PRACTICE EXAM 27: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. The cosmic microwave background is a faint glow of radiation found coming from every direction in space. What does the existence of this radiation provide evidence for?

A. The Big Bang, because this radiation is the cooled remnant of the hot, dense early universe spreading outward

B. The idea that the Sun is the center of the universe and emits this radiation evenly in all directions

C. The notion that the universe is shrinking, since the radiation grows stronger as galaxies move closer

D. The theory that stars create all radiation in the universe through the burning of hydrogen as fuel

2. Billions of years from now, the Sun will run out of hydrogen fuel in its core. Which sequence describes the most likely future of the Sun?

A. The Sun will explode as a supernova and collapse into a black hole at the center of the solar system

B. The Sun will split into several smaller stars that will drift apart and shine on independently for ages

C. The Sun will instantly go dark and cold, ending all of its energy output in a single sudden moment

D. The Sun will swell into a red giant, then shed its outer layers and shrink into a dim white dwarf

3. Where did the oxygen atoms that make up much of your body and the water you drink originally form?

A. They formed in the first few minutes after the Big Bang, when the entire universe was still extremely hot

B. They were forged by nuclear fusion inside stars and released into space when those stars reached the end of their lives

C. They were created by chemical reactions in Earth's early atmosphere shortly after the planet first formed

D. They are continuously produced by the radioactive decay of heavier elements deep within Earth's interior

4. A comet orbits the Sun with a period of 27 Earth years. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is the comet's approximate average distance from the Sun?

A. About 27 AU, because the average distance is always equal to the orbital period measured in years

B. About 3 AU, because the average distance is found by taking the square root of the period in years

C. About 9 AU, because 27 squared is 729, and the cube root of 729 is 9 astronomical units

D. About 54 AU, because the average distance is always twice the value of the orbital period in years

5. On the winter solstice in the Northern Hemisphere, New York State has its shortest day of the year. Which statement best explains why the day is so short?

A. The Sun stops producing as much light in winter, so there are fewer hours of usable daylight each day

B. The Northern Hemisphere is tilted away from the Sun, so the Sun stays low and is above the horizon for fewer hours

C. Earth is at its farthest point from the Sun, so sunlight takes longer to arrive and the day appears shorter

D. Thick winter clouds block the Sun for part of each day, reducing the total number of daylight hours

6. During one phase, the Moon is positioned between Earth and the Sun, and the side facing Earth receives no sunlight, so the Moon is essentially invisible from Earth. What phase is this?

A. The full moon, when the entire disk of the Moon is brightly illuminated and visible throughout the night

B. The first quarter, when exactly the right half of the Moon's disk appears illuminated in the evening sky

C. The waning gibbous, when more than half of the Moon's disk is lit but the lit portion is shrinking

D. The new moon, when the Moon lies between Earth and the Sun and its dark side faces toward Earth

7. Comets and asteroids are often described as leftover material from the early solar system. What does studying them help scientists learn?

A. The exact future locations where new stars will form in distant regions of the Milky Way galaxy

B. The chemical makeup of the Sun's core, which is otherwise impossible for scientists to ever study

C. About the materials and conditions present when the planets first formed billions of years ago

D. The precise date on which the universe itself first began expanding from a hot, dense initial state

8. A solar eclipse happens when the Moon blocks the Sun's light from reaching part of Earth's surface. During which moon phase can a solar eclipse occur?

A. The new moon phase, when the Moon passes between Earth and the Sun and can block the Sun's light

B. The full moon phase, when the Moon is on the far side of Earth from the Sun and is fully illuminated

C. The first quarter phase, when the Moon appears half lit and is high in the sky during the evening hours

D. The last quarter phase, when the Moon rises around midnight and appears half lit in the early morning

9. The largest tidal ranges of the month occur when the gravitational pulls of the Sun and the Moon combine. When do these large spring tides take place?

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

B. During the waxing and waning gibbous phases, when more than half of the Moon's face is lit by the Sun

C. Only during eclipses, when the shadow of the Earth or the Moon falls directly on the other body in space

D. During the new moon and full moon phases, when the Sun, Earth, and Moon are arranged in a straight line

10. Energy generated in the Sun's core eventually leaves the Sun and travels through the vacuum of space to reach Earth. How does this energy travel across empty space?

