PRACTICE EXAM 57: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. Astronomers see only about 5 percent of the universe's contents in the form of ordinary matter, while the remaining 95 percent consists of two components that have not been directly observed. Which two components make up the missing 95 percent?

A. Antimatter and ordinary cold gas, which together account for the majority of the matter and energy that astronomers have not yet been able to detect directly in the universe

B. Solid ice and warm liquid water, which together account for the majority of the matter and energy that astronomers have not yet been able to detect directly throughout the universe

C. Interstellar dust and individual rogue planets, which together account for the majority of the matter and energy that astronomers have not yet been able to detect across the universe

D. Dark matter and dark energy, which together account for the majority of the matter and energy that have not been directly detected but are inferred from observations

2. A nebula is a cloud of gas and dust in space that can serve as a stellar nursery. Which of the following best describes how a star begins to form inside such a nebula?

A. A dense region of the nebula collapses under its own gravity, growing hotter and denser at the center until temperatures are high enough to begin nuclear fusion

B. A nearby galaxy passes close enough to the nebula to physically scrape some of its material together, which directly creates a star without any kind of internal collapse occurring at all

C. The Sun specifically chooses certain parts of every nebula to begin the formation of new stars, with no role at all played by any kind of gravitational collapse of the material in the cloud

D. Cold winds from a neighboring planet blow directly across the nebula, instantly freezing parts of it into a brand-new fully-formed star without any nuclear fusion ever taking place

3. A white dwarf is the dense, cooling remnant left behind after a low-mass star like the Sun has ended its life. Which of the following correctly describes the typical properties of a white dwarf?

A. A white dwarf is a star that is actively fusing hydrogen into helium in its core and is rapidly growing larger as it gathers fresh hydrogen gas from the surrounding interstellar medium

B. A white dwarf is a brand-new, very hot star that has only just turned on its first round of nuclear fusion and will continue to grow more luminous over the next several billion years

C. A white dwarf is the dense, cooling remnant of a low-mass star that no longer fuses elements in its core, slowly cooling over billions of years without producing any new energy

D. A white dwarf is the central black hole left behind by a low-mass star, which gradually pulls in the surrounding material until it eventually grows to a very large size over time

4. A planet has an orbital period of 125 years. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is its approximate average distance from the Sun?

A. About 5 AU, because the orbital period in years is always equal to 25 times the average distance from the Sun in AU, regardless of the actual size of the orbit

B. About 25 AU, because 125 squared is 15,625, and the cube root of 15,625 is exactly 25 AU

C. About 125 AU, because the orbital period in years is always equal to the average distance from the Sun in AU, regardless of the size of the orbit being analyzed

D. About 11 AU, because the average distance from the Sun is always equal to the square root of the orbital period in years, regardless of the actual length of the orbit

5. Earth's tilted axis points in nearly the same direction in space throughout the year, even as Earth orbits the Sun. Which of the following correctly describes the consequence of this fixed axial orientation?

A. The Northern Hemisphere always experiences summer no matter where Earth is in its orbit, since the axis of the Earth is permanently tilted toward the Sun throughout the year

B. Day length and direct sunlight stay exactly the same all year round at every location on Earth, since the axis of the Earth never changes its orientation in space during the year

C. Different hemispheres lean toward the Sun at different times of year, producing the changing seasons and the differences in day length between summer and winter at most latitudes

D. The Sun deliberately changes its angle in the sky every few months, so that summer and winter occur in opposite hemispheres of the Earth at different times throughout the year

6. A first quarter Moon, with the right half of its visible disk illuminated, can be seen high in the sky at sunset. About one week later, which Moon phase will be visible?

A. A waning crescent, the thin sliver phase of the Moon that appears just before the new moon, with the lit portion shrinking on the left side in the early morning sky just before dawn

B. 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 early evening sky just after sunset

C. A new moon, when the Moon lies between the Earth and the Sun and the side facing us is dark, so the Moon cannot easily be seen anywhere in the sky at any time of day

D. A full moon, when the Earth lies between the Sun and the Moon, and the entire side of the Moon facing us is brightly lit throughout the entire night for many hours

7. A scientist explains that comets are made mostly of ice, dust, and rocky particles, while asteroids are made mostly of rock and metal. Which of the following best explains why these two types of objects have such different compositions?

A. Comets and asteroids both formed from completely different clouds of gas and dust than the rest of the solar system, which is the main reason their compositions are different

B. Comets formed in the cold outer regions of the early solar system where ices could remain solid, while asteroids formed closer to the Sun where temperatures were too high for ice

C. Comets and asteroids both formed at exactly the same temperature in the very same region of the early solar system, but later somehow developed different compositions on their own

D. Comets and asteroids have exactly the same composition as each other, and any apparent difference is just an illusion based on how each kind of object happens to appear in space

8. Solar prominences are huge arches of plasma that loop outward from the Sun's surface and are anchored at both ends in regions of strong magnetic activity. Which of the following best describes solar prominences?

A. Solar prominences are huge plasma loops anchored at both ends in the Sun's surface, shaped by magnetic field lines that emerge from regions of strong magnetic activity on the Sun

B. Solar prominences are tiny black holes that form briefly on the Sun's surface and then disappear within a few seconds, with no connection to magnetic activity in the Sun's atmosphere

C. Solar prominences are physical jets of solid rock thrown outward from the Sun's surface by powerful eruptions, with no connection to magnetic activity in the Sun's outer atmosphere

D. Solar prominences are extremely cold clouds of ice that form briefly on the Sun's surface and then disappear within a few seconds, with no connection to any magnetic activity on the Sun

9. During a lunar eclipse, the Moon often appears reddish rather than completely dark, even when it is in Earth's shadow. Which of the following best explains the reddish color of the eclipsed Moon?

