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

1. Which piece of evidence is considered a direct leftover signal from the hot, dense early state of the universe?

A. The light from the Sun, which reaches Earth in about eight minutes after leaving the Sun's surface

B. The craters found on the Moon, which preserve a record of impacts from early in the solar system

C. The cosmic microwave background, a faint radiation found coming evenly from every direction in space

D. The rings of Saturn, which are made of countless small icy particles orbiting the planet in a flat band

2. A star begins to form when a region of a giant cloud of gas and dust collapses under its own gravity. What finally causes the new object to "turn on" and shine as a star?

A. The collapsing material grows so hot and dense at the center that nuclear fusion begins and releases energy

B. The cloud is struck by light from a nearby star, which chemically ignites the gas and dust into a glowing star

C. The cloud begins to spin so rapidly that friction between its particles heats it until it glows brightly as a star

D. The gas and dust freeze solid into a single dark rock, which then suddenly bursts into light without any warning

3. Stars shine because they fuse lighter elements into heavier ones, releasing energy. Which statement correctly describes the fusion taking place in a star like the Sun right now?

A. The Sun is fusing iron into even heavier elements, which is the reaction that releases the most energy of all

B. The Sun is splitting heavy uranium atoms into lighter ones, the same process used in nuclear power reactors

C. The Sun is breaking helium back down into hydrogen, which then escapes outward as part of the solar wind

D. The Sun is fusing hydrogen nuclei into helium, converting a small amount of mass into a large amount of energy

4. A planet orbits the Sun at an average distance of 49 AU. Using Kepler's Third Law ($T^2 = a^3$ in solar units), about how long is the planet's orbital period?

A. About 49 years, because the orbital period in years is always exactly equal to the average distance in AU

B. About 343 years, because 49 cubed is about 117,649, and the square root of that value is roughly 343 years

C. About 7 years, because the orbital period is found by simply taking the square root of the average distance in AU

D. About 98 years, because the orbital period is always equal to exactly twice the value of the average distance in AU

5. Which statement correctly explains why most places on Earth experience changing seasons throughout the year?

A. Earth's axis is tilted, so as Earth orbits the Sun, the angle and length of sunlight each hemisphere receives changes

B. Earth's distance from the Sun changes dramatically through the year, bringing summer when close and winter when far

C. The Sun changes the amount of energy it gives off through the year, producing the warm and cold seasons on Earth

D. The Moon blocks part of the Sun's light during certain months, which cools the Earth and brings the colder seasons

6. Between the first quarter moon and the full moon, the Moon appears more than half lit and its bright portion keeps growing larger each night. What is this phase called?

A. A waning crescent, the thin sliver phase the Moon passes through just before returning to the new moon stage

B. A waning gibbous, the more-than-half phase the Moon passes through just after it has reached the full moon stage

C. A waxing crescent, the thin sliver phase the Moon passes through just after it has left the new moon stage behind

D. A waxing gibbous, the more-than-half phase the Moon passes through between the first quarter and the full moon

7. The eight planets all orbit the Sun within nearly the same flat plane rather than at widely different angles. Which idea best explains this?

A. The Sun's magnetic field gradually bent each planet's orbit until all of the orbits lined up in the same plane

B. Repeated collisions among the fully formed planets slowly knocked all of their orbits into one shared flat plane

C. The planets all formed together from a single flat, spinning disk of gas and dust that surrounded the young Sun

D. Each planet was captured from a random direction in space and just happened by chance to end up in the same plane

8. During a lunar eclipse, the Moon passes into Earth's shadow. For this to occur, the Moon must be on the side of Earth opposite the Sun. During which phase does a lunar eclipse take place?

A. The new moon, when the Moon lies directly between the Earth and the Sun with its dark side facing toward us

B. The full moon, when the Moon is on the far side of Earth from the Sun and can pass into the Earth's shadow

C. The first quarter, when only the right half of the Moon's visible disk appears illuminated in the evening sky

D. The waxing crescent, when only a thin sliver of the Moon appears lit just a few days after the new moon stage

9. The greatest difference between high and low tides, known as a spring tide, happens when the gravitational pulls of the Sun and Moon combine. During which two phases does this occur?

A. The new moon and full moon, when the Sun, Earth, and Moon are lined up in a nearly straight line together

B. The first quarter and last quarter, when the Sun and Moon pull on Earth's water at right angles to each other

C. The waxing and waning crescent phases, when only a thin sliver of the Moon's face appears to be illuminated

D. Only during eclipses, when the shadow of the Earth or of the Moon falls directly across the surface of the other

10. Energy produced in the Sun's core travels outward and eventually crosses the empty space between the Sun and Earth. How does this energy travel across the vacuum of space?