A. By conduction, in which heat passes directly from one touching particle to the next all the way to Earth

B. By radiation, in which energy travels as electromagnetic waves that can move through the vacuum of space

C. By convection, in which warm material physically rises and carries the heat outward from the Sun to Earth

D. By a stream of solid particles that the Sun launches directly toward Earth's surface like tiny bullets

11. A beam of sunlight striking the ground at a steep, nearly overhead angle delivers more energy per unit area than the same beam striking at a low, slanting angle. Why is this the case?

A. Sunlight that arrives at a low angle is somehow stronger and hotter than sunlight arriving from overhead

B. The Sun is physically much closer to places where its light strikes the ground at a steep, overhead angle

C. A steep, overhead beam is concentrated on a smaller area, while a slanting beam is spread over a larger area

D. The atmosphere adds extra energy to overhead sunlight but removes energy from low-angle sunlight instead

12. A road cut exposes several undisturbed horizontal layers of sedimentary rock, one on top of another. Which layer was deposited first?

A. The bottom layer, because in an undisturbed sequence the layers are deposited from the bottom upward over time

B. The top layer, because the uppermost layer is always the first one to be laid down in any rock sequence

C. The middle layer, because deposition always begins in the center of a sequence and works outward in both directions

D. None can be determined, because the order in which sedimentary layers form is completely random in every case

13. A radioactive isotope has a half-life of 5,000 years. A sample originally contained 80 grams of the isotope, and 5 grams now remain. About how much time has passed?

A. About 5,000 years, because one half-life is enough to reduce the sample from 80 grams to 5 grams remaining

B. About 10,000 years, because two half-lives are enough to reduce the sample from 80 grams to 5 grams remaining

C. About 15,000 years, because three half-lives are enough to reduce the sample from 80 grams to 5 grams remaining

D. About 20,000 years, because four half-lives are needed to reduce the sample from 80 grams down to 5 grams

14. Which feature would make a particular fossil organism especially useful as an index fossil for matching rock layers of the same age?

A. The organism was very large and heavy, which made it more likely to be preserved as a fossil in rock

B. The organism lived continuously for hundreds of millions of years across a single isolated region

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

D. The organism is still alive today and can be found living across many continents around the world

15. In an outcrop, a fault clearly cuts across and offsets several sedimentary rock layers. What does the principle of cross-cutting relationships tell us about the fault?

A. The fault formed before the rock layers, which were later deposited on top of the already-broken fault zone

B. The fault formed after the rock layers, because a feature that cuts across rocks must be younger than them

C. The fault and the layers formed at the very same time, since the fault and the rock are touching each other

D. The fault's age cannot be compared to the layers without first dating both of them with radioactive isotopes

16. The fossil record shows several events in which a large fraction of Earth's species disappeared in a relatively short span of geologic time. These events are known as what?

A. Mass extinctions, brief intervals during which a large proportion of Earth's species died out across the globe

B. Index fossils, the preserved remains of organisms used to match the ages of rock layers around the world

C. Unconformities, buried surfaces where rock was eroded away before new layers were deposited above them

D. Half-lives, the lengths of time required for half of a radioactive isotope in a rock sample to decay away

17. When the continents of South America and Africa are fitted back together like puzzle pieces, mountain belts and rock layers line up across the join, and identical fossils appear on both sides. What do these observations support?

A. The idea that the two continents have always been in their present positions and have never moved at all

B. The idea that identical organisms evolved completely independently on the two separate continents by chance

C. The idea that the Atlantic Ocean between the continents is steadily growing narrower as they move closer

D. The idea that the two continents were once joined as part of a single landmass and have since drifted apart

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 floor far from any land, where only the finest clay particles slowly settled to the bottom

B. A swift mountain river 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 time

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

19. Down the center of the Atlantic Ocean runs a long underwater mountain range where new ocean crust is constantly being created. What type of plate boundary is found along this ridge?

A. A convergent boundary, where one plate is being forced down beneath another plate into the deep mantle

B. A divergent boundary, where two plates are pulling apart and magma rises to form new ocean crust between them

C. A transform boundary, where two plates are grinding horizontally past each other along a long fault line

D. A passive margin, where the edge of a continent lies quietly far from any active plate boundary or activity

20. Moving from Earth's surface down to its center, which sequence correctly lists the major layers in order?

A. Crust, mantle, liquid outer core, and solid inner core, moving from the surface inward toward the center

B. Mantle, crust, solid outer core, and liquid inner core, moving from the surface inward toward the center

C. Liquid outer core, solid mantle, crust, and gaseous inner core, moving from the surface inward to the center

D. Crust, liquid mantle, gaseous outer core, and crust again, repeating in layers all the way to the center

21. Magma deep underground slowly cools and hardens into solid rock without ever reaching the surface. What type of rock forms?