A. The Moon's surface is naturally reddish in color, and the loss of the brighter sunlight during the eclipse makes this redness more visible to observers on the surface of the Earth

B. Mars, which is also reddish, happens to align directly behind the Moon during every lunar eclipse, lending its reddish color to the Moon for the duration of the entire eclipse event

C. Earth's atmosphere bends and filters sunlight, removing more of the blue light and allowing reddish light to reach the Moon, which gives it a reddish glow during a total eclipse

D. The Moon's atmosphere temporarily turns reddish during every lunar eclipse, which is the main reason the Moon often takes on a reddish color when it is in the shadow of the Earth

10. The Moon and Sun together produce the tides on Earth, but the Moon plays a larger role. Which of the following best explains why the Moon has a stronger tidal influence on Earth than the Sun does?

A. The Moon has a much greater total mass than the Sun, which is the main reason its gravitational pull on Earth's oceans is stronger than the Sun's pull is on those oceans

B. The Moon is much closer to Earth than the Sun, and tidal force decreases sharply with distance, so the Moon's proximity more than compensates for its smaller total mass

C. The Moon's gravitational pull is amplified by its magnetic field, which makes its overall effect on Earth's water far stronger than the Sun's gravitational pull on Earth's oceans

D. The Moon and the Sun actually exert exactly the same tidal force on Earth's oceans, and the apparent stronger influence of the Moon is just an illusion based on how tides are observed

11. Jupiter is the largest planet in the solar system and has more than 90 known moons orbiting it. Why is Jupiter able to retain so many moons compared to many of the smaller planets?

A. Jupiter's very strong gravity, due to its large mass, allows it to hold onto many moons in stable orbits, even at large distances from its center across the broad region of its orbit

B. Jupiter's color is reddish-brown, which is the main reason Jupiter is able to hold onto so many moons in stable orbits across the broad region surrounding it in the outer solar system

C. Jupiter's surface temperature is extremely cold, which is the main reason Jupiter is able to hold onto so many moons in stable orbits across the broad region surrounding it in space

D. Jupiter has no magnetic field of any kind, which is the main reason Jupiter is able to hold onto so many moons in stable orbits across the broad region surrounding it in the solar system

12. A geologist works with an outcrop in which a sequence of rock layers is interrupted by a vertical igneous dike that cuts across all of the layers. Which of the following is true about the age of the dike relative to the layers?

A. The dike must be older than all of the layers, because any igneous feature must always exist long before any sedimentary layers can form across the same region of the crust

B. The dike must be exactly the same age as the layers it cuts across, because igneous activity always happens at the same time as the deposition of every nearby sedimentary rock

C. The dike must be older than only the topmost layer it cuts across, but the lower layers it cuts across must be older than the dike, regardless of any other geologic features

D. The dike must be younger than all of the layers it cuts across, because the layers must have existed before the dike could intrude through them, by cross-cutting relationships

13. A scientist studying a metamorphic rock notices that the rock contains tiny crystals of zircon, a mineral that can be reliably dated by measuring uranium-to-lead ratios. Which of the following statements best describes how this dating works?

A. Uranium decays into lead at a rate that varies wildly from one sample to another, which is the main reason that scientists choose zircons for dating metamorphic and igneous rocks

B. Uranium decays into lead at a known constant rate, so the ratio of remaining uranium to accumulated lead within a zircon crystal can be used to estimate the crystal's age

C. Uranium does not decay into lead at all, so the ratio of uranium to lead in a zircon crystal has nothing to do with its age and cannot be used to date the rock that contains it

D. Lead decays into uranium at an unknown rate, so the ratio of lead to uranium in a zircon crystal has nothing to do with its age and cannot reliably be used to date the rock containing it

14. A radioactive isotope has a half-life of 600 years. A sample now contains one-half of the original amount of this isotope. About how much time has passed since the sample formed?

A. About 600 years, because reducing the original amount of a radioactive isotope to one-half of the original requires only one full half-life of that isotope's decay

B. About 1,200 years, because reducing the original amount of a radioactive isotope to one-half of the original always requires exactly two full half-lives of decay no matter what

C. About 300 years, because reducing the original amount of the radioactive isotope to one-half of the original requires only half of one full half-life of the isotope's decay

D. About 6,000 years, because reducing the original amount of the radioactive isotope to one-half of the original always requires exactly ten full half-lives of decay no matter what

15. Fossils form in many different ways, including the preservation of original bone material, the replacement of bone by minerals, and the formation of natural casts or molds in soft sediment. Which of the following best describes a "trace fossil"?

A. A trace fossil is a preserved piece of original animal hair, which is the only kind of trace fossil that has ever been discovered in any fossil-bearing rock layer anywhere in the world

B. A trace fossil is a piece of unaltered bone material from a long-extinct animal, which is the only kind of trace fossil that has ever been discovered in any fossil-bearing rock layer

C. A trace fossil is a preserved record of activity by an organism, such as a footprint, burrow, or fossilized droppings, rather than preserved body parts of the organism itself

D. A trace fossil is a complete skeleton of an ancient animal that has been replaced by minerals, which is the only kind of trace fossil that has ever been discovered in any rock layer

16. A region's rock record contains a thick sequence of marine fossil-bearing limestones, followed by a thick sequence of land plant-bearing coal seams, followed by a thick sequence of windblown sandstones. Which of the following best summarizes the environmental history of this region?

A. The region has always been a deep open ocean, with no change in environmental conditions or any other features of the surrounding region over its entire geologic history

B. The region transitioned over time from a shallow marine environment to a coastal swamp environment to a dry desert environment, recording major changes in conditions

C. The region has always been a dry desert, with no change in environmental conditions or in any other geologic features of the surrounding region over its entire geologic history

D. The region's rock record shows no evidence at all of any past environmental changes, since rock records cannot ever be used to reconstruct any past environmental conditions

17. Wegener's hypothesis of continental drift was largely rejected during his lifetime, but it eventually evolved into the modern theory of plate tectonics, which is widely accepted today. Which of the following best explains why this change in scientific acceptance occurred?