A. By conduction, as heat is passed directly from one touching particle to the next all the way across to the Earth

B. By convection, as warm material physically rises and carries the heat outward across the gap from the Sun to Earth

C. By radiation, as energy travels in the form of electromagnetic waves that can move through the vacuum of empty space

D. By a steady stream of solid rocks that the Sun continuously hurls outward toward the surface of the planet Earth

11. Regions near the equator are warm year-round, while the polar regions stay cold. Which statement best explains this difference in temperature?

A. The equator is far closer to the Sun than the poles are because of the way the Earth spins around on its axis

B. The Sun deliberately directs much more of its radiation toward the equator and far less toward the polar regions

C. The thick ice at the poles produces its own cold air, which spreads outward and chills the entire polar region

D. Sunlight strikes the equator from a steep, nearly overhead angle but strikes the poles at a low, slanting angle

12. In a sequence of undisturbed sedimentary rock layers, where would a geologist expect to find the youngest layer?

A. At the bottom of the sequence, because the deepest layer is always the most recently deposited one in the sequence

B. At the top of the sequence, because each new layer is deposited on top of the layers that were already there before it

C. Exactly in the middle of the sequence, because deposition always begins in the center and then builds outward over time

D. The youngest layer cannot be identified at all, because sedimentary layers are deposited in a completely random order

13. A radioactive isotope has a half-life of 3,000 years. A sample now contains one-eighth of its original amount of this isotope. How much time has passed since the sample formed?

A. About 3,000 years, because a single half-life reduces the isotope to one-eighth of its original amount remaining

B. About 6,000 years, because two half-lives are needed to reduce the isotope to one-eighth of its original amount

C. About 9,000 years, because three half-lives are needed to reduce the isotope to one-eighth of its original amount

D. About 24,000 years, because eight half-lives are needed to reduce the isotope to one-eighth of its original amount

14. Which characteristics would make a fossil organism especially useful as an index fossil for matching the ages of rock layers in different places?

A. The organism was geographically widespread across the globe but lived during only a short, well-defined span of geologic time

B. The organism was very large and had heavy bones, but it lived in only one small, isolated valley for a very long time

C. The organism is still living today and can now be found spread across many different continents all around the world

D. The organism lived continuously for hundreds of millions of years but was found in only one small region the entire time

15. In a cliff, a geologist finds a buried, eroded surface separating older rock below from much younger rock above. What does this feature, called an unconformity, primarily represent?

A. A period of continuous, unbroken deposition during which sediment piled up steadily without any interruption at all

B. A boundary where two rock layers of exactly the same age formed side by side under completely identical conditions

C. A place where hot molten rock was forced upward between two existing layers and then cooled into solid rock over time

D. A gap in the rock record, representing a span of time during which rock was eroded away or was never deposited at all

16. A thin worldwide layer of rock about 66 million years old is rich in the rare element iridium and contains grains of shocked quartz. What event is this layer strong evidence for?

A. A long, slow cooling of the global climate that gradually lowered sea levels over many tens of millions of years

B. A massive asteroid impact, which scattered iridium worldwide and helped trigger a major mass extinction event

C. A series of routine, ordinary volcanic eruptions that slowly built up thick layers of lava across the continents

D. A reversal of the Earth's magnetic field, which is permanently recorded within the rocks of the ocean floor

17. Which observation provides strong evidence that South America and Africa were once joined together as part of a single landmass?

A. Mountain belts, rock layers, and fossils line up across the join when the two continents are fitted back together

B. The two continents currently have similar climates and similar ocean currents flowing along their nearby coasts

C. Both continents are home to large rainforests containing many plant and animal species that are broadly similar

D. The Atlantic Ocean lying between the two continents is steadily growing narrower as the continents move closer

18. A dark rock layer is made almost entirely of compressed, carbon-rich plant material and forms a thick coal seam. Which past environment is most consistent with this rock?

A. A deep, cold ocean basin far from any land, where only the very finest clay particles slowly settled to the bottom

B. A swift, rocky mountain stream that tumbled and rounded large pebbles before depositing them together downstream

C. A warm, swampy wetland where dense plant growth accumulated, was buried, and was compressed over a long period of time

D. A dry desert basin where strong winds piled well-sorted sand into large, sweeping dunes over very long periods of time

19. Off the western coast of South America, a deep ocean trench runs parallel to the coast, and a chain of volcanoes rises just inland in the Andes Mountains. What plate process produces both of these features?

A. Two continental plates colliding and crumpling upward to form a high mountain range that contains no volcanoes

B. Two plates sliding horizontally past one another along a fault, producing many earthquakes but no volcanoes at all

C. Two plates pulling apart at a divergent boundary, where rising magma forms a long mountain ridge on the seafloor

D. An oceanic plate subducting beneath a continental plate, which forms the deep trench and feeds the inland volcanoes

20. Seismographs around the world detect P-waves but not S-waves on the far side of Earth from a large earthquake, creating an S-wave "shadow zone." What does this absence of S-waves reveal about Earth's interior?