A. A sedimentary rock, formed from the compaction and cementing of fragments of older rocks into layers

B. A metamorphic rock, formed when an existing rock is altered by heat and pressure without ever melting

C. An intrusive igneous rock, formed when magma cools and solidifies slowly below the Earth's surface

D. A clastic rock, formed only when loose sediment is deposited by wind or water and then cemented together

22. When the same mineral is found in different colors, geologists often rub it across a tile to see the color of its powder, which stays the same regardless of the mineral's surface color. What property are they observing?

A. Hardness, the resistance of a mineral to being scratched by another material of known hardness value

B. Cleavage, the way in which a mineral breaks along smooth, flat planes in one or more directions

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

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

23. A dark igneous rock has crystals so small they cannot be seen without magnification. What does this fine-grained texture indicate about where and how the rock formed?

A. The rock formed deep underground, where the magma cooled very slowly over a span of millions of years

B. The rock formed at or near the surface, where lava cooled quickly, leaving little time for crystals to grow

C. The rock formed from layers of sediment that were compacted and cemented together over long periods of time

D. The rock formed when an older rock was heated and squeezed until its minerals recrystallized into bands

24. Water vapor rises into the atmosphere, cools, and condenses into clouds. When the water droplets in a cloud grow heavy enough, they fall to the surface. What is this part of the water cycle called?

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

B. Evaporation, the process in which liquid water at the surface absorbs energy and changes into water vapor

C. Transpiration, the process in which plants release water vapor into the atmosphere through pores in their leaves

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

25. The upper surface of the zone where all the spaces in the underground rock and soil are completely filled with water is given a specific name. What is this surface called?

A. The aquifer, which is the name for any underground layer of solid rock that contains no water at all

B. The watershed, which is the name for the entire area of land that drains its rainwater into one river

C. The water table, which is the upper boundary of the underground zone fully saturated with groundwater

D. The runoff line, which marks the level above which all rainwater flows across the surface into streams

26. The ocean plays a major role in the carbon cycle. Which statement correctly describes one way the ocean affects atmospheric carbon dioxide?

A. The ocean produces carbon dioxide from salt and continuously adds it to the atmosphere over time

B. The ocean has no effect on atmospheric carbon dioxide because seawater cannot hold any dissolved gases

C. The ocean reflects carbon dioxide back into space, preventing it from ever building up in the atmosphere

D. The ocean absorbs large amounts of carbon dioxide from the air, acting as a major carbon reservoir

27. In the Arctic, bright sea ice reflects sunlight, but as the ice melts it exposes dark ocean water that absorbs more sunlight, causing further warming and more melting. What kind of feedback does this describe?

A. A positive feedback, because the melting reduces the surface reflectivity and amplifies the original warming

B. A negative feedback, because the exposed ocean water cools the Arctic and reverses the original warming

C. A neutral process, because melting ice has no measurable effect on how much sunlight the surface absorbs

D. An external forcing, because the melting ice comes from a source completely outside the climate system

28. In a cold mountain climate, water repeatedly seeps into cracks in rock, freezes and expands at night, then melts during the day. Over many cycles the rock splits apart. What process is this?

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

B. Mechanical weathering by frost wedging, in which freezing water expands in cracks and physically breaks the rock

C. Erosion, in which the broken pieces of rock are picked up and carried away to be deposited somewhere else

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

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

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

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

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

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

30. In summer, a maritime tropical (mT) air mass moves from the warm Gulf of Mexico into the southeastern United States. What weather would this air mass most likely bring?

A. Cold and dry conditions with clear skies and the sharpest drop in temperature of the entire season

B. Cool and dry conditions producing crisp, clear mornings followed by pleasant, mild sunny afternoons

C. Bitterly cold and snowy conditions typical of air that has formed over a frozen polar landscape far away

D. Warm and humid conditions with high humidity and a strong chance of afternoon thunderstorms developing

31. A fast-moving cold front pushes into a region of warm, moist air on a summer afternoon. What weather is most likely to develop along the front?