A. The original hypothesis of continental drift was completely wrong, and modern plate tectonic theory has no relationship to any of Wegener's original observations or ideas about it

B. The original hypothesis of continental drift was completely correct, and no new observations or ideas have been added in the development of the modern theory of plate tectonics

C. New observations such as paleomagnetic stripes in ocean rocks and seafloor spreading provided strong evidence and a mechanism for moving continents, supporting plate tectonics

D. The original hypothesis was rejected by every scientist of every nationality, and no new observations or ideas have ever been added in the development of the modern plate tectonic theory

18. Mass extinctions punctuate Earth's history, with the most famous one occurring at the end of the Cretaceous Period and ending the era of non-avian dinosaurs. Which of the following best describes the likely role of large asteroid impacts in these mass extinctions?

A. Large asteroid impacts are now considered to have had no role at all in any mass extinction event in Earth's history, since no asteroid has ever produced any kind of widespread impact

B. Large asteroid impacts gradually slow over many millions of years, which is the main reason for the gradual disappearance of so many species at the end of the Cretaceous Period in particular

C. A large asteroid impact at the end of the Cretaceous Period rapidly altered global conditions, contributing to the mass extinction of many species including the non-avian dinosaurs

D. Large asteroid impacts have only struck the Earth in the past few thousand years, which is the main reason that they are now considered to have triggered mass extinction events on Earth

19. A divergent boundary is a region where two tectonic plates pull apart and new oceanic crust forms between them. Which of the following best describes the main feature found along most divergent plate boundaries in the oceans?

A. A mid-ocean ridge, a long underwater mountain chain that runs along the divergent plate boundary in the oceans, where rising magma fills the gap between the two separating plates

B. A deep ocean trench, a long, narrow, and very deep depression in the ocean floor where one plate is forced beneath another plate at a convergent plate boundary in the ocean

C. A continental rift valley, a steep-walled valley on the surface of a continent where the crust is being pulled apart by the divergence of two plates on the continental land surface

D. A transform fault, a long fracture in the ocean floor where two plates slide past each other horizontally and where no rising magma fills any gap between any plates anywhere in space

20. Earth's outermost solid layer, the lithosphere, behaves rigidly and rides on top of a partially molten layer below it. What is this partially molten layer called?

A. The crust, the thin outermost solid layer of the Earth that contains all surface rocks and minerals, and which makes up the topmost portion of the entire rigid lithosphere as well

B. The inner core, the solid metal sphere at the very center of the Earth, which is far below the lithosphere and is composed mostly of solid iron and nickel in extreme conditions

C. The outer core, a layer of molten metal that surrounds the inner core and lies far below the lithosphere, where the flow of liquid iron generates Earth's overall magnetic field

D. The asthenosphere, the partially molten layer of the upper mantle that lies just beneath the lithosphere and on which the rigid lithospheric plates move slowly across Earth's surface

21. A coarse-grained intrusive igneous rock contains large interlocking crystals of feldspar, quartz, and mica. Which of the following best describes how this rock most likely formed?

A. Magma cooled slowly deep underground, allowing time for large crystals to grow and intergrow, producing a coarse-grained texture that is typical of intrusive igneous rocks

B. Sediment was rapidly deposited and quickly cemented at the surface, producing a coarse-grained sedimentary rock that closely resembles the texture of an intrusive igneous rock

C. Lava cooled extremely rapidly at the surface, leaving no time for any crystals to grow, producing a fine-grained or glassy texture that is typical of all intrusive igneous rocks

D. An existing rock was buried and metamorphosed by heat and pressure, producing a foliated metamorphic rock that closely resembles the coarse-grained texture of intrusive igneous rock

22. A geologist is comparing two minerals using the Mohs hardness scale. One mineral can be scratched by a fingernail, while the other cannot be scratched even by a steel knife. Which of the following correctly describes their relative hardness on the Mohs scale?

A. The fingernail-scratchable mineral is much harder than the knife-resistant mineral, since being scratched by a fingernail always indicates a high position on the Mohs hardness scale

B. The fingernail-scratchable mineral and the knife-resistant mineral are exactly the same hardness, since the Mohs hardness scale gives every mineral the same number regardless of test results

C. The fingernail-scratchable mineral is much softer than the knife-resistant mineral, with a Mohs hardness less than about 2.5, while the knife-resistant mineral has a Mohs hardness above about 5.5

D. The fingernail-scratchable mineral has no hardness at all on the Mohs scale, since only the knife-resistant mineral can be assigned a numerical value of any kind on the Mohs hardness scale

23. A region's freshwater supply depends on its surface water (rivers and lakes) and its groundwater (water held in aquifers below the ground). Which of the following best describes how groundwater and surface water are related?

A. Groundwater and surface water are completely unrelated, since water that falls as rain or snow can never move between these two different reservoirs over any timescale at all

B. Groundwater can move into rivers and lakes through springs and seeps, while surface water can also recharge groundwater by soaking down through the soil and rock into aquifers

C. Surface water always moves downward into groundwater and never upward back into surface water, regardless of season, regional rainfall, or any other geologic or hydrologic factor

D. Groundwater always moves upward into surface water and never downward back into groundwater, regardless of season, regional rainfall, or any other geologic or hydrologic factor

24. Soil scientists study a soil profile by digging down through the layers, or horizons, beneath the surface. Which of the following best describes the typical sequence of soil horizons from the surface downward in a mature soil?

A. From the surface downward, the typical sequence is: bedrock, partially weathered rock, mineral-rich subsoil, and topsoil rich in organic matter at the very bottom of the soil profile

B. From the surface downward, the typical sequence is: bedrock, topsoil rich in organic matter, partially weathered rock, and mineral-rich subsoil in the middle of the soil profile from top to bottom

C. From the surface downward, the typical sequence is: mineral-rich subsoil, partially weathered rock, topsoil rich in organic matter, and finally bedrock at the very top of the soil profile

D. From the surface downward, the typical sequence is: topsoil rich in organic matter, mineral-rich subsoil, partially weathered rock, and finally solid bedrock at the deepest level

25. The water cycle moves water continuously among the atmosphere, the oceans, the land, and living things. Which of the following statements correctly describes the role of the Sun in driving the water cycle?