A. Earth has a liquid outer core, because S-waves cannot travel through liquids and are therefore blocked by this layer

B. Earth's interior is completely solid throughout, because both P-waves and S-waves travel freely all the way through it

C. Earth's interior is made entirely of gas, because gas is the only material capable of stopping S-waves from passing

D. Earthquakes are simply too weak to send S-waves all the way through the planet and out to its far side from the source

21. Molten magma deep underground slowly cools and hardens into a coarse-grained rock with large, interlocking crystals, never reaching the surface. What type of rock is this?

A. A sedimentary rock, formed from fragments of older rocks that were deposited in layers and then compacted and cemented

B. An intrusive igneous rock, formed when magma cools and solidifies slowly far below the surface of the Earth over time

C. A metamorphic rock, formed when an existing rock is changed by intense heat and pressure without ever fully melting

D. A volcanic glass, formed when erupting lava is cooled so suddenly that no mineral crystals have any time to grow at all

22. The same mineral can sometimes appear in several different surface colors, so geologists rub it across an unglazed tile and look at the color of the powder it leaves behind. Which property are they testing?

A. Hardness, which is a measure of how strongly a mineral resists being scratched by another material of known hardness

B. Cleavage, which is the tendency of a mineral to break along smooth, flat parallel planes in one or more directions

C. Luster, which describes the way the surface of a mineral reflects light, such as a metallic, glassy, or dull appearance

D. Streak, which is the color of the powder a mineral leaves behind and which is often more reliable than its surface color

23. A dark igneous rock has crystals so tiny they cannot be seen even with a hand lens. What does this fine-grained texture indicate about how and where the rock formed?

A. It formed deep underground, where the magma cooled extremely slowly over millions of years, growing very large crystals

B. It formed from layers of sediment that were compacted and cemented together rather than from any kind of molten material

C. It formed at or near the surface, where lava cooled quickly and left little time for large mineral crystals to grow

D. It formed when an existing rock was heated and squeezed until its minerals recrystallized into clearly visible bands

24. The Sun heats the surface of a lake, and over the course of a sunny day, the water level slowly drops as liquid water changes into invisible water vapor that rises into the air. What is this process called?

A. Evaporation, the process in which liquid water absorbs energy and changes into water vapor that enters the atmosphere

B. Condensation, the process in which water vapor cools and changes into the tiny liquid droplets that make up clouds

C. Precipitation, the process in which water falls from the clouds back down to the surface as rain, snow, sleet, or hail

D. Infiltration, the process in which water at the surface soaks downward through the soil into the rock and groundwater

25. A town is drilling a well and wants to reach a layer that will allow groundwater to flow easily and quickly toward the well. Which property of the underground material is most important for allowing water to move through it?

A. The color of the rock, since darker rocks absorb more solar heat and therefore allow groundwater to flow more quickly

B. The permeability of the rock, which describes how easily water can pass through the connected pore spaces within it

C. The hardness of the rock, since harder rocks always allow water to flow through them more easily than softer rocks do

D. The density of the rock, since the heaviest rocks per unit of volume are always the ones that let water flow the fastest

26. Coal, oil, and natural gas store carbon that living things removed from the air and that was then buried underground over millions of years. How does burning these fuels today affect the carbon cycle?

A. It removes large amounts of carbon dioxide from the air and stores it underground, which gradually cools the planet over time

B. It has no measurable effect on the atmosphere, because the carbon released by burning these fuels is far too small to matter

C. It rapidly returns long-buried carbon to the air as carbon dioxide, adding it faster than natural processes can remove it

D. It permanently changes atmospheric carbon dioxide into solid rock, locking the carbon safely beneath the surface for good

27. As the climate warms, frozen ground called permafrost begins to thaw and release methane, a strong greenhouse gas. The methane traps additional heat, which causes still more permafrost to thaw. What kind of feedback is this?

A. A negative feedback, because the released methane gradually cools the atmosphere and reverses the original warming trend

B. An external forcing, because the methane comes from a source that lies entirely outside of the Earth's climate system

C. A neutral process, because methane released into the atmosphere has no measurable effect on the planet's temperature at all

D. A positive feedback, because the released methane amplifies the very warming that caused the permafrost to thaw in the first place

28. In a region with thick limestone bedrock and plenty of rainfall, large underground caves and sinkholes form over thousands of years as slightly acidic groundwater dissolves the rock. What type of weathering is mainly responsible?

A. Chemical weathering, in which the slightly acidic water reacts with and dissolves the soluble limestone over long periods of time

B. Frost wedging, in which water that freezes within cracks expands and physically pries the limestone apart into smaller pieces

C. Wind abrasion, in which sand carried along by the wind grinds against the limestone and slowly wears the caves into the rock

D. Glacial erosion, in which a thick sheet of slowly moving ice scrapes out and carves the caves directly into the solid bedrock

29. A glacier moving slowly through a mountain valley scrapes and widens it, leaving behind a valley with a distinctive broad, rounded cross-section. What shape does a glacially carved valley typically have?

