 into the surrounding atmosphere

38. A region replaces a large area of natural wetland with a parking lot and a strip mall. Which of the following is the most direct environmental consequence of this change?

A. Loss of wetland habitat for many species, increased runoff during heavy rain, and reduced natural filtering of pollutants from the water that drains across the developed area

B. A sudden long-term increase in the local population of fish, since paving over the wetland directly creates more space for fish to live in nearby streams and rivers around the area

C. A complete recovery of the original old-growth forest that grew in the area before the wetland ever existed, since removing the wetland always allows the forest to return on its own

D. A permanent end to all global climate change worldwide, since removing a single small wetland is always enough to fully reverse climate change across the entire planet at once

39. Mining valuable minerals such as copper, gold, and rare earth elements can cause significant environmental damage if it is poorly managed. Which of the following is one major environmental concern associated with poorly managed mining operations?

A. Mining always permanently removes all greenhouse gases from the atmosphere, since mineral extraction has been shown to directly remove carbon dioxide and methane from the air

B. Mining always physically lowers the temperature of the entire planet by several degrees, since the act of removing minerals from the Earth physically cools the planet's surface and air

C. Mining always immediately and permanently halts every form of climate change worldwide, since extracting minerals always removes the underlying cause of climate change everywhere

D. Mining can release toxic substances such as heavy metals and acid drainage into nearby soil and water, contaminating ecosystems and water supplies if waste is not carefully managed

40. Which of the following best describes the goal of sustainable agriculture?

A. To maximize crop yields in the short term, regardless of the long-term effects on the soil, water, and the surrounding ecosystem of the farmland and the broader region

B. To meet current food needs in a way that maintains the long-term productivity of the soil, conserves water and biodiversity, and limits environmental harm for future generations

C. To replace all natural ecosystems on Earth with intensively farmed land as quickly as possible, regardless of the long-term effects on the soil, water, and the surrounding ecosystem

D. To increase the amount of pesticide and chemical fertilizer applied to every farm field, regardless of the long-term effects on the soil, water, and the surrounding ecosystem of the farmland

41. A region's average yearly amount of fresh water available is fixed by its climate and geography, but the demand for water depends on human activity. Which of the following best describes the concept of water sustainability?

A. Water sustainability is achieved only when a region uses every last drop of available water within the same year that it falls as precipitation, leaving none behind for future use

B. Water sustainability is achieved when water is used in a way that allows the supply to meet present needs while still being available to meet the needs of future generations

C. Water sustainability is achieved only when a region eliminates all human water use entirely, since any human use at all of water is always considered unsustainable in nature

D. Water sustainability is achieved only when a region completely replaces all of its freshwater supply with ocean water, since seawater is always considered to be more sustainable

42. Climate models predict that continued warming will cause many low-lying coastal cities to experience more frequent flooding from rising sea levels and stronger storm surges. Which of the following best describes the relationship between rising sea level and storm surges?

A. Rising sea level has no measurable connection to storm surges of any kind, since the sea-level changes that result from a warming climate are far too small to affect storm surge

B. Rising sea level always completely cancels out all storm surges of any kind, since the higher base sea level has been shown to directly absorb all of the energy from any storm surge

C. Rising sea level raises the baseline from which storm surges are measured, so the same surge from a given storm reaches higher inland and causes more flooding than it would have

D. Rising sea level has been shown to permanently stop hurricanes and other tropical cyclones from ever making landfall again, which would eliminate all storm surges in coastal cities

43. Many countries have set goals to reduce greenhouse gas emissions over the coming decades in order to limit further global warming. Which of the following best describes why this kind of action is important?