A. The Sun supplies the energy that drives evaporation and powers atmospheric circulation, lifting water from oceans and surfaces into the atmosphere where it can later condense and fall as precipitation

B. The Sun has no role at all in the water cycle, since the movement of water from the oceans and other surfaces of the Earth into the atmosphere is completely independent of solar radiation

C. The Sun freezes water directly from oceans and other surfaces into ice in the atmosphere, with no liquid water phase at all involved in any stage of the natural water cycle on the planet

D. The Sun deliberately controls the exact amount of rain that falls in every single location around the Earth at all times, with no other influence from the surrounding atmosphere or oceans

26. A wide, slow-moving river meanders across a flat plain, depositing fine sediment on the inside of each curve and eroding the outside of each curve. Which of the following best describes how this pattern is likely to change the shape of the river channel over many years?

A. The river will gradually straighten itself out as each curve becomes shallower over time, eventually returning to a perfectly straight channel that has no meandering features anywhere in the river

B. The river will eventually freeze solid at every curve in the channel, with no further change in the position of the channel from year to year, regardless of the season or any other factors

C. The river's meanders will gradually become more pronounced and migrate across the plain, sometimes cutting off curves to form isolated oxbow lakes when the river straightens itself in a flood

D. The river will become deeper but narrower at each meander over time, eventually carving a single straight, narrow canyon through the floodplain with no further curves of any kind

27. A region experiences several severe earthquakes within a single year, even though it lies far from any plate boundary. Which of the following could best explain this unusual pattern of intraplate earthquakes?

A. The earthquakes are entirely random events with no underlying geologic cause of any kind, since intraplate earthquakes are physically impossible in any region of the world far from any plate boundary

B. The region likely contains old faults from past tectonic activity that can release stored stress in the interior of a plate, even without the influence of an active nearby plate boundary

C. The Moon's gravitational pull on the Earth physically lifts the entire region during certain phases of the lunar cycle, which is the main cause of all intraplate earthquakes occurring anywhere

D. The region lies directly above an active subduction zone that was simply missed during the most recent global mapping of all plate boundaries, even though all of them are otherwise known

28. A coral reef ecosystem provides habitat for thousands of species, protects coastlines from storm waves, and supports tourism and fisheries. The reef is most vulnerable to environmental changes that affect the warm, clear, shallow water it requires. Which of the following best describes a major threat to coral reefs from climate change?

A. Cooler ocean temperatures and increased water clarity, which are the main projected consequences of climate change for coral reefs around the world over the next several decades

B. Lower sea levels and reduced storm activity, which are the main projected consequences of climate change for coral reefs around the world over the next several decades and beyond

C. Increased rainfall in tropical regions and stronger trade winds, which are the main projected consequences of climate change for coral reefs around the world over the next several decades

D. Warmer ocean temperatures and ocean acidification, both of which can stress corals, cause bleaching, and reduce the ability of corals to build calcium carbonate skeletons

29. A river carries dissolved minerals from the land into the ocean. Over geologic time, this process has played a major role in producing one major property of seawater. Which property is this?

A. The saltiness of seawater, since rivers have continuously delivered dissolved minerals to the oceans over billions of years, and the oceans concentrate these dissolved substances as water evaporates

B. The blue color of seawater, since rivers carry colored dissolved minerals that gradually accumulate in the oceans and produce the deep blue color that is observed in clear marine water

C. The temperature of seawater, since rivers carry warm water from the land that gradually warms the oceans and raises their average temperature over many millions of years of time

D. The transparency of seawater, since rivers carry transparent dissolved minerals that gradually accumulate in the oceans and produce the very clear water that is observed at sea

30. A meteorologist is analyzing a weather map showing the distribution of temperature across the country. Which of the following kinds of lines on a weather map connect points of equal temperature?

A. Isobars, which connect points of equal atmospheric pressure on a weather map, used to identify regions of high and low pressure and the winds that flow between them across the country

B. Isotherms, which connect points of equal temperature on a weather map, used to show how temperature varies across the surface of the Earth and to identify regions of warm and cold air

C. Contour lines, which connect points of equal elevation on a topographic map, used to show how the elevation of the land varies across a region but not the temperature or any related quantity

D. Latitude lines, which are imaginary lines connecting points of equal latitude on a globe, used to identify how far north or south of the equator a place is but not any actual temperature value

31. A meteorologist explains that a region's prevailing winds typically blow from the same general direction throughout the year. Which of the following best describes how prevailing winds influence regional climate?

A. Prevailing winds have no measurable effect on regional climate, since the direction from which the wind usually blows has never been shown to affect the climate of any region of the world

B. Prevailing winds always carry exactly the same air, regardless of the surface they cross, which is the main reason that prevailing winds have no measurable effect on the climate of any region

C. Prevailing winds can bring warm or cool, moist or dry air depending on the surface they cross, shaping a region's typical temperature and precipitation patterns over the course of the year

D. Prevailing winds always blow from the same direction at the same speed everywhere in the world, which is the main reason that prevailing winds have no measurable effect on the climate of any region

32. A meteorologist explains that the air in the atmosphere is in constant motion, with warm air rising and cool air sinking. This circulation transports heat from the equator toward the poles. Which of the following best summarizes the broad pattern of atmospheric circulation in the tropics?

A. Cold air rises near the equator and warm air sinks near the subtropics, producing the trade winds at the surface and the high-pressure systems that bring heavy rain to the equatorial regions

B. Warm air rises near the equator, flows poleward at high altitude, and sinks near the subtropics, with surface winds returning toward the equator as the trade winds in the global atmosphere

C. Warm air sinks near the equator and cold air rises near the subtropics, producing the trade winds at the surface and the high-pressure systems that bring heavy rain to the subtropical regions

D. Air does not circulate in the atmosphere at all, since the tropical regions and the subtropics each contain completely stagnant air with no movement between them at any time of the year

33. A scientist explains that severe thunderstorms can produce a wide range of dangerous weather conditions. Which of the following lists weather hazards that are commonly associated with severe thunderstorms?

