PRACTICE EXAM 25: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. Scientists estimate the age of the universe to be about 13.8 billion years. This estimate is based primarily on which kind of observation?

A. Counting the number of craters preserved on the surfaces of the Moon and the rocky planets

B. Measuring the temperature at the core of the Sun and comparing it to other nearby stars

C. Measuring the rate at which galaxies are moving apart and tracing that expansion backward in time

D. Adding up the ages of the oldest rocks that have been collected from Earth and from meteorites

2. A star far more massive than the Sun reaches the end of its life. Which sequence of events is most likely for such a massive star?

A. It quietly cools and fades in place, gradually shrinking into a small, dim white dwarf over time

B. It explodes as a supernova, then leaves behind a dense neutron star or a black hole at its center

C. It splits peacefully into several smaller stars that drift apart and continue to shine independently

D. It expands forever, growing larger and larger without limit until it fills its entire host galaxy

3. Why do astronomers say that the formation and death of earlier generations of stars was necessary for rocky planets like Earth to exist?

A. Earlier stars used up all the dangerous radiation in space, making it safe for planets to later form

B. Earlier stars pushed the planets into their current orbits through the gravity of their bright light

C. Earlier stars warmed the empty regions of space enough for solid planets to begin condensing there

D. Earlier stars produced the heavy elements like silicon and iron and spread them into space when they died

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

A. About 8 years, because 4 cubed equals 64, and the square root of 64 is 8 years for the period

B. About 4 years, because the orbital period in years always equals the average distance in AU exactly

C. About 12 years, because the orbital period equals the average distance multiplied by three each time

D. About 2 years, because the orbital period equals the square root of the average distance in AU

5. A student claims that summer happens because Earth is closer to the Sun and winter happens because Earth is farther away. Why is this explanation incorrect for the Northern Hemisphere?

A. Earth's distance from the Sun never changes at all as it travels around its orbit each year

B. The Sun gives off the same amount of energy in every direction, so distance could not matter

C. The Northern and Southern Hemispheres experience the same season at the same time of year

D. Earth is actually slightly closer to the Sun during Northern Hemisphere winter, so tilt, not distance, causes seasons

6. An observer sees the Moon high in the southern sky around 6 a.m., with its left half illuminated and its right half dark. What phase is the Moon in?

A. First quarter, the phase about one week after new moon, when the right half of the Moon is lit

B. Last quarter, the phase about one week after full moon, when the left half of the Moon is lit

C. Waxing crescent, the thin phase just after new moon, when only a sliver on the right is lit

D. Full moon, the phase when the entire face of the Moon is fully illuminated and visible all night

7. Comets travel in very long, stretched-out orbits and are made largely of ice and dust. When a comet passes close to the Sun, what causes it to grow a glowing tail?

A. Heat from the Sun vaporizes the comet's ices, releasing gas and dust that stream away from the Sun

B. The comet collides with tiny particles in space, which knock loose a trail of glowing fragments

C. The Sun's gravity physically stretches the solid comet into a long thin shape pointing toward the Sun

D. The comet's own internal heat suddenly melts its surface, releasing a glowing cloud of molten rock

8. A total solar eclipse can occur only when the Moon passes directly between Earth and the Sun. During which moon phase does this alignment happen?

A. The full moon phase, when the Moon is on the opposite side of Earth from the Sun in the sky

B. The first quarter phase, when the Moon appears half illuminated as seen from Earth's surface

C. The new moon phase, when the Moon is positioned between Earth and the Sun and is not normally visible

D. The last quarter phase, when the Moon rises near midnight and is highest in the sky around dawn

9. The largest tidal ranges of the month, called spring tides, occur when the Sun, Earth, and Moon are arranged in a nearly straight line. During which two moon phases does this alignment occur?

A. The first quarter and last quarter phases, when the Moon appears exactly half illuminated from Earth

B. The new moon and full moon phases, when the Sun and Moon line up and their gravitational pulls combine

C. The waxing and waning crescent phases, when only a thin sliver of the Moon is visible in the sky

D. The waxing and waning gibbous phases, when more than half of the Moon's face appears illuminated

10. Each second, the Sun converts about 4 million tons of its mass into energy through nuclear fusion. What ultimately happens to this energy?