A. A narrow, V-shaped cross-section, which is the shape produced when a fast-flowing river cuts straight down into the rock

B. A perfectly flat cross-section with vertical walls, a shape that is produced only by the deposition of windblown sand

C. A broad, U-shaped cross-section, which is the characteristic shape produced when a glacier scrapes and carves a valley

D. A circular, bowl-shaped crater, which is the shape produced when molten lava erupts at the surface and then drains away

30. In the middle of winter, a continental polar (cP) air mass forms over the cold, snow-covered interior of Canada and then moves southward into the United States. What weather would this air mass bring?

A. Warm, humid air that produces high humidity along with a strong chance of heavy afternoon thunderstorms across the region

B. Cold, dry air that often brings clear skies along with a sharp drop in temperature across the region it moves into

C. Cool, moist ocean air that brings long stretches of gray skies, frequent fog, and steady light drizzle to the region

D. Hot, dry desert air that brings extended drought conditions and clouds of blowing dust across the affected region

31. A warm front moves into a region as a mass of warm air slowly slides up and over a retreating mass of cooler air. What weather typically accompanies the passage of a warm front?

A. A sudden, violent line of thunderstorms followed within minutes by a sharp drop into much colder and much drier air

B. Several days of motionless fog and unmoving low gray clouds that simply hang over the same area without changing at all

C. Completely clear skies and steady high pressure, with no clouds and no precipitation of any kind for the entire period

D. A long period of light to moderate steady rain or drizzle, followed by warmer, more humid air once the front has passed

32. On a clear night, the air temperature drops while the actual amount of water vapor in the air stays the same. What happens to the relative humidity as the night air cools?

A. It rises, because cooler air can hold less water vapor, so the air moves closer and closer to its saturation point

B. It falls, because cooler air is somehow able to hold far more water vapor than warm air is able to hold at any time

C. It stays exactly the same all night, since the actual amount of water vapor present in the air has not changed at all

D. It instantly drops down to zero, because cold air during the night is never able to contain any water vapor whatsoever

33. Hurricanes form over warm tropical oceans and quickly lose strength once they move over land. What is the main reason a hurricane weakens after it comes ashore?

A. The increased friction with the land instantly freezes the warm, moist core of the storm below the freezing point of water

B. The Coriolis effect that organizes the storm completely disappears the very moment the hurricane crosses from sea onto land

C. The storm is cut off from the warm ocean water that supplied the heat and the moisture needed to power and sustain it

D. The cooler land surface releases cold air upward that immediately replaces all of the storm's warm, rising central air

34. Sunlight warms Earth's surface, and the warmed surface then radiates energy back upward as infrared (heat) radiation. How do greenhouse gases such as carbon dioxide affect this outgoing infrared radiation?

A. They reflect the incoming sunlight back out into space before it can ever reach and warm the surface of the Earth below

B. They absorb much of the outgoing infrared radiation and re-radiate part of it back downward, warming the lower atmosphere

C. They allow all of the outgoing infrared radiation to escape directly into space, which cools the lower atmosphere quickly

D. They convert the outgoing infrared radiation into visible light, which then passes easily out of the atmosphere into space

35. Global winds, such as the trade winds, do not travel in straight north-south lines but instead curve as they cross the surface of the Earth. What is responsible for this curving of the global wind patterns?

A. The Coriolis effect, produced by the rotation of the Earth, which deflects the moving air to one side as it travels along

B. The gravitational pull of the Moon, which drags the moving air off to the side as the Moon travels around the Earth in orbit

C. The ocean currents below, which physically push the winds above them into curved paths as the water flows around the globe

D. The Earth's magnetic field, which steers the moving air in curved paths the same way it steers the needle of a compass

36. A scientist points out that one unusually warm winter does not by itself prove that the climate is changing over the long term. What is the best reasoning behind this statement?

A. Warm winters can no longer happen at all now that the global climate has clearly started to warm up over recent decades

B. A single winter's weather matters far more than many decades of collected data when scientists are judging the climate

C. A warm winter proves that human activities have no effect at all on the climate and that all temperature changes are random

D. Climate is the long-term average of weather over many years, so one warm winter is short-term weather, not a climate trend

37. Which of the following statements correctly describes the difference between renewable and nonrenewable energy resources?

A. Renewable resources are always cheaper than nonrenewable ones, while nonrenewable resources are always far more expensive

B. Renewable resources are naturally replenished on human timescales, while nonrenewable resources are used up and not quickly replaced

C. Renewable resources produce no usable energy at all, while nonrenewable resources supply every bit of the world's energy

D. Renewable resources are only ever found deep underground, while nonrenewable resources are found only above the surface

38. A factory keeps its costs low by releasing pollution into the air, but nearby residents suffer more breathing problems and higher medical bills as a result. The residents' medical costs are best described as which of the following?