A. Snowstorms, blizzards, and ice storms, which are the most common weather hazards associated with severe thunderstorms during the summer months in the United States and around the world

B. Sandstorms, dust storms, and droughts, which are the most common weather hazards associated with severe thunderstorms during the summer months in the United States and around the world

C. Tides, ocean currents, and rising sea levels, which are the most common weather hazards associated with severe thunderstorms during the summer months in the United States and around the world

D. Lightning, hail, damaging straight-line winds, and the possibility of tornado formation, all of which can occur during severe thunderstorms

34. A scientist explains that climate change has been documented through several independent lines of evidence collected over many decades. Which of the following best describes one such line of evidence?

A. Long-term temperature records, satellite measurements of sea ice extent, and tide gauge records of sea level all show consistent changes over many decades that are linked to a warming climate

B. A single day of unusually warm weather in one city during one summer, which by itself is enough to definitively prove that the entire global climate is warming and the planet is changing

C. A single day of unusually cold weather in one city during one winter, which by itself is enough to definitively prove that the entire global climate is cooling and the planet is changing

D. A single hurricane making landfall in one region during one season, which by itself is enough to definitively prove that the entire global climate is warming and the planet is changing

35. A scientist describes a region whose climate is influenced by its position next to a large body of water, by its elevation, and by the prevailing winds that cross it. Which of the following best describes how a large body of water typically influences nearby climates?

A. A large body of water has no measurable effect on the climate of any region near it, since the temperature of seawater and freshwater never has any influence on the air above it

B. A large body of water always makes the climate of every nearby region uniformly hot, regardless of latitude or any other factor, since the water is always very warm everywhere in the world

C. A large body of water moderates the climate of nearby land by warming and cooling slowly, leading to milder summers and milder winters compared with locations far from the water

D. A large body of water always makes the climate of every nearby region uniformly cold, regardless of latitude or any other factor, since the water is always very cold everywhere in the world

36. Permafrost is permanently frozen ground found in cold regions such as the Arctic. Which of the following best describes a major concern about thawing permafrost as the climate warms?

A. Thawing permafrost permanently lowers sea level around the world, since the water released from the frozen soil is somehow pulled directly back down into the deep interior of the planet

B. Thawing permafrost causes the global average temperature of the surface to fall sharply, since the cold water released from the frozen soil cools the air above it over the surrounding region

C. Thawing permafrost has no measurable effect on climate, since the carbon stored in frozen soils never returns to the atmosphere as it thaws, regardless of conditions in the surrounding region

D. Thawing permafrost releases methane and carbon dioxide stored in the frozen soil, which adds to the greenhouse gases in the atmosphere and accelerates further warming of the planet

37. A city is planning a new transit system and is comparing several different power sources for its trains. Which of the following choices would have the lowest direct greenhouse gas emissions?

A. Electricity generated from renewable sources such as wind, solar, and hydroelectric power, which produces little or no direct greenhouse gas emissions while in operation

B. Diesel fuel, which is a refined petroleum product that releases significant amounts of carbon dioxide, nitrogen oxides, and other air pollutants when it is burned by a vehicle in operation

C. Coal, a fossil fuel that releases significant amounts of carbon dioxide, sulfur dioxide, and other air pollutants when it is burned to generate the electricity used by a transit system in operation

D. Natural gas, a fossil fuel that releases significant amounts of carbon dioxide and methane when it is burned to generate the electricity used by a transit system over its entire period of operation

38. A region has a long history of intensive farming on its grasslands. Over the years, repeated plowing, monoculture cropping, and removal of perennial grasses have led to widespread soil erosion. Which of the following best describes the most direct environmental consequence of this kind of land use?

A. The soil becomes much deeper and more fertile each year, with no measurable loss of any topsoil from the surface and no decline in agricultural productivity of any kind over many decades of farming

B. The local climate becomes wetter on average each year, with much heavier rainfall in every season and a permanent return of large permanent lakes and wetlands across the region as a result of farming

C. The fertility of the soil declines as topsoil is lost to wind and water erosion, reducing the soil's ability to support healthy crops and increasing dust storms during dry seasons in the region

D. The local climate becomes much colder on average each year, with much heavier snowfall in every winter and a permanent return of large permanent glaciers across the region as a result of farming

39. A city is built downstream of a river that drains a region of mountains. Heavy snowfall in the mountains during a particularly wet winter is followed by a sudden warm spell in early spring. Which of the following would the city most likely need to prepare for as a direct consequence of these conditions?

A. A long-lasting drought, since the sudden warm spell will cause all of the recently fallen snow to evaporate directly into the atmosphere without any of it ever reaching the river or the surrounding city downstream

B. River flooding, since the sudden warm spell will cause rapid snowmelt that flows into the river, raising water levels and increasing the risk of flooding downstream where the city is located

C. A severe ice storm, since the sudden warm spell will cause all of the river's water to freeze solid upstream, blocking the flow of any water to the city downstream and forcing a citywide ice storm

D. A long-lasting drought, since the snow in the mountains has no measurable effect on the flow of any river or any other body of water downstream of the mountains, even after sudden warming

40. Many countries have adopted policies that require energy-efficient appliances, lighting, and buildings. Which of the following best describes the main environmental benefit of these kinds of efficiency standards?

A. Efficiency standards eliminate all of the world's environmental problems forever, with no need to take any other action of any kind in any sector of the global economy, regardless of how energy is produced

B. Efficiency standards 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

C. Efficiency standards have no measurable effect on the environment in any way, since improvements in efficiency are never able to reduce energy demand or emissions from any sector of the economy

D. Efficiency standards reduce the total amount of energy needed to provide the same level of service, lowering demand for fossil fuels and reducing greenhouse gas emissions from energy generation

41. A scientist explains that biodiversity supports many important services that ecosystems provide to people. Which of the following best describes one example of how biodiversity supports these services?