A. Limiting greenhouse gas emissions can reduce the future severity of climate change and lower the risk of damaging impacts on ecosystems, infrastructure, and human well-being

B. Limiting greenhouse gas emissions will permanently and instantly reverse all of the climate change that has already occurred over the past several centuries, with no further action ever needed at all

C. Limiting greenhouse gas emissions has no measurable effect on the climate in any way, since the atmosphere is so vast that human emissions cannot possibly have any effect on it at all

D. Limiting greenhouse gas emissions is purely a matter of personal taste and offers no real environmental benefit, since climate change is entirely natural and unaffected by human emissions

44. A community planting native trees and shrubs along streambanks is undertaking which type of environmental action?

A. The community is undertaking a deforestation project, deliberately removing all of the trees and vegetation from the banks of a stream in order to make the area easier to develop later on

B. The community is undertaking a desertification project, deliberately turning a once-vegetated area into a desert by removing all native plants and exposing the soil to direct sun and wind

C. The community is undertaking a coastal erosion project, deliberately speeding up the wearing away of soil along the streambank in order to make the local stream channel deeper

D. The community is undertaking a habitat restoration project, replanting native vegetation in order to stabilize the soil, improve water quality, and support local wildlife along the stream

45. When greenhouse gas emissions are reduced, the energy used in homes and businesses often becomes a key target. Which of the following actions would most directly reduce the energy used by an average home?

A. Replacing every window in the home with single-pane glass that has no insulating layer at all, since older single-pane glass is by far the most energy-efficient material that exists

B. Setting the thermostat to extremely high temperatures during the summer and extremely low temperatures during the winter, since extreme settings always reduce the energy use of any home

C. Improving insulation, sealing air leaks, and installing energy-efficient heating and cooling equipment, which together reduce the amount of energy required to maintain comfortable indoor temperatures

D. Leaving all lights, appliances, and electronics turned on at all times throughout the entire home, since this always reduces the long-term energy use of the average home over time

46. Marine fisheries around the world are important sources of food and income, but many fish populations have been overfished. Which of the following best describes the meaning of "overfishing"?

A. Overfishing is the act of catching fish at a rate that exceeds the population's ability to reproduce and recover, leading to declining fish populations and potential collapse of the fishery

B. Overfishing is the act of catching fish at a rate that is much slower than the rate at which the population of fish naturally reproduces, which always allows the fishery to grow over time

C. Overfishing is the act of releasing far more fish into the ocean than are caught by fishermen each year, which always leads to declining fish populations and a potential fishery collapse

D. Overfishing is the act of choosing to fish only with traditional rod-and-reel methods rather than with modern fishing gear, which always leads to declining fish populations in the area

47. Air quality in many cities is monitored using indices that track concentrations of pollutants such as ozone and fine particulate matter. Why is monitoring air quality important from a public health perspective?

A. Air quality is monitored only because it provides interesting weather data, with no real connection to the health of the population of the city or the residents in nearby communities

B. Air quality is monitored because air pollutants can worsen asthma, heart disease, and other health problems, and tracking these levels allows public warnings and protective actions to be taken

C. Air quality is monitored only because it is required by law in every city in the world, with no real connection to the health of the population of any city or its surrounding region

D. Air quality is monitored only because it provides scientific data for international researchers, with no real connection to the health of the population of any city or its surrounding area

48. An engineering team is designing a new bridge over a busy waterway. The team must satisfy a number of specific requirements, including a minimum load-bearing capacity, a maximum cost, and a specific span length. These requirements are best described as which of the following?

A. Aesthetic preferences, which are personal opinions about how a design looks, with no measurable effect on the function, safety, or cost of any engineering project of any kind

B. Random suggestions, which are casual ideas thrown out by team members during a brainstorming session, with no measurable effect on the function, safety, or cost of the project

C. Brainstorming results, which are an unstructured list of design ideas generated during the very earliest part of the design process, with no measurable effect on the final outcome of the project

D. Criteria and constraints, the requirements and limits the design must meet, against which competing design options will later be evaluated and compared during the engineering process

49. An engineering team builds and tests a series of prototypes of a new flood-warning device, refining the design after each test based on the test results. Which of the following best describes this approach to engineering design?

A. Iterative design, in which a design is repeatedly tested, evaluated, and improved through multiple cycles, with each new version informed by what was learned from previous versions

B. One-shot design, in which the team builds only a single version of the design and immediately puts it into use without any testing at all, regardless of how it actually performs

C. Random design, in which the team selects one version of the design completely at random and immediately puts it into use without any testing or evaluation of the final version

D. Frozen design, in which the team builds the first prototype of the design and then forbids any further changes to the design no matter what problems are revealed by testing it

50. Engineers often use mathematical models and computer simulations as part of the design process. Which of the following best describes one important advantage of using a model or simulation rather than only testing physical prototypes?