A. It is stored permanently within the Sun's core and never leaves the interior of the Sun at all

B. It is absorbed entirely by the planets closest to the Sun, leaving the outer planets in darkness

C. It instantly disappears from the universe, since energy released by fusion cannot be detected

D. It radiates outward through space as light and heat, some of which reaches Earth as sunlight

11. In New York State, the air temperature is usually lower at sunrise than in the early afternoon, even on a clear day. Which factor best explains why the afternoon is warmer?

A. The Sun is higher in the sky in the afternoon, so its rays strike the surface more directly and heat it more

B. The Sun emits more total energy in the afternoon than it does during the early morning hours

C. Earth is physically closer to the Sun in the afternoon than it is at the moment of sunrise each day

D. The atmosphere completely blocks all sunlight at sunrise, so no solar heating occurs until midday

12. In most undisturbed rock sequences, deeper layers are older than the layers above them. Under what circumstance might this normal age order be reversed?

A. When the layers are made entirely of the same type of sedimentary rock from top to bottom

B. When the layers contain fossils of organisms that are all the same age throughout the sequence

C. When powerful tectonic forces have folded or overturned the rock layers after they were deposited

D. When the layers were deposited very slowly over an extremely long span of geologic time

13. A radioactive isotope used to date rocks has a half-life of 50,000 years. A sample now contains one-sixteenth of its original amount of this isotope. How old is the sample?

A. About 50,000 years old, because one half-life reduces the isotope to one-sixteenth of the original

B. About 100,000 years old, because two half-lives reduce the isotope to one-sixteenth of the original

C. About 150,000 years old, because three half-lives reduce the isotope to one-sixteenth of the original

D. About 200,000 years old, because four half-lives reduce the isotope to one-sixteenth of the original

14. Geologists prefer to use certain fossils, called index fossils, to identify and match rock layers of the same age. Which organism would make the best index fossil?

A. A deep-burrowing worm that lived for hundreds of millions of years in only one small swamp

B. A free-floating ocean organism that spread across the world but existed for only a brief geologic time

C. A large land mammal that lived in just one mountain valley for a very long span of geologic time

D. A type of bacteria that has existed almost unchanged from the earliest oceans up to the present day

15. A rock outcrop shows sedimentary layers that are cut by a fault, and the fault itself is cut across by a later igneous intrusion. What is the correct order of events from oldest to youngest?

A. The sedimentary layers formed first, then the fault broke them, and finally the intrusion cut across the fault

B. The igneous intrusion formed first, then the fault cut the intrusion, and finally the sedimentary layers formed

C. The fault formed first, then the sedimentary layers were deposited, and finally the intrusion cut across them

D. All three features formed at the same time, so no order of events can be determined from the outcrop

16. Earth's fossil record shows that there have been several mass extinctions, each followed eventually by the appearance of many new species. What does this overall pattern reveal about life on Earth?

A. Life on Earth has remained completely unchanged since the very first organisms appeared in the oceans

B. Each mass extinction permanently ended all life, so life had to begin again from nonliving matter each time

C. The total number of species on Earth has steadily decreased and will soon reach zero in the near future

D. Life has changed dramatically over geologic time, with extinctions clearing the way for new forms to arise

17. The coastlines of South America and Africa appear to fit together like puzzle pieces, and matching rock formations and fossils are found on both. These observations support which idea?

A. The two continents were formed at the same instant and have always remained exactly where they are now

B. The Atlantic Ocean between the two continents is steadily shrinking as the continents move closer together

C. The two continents were once joined as part of a larger landmass and have since drifted apart over time

D. Identical organisms evolved completely separately on the two continents without any past connection

18. A rock layer is made of very fine-grained mud that hardened into thin, flat sheets, contains no ripple marks, and holds fossils of tiny floating ocean organisms. Which past environment does this best indicate?

A. A deep, calm body of water where only the finest particles slowly settled out far from any shore

B. A fast-moving mountain river that tumbled and rounded large pebbles before depositing them downstream

C. A windswept desert where blowing sand was piled into large dunes of well-sorted, rounded grains

D. A glacier that scraped up and dropped a chaotic, unsorted mix of boulders, sand, and fine clay together

19. The Hawaiian Islands form a chain of volcanoes in the middle of the Pacific Plate, far from any plate boundary. What best explains the origin of these islands?