A. A diverse mix of crops in a single field always produces lower total yields than a single uniform crop, which is the main reason that monocultures are always preferred by farmers around the world

B. A diverse community of insects, birds, and other organisms helps pollinate crops, control pests, and recycle nutrients, supporting the productivity of agricultural and natural ecosystems

C. A diverse community of plants and animals always reduces the total productivity of an ecosystem, which is the main reason that biodiversity is always considered harmful to natural ecosystems

D. A diverse community of decomposers always slows the natural decay of dead organic material, which is the main reason that biodiversity is always considered harmful to natural ecosystems

42. A coastal city is planning to address the risks of more frequent flooding from rising seas. Which of the following actions would be best classified as an example of adaptation rather than mitigation?

A. Building a seawall, elevating critical infrastructure, and restoring coastal wetlands to reduce damage from rising seas and storm surges along the city's vulnerable low-lying shoreline

B. Switching the city's power supply from coal-fired power plants to renewable wind and solar farms, in order to reduce the greenhouse gas emissions that are driving sea-level rise globally

C. Adopting strict efficiency standards for new buildings to reduce energy use, in order to reduce the greenhouse gas emissions that are driving sea-level rise globally over time and around the world

D. Planting large numbers of trees in the region's parks and along the city's streets, in order to remove carbon dioxide from the atmosphere and reduce the underlying cause of climate change over time

43. A country is considering how to manage its remaining old-growth forests. Which of the following best describes one important reason to protect old-growth forests?

A. Old-growth forests have no measurable role in the global carbon cycle, since the carbon stored in any forest is never affected by harvesting or by any other kind of forest management practice anywhere

B. Old-growth forests are home to fewer species than younger forests, which is the main reason that protecting them is considered important for maintaining biodiversity in many regions around the world

C. Old-growth forests release large amounts of carbon dioxide back into the atmosphere as they grow, which is the main reason that protecting them is considered important for climate stability worldwide

D. Old-growth forests store large amounts of carbon, provide habitat for many species, and support important ecosystem services, all of which would be lost if these forests were cleared

44. A country is planning to reduce its dependence on fossil fuels by investing in a mix of renewable energy sources. Which of the following lists three examples of renewable energy sources that the country might consider?

A. Coal, oil, and natural gas, which are the three most widely used examples of renewable energy sources in the world, since they are all replenished naturally over millions of years

B. Uranium, plutonium, and thorium, which are the three most widely used examples of renewable energy sources in the world, since they all release energy through nuclear reactions

C. Wind, solar, and hydroelectric, which are all replenished naturally on human timescales and produce relatively low greenhouse gas emissions compared with most fossil fuel sources

D. Diesel fuel, kerosene, and propane, which are the three most widely used examples of renewable energy sources in the world, since they are all liquid fuels that can be transported easily

45. A city builds new bike paths and improves its public transportation system. Which of the following best describes the most direct environmental benefit of this kind of infrastructure investment?

A. The city's average rainfall is permanently changed, since changes to the city's transportation system have been shown to directly alter long-term precipitation patterns over the surrounding region

B. The city's air quality improves and its greenhouse gas emissions per person decline, since fewer people choose to drive personal cars for many of their daily trips around the city

C. The city's average temperature falls sharply in the summer, since changes to the city's transportation system have been shown to directly cool the climate of the surrounding region of the country

D. The city's residents no longer need to use any source of energy of any kind for their daily lives, since changes to the city's transportation system fully replace every other source of energy demand

46. A scientist explains that some impacts of climate change can be difficult or impossible to reverse on human timescales. Which of the following best illustrates such an impact?

A. The loss of species that go extinct as their habitats become unsuitable due to changing temperatures and weather patterns, since extinction is permanent and species cannot be recovered later

B. A single day of unusually warm weather during one summer in one region, since warm weather always passes within a few hours and is never associated with any long-term effects of any kind

C. A short-lived heat wave that lasts only several days in one region, since such heat waves always pass within a few hours and are never associated with any long-term effects of any kind on the climate

D. A brief, mild winter season in one region, since such mild winters always pass within a few weeks and are never associated with any long-term effects of any kind on the global climate

47. A country has set a goal of reaching "net-zero" greenhouse gas emissions by mid-century. Which of the following best describes what "net-zero" emissions means?

A. Net-zero emissions means producing no products or services that involve any kind of energy use, since all economic activity must completely stop in order to reach net-zero emissions in any country

B. Net-zero emissions means reducing all emissions to exactly zero from every single source of emissions everywhere in the country, with no remaining emissions of any kind from any sector at all

C. Net-zero emissions means continuing to release greenhouse gases at the current rate, since the term "net-zero" refers only to the difference between two different sources of emissions in any sector

D. Net-zero emissions means cutting greenhouse gas emissions sharply and balancing any remaining emissions with equivalent removals of carbon from the atmosphere through natural or technological means

48. An engineering team is asked to design a new water purification system for use in a remote village. Before sketching any solutions, the team gathers information about the available water sources, the materials the village can supply or obtain, the cost the village can afford, and the skills the local technicians have. Which step of the engineering design process is the team performing?

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. Defining the problem, since gathering information about the situation and identifying the criteria and constraints that the solution must address is a key part of the early problem-definition phase

D. Producing the final product, since gathering information about a problem is the same step as completing and delivering a finished, fully built design to the people who will actually use it daily

49. A team designing a new bridge has built and tested a small-scale physical model. The model has revealed a weakness in one of the bridge supports that was not anticipated in the original design. Which of the following best describes the team's most appropriate next action?

A. Conceal the weakness in the original design from the public and proceed to build the full-scale bridge using the original plans, since revealing flaws found in any physical model is never an acceptable practice

B. Use the information from the test to modify the design, addressing the weakness in the support, and then test the modified design again to see whether the change has been effective

C. Abandon the project entirely, since the discovery of any unanticipated weakness in any physical model always proves that the underlying design can never be made to work safely under any conditions

D. Build the full-scale bridge using the original plans without any further changes and then evaluate its safety only after the bridge has been opened to vehicle and pedestrian traffic across the river

50. Engineers often work in teams that include people from many different backgrounds, such as electrical engineers, civil engineers, environmental scientists, and architects. Which of the following best explains one important benefit of working in such interdisciplinary teams?