A. Models and simulations always produce results that are 100% identical to those of every physical test, with no possible difference at all, so physical testing of prototypes is never needed at any time

B. Models and simulations are used only when no physical prototype can ever be built, which is rarely the case, so models and simulations are very rarely useful in actual engineering practice

C. Models and simulations let engineers explore many possible designs and scenarios quickly and at lower cost than building and testing many full-scale physical prototypes for every design

D. Models and simulations are always far more accurate than any physical test of a full-scale prototype, which is why every modern engineering decision is now based only on simulations alone

Practice Exam 56: Answer Key with Explanations

1. B — A star's color tells scientists its surface temperature: hotter stars peak at shorter, bluer wavelengths and cooler stars peak at longer, redder wavelengths. This is Wien's displacement law in practice. Temperature, not distance or composition, sets a star's dominant color.
2. D — The age of the universe is estimated by combining the expansion rate of the universe with the cosmic microwave background, which together reveal how long ago expansion began. These two independent measurements converge on roughly 13.8 billion years. Earth-based numbers like orbital period or stellar counts cannot fix that age.
3. C — A massive star's iron core collapses under gravity once fusion can no longer release energy, and the rebounding material blasts the outer layers into space as a core-collapse supernova. Iron fusion absorbs rather than releases energy, ending the star's support. The collapse and rebound drive the explosion.
4. A — The solar system formed from a single rotating disk of gas and dust, so its planets, asteroids, and comets inherited the same plane and direction of motion from that original disk. Conservation of angular momentum flattened the cloud as it collapsed. This is the nebular hypothesis.
5. D — Kepler's Third Law gives $T^2 = a^3$, so with T = 27, T^2 equals 729 and a is the cube root of 729, exactly 9 AU. The square of the period sets the cube of the distance. This relationship applies to any object orbiting the Sun.
6. B — Earth's axis is tilted by about 23.5 degrees, so one hemisphere leans toward the Sun while the other leans away, producing opposite seasons in the two hemispheres. The orientation of the tilt, not its size or any flipping, drives the seasons. This is the core geometry of the seasonal cycle.
7. A — A waning crescent in the predawn sky is followed about a week later by a waxing crescent in the evening sky, with the new moon between them. The lunar cycle proceeds new → waxing → full → waning → new. Seven days after waning crescent places the Moon just past new, in waxing crescent.
8. C — The Sun is about 4.6 billion years old and is currently a middle-aged main-sequence star, with about half of its hydrogen-fusing lifetime still ahead. Its expected total main-sequence life is roughly 10 billion years. The Sun is steady and stable in this stage.
9. B — The solar wind interacts with Earth's magnetic field and atmosphere to produce auroras near the polar regions, where charged particles excite atoms in the upper atmosphere. Earth's magnetic field funnels the particles toward the poles. The glow is light released when excited atoms relax.
10. D — The Moon's gravity is the main driver of Earth's tides, while the Sun's gravity modifies them depending on alignment, producing larger spring tides at new and full moons and smaller neap tides at the quarters. Tides depend on the gradient of gravity, not just total pull. The Sun and Moon together shape the tidal range.
11. A — Heavy cratering on Mercury and the Moon shows that their surfaces have not been significantly modified by erosion or active geologic processes for a very long time, so old impact scars remain visible. Earth's craters, by contrast, are largely erased by erosion and tectonics. Crater density is a clock for surface age.
12. C — Comparing rocks as older or younger without giving exact ages is relative dating, which identifies sequence rather than numerical age. Principles like superposition and cross-cutting relationships drive these comparisons. Absolute dating, by contrast, gives ages in years.
13. A — By superposition, layers below an undisturbed ash bed are older than 75 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-quarter remaining means two half-lives have passed, since 1 → 1/2 → 1/4. Two half-lives × 2,000 years equals 4,000 years. Counting halvings is the key to radiometric age problems.
15. B — Extinction is the permanent disappearance of a species from Earth, occurring when no individuals remain alive anywhere on the planet. It ends a species' presence in the fossil record. Extinction differs from migration or radiation, which involve relocation or diversification.
16. C — Matching coastlines, rock formations, mountain belts, and fossils on now-separated continents align when the continents are reassembled, supporting Wegener's idea of a former supercontinent. The matches make sense only if the lands were once joined. This was central evidence for continental drift.
17. A — Tiny bubbles of ancient air trapped in Antarctic ice contain samples of the atmosphere from when each layer of ice formed, allowing past gas levels and temperatures to be reconstructed. Isotope ratios in the ice record temperature. Together they yield hundreds of thousands of years of climate history.
18. D — A single eruption deposits volcanic ash across a wide area in a very short time, so the same ash bed in different places represents the same instant in geologic time. This makes ash beds excellent time markers. They are powerful tools for correlating distant rock sequences.
19. C — A coastal volcanic mountain range with an offshore trench forms where an oceanic plate descends beneath a continental plate, creating the trench and feeding inland volcanoes. The descending plate triggers melting above it. The Andes are a classic example.
20. B — The Hawaiian Islands sit above a hotspot, a region of unusually hot rising mantle material that melts through the moving Pacific Plate from below. As the plate slides over the hotspot, a chain of volcanic islands forms. The age of the islands increases with distance from the active hotspot.
21. D — Basalt's fine-grained texture forms at or near the surface from rapidly cooling lava, which leaves little time for crystals to grow. Rapid cooling limits crystal size. Slow, deep cooling, by contrast, produces large, visible crystals.
22. B — Streak color is determined by the powdered form of the mineral, which is much more consistent for a given mineral than its variable surface color. Crushing eliminates oxidation and impurity effects on the surface. This is why streak is often more diagnostic than color.
23. A — A river that slows as its slope decreases on a plain drops its heaviest particles first while carrying finer ones farther, depositing sand, gravel, and silt across the plain. Slower water has less energy to carry sediment. This is why grain size sorts out from coarser upstream to finer downstream.
24. C — An artesian well is one in which pressure in a confined aquifer drives water upward through the casing, sometimes high enough to flow at the surface without a pump. The aquifer's confinement under impermeable layers builds the pressure. Tapping it releases the stored head.
25. D — Evaporation is the process in which liquid water at the surface absorbs energy from the Sun and changes into water vapor that joins the atmosphere. It is the main pathway turning surface water into atmospheric vapor. Condensation and sublimation are different transitions.
26. A — Well-rounded, well-sorted sand grains form in environments with steady moving water or wind that transports sand far enough to round and sort the grains before deposition. Transport energy works the grains; sorting reflects consistent flow. Cementation later turns the deposit into sandstone.
27. B — Topsoil is the most fertile layer because it contains the most organic matter and the most nutrients needed by plant roots, since dead plants and animals decompose at or near the surface. Decomposers concentrate nutrients there. Losing topsoil to erosion strips fertility.