A. A private profit, since it is money that the factory earns directly by selling the products it manufactures and ships

B. A renewable resource, since the residents are able to use the surrounding air over and over without it ever running out

C. A negative externality, since it is a cost of the factory's activity that falls on people outside of the transaction itself

D. A government subsidy, since it is a direct cash payment that the residents receive from the government every single year

39. A population of wild fish in a coastal region collapses after being caught in enormous numbers year after year, faster than the fish can reproduce. Which driver of biodiversity loss does this best illustrate?

A. Overharvesting, in which a species is taken from the wild faster than its population is able to reproduce and recover over time

B. Habitat fragmentation, in which a once-continuous habitat is broken apart into many small, isolated, disconnected pieces

C. Climate change, in which steadily rising temperatures push organisms beyond the range of conditions that they can tolerate

D. An invasive species, in which a non-native organism is introduced and then outcompetes or preys upon the native organisms

40. Fungi and bacteria in the soil break down dead plants and animals and return their nutrients to the soil so that new plants can grow. This nutrient recycling is best classified as which type of ecosystem service?

A. A provisioning service, because the decomposers are directly supplying people with food, lumber, fresh water, and raw materials

B. A regulating service, because the decomposers control flooding, filter the air, and help to moderate the local climate over time

C. A cultural service, because the decomposers provide people with recreation, natural beauty, and spiritual or artistic inspiration

D. A supporting service, because nutrient recycling underlies and makes possible the other ecosystem services that people depend on

41. Which of the following is a projected effect of continued global warming that is supported by strong scientific consensus?

A. The world's glaciers and great ice sheets will steadily grow larger and thicker as global temperatures continue to climb each year

B. Average global surface temperatures will soon begin to fall steadily as the concentration of greenhouse gases keeps on rising

C. Global sea levels will continue to rise as the ocean water warms and expands and as land-based ice continues to melt over time

D. The oceans will slowly become more alkaline and basic as they absorb more carbon dioxide gas from the atmosphere above them

42. The protective ozone layer high in the atmosphere over Antarctica thinned dramatically during the late twentieth century. Which human-made chemicals were primarily responsible for this thinning?

A. Carbon dioxide molecules released into the atmosphere by the burning of coal, oil, and natural gas in power plants around the world

B. Chlorofluorocarbons (CFCs), chemicals that were once widely used in refrigerators, air conditioners, and aerosol spray cans

C. Sulfur dioxide gas released from the tall smokestacks of coal-burning power plants and from many large industrial factories

D. Nitrogen-based fertilizers spread across farm fields that then washed off into the nearby rivers, lakes, and coastal ocean waters

43. A fishing community wants to manage its local fishery so that the fish population stays healthy and productive for future generations. Which practice best supports this goal of sustainability?

A. Catching as many fish as possible every season in order to maximize the community's income before the fish supply runs out

B. Removing all of the natural predators of the target fish species so that a much greater number of the fish survive each year

C. Ignoring all fish population data entirely and basing the size of the yearly catch only on the current market price of fish

D. Setting catch limits at or below the rate at which the fish population can naturally reproduce, allowing it to recover over time

44. The human population grew very slowly for most of history and then increased rapidly over the past two centuries to about 8 billion people. Which development most directly contributed to this rapid growth?

A. Advances in agriculture, sanitation, and medicine, which together increased the food supply and lowered the human death rate

B. A worldwide decline in the amount of food available, which somehow forced families everywhere to have far fewer children

C. A dramatic cooling of the global climate, which made much more of the Earth's land surface suitable for human settlement

D. The sudden and complete elimination of every single infectious disease from all human populations everywhere on the planet

45. A coastal city, expecting higher seas and stronger storms, raises its roads, builds flood barriers, and restores its protective wetlands. Which climate change strategy does this best represent?

A. Mitigation, because the city is reducing the greenhouse gas emissions that are the underlying root cause of climate change

B. Geoengineering, because the city is deliberately altering the entire global climate system on a very large planetary scale

C. Adaptation, because the city is adjusting its infrastructure to cope with climate impacts that are already beginning to occur

D. Prevention, because these actions will permanently stop the sea level from ever rising along this coastline again in the future

46. Which statement correctly describes the cause and one major effect of ocean acidification?

A. Warmer ocean temperatures cause acidification, which makes it much easier for corals and shellfish to build their hard structures

B. The ocean absorbing carbon dioxide from the air lowers its pH, which makes it harder for corals and shellfish to build their shells

C. Salt washing in from rivers causes acidification, which makes the whole ocean far too salty for any fish or shellfish to survive in

D. Dissolved oxygen causes acidification, which has no measurable effect on any of the organisms that live in the ocean at all

47. Farming, permanent villages, and the first cities all developed during the Holocene Epoch, a span of roughly the last 11,000 years. Which characteristic of the Holocene best explains why these developments became possible?