A. Interdisciplinary teams always reach decisions much more slowly than teams of specialists in one field, which is the main reason that they are widely considered useful in modern engineering practice

B. Interdisciplinary teams have no measurable benefit in engineering practice, since every member of every engineering project must always come from exactly the same field as every other member

C. Interdisciplinary teams bring together different kinds of expertise, which allows them to consider a wider range of criteria and constraints and to find solutions that single-discipline teams might miss

D. Interdisciplinary teams have no real role in engineering, since every modern engineering problem can always be solved by a single individual working alone with no input from any other person at all

Practice Exam 57: Answer Key with Explanations

1. D — Dark matter and dark energy together make up about 95 percent of the universe's contents and have not been directly detected, only inferred from their gravitational effects and from cosmic expansion. Ordinary matter accounts for only about 5 percent. The nature of dark matter and dark energy remains an open question in cosmology.
2. A — A star begins when a dense region of a nebula collapses under its own gravity, growing hotter and denser at the center until nuclear fusion ignites. Gravity supplies the compression, and fusion is what turns the protostar into a true star. This is how stars are born in stellar nurseries.
3. C — A white dwarf is the dense, cooling remnant of a low-mass star that no longer fuses elements in its core and slowly cools over billions of years. It is the end stage of stars like the Sun. Without fusion, it shines only on its leftover heat.
4. B — Kepler's Third Law gives $T^2 = a^3$, so with T = 125, T^2 equals 15,625 and a is the cube root of 15,625, exactly 25 AU. The square of the period sets the cube of the distance. This relationship applies to any object orbiting the Sun.
5. C — Because Earth's tilted axis keeps the same orientation in space, different hemispheres lean toward the Sun at different times of year, producing the changing seasons and differences in day length. The tilt does not flip; the orbital position changes. This is the geometric basis of the seasonal cycle.
6. D — A first quarter Moon is followed about a week later by the full moon, when the side facing Earth is fully lit and the Moon rises at sunset. The lit fraction grows from half to full during the waxing gibbous phase between them. Seven days after first quarter places the Moon at full.
7. B — Comets formed in the cold outer regions of the early solar system where ices could remain solid, while asteroids formed closer to the Sun where it was too hot for ice. The frost line set this compositional divide. Distance from the young Sun controlled what could condense.
8. A — Solar prominences are huge plasma loops anchored at both ends in the Sun's surface, shaped by magnetic field lines emerging from regions of strong magnetic activity. The magnetic field channels and supports the plasma. Prominences can last weeks and sometimes erupt outward as coronal mass ejections.
9. C — During a lunar eclipse, Earth's atmosphere bends and filters sunlight, removing more blue light and letting reddish light reach the Moon, which gives it a reddish glow. The Moon is lit by all the sunrises and sunsets occurring on Earth at once. This is why the eclipsed Moon often looks coppery red.
10. B — The Moon's tidal influence exceeds the Sun's because tidal force decreases sharply with distance, and the Moon's proximity more than compensates for its smaller mass. Tides depend on the gradient of gravity across Earth, not on total pull. The Moon's tide is roughly twice the Sun's.

11. A — Jupiter's very strong gravity, due to its large mass, lets it hold many moons in stable orbits even at large distances. More mass means a deeper gravitational well that can capture and retain satellites. This is why the gas giants dominate the moon census of the solar system.
12. D — By cross-cutting relationships, an igneous dike that cuts across rock layers must be younger than the layers it cuts, because the layers had to exist before the dike could intrude. The disrupting feature always postdates what it disrupts. This is a foundational principle of relative dating.
13. B — Uranium decays into lead at a known constant rate, so the ratio of remaining uranium to accumulated lead within a zircon crystal can be used to estimate its age. Zircons trap uranium but exclude lead when they form. This makes uranium-lead dating one of the most reliable methods for old rocks.
14. A — One-half remaining means exactly one half-life has passed, since a half-life is defined as the time for half of the isotope to decay. One half-life × 600 years equals 600 years. Counting halvings is the key to radiometric age problems.
15. C — A trace fossil is a preserved record of activity by an organism, such as a footprint, burrow, or fossilized droppings, rather than preserved body parts. Trace fossils record behavior rather than anatomy. They provide unique information about how ancient organisms lived.
16. B — A sequence from marine limestones up through coal seams to windblown sandstones records changing environments over time, from shallow marine to coastal swamp to dry desert. Sedimentary rocks preserve the conditions of their formation. Such transitions are common in the rock record.
17. C — New observations such as paleomagnetic stripes in ocean rocks and seafloor spreading provided both strong evidence and a mechanism for moving continents, leading to plate tectonics. The missing mechanism that Wegener lacked was supplied by mantle convection. Evidence and explanation together won acceptance.
18. C — A large asteroid impact at the end of the Cretaceous Period rapidly altered global conditions, contributing to the mass extinction of many species, including non-avian dinosaurs. The iridium-rich K-Pg boundary layer is direct evidence. Climate disruption from the impact drove the extinctions.
19. A — Most oceanic divergent boundaries are marked by a mid-ocean ridge, a long underwater mountain chain where rising magma fills the gap between separating plates. New oceanic crust forms continuously at the ridge. The Mid-Atlantic Ridge is a classic example.
20. D — The asthenosphere is the partially molten layer of the upper mantle on which the rigid lithospheric plates move slowly. Its plastic behavior allows plate motion above it. Lithosphere riding on asthenosphere is the geometry behind plate tectonics.
21. A — A coarse-grained intrusive igneous rock forms when magma cools slowly deep underground, allowing time for large crystals to grow and intergrow. Slow cooling produces the visible, interlocking crystals. Granite is the most familiar example.
22. C — A mineral scratched by a fingernail has a Mohs hardness less than about 2.5, while one that resists a steel knife has a hardness above about 5.5. Hardness is determined by which materials a sample can and cannot scratch. The Mohs scale orders minerals by this relative hardness.
23. B — Groundwater can move into rivers and lakes through springs and seeps, while surface water can recharge groundwater by soaking down through soil and rock into aquifers. The two reservoirs exchange water continuously. Their interaction is central to the freshwater system.
24. D — A typical mature soil profile from the surface down is topsoil rich in organic matter, mineral-rich subsoil, partially weathered rock, and finally solid bedrock. Soils develop from the bedrock

upward over time. This sequence reflects increasing weathering and organic input toward the surface.