A. The islands formed at a transform boundary where two plates grind horizontally past each other

B. The islands formed as the plate moved over a stationary hot spot, a plume of rising magma from deep within the mantle

C. The islands formed at a deep ocean trench where one plate is subducting beneath another plate

D. The islands formed at a mid-ocean ridge where two plates are pulling apart from one another

20. Heat from Earth's interior causes hot mantle rock to rise while cooler rock sinks, creating slow circulating motions. How do these motions affect the surface of the Earth?

A. They have no effect on the surface, because the mantle is sealed off from the crust above it

B. They cause the Sun to appear to rise and set as the surface circulates beneath the atmosphere

C. They produce the daily ocean tides by pushing seawater toward and away from the coastlines

D. They drive the slow movement of tectonic plates, producing earthquakes, volcanoes, and mountains

21. Which of the following correctly describes a way that one type of rock can change into another in the rock cycle?

A. A metamorphic rock can become sediment only if it is first launched into space and then returns to Earth

B. An igneous rock can never change into any other type of rock once it has cooled and hardened completely

C. A sedimentary rock can melt into magma and later cool to form an igneous rock through the rock cycle

D. A sedimentary rock can change into an igneous rock only by being compacted, never by being melted at all

22. A mineral is defined as a naturally occurring, inorganic solid with a definite chemical composition and an orderly internal arrangement of atoms. Based on this definition, which of the following is a mineral?

A. Quartz, a naturally formed solid with a fixed chemical formula and atoms arranged in a regular crystal pattern

B. Window glass, a solid that is manufactured by people and lacks any orderly internal arrangement of atoms

C. Wood, a solid material produced by living trees and made of once-living organic plant tissue and cells

D. Motor oil, a thick liquid refined from petroleum that has no fixed shape and no crystal structure at all

23. Lava that erupts from a volcano and cools rapidly at Earth's surface tends to form rocks with which texture?

A. A coarse-grained texture with large crystals, because rapid cooling allows crystals plenty of time to grow

B. A texture made entirely of rounded pebbles cemented together, like that of a sedimentary conglomerate

C. A banded, foliated texture, like that produced when rock is squeezed under intense heat and pressure

D. A fine-grained or glassy texture, because rapid cooling does not allow large crystals time to grow

24. Clouds form when warm, moist air rises, cools, and the water vapor in it changes into tiny liquid droplets. What is this process of water vapor changing into liquid called?

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

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

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

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

25. After a long period of heavy rainfall, the level of standing water in many local wells rises. What does the rising water level in the wells most directly indicate?

A. The permeability of the underground rock has permanently increased because of the heavy rainfall

B. The bedrock beneath the wells has begun to dissolve, allowing more water to collect in the wells

C. The water table has risen because the heavy rainfall recharged the groundwater stored underground

D. The porosity of the soil dropped to zero, forcing all the water upward to the surface of the ground

26. Which two opposing processes move carbon between the atmosphere and living organisms, keeping carbon cycling through ecosystems?

A. Photosynthesis, which takes carbon dioxide out of the air, and respiration, which returns carbon dioxide to it

B. Evaporation, which lifts carbon into the air, and condensation, which returns the carbon to the surface

C. Weathering, which adds carbon to the air, and erosion, which carries that same carbon out to the sea

D. Melting, which frees carbon from the ice, and freezing, which locks the carbon back into the ice again

27. Bright ice and snow reflect much of the sunlight that hits them, while dark ocean and land absorb most of it. As global warming melts ice and snow, what happens to this reflectivity, and what is the result?

A. The reflectivity increases, which cools the planet and stops any further warming from taking place

B. The reflectivity stays the same, so melting ice has no effect on how much sunlight the surface absorbs

C. The reflectivity increases, which has no measurable effect on the temperature of the planet at all

D. The reflectivity decreases, so the darker surfaces absorb more sunlight, amplifying the warming further

28. A large boulder gradually breaks into many smaller pieces of the same rock through repeated freezing and thawing, but its mineral composition does not change. What type of weathering is this?

A. Chemical weathering, in which the rock's minerals react with water and air to form entirely new substances

B. Mechanical weathering, in which the rock is physically broken into smaller pieces without changing its composition

C. Biological dissolution, in which living organisms chemically dissolve the rock and absorb its dissolved minerals

D. Deposition, in which sediment carried by wind or water is dropped and accumulates in a brand-new location

29. As a thick continental glacier advances across a landscape, it picks up rock fragments and uses them to scrape and polish the bedrock beneath it. What surface feature does this scraping commonly leave behind?