A. The Holocene has had a relatively warm and stable climate, which made farming dependable and allowed people to settle in one place

B. The Holocene was an extremely cold ice age during which thick sheets of ice covered the great majority of the planet's surface

C. During the Holocene, the level of oxygen in the atmosphere first rose high enough for human beings to be able to breathe and survive

D. The Holocene had a chaotic, rapidly shifting climate that forced early humans to keep moving constantly from one place to another

48. An engineering team designing a new footbridge is told that it must safely hold at least 50 people at once (a requirement for success) and must be finished within a fixed budget (a limit that cannot be exceeded). The load requirement and the budget limit are examples of, in order, which two things?

A. Two prototypes, since each one is an early working model that is built and then tested before the final footbridge is constructed

B. Two externalities, since both are costs that fall on people who are not directly involved in the building of the new footbridge

C. Two feedback loops, since each one describes the way that the new footbridge responds to changes in its surroundings over time

D. A criterion and a constraint, since one is a requirement that the design must meet and the other is a fixed limit it cannot exceed

49. After building and testing a prototype of a new footbridge, an engineering team finds that it safely holds the required number of people but sways uncomfortably in strong winds. According to the engineering design process, what should the team do next?

A. Abandon the entire project completely, because any problem found during testing proves the design can never be made to work at all

B. Use what they learned from the test to redesign the bridge so that it sways less, and then test the improved version once again

C. Open the swaying bridge to the public without making any changes, because the first version of any design is always the final one

D. Hide the swaying problem from the public so that nobody ever finds out the original prototype had a performance issue during testing

50. Before building a new footbridge, engineers run a computer model that simulates how several different bridge designs would respond to crowds and to strong winds. What is the greatest value of running such a model first?

A. The model guarantees one single exact outcome that is certain to happen no matter what real conditions actually arise later on

B. The model removes any need for the engineers to ever take real measurements of the bridge or the wind before or after building it

C. The model lets engineers compare the likely performance of different designs and spot problems before spending money to build the bridge

D. The model proves with complete certainty that every design that was tested will perform perfectly under any conditions whatsoever

Practice Exam 50: Answer Key with Explanations

1. C — The cosmic microwave background is faint radiation reaching us evenly from all directions, the cooled-down remnant of the hot, dense early universe. Its uniform presence across the whole sky is direct evidence of the Big Bang. It is one of the strongest pieces of support for the expanding-universe model.
2. A — A protostar becomes a true star when its collapsing core grows hot and dense enough to ignite nuclear fusion, which releases energy and halts the collapse. Gravity supplies the compression, but fusion is what makes the object shine. This ignition marks the true birth of a star.
3. D — The Sun fuses hydrogen nuclei into helium in its core, converting a small amount of mass into a large amount of energy. This is the dominant reaction in any main-sequence star like the Sun. Fusing iron or splitting uranium does not power ordinary stars.
4. B — Kepler's Third Law gives $T^2 = a^3$, so with a = 49, a^3 equals about 117,649 and T is the square root of that, roughly 343 years. The cube of the distance sets the square of the period. This relationship holds for any object orbiting the Sun.