28. C — Rivers contribute to making the oceans salty over geologic time and continuously add new sediment that builds up along continental margins to form thick layers of rock. Dissolved ions accumulate in seawater while sediment piles offshore. Both effects act over millions of years.
29. A — A soft cliff worn back by waves striking its base is coastal erosion by wave action, in which breaking-wave energy undermines the cliff and causes its face to retreat landward. Wave attack at the base is the primary driver. Glacial, wind, and frost processes operate elsewhere.
30. C — A warm front, where warm air slides slowly up and over retreating cooler air, often produces broad layers of clouds and long periods of steady precipitation. The gentle frontal slope yields widespread, prolonged rain. This differs from the narrow, intense storms of a cold front.
31. A — In a high-pressure system, air sinks, warming and drying as it descends, which suppresses cloud formation and discourages precipitation. The sinking motion explains the link to fair weather. Low-pressure systems, by contrast, involve rising air and storms.
32. D — The apparent deflection of moving air and water caused by Earth's rotation is the Coriolis effect, which curves winds to the right in the Northern Hemisphere and to the left in the Southern. It shapes large-scale wind and current patterns. The effect grows with latitude and speed.
33. C — Cold ocean water does not provide enough heat and moisture to power a tropical cyclone, which depends on warm seawater for the energy that sustains its winds. Without that supply, the storm weakens. This is why hurricanes weaken over cold water or land.
34. A — Doppler radar sends out radio waves and analyzes the change in frequency of the waves reflected back from raindrops, hailstones, and other particles in a storm, revealing both precipitation and wind speed. The frequency shift measures motion toward or away from the radar. This is the Doppler effect applied to weather.
35. B — Higher elevations tend to be cooler than lower elevations at the same latitude because air temperature generally decreases with altitude in the troposphere. The temperature falls by several degrees per kilometer of rise. This is why mountain summits are colder than nearby valleys.
36. D — Rising average temperatures in a region over many decades, even when some individual days remain cold, illustrates the climate–weather distinction. Climate is the long-term average; weather is the day-to-day variation. Both can be true at the same time.
37. C — An offshore wind farm converts energy from steady ocean winds into electricity without burning fuel and without greenhouse gas emissions, making it sustainable and locally generated. Wind is replenished continuously by solar heating of the atmosphere. It avoids the imports and pollution of fossil-fuel plants.
38. A — Replacing wetland with pavement causes loss of wetland habitat, increased runoff during heavy rain, and reduced natural filtering of pollutants. Wetlands serve as nurseries, sponges, and filters. Their loss carries ecological and human costs.
39. D — Poorly managed mining can release toxic substances such as heavy metals and acid drainage into nearby soil and water, contaminating ecosystems and water supplies. Careful waste management and reclamation are needed to limit these impacts. The other options misstate basic environmental science.
40. B — Sustainable agriculture meets current food needs in a way that maintains soil productivity, conserves water and biodiversity, and limits environmental harm for future generations. It balances present yield with long-term capacity. This contrasts with short-term maximization at any environmental cost.
41. B — Water sustainability means using water so that supply meets present needs while remaining available for future generations. Matching withdrawals to natural replenishment is central to this balance. Neither total use nor total abstention defines sustainability.