A. Large sand dunes arranged in long parallel ridges across the surface of the exposed bedrock

B. Deep V-shaped river canyons cut sharply downward into the solid bedrock by fast-flowing water

C. Long parallel scratches and grooves in the bedrock that record the direction the ice was moving

D. Rounded volcanic craters left where molten lava erupted upward through the overlying glacier ice

30. A maritime tropical (mT) air mass forms over a warm tropical ocean and then moves over land. Which combination of temperature and moisture would this air mass carry?

A. Warm and humid, because it formed over warm water that added both heat and abundant moisture to the air

B. Cold and dry, because air masses always lose their heat and moisture as soon as they form over the ocean

C. Cold and humid, because tropical oceans are actually colder than the land masses that surround them

D. Hot and bone-dry, because ocean air masses never pick up any water vapor from the sea beneath them

31. A cold front and a warm front differ in the type of weather they bring. Which statement correctly describes a typical cold front?

A. It advances slowly and gently, producing a long, steady period of light rain that can last several days

B. It advances rapidly, forcing warm air upward steeply and often producing a narrow band of intense storms

C. It never produces any clouds or precipitation, leaving completely clear skies as it passes over a region

D. It always brings warmer, more humid air directly behind it as it pushes through the affected region

32. On a humid evening, fog often forms near the ground after sunset as the air cools. What is the most direct cause of this fog formation?

A. The wind speed increases sharply after sunset, mechanically pushing the fog together near the ground

B. The air pressure rises rapidly at night, which squeezes liquid water droplets out of the dry night air

C. The ground releases stored heat upward, which boils surface water into a thick layer of rising steam

D. The air cools to its dew point, so water vapor condenses into tiny droplets that form the fog

33. Hurricanes form over tropical oceans in late summer and lose strength when they move over land or cold water. Which condition is essential for a hurricane to form and grow stronger?

A. A steady supply of cold, dry polar air flowing into the storm from higher latitudes near the poles

B. Strong winds blowing in opposite directions at different altitudes, which tear developing storms apart

C. Warm ocean water, which evaporates and supplies the heat and moisture that power the growing storm

D. A position directly on the equator, where the Earth's rotation has its strongest effect on the winds

34. Sunlight passes through the atmosphere and warms Earth's surface, which then radiates heat back upward as infrared energy. How do greenhouse gases interact with this outgoing infrared energy?

A. They absorb much of the outgoing infrared energy and re-radiate part of it back down toward the surface

B. They allow all of the outgoing infrared energy to escape directly into space without any absorption at all

C. They convert the outgoing infrared energy into visible light that then leaves the atmosphere harmlessly

D. They reflect the incoming sunlight back into space before it can ever reach and warm Earth's surface

35. At night along a coast, the land cools faster than the nearby ocean, and a breeze begins to blow from the land out toward the sea. What causes this nighttime land breeze?

A. The Moon's gravity pulls the cooler night air from the land directly out over the surface of the ocean

B. The ocean water cools faster than the land at night, so cold sea air rushes inland toward the shore

C. Salt in the sea air makes it heavier, so it sinks and slides down toward the land throughout the night

D. The warmer air over the relatively warm ocean rises, and cooler air from the land flows out to replace it

36. To reconstruct climate conditions from hundreds of years before thermometers existed, scientists sometimes study the width of annual growth rings in very old trees. What can these tree rings reveal?

A. The exact air pressure and wind direction recorded on each individual day of the distant past

B. Past growing conditions such as temperature and rainfall, since rings are wider in favorable years

C. The precise chemical makeup of the atmosphere, including the past levels of every greenhouse gas

D. The total number of animals that lived in the surrounding forest during each year of the tree's life

37. Which of the following groups contains only renewable energy resources?

A. Solar power, wind power, and hydroelectric power, all of which are continuously replenished by natural processes

B. Coal, oil, and natural gas, which are fossil fuels that took millions of years to form underground

C. Uranium, coal, and petroleum, which are all extracted from the ground and used up when consumed

D. Natural gas, gasoline, and diesel fuel, all of which are produced by refining crude oil from the ground

38. A town must decide whether to build a new factory that would create jobs but also increase air pollution affecting nearby residents. To make a fair decision, the town should weigh which of the following?