5. A — Seasons arise because Earth's axis is tilted, so as Earth orbits the Sun, each hemisphere alternately leans toward and away from it, changing the angle and duration of sunlight. The tilt, not distance from the Sun, drives the seasons. This is why opposite hemispheres have opposite seasons.
6. D — A more-than-half-lit Moon whose bright portion grows larger each night between first quarter and full is a waxing gibbous. "Waxing" means the lit fraction is increasing, and "gibbous" means more than half is lit. This phase falls just before the full moon.
7. C — The planets orbit in nearly the same plane because they all condensed from a single flat, spinning disk of gas and dust around the young Sun. The disk's shape gave the orbits their shared plane. This coplanar arrangement is a key prediction of the nebular hypothesis.
8. B — A lunar eclipse occurs at the full moon, when the Moon is on the side of Earth opposite the Sun and can pass into Earth's shadow. Only then is the alignment right for the shadow to fall on the Moon. The tilt of the Moon's orbit explains why eclipses do not happen every full moon.
9. A — Spring tides occur at the new and full moons, when the Sun, Earth, and Moon are nearly in a straight line and the Sun's and Moon's gravitational pulls combine. This alignment produces the largest tidal range. At the quarter phases, by contrast, the pulls partly cancel, yielding weaker neap tides.
10. C — Energy crosses the vacuum of space by radiation, traveling as electromagnetic waves that need no medium. Conduction and convection both require matter and cannot operate across empty space. Radiation is therefore the only way the Sun's energy can reach Earth.
11. D — The equator stays warm because sunlight strikes it from a steep, nearly overhead angle, concentrating energy on a small area, while the poles receive low, slanting rays spread over a larger area. The angle of insolation controls this concentration. This difference, not distance to the Sun, drives the temperature contrast.
12. B — By the principle of superposition, each new sedimentary layer is deposited on top of older ones, so the youngest layer in an undisturbed sequence lies at the top. Layers accumulate upward over time. This rule is the foundation of relative dating in horizontal strata.
13. C — One-eighth remaining means three half-lives have passed, since $1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8$. Three half-lives × 3,000 years equals 9,000 years. Counting the number of halvings is the key to solving radiometric age problems.
14. A — A good index fossil comes from an organism that was geographically widespread but existed for only a short span of geologic time. Wide distribution allows rock layers in different regions to be correlated, and a brief existence pins the age precisely. Long-lived or narrowly distributed organisms make poor index fossils.
15. D — An unconformity is a buried, eroded surface representing a gap in the rock record, a span during which rock was eroded away or never deposited. It marks missing time between the older rock below and younger rock above. Recognizing unconformities is essential for reconstructing geologic history.
16. B — A worldwide iridium-rich layer containing shocked quartz, dated to about 66 million years ago, is strong evidence of a massive asteroid impact. Iridium is rare in Earth's crust but common in asteroids, and shocked quartz forms under extreme impact pressures. This impact helped trigger the mass extinction that ended the dinosaurs.
17. A — The strongest evidence that South America and Africa were once joined is that mountain belts, rock layers, and fossils line up across the join when the continents are fitted back together. Such matching across an ocean is best explained by a former connection. This was central evidence for continental drift.

18. C — A thick coal seam made of compressed, carbon-rich plant material indicates a warm, swampy wetland where dense vegetation accumulated, was buried, and was compressed over time. Coal requires abundant plant growth and burial. Deep ocean, mountain stream, and desert settings would not produce coal.
19. D — A deep offshore trench paired with an inland volcanic mountain chain forms where an oceanic plate subducts beneath a continental plate. The descending plate creates the trench, and melting above it feeds the volcanoes. This ocean-continent convergence built the Andes.
20. A — The S-wave shadow zone exists because S-waves cannot travel through liquids, so they are blocked by Earth's liquid outer core. Their absence on the far side of the planet reveals that layer's liquid state. This behavior of seismic waves is how Earth's internal structure was mapped.
21. B — Magma that cools slowly deep underground forms intrusive igneous rock with large, interlocking crystals, because slow cooling allows time for crystals to grow. The coarse grain size is the signature of slow, deep cooling. Rock that never reaches the surface and crystallizes from melt is intrusive igneous.
22. D — Rubbing a mineral across an unglazed tile tests its streak, the color of the powder it leaves behind. Streak is often more reliable than surface color because it stays consistent even when the outer color varies. This makes it a useful diagnostic property.
23. C — Crystals too small to see indicate a fine-grained texture that forms when lava cools quickly at or near the surface, leaving little time for crystals to grow. Rapid cooling limits crystal size. Slow, deep cooling, by contrast, produces large, visible crystals.
24. A — Evaporation is the process in which liquid water absorbs energy from the Sun and changes into water vapor that enters the atmosphere, lowering the lake's level. The added energy lets molecules escape the liquid surface. Evaporation is the opposite of condensation, which forms liquid droplets from vapor.
25. B — Permeability, which describes how easily water moves through the connected pore spaces of a rock, is the key property for groundwater flow toward a well. Highly permeable layers let water pass readily. Color, hardness, and density do not determine how freely water flows.
26. C — Burning fossil fuels rapidly returns long-buried carbon to the atmosphere as carbon dioxide, adding it faster than natural processes can remove it. This carbon had been locked away for millions of years. The resulting buildup is the main driver of human-caused climate change.
27. D — Thawing permafrost releasing methane that traps more heat and thaws still more permafrost is a positive feedback, because the effect amplifies the original warming. The process reinforces itself rather than reversing. Such feedbacks can accelerate climate change beyond the initial trigger.
28. A — Caves and sinkholes dissolved into limestone by slightly acidic groundwater are products of chemical weathering, in which water reacts with and dissolves the soluble rock. The acid breaks down the limestone over long periods. This contrasts with mechanical processes that only break rock physically.
29. C — A glacier scrapes and widens a valley into a broad, U-shaped cross-section as the thick, heavy ice grinds along. The flat-bottomed, steep-sided U shape is the hallmark of glacial carving. A river, by contrast, cuts a narrow V-shaped valley.
30. B — A continental polar air mass forms over cold, dry land and brings cold, dry air, often with clear skies and falling temperatures. "Continental" indicates dryness and "polar" indicates cold. This sharply contrasts with warm, humid maritime tropical air.
31. D — A warm front, where warm air slides gradually up over retreating cooler air, typically brings a long period of light to moderate steady rain, followed by warmer, more humid conditions once

it passes. The gentle frontal slope produces widespread, steady precipitation. This differs from the brief, intense storms of a cold front.