42. C — Rising sea level raises the baseline from which storm surges are measured, so the same surge reaches higher inland and causes more flooding. The two effects compound rather than cancel. This is why coastal flood risk rises faster than sea level alone might suggest.
43. A — Limiting greenhouse gas emissions reduces the future severity of climate change and lowers the risk of damaging impacts on ecosystems, infrastructure, and human well-being. Cuts now shape the climate decades from now. Action does not reverse past warming, but it limits future harm.
44. D — Planting native trees and shrubs along streambanks is habitat restoration, replanting native vegetation to stabilize soil, improve water quality, and support local wildlife. Riparian buffers anchor banks and filter runoff. This contrasts with deforestation or desertification.
45. C — Improving insulation, sealing air leaks, and installing energy-efficient heating and cooling equipment together reduce the energy needed to maintain comfortable indoor temperatures. Efficiency upgrades cut both costs and emissions. They are core measures in residential climate action.
46. A — Overfishing is catching fish at a rate that exceeds the population's ability to reproduce and recover, leading to declining populations and potential fishery collapse. The harvest outpaces natural recruitment. Limits and sustainable practices are needed to prevent collapse.
47. B — Air quality monitoring matters because pollutants such as ozone and fine particulate matter can worsen asthma, heart disease, and other health problems, and tracking levels supports public warnings and protective actions. Awareness allows vulnerable people to limit exposure. It also guides regulatory action.
48. D — A minimum load capacity, a maximum cost, and a specified span length are criteria and constraints—the requirements and limits a design must meet, against which competing options are evaluated. Criteria define success; constraints set boundaries. They are central to framing an engineering problem.
49. A — Repeatedly testing, evaluating, and improving a design through multiple cycles is iterative design, with each new version informed by what was learned. Iteration is central to good engineering. It contrasts with one-shot, random, or frozen approaches.
50. C — Models and simulations let engineers explore many possible designs and scenarios quickly and at lower cost than building and testing many full-scale prototypes. They support better decisions before committing to expensive builds. They complement, rather than replace, physical testing.