A. Only the profits the factory owners expect to earn, since their income is the most important factor

B. Only the number of new jobs created, because employment is the single benefit that matters most

C. Both the benefits, such as jobs and income, and the costs, such as the health effects of the pollution

D. Only the construction cost of the factory building, ignoring all of the long-term effects on the town

39. A non-native plant is accidentally introduced to a wetland, where it spreads rapidly, crowds out the native plants, and reduces the variety of species living there. Which driver of biodiversity loss does this illustrate?

A. Overharvesting, in which a species is removed from the wild faster than it can naturally reproduce

B. An invasive species, in which an introduced organism spreads and outcompetes the native organisms

C. Climate change, in which rising temperatures push native organisms beyond the limits they can tolerate

D. Habitat fragmentation, in which a continuous habitat is divided into small, isolated, disconnected pieces

40. Decomposers such as fungi and bacteria break down dead plants and animals, returning 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 decomposers directly supply food, timber, and fresh water to people

B. A cultural service, because decomposers provide recreation, beauty, and inspiration to human communities

C. A regulating service, because decomposers control floods, filter the air, and moderate the local climate

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

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

A. Heat waves will become more frequent, more intense, and longer-lasting in many regions around the world

B. The average global temperature will fall steadily as greenhouse gas concentrations continue to increase

C. Glaciers and polar ice sheets will grow much larger as the planet's surface temperature keeps rising

D. The oceans will steadily become more alkaline as they absorb more carbon dioxide from the atmosphere

42. Acid rain forms when certain gases released by burning fossil fuels react with water vapor in the atmosphere. Which two gases are the main contributors to acid rain?

A. Carbon dioxide and oxygen, which combine in the air to form a strong acid that falls as acid rain

B. Helium and argon, two inert gases that react with rainwater to lower its pH and make it acidic

C. Sulfur dioxide and nitrogen oxides, which react with water in the air to form sulfuric and nitric acids

D. Water vapor and nitrogen gas, the two most abundant gases, which together acidify falling rain

43. A coastal fishing community notices that its catch is shrinking each year because too many fish are being taken. Which action would best help the fishery recover and remain productive for the future?

A. Increasing the catch every year to make up for the shrinking numbers before the fish disappear completely

B. Setting limits on the number of fish that can be caught so the population can reproduce and recover

C. Removing all the natural predators of the fish so that a greater number of the fish survive each year

D. Ignoring the shrinking catch entirely and continuing to fish exactly as the community always has before

44. As the human population and its demand for resources have grown, the rate at which species are going extinct has risen far above the natural background rate. What is the main reason human activity has accelerated extinctions?

A. Human activities such as habitat destruction, pollution, and overharvesting place severe pressure on many species

B. Humans have intentionally bred and released enough new species to replace every one that goes extinct

C. The growth of the human population has had no measurable effect on the survival of other living species

D. Extinctions are caused entirely by natural events such as volcanoes, with no contribution from human activity

45. A city government decides to expand its public transit system and require more energy-efficient buildings, specifically to cut the city's greenhouse gas emissions. Which climate change strategy does this best represent?

A. Adaptation, because the city is adjusting to climate impacts that have already begun to affect its residents

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

C. Recovery, because the city is responding to a climate disaster that has already struck its neighborhoods

D. Mitigation, because the city is reducing the greenhouse gas emissions that cause climate change

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

A. Rising ocean temperatures cause acidification, which makes it easier for corals to build their skeletons

B. Dissolved oxygen causes acidification, which has no measurable effect on any marine organisms at all

C. Carbon dioxide absorbed from the air causes acidification, which makes it harder for shellfish to build their shells

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

47. The roughly 11,000-year-long Holocene Epoch has had an unusually steady climate compared with the rapid swings of the preceding ice ages. Why has this steadiness mattered for human societies?

A. The steady climate triggered the rapid evolution of brand-new human species during this short epoch

B. The steady climate made farming dependable, which allowed people to settle in one place and build cities

C. The steady climate finally raised the atmosphere's oxygen to a level high enough for humans to breathe

D. The steady climate eliminated every natural hazard, leaving early farming communities with no dangers at all

48. A team of engineers is asked to design a system to provide clean drinking water to a village that currently has none. What should the engineers do first, before designing any solution?

A. Define the problem clearly, identifying the village's water needs, the available resources, and the limits they must work within

B. Immediately purchase the most expensive water purification machine they can find and ship it to the village

C. Build several finished water systems at once and install all of them in the village before doing any testing

D. Choose a design based only on which water system looks the most modern and impressive to outside visitors

49. After installing a prototype water filter in the village, the engineers find that it produces clean water but breaks down too often to be reliable. According to the engineering design process, what should they do next?