32. A — As night air cools while the amount of water vapor stays fixed, the relative humidity rises because cooler air can hold less vapor, moving the air toward saturation. Relative humidity compares actual vapor to the maximum the air can hold. Continued cooling to the dew point produces dew or fog.
33. C — A hurricane weakens over land because it is cut off from the warm ocean water that supplied the heat and moisture powering it. Without that energy source, the storm rapidly loses strength. This is why hurricanes intensify over warm seas and decay once ashore.
34. B — Greenhouse gases absorb much of the outgoing infrared radiation from Earth's surface and re-radiate part of it back downward, warming the lower atmosphere. They act on outgoing heat rather than reflecting incoming sunlight. This absorption and re-emission is the essence of the greenhouse effect.
35. A — Global winds curve because of the Coriolis effect, produced by Earth's rotation, which deflects moving air to one side as it travels. This deflection bends straight north-south airflow into curved paths like the trade winds. The Coriolis effect shapes large-scale wind and ocean current patterns worldwide.
36. D — Because climate is the long-term average of weather over many years, one warm winter is short-term weather, not a climate trend, and cannot by itself prove or disprove climate change. Long-term data, not a single season, reveals climate trends. Distinguishing weather from climate is essential to interpreting both.
37. B — Renewable resources are naturally replenished on human timescales, while nonrenewable resources are used up faster than they can be replaced. This replenishment rate is the defining difference. Solar, wind, and water are renewable, whereas fossil fuels and uranium are finite.
38. C — The residents' medical costs are a negative externality, a cost of the factory's activity that falls on people outside the transaction. Externalities are real costs the producer does not pay. Accounting for them is essential to honest cost-benefit analysis.
39. A — A fish population collapsing after being caught faster than it can reproduce illustrates overharvesting, the removal of a species from the wild beyond its capacity to recover. The harvest rate exceeds the reproduction rate. This is a major driver of biodiversity loss in marine systems.
40. D — Nutrient recycling by decomposers is a supporting service, because it underlies and makes possible the other ecosystem services people depend on. Supporting services maintain the basic processes, such as soil formation and nutrient cycling, that sustain life. Without them, provisioning and regulating services could not function.
41. C — Strong scientific consensus supports that global sea levels will continue to rise as ocean water warms and expands and as land ice melts. Both thermal expansion and added meltwater raise sea level. The other options contradict observed trends and ocean chemistry, which is becoming more acidic, not basic.
42. B — Ozone-layer thinning over Antarctica was caused mainly by chlorofluorocarbons (CFCs), chemicals once used in refrigerators, air conditioners, and aerosol cans. CFCs release chlorine that destroys ozone high in the atmosphere. International limits on CFCs have since allowed the ozone layer to begin recovering.
43. D — Setting catch limits at or below the rate at which the fish population can reproduce supports sustainability by allowing the population to recover. Harvesting within the reproductive capacity prevents collapse. Matching the catch to recovery rates is the core of sustainable fisheries management.

44. A — Rapid recent population growth was driven mainly by advances in agriculture, sanitation, and medicine, which increased the food supply and lowered the death rate. More people survived as food became more abundant and disease less deadly. These improvements, not climate or eliminated disease, fueled the surge.
45. C — Raising roads, building flood barriers, and restoring wetlands to cope with rising seas is adaptation, because the city is adjusting to climate impacts that are already occurring. Adaptation manages the effects, while mitigation reduces the emissions causing them. Coping with unavoidable impacts is the defining feature of adaptation.
46. B — Ocean acidification occurs as the ocean absorbs carbon dioxide from the air, lowering its pH, which makes it harder for corals and shellfish to build their carbonate shells. Lower pH reduces the carbonate minerals these organisms need. This threat ripples through marine food webs.
47. A — Farming and the first cities became possible because the Holocene has had a relatively warm and stable climate, which made agriculture dependable and allowed permanent settlement. Predictable growing seasons were essential for farming. Climatic stability, not an ice age or oxygen changes, enabled civilization.
48. D — The load requirement is a criterion, defining what the design must achieve, while the budget limit is a constraint, a fixed restriction it cannot exceed. Criteria define success and constraints set boundaries. Distinguishing the two is fundamental to framing an engineering problem.
49. B — When a prototype reveals a problem, the engineering design process calls for using the test results to redesign it and then test the improved version again. 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 — The greatest value of the model is that it lets engineers compare the likely performance of different designs and spot problems before spending money to build the bridge. Models allow ideas to be tested safely and cheaply in advance. They guide decisions while acknowledging uncertainty, rather than guaranteeing outcomes.