A. A long stretch of light, steady drizzle that lasts for several days as the two air masses gradually mix together

B. A narrow band of heavy thunderstorms, followed by clearing skies and a shift to cooler, drier air behind the front

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

D. Clear skies and steadily rising temperatures as warm air smoothly slides in to replace the cooler air at the surface

32. As air cools in the evening, its temperature drops closer and closer to its dew point. What happens when the air temperature finally reaches the dew point?

A. The air becomes saturated, and water vapor begins to condense into liquid, forming dew, fog, or clouds

B. The air suddenly loses all of its water vapor, becoming completely dry with a relative humidity of zero

C. The air pressure rises sharply, which forces all moisture out of the region and guarantees clear skies

D. The air temperature stops dropping entirely and is unable to fall any lower for the rest of the night

33. Which combination of conditions is necessary for a hurricane to form and grow stronger over a tropical ocean?

A. Cold ocean water, strong winds blowing in opposite directions at different heights, and a location on the equator

B. Cold, dry air sinking from the upper atmosphere combined with a steady supply of polar air from high latitudes

C. Warm ocean water above about 26.5°C, plenty of moisture, low wind shear, and some distance from the equator

D. A completely calm, windless atmosphere with no moisture and a surface located directly over dry desert land

34. Sunlight warms Earth's surface, which then gives off heat in the form of infrared radiation. What do greenhouse gases do with this outgoing infrared radiation?

A. They reflect it straight back to the surface like a mirror, without ever absorbing any of the energy themselves

B. They speed its escape into space, which cools the surface faster than it would cool without any greenhouse gases

C. They convert it into visible light, which then passes easily out through the atmosphere and into outer space

D. They absorb much of it and re-radiate part of it back toward the surface, warming the lower atmosphere

35. On a hot, sunny afternoon at the beach, a cool breeze blows from the water toward the land. What causes this daytime sea breeze?

A. The ocean water heats up faster than the land, so warm air rises over the sea and pulls land air outward

B. The land heats up faster than the water, so warm air rises over the land and cooler sea air flows in to replace it

C. The Moon's gravitational pull drags the cool ocean air toward the shore during the warmest part of the day

D. The salt in the sea air makes it sink and slide downhill toward the land throughout the afternoon hours

36. Scientists drill deep into glaciers and ice sheets to study the layers of ancient ice and the air bubbles trapped within them. What can these ice cores reveal about the past?

A. Past atmospheric conditions, including the levels of greenhouse gases like carbon dioxide in earlier times

B. The exact daily weather, including cloud cover and wind direction, on every individual day of the distant past

C. The precise number of animals that lived on the surface of the ice during each year of the glacier's history

D. The future climate conditions that the Earth is guaranteed to experience over the next several centuries ahead

37. Which of the following groups lists only nonrenewable energy resources?

A. Solar power, wind power, and geothermal energy, all of which are constantly renewed by natural processes

B. Hydroelectric power, wind power, and solar power, all of which can be relied on continuously without running out

C. Coal, petroleum, and natural gas, all of which form over millions of years and cannot be replaced once used up

D. Wind power, flowing water, and sunlight, all of which are continuously replenished by the natural world

38. A factory increases its profits by dumping waste into a river instead of treating it, but a downstream town must then pay to clean the contaminated water. The cleanup cost paid by the town is an example of what?

A. A private benefit, since it is income the factory earns directly by selling the products that it manufactures

B. A renewable resource, since the town can use the river water again and again without it ever being depleted

C. A government subsidy, since it is a payment the town receives from the government to support its local economy

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

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

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

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

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

D. An invasive species, in which a non-native organism is introduced and outcompetes the native organisms for resources

40. Many people visit forests and mountains to hike, camp, take photographs, and find peace and inspiration in nature. These nonmaterial benefits that people gain from ecosystems are best classified as which type of service?

A. A provisioning service, because the ecosystem is directly supplying food, fresh water, timber, and other raw materials

B. A cultural service, because the ecosystem provides recreation, beauty, inspiration, and other nonmaterial benefits to people

C. A regulating service, because the ecosystem is controlling floods, filtering the air, and moderating the local climate

D. A supporting service, because the ecosystem is carrying out nutrient cycling and the formation of fertile new soil

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

A. The total amount of ice stored in the world's glaciers and ice sheets will steadily increase in the coming century

B. Average global surface temperatures will fall sharply and steadily as greenhouse gas concentrations keep rising

C. Many regions will experience more frequent and more intense heat waves, droughts, and other extreme weather events

D. The oceans will become steadily more alkaline and basic as they take in more carbon dioxide from the atmosphere

42. Acid rain that damaged forests and lakes in the northeastern United States formed when pollutants from burning fossil fuels combined with water in the atmosphere. Which two pollutants were chiefly responsible?