A. Remove the filter and tell the village that providing clean water is simply impossible to achieve

B. Leave the unreliable filter exactly as it is, since the first version of any design is always the final one

C. Hide the breakdown problem from the village so that no one ever learns the prototype had a weakness

D. Use what they learned to redesign the filter to be more reliable, then test the improved version again

50. Before building a large dam, engineers use a computer model to simulate how the dam would change the flow of the river and the risk of flooding downstream. What is the greatest value of running such a model first?

A. The model guarantees one exact outcome that will happen no matter what conditions actually occur later

B. The model removes any need to ever take real measurements of the river before or after the dam is built

C. The model lets engineers test different designs and foresee likely problems before committing to construction

D. The model proves with complete certainty that the dam will have no effect on the river or the people downstream

ANSWERS KEYS WITH EXPLANATIONS

1. C — The age of the universe comes from measuring how fast galaxies are moving apart and tracing that expansion backward to a single starting point. The expansion rate (Hubble's constant) sets the timescale since the Big Bang. This method, not crater counts or rock ages, yields the roughly 13.8-billion-year figure.
2. B — A star much more massive than the Sun ends its life in a supernova explosion, leaving behind a dense neutron star or, if massive enough, a black hole. Only low-mass stars like the Sun end as white dwarfs. A star's mass determines whether it fades quietly or explodes.
3. D — Earlier generations of stars forged heavy elements such as silicon and iron and scattered them into space when they died, providing the raw material for rocky planets. The Big Bang made only the lightest elements. Without prior stellar life and death, the ingredients for planets like Earth would not exist.
4. A — Kepler's Third Law gives $T^2 = a^3$, so with a = 4, $a^3 = 64$ and T equals the square root of 64, which is 8 years. The cube of the distance sets the square of the period. This law connects any planet's distance from the Sun to its orbital period.
5. D — Seasons are caused by axial tilt, not distance; in fact Earth is slightly closer to the Sun during Northern Hemisphere winter, which disproves the distance explanation. The tilt changes the angle and duration of sunlight each hemisphere receives. This is why the hemispheres have opposite seasons at the same distance.
6. B — A Moon lit on its left half, highest in the sky around dawn, is the last quarter phase, occurring about a week after full moon. The Moon is waning, with illumination decreasing toward new. Left-side illumination and a pre-dawn high point identify last quarter for Northern Hemisphere observers.
7. A — A comet's tail forms because heat from the Sun vaporizes its ices, releasing gas and dust that stream away from the Sun. Solar radiation and solar wind push this released material outward, so the tail points away from the Sun. The tail grows as the comet nears the Sun and heating intensifies.
8. C — A total solar eclipse occurs at the new moon phase, when the Moon lies between Earth and the Sun and can block the Sun from view. The new moon is normally invisible because its lit side faces away from us. A tilted lunar orbit is why eclipses do not happen at every new moon.
9. B — Spring tides occur at new moon and full moon, when the Sun and Moon line up and their gravitational pulls combine to produce the largest tidal ranges. The aligned pulls reinforce each other, creating higher highs and lower lows. This contrasts with the smaller neap tides at the quarter phases.