25. A — The Sun supplies the energy that drives evaporation and powers atmospheric circulation, lifting water from oceans and surfaces into the atmosphere where it can later condense and fall as precipitation. Without solar energy, the water cycle would shut down. Sunlight is the engine of the hydrologic cycle.
26. C — A meandering river's meanders gradually become more pronounced and migrate across the plain, sometimes cutting off curves to form oxbow lakes when the channel straightens during a flood. Erosion outside bends and deposition inside bends drive this evolution. The pattern is characteristic of slow, low-gradient rivers.
27. B — Intraplate earthquakes can occur where the region contains old faults from past tectonic activity that release stored stress in the plate interior. Such ancient zones of weakness reactivate under regional stresses. The New Madrid Seismic Zone in the central United States is a well-known example.
28. D — Warmer ocean temperatures and ocean acidification both stress corals, cause bleaching, and reduce the ability of corals to build calcium carbonate skeletons. Heat triggers loss of symbiotic algae, and acidification weakens skeleton-building. Together these threats endanger reef ecosystems worldwide.
29. A — Rivers continuously deliver dissolved minerals to the oceans, and as water evaporates these salts concentrate, contributing over geologic time to the saltiness of seawater. Salt enters but does not leave with evaporation. This is the long-term basis of ocean salinity.
30. B — Isotherms are lines connecting points of equal temperature on a weather map, used to show how temperature varies across the surface and to identify warm and cold air regions. They are temperature contours. Isobars and contour lines map other quantities.
31. C — Prevailing winds can bring warm or cool, moist or dry air depending on the surface they cross, shaping a region's typical temperature and precipitation. Winds crossing warm oceans pick up moisture; those crossing cold land arrive cold and dry. This is why upwind geography matters for climate.
32. B — In the tropics, warm air rises near the equator, flows poleward at high altitude, sinks near the subtropics, and returns toward the equator at the surface as the trade winds. This is the Hadley circulation. It is the largest atmospheric circulation cell.
33. D — Severe thunderstorms commonly produce lightning, hail, damaging straight-line winds, and the possibility of tornadoes. All four hazards can occur in a single storm. These are the defining dangers of severe convection.
34. A — Long-term temperature records, satellite measurements of sea ice extent, and tide gauge records of sea level all show consistent changes over many decades linked to a warming climate. The agreement across independent measurements is what makes the conclusion robust. Single events do not establish climate trends.
35. C — A large body of water moderates the climate of nearby land by warming and cooling slowly, leading to milder summers and milder winters compared with locations far from the water. Water's high specific heat damps temperature swings. This is why coastal climates are less extreme than continental ones.
36. D — Thawing permafrost releases methane and carbon dioxide stored in frozen soil, adding to atmospheric greenhouse gases and accelerating further warming. This is a positive climate feedback. It is a major concern for Arctic regions and global climate.

37. A — Electricity generated from renewable sources such as wind, solar, and hydroelectric produces little or no direct greenhouse gas emissions during operation. No fuel is burned to generate the power. This makes renewables the lowest-emission choice for powering transit.
38. C — Repeated plowing, monoculture, and removal of perennial grasses lead to declining soil fertility as topsoil is lost to wind and water erosion, reducing the soil's ability to support crops and increasing dust during dry seasons. The Dust Bowl of the 1930s is a historical example. Sustainable practices help prevent this.
39. B — A sudden warm spell after heavy mountain snowfall causes rapid snowmelt, raising river levels and increasing the risk of downstream flooding. Snowpack acts as a delayed water source that releases quickly when temperatures rise. Communities downstream must prepare for high flows.
40. D — Efficiency standards reduce the energy needed to provide the same service, lowering demand for fossil fuels and reducing greenhouse gas emissions from energy generation. Less demand means less fuel burned. Efficiency is one of the most cost-effective climate strategies.
41. B — A diverse community of insects, birds, and other organisms helps pollinate crops, control pests, and recycle nutrients, supporting the productivity of agricultural and natural ecosystems. Biodiversity underpins many ecosystem services. Protecting it benefits people directly.
42. A — Building a seawall, elevating infrastructure, and restoring coastal wetlands to reduce damage from rising seas is adaptation, because it adjusts the city to climate impacts already occurring. Mitigation, by contrast, reduces emissions. Coping with unavoidable impacts is the defining feature of adaptation.
43. D — Old-growth forests store large amounts of carbon, provide habitat for many species, and support important ecosystem services, all of which would be lost if these forests were cleared. They take centuries to develop. Protecting them preserves both climate and biodiversity benefits.
44. C — Wind, solar, and hydroelectric are all replenished naturally on human timescales and produce relatively low greenhouse gas emissions compared with fossil fuels. They draw on continuous natural flows of energy. This makes them core options for clean energy transitions.
45. B — Bike paths and improved public transportation improve air quality and reduce greenhouse gas emissions per person, since fewer people drive personal cars for daily trips. Lower fuel use means lower emissions and pollutants. Transportation is a major target for urban climate action.
46. A — The loss of species that go extinct as habitats become unsuitable is irreversible on human timescales, because extinction is permanent and species cannot be recovered. Brief weather events, by contrast, pass quickly. Biodiversity loss is among the hardest climate impacts to reverse.
47. D — Net-zero emissions means cutting greenhouse gas emissions sharply and balancing any remaining emissions with equivalent removals of carbon from the atmosphere through natural or technological means. Sources and sinks are balanced. Reaching net-zero is a key climate-stability milestone.
48. C — 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. B — When a prototype reveals an unanticipated weakness, the appropriate next step is to use the test information to 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 useful information, not a reason to abandon the project.

50. C — Interdisciplinary teams bring together different kinds of expertise, allowing them to consider a wider range of criteria and constraints and to find solutions that single-discipline teams might miss. Diverse perspectives strengthen design. Complex engineering problems benefit from this breadth.