10. D — The energy from fusion radiates outward through space as light and heat, a small fraction of which reaches Earth as sunlight. Energy is conserved, not destroyed, as mass converts to radiant energy via $E = mc^2$. This outgoing radiation is what makes the Sun shine and warms the planets.
11. A — The afternoon is warmer because the Sun is higher in the sky, so its rays strike the surface more directly and deliver more concentrated heating. A higher Sun angle concentrates energy over less area. The Sun's output is constant, so the difference comes from angle, not distance or emission.
12. C — The normal age order can be reversed when powerful tectonic forces fold or overturn rock layers after deposition. Such deformation can flip a sequence so that older rock sits above younger rock. Recognizing overturned beds is important for correctly applying superposition.
13. D — One-sixteenth remaining means four half-lives have passed, since $1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8 \rightarrow 1/16$. Four half-lives × 50,000 years equals 200,000 years. Counting the number of halvings is the key to radiometric age problems.
14. B — The best index fossil comes from an organism that was geographically widespread but lived for only a brief geologic time, such as a free-floating ocean species. Wide distribution allows correlation across regions, and brief existence pins the age precisely. Long-lived or narrowly distributed organisms make poor index fossils.
15. A — By cross-cutting relationships, the sedimentary layers must predate the fault that breaks them, and the fault must predate the intrusion that cuts across it. So the order is layers first, then fault, then intrusion. Each feature is younger than whatever it cuts through.
16. D — The repeated pattern of extinction followed by new species shows that life has changed dramatically over geologic time, with extinctions clearing the way for new forms to arise. Mass extinctions reset ecosystems and trigger bursts of diversification. Life has continually changed, not remained static or restarted from nonliving matter.
17. C — The puzzle-piece fit of the coastlines plus matching rocks and fossils supports the idea that South America and Africa were once joined and have since drifted apart. These features align only if the continents were formerly connected. This was key evidence for continental drift and plate tectonics.
18. A — Very fine mud hardened into thin sheets, lacking ripple marks and holding floating ocean fossils, indicates a deep, calm body of water where only the finest particles slowly settled far from shore. Calm, deep water allows fine sediment to accumulate undisturbed. Energetic river, desert, or glacial settings would leave coarser, different deposits.
19. B — The Hawaiian chain formed as the Pacific Plate moved over a stationary hot spot, a plume of rising mantle magma. Each island formed as the plate carried older volcanoes away from the plume while new ones formed above it. This explains volcanism far from any plate boundary.
20. D — Rising and sinking mantle rock creates convection currents that drive the slow movement of tectonic plates, producing earthquakes, volcanoes, and mountains. This circulation transfers Earth's internal heat and drags the overlying plates. Mantle convection is the engine of plate tectonics.
21. C — In the rock cycle, a sedimentary rock can melt into magma and later cool to form an igneous rock. Any rock type can transform into another through melting, weathering, or metamorphism. The cycle continually recycles Earth's materials among the three rock types.
22. A — Quartz fits the definition of a mineral: a naturally occurring, inorganic solid with a fixed chemical formula and an orderly crystal structure. Glass lacks orderly structure, wood is organic, and oil is a liquid. Meeting all parts of the definition is what makes quartz a true mineral.

23. D — Rapid cooling of lava at the surface produces a fine-grained or glassy texture, because crystals have little time to grow. Slow underground cooling, by contrast, yields large crystals. Texture is therefore a direct record of how quickly an igneous rock cooled.
24. B — Water vapor cooling and changing into tiny liquid droplets is condensation, the process that forms clouds. Rising moist air cools until its vapor condenses around particles. Condensation is the opposite of evaporation, which converts liquid water into vapor.
25. C — Rising well levels after heavy rain indicate that the water table has risen because the rainfall recharged the groundwater. The water table moves up and down with the balance of recharge and withdrawal. More rainfall means more replenishment, raising the level that fills wells.
26. A — Photosynthesis removes carbon dioxide from the air to build plant tissue, and respiration returns carbon dioxide to the air, cycling carbon through ecosystems. These opposing processes keep carbon moving between organisms and the atmosphere. They are the biological core of the carbon cycle.
27. D — Melting bright ice lowers the surface reflectivity, so darker land and ocean absorb more sunlight and warm further, amplifying the original warming. This is the ice-albedo positive feedback. The reinforcing loop accelerates warming rather than stabilizing the climate.
28. B — A boulder breaking into smaller pieces of the same rock through freeze-thaw, with no change in composition, is mechanical weathering. Mechanical weathering physically fragments rock without altering its minerals. This distinguishes it from chemical weathering, which changes the rock's composition.
29. C — A glacier dragging embedded rock fragments scrapes long parallel scratches and grooves, called striations, into the bedrock. These marks record the direction the ice was flowing. Striations are a classic indicator of past glaciation in a landscape.
30. A — A maritime tropical air mass forms over warm tropical ocean, so it is warm and humid, carrying both heat and abundant moisture. "Maritime" indicates moisture and "tropical" indicates warmth. This contrasts with cold, dry continental polar air masses.
31. B — A cold front advances rapidly, forcing warm air upward steeply and often producing a narrow band of intense thunderstorms, followed by cooler, drier air. The steep frontal slope drives quick, vigorous uplift. This contrasts with the gentle, prolonged precipitation of a warm front.
32. D — Fog forms when the air cools to its dew point, causing water vapor to condense into tiny droplets near the ground. Nighttime cooling after sunset lowers the temperature to saturation. The dew point is the temperature at which the air becomes saturated and condensation begins.
33. C — Warm ocean water is essential for hurricane formation because it evaporates and supplies the heat and moisture that power the storm. This is why hurricanes form over tropical seas and weaken over land or cold water. Strong wind shear and an equatorial position actually inhibit, not aid, hurricane development.
34. A — Greenhouse gases absorb much of the outgoing infrared energy from Earth's surface and re-radiate part of it back downward, warming the lower atmosphere. They act on outgoing longwave radiation, not by reflecting incoming sunlight. This absorption and re-emission is the essence of the greenhouse effect.
35. D — A nighttime land breeze forms because the air over the relatively warm ocean rises, and cooler air from the faster-cooling land flows out to replace it. The temperature contrast between land and sea drives the circulation. This reverses the daytime sea breeze, which blows from sea to land.

36. B — Tree rings reveal past growing conditions such as temperature and rainfall, since rings are wider in favorable years and narrower in harsh ones. The ring pattern serves as a proxy record of climate. This lets scientists reconstruct conditions from before instrument records existed.
37. A — Solar, wind, and hydroelectric power are all renewable because they are continuously replenished by natural processes and not used up. The other lists include fossil fuels or uranium, which are finite. Continuous natural replenishment is what defines a renewable resource.
38. C — A fair decision weighs both the benefits, such as jobs and income, and the costs, such as the health effects of pollution. Considering only one side would distort the outcome. A complete cost-benefit analysis includes externalities like pollution-related health impacts.
39. B — A non-native plant that spreads and crowds out native species illustrates an invasive species, an introduced organism that outcompetes natives. Free of natural controls, it reduces local biodiversity. This differs from overharvesting, climate change, or habitat fragmentation.
40. D — Nutrient recycling by decomposers is a supporting service because it underlies and makes possible the other ecosystem services. Supporting services are the basic processes that sustain ecosystems. Without nutrient cycling, food production and other services could not function.
41. A — Strong scientific consensus supports that heat waves will become more frequent, intense, and longer-lasting in many regions as warming continues. Rising average temperatures shift conditions toward more extreme heat. The other options contradict observed trends and ocean chemistry, which is becoming more acidic, not basic.
42. C — Acid rain forms mainly from sulfur dioxide and nitrogen oxides, which react with atmospheric water to produce sulfuric and nitric acids. These gases come largely from burning fossil fuels. Reducing their emissions is how acid rain has been curbed.
43. B — Setting limits on the catch lets the fish population reproduce and recover, supporting a sustainable fishery. Harvesting within the population's reproductive capacity prevents collapse. Matching the catch to recovery rates is the core of sustainable fisheries management.
44. A — Human activities such as habitat destruction, pollution, and overharvesting place severe pressure on many species, accelerating extinctions far above the natural rate. Growing population and resource demand intensify these pressures. These human-driven factors, not natural events alone, explain the elevated extinction rate.
45. D — Expanding transit and requiring efficient buildings to cut emissions is mitigation, because it reduces the greenhouse gases that cause climate change. Mitigation targets the underlying cause, while adaptation copes with impacts. Lowering emissions at the source is the defining feature of mitigation.
46. C — Ocean acidification is caused by carbon dioxide absorbed from the air, which forms a weak acid and lowers seawater pH, making it harder for shellfish to build their shells. Reduced carbonate availability impairs shell formation. This chemical effect threatens corals, mollusks, and other calcifying organisms.
47. B — The steady Holocene climate made farming dependable, allowing people to settle in one place and build cities. Predictable growing seasons were essential for agriculture and permanent settlement. Climatic stability, not evolution or oxygen changes, enabled the rise of civilization.
48. A — Before designing a solution, the engineers should define the problem clearly, identifying the village's needs, available resources, and the constraints they must work within. A precise problem definition guides every later step. Skipping it risks building a solution that fails to meet the real need.
49. D — When a prototype proves unreliable, the engineering process calls for using what was learned to redesign it and then test the improved version again. Iteration—testing, refining, and retesting—

is central to good engineering. A failed test provides information, not a reason to abandon the project.

50. C — The greatest value of the model is that it lets engineers test different designs and foresee likely problems before committing to costly construction. Models allow ideas to be explored safely and cheaply in advance. They guide decisions while acknowledging uncertainty, and they support rather than replace real measurements.