A. Carbon dioxide and oxygen, which combined in the air to form a strong acid that then fell as acid rain

B. Helium and neon, two inert gases released by power plants that reacted with rainwater to make it acidic

C. Water vapor and nitrogen gas, the two most common atmospheric gases, which together acidified the falling rain

D. Sulfur dioxide and nitrogen oxides, which reacted with water in the atmosphere to form sulfuric and nitric acids

43. A community wants to conserve raw materials and reduce the volume of trash sent to its landfill. Which practice would most directly accomplish both of these goals at once?

A. Recycling materials such as aluminum, glass, and paper so that they can be processed and made into new products

B. Burning all of the community's trash in open fires so that none of it ever has to be sent to the landfill at all

C. Burying all trash, including recyclable materials, as deeply as possible beneath the surface of the landfill site

D. Shipping all of the community's trash far away so that it becomes the responsibility of a different community

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

A. A worldwide decline in the amount of food available, which forced families to have far fewer children over time

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

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

D. The complete and permanent elimination of every infectious disease from all human populations across the globe

45. A coastal community, anticipating stronger storms and higher seas, restores its protective wetlands, raises its roads, and elevates its buildings. Which climate change strategy does this best represent?

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

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

C. Adaptation, because the community is adjusting its surroundings to cope with climate impacts that are already arriving

D. Reversal, because these actions will completely undo climate change and stop the sea level from ever rising again

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

A. The ocean absorbing carbon dioxide from the air lowers its pH, making it harder for corals and shellfish to build their structures

B. The ocean absorbing carbon dioxide raises its pH, which makes it much easier for corals and shellfish to build their structures

C. Warmer ocean temperatures alone cause acidification, which has no effect at all on any of the organisms living in the sea

D. Rivers washing salt into the ocean cause acidification, which makes the entire ocean far too salty for fish to survive in

47. Permanent farming settlements and the first cities both appeared during the Holocene Epoch. Which characteristic of the Holocene best explains why these developments were able to occur?

A. The Holocene had a chaotic, rapidly shifting climate that forced early humans to constantly move from place to place

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

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

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

48. In engineering, the requirements a successful design must satisfy are called criteria, and the limits within which the design must operate are called constraints. A bridge that "must support a 40-ton truck" is an example of which of these?

A. A constraint, because the load the bridge must support is a limit that the design is not allowed to exceed

B. A criterion, because supporting the 40-ton truck is a requirement that a successful bridge design must meet

C. An externality, because the truck's weight is a cost that falls on people not involved in the bridge project

D. A prototype, because the 40-ton load is an early working model used to test the performance of the bridge

49. After building and testing a prototype of a new water purification device, an engineering team discovers that it removes germs but works too slowly to supply enough clean water. What does the engineering design process say the team should do next?

A. Give up on the project entirely, because any problem found during testing proves the design can never be made to work

B. Sell the slow prototype to users without changing anything, because the first version built is always the final design

C. Use what they learned from the test to redesign the device to work faster, and then test the improved version again

D. Hide the test results from the public so that no one ever finds out the original prototype had a performance problem

50. Before constructing a large flood-control project, engineers run a computer model that simulates how the project would affect water levels under many different rainfall scenarios. What is the greatest value of running such a model first?

A. It lets engineers test different designs and foresee likely problems before spending money to build anything

B. It guarantees a single exact outcome that is certain to happen regardless of the actual rainfall conditions later

C. It removes any need to ever collect real measurements of rainfall or water levels before or after the project is built

D. It proves with complete certainty that the project will have absolutely no effect on the river or the people nearby

ANSWERS KEYS WITH EXPLANATIONS

1. A — The cosmic microwave background is the cooled, leftover radiation from the hot, dense early universe, now spread thinly across all of space. Its uniform presence in every direction is strong evidence for the Big Bang. This radiation is one of the central pillars supporting Big Bang cosmology.
2. D — A star like the Sun will swell into a red giant once its core hydrogen runs out, then shed its outer layers and shrink into a dim white dwarf. Only far more massive stars explode as supernovae and form black holes. A star's mass determines its evolutionary endpoint.
3. B — Oxygen atoms were forged by nuclear fusion inside stars and released into space when those stars died, later becoming part of new planets and living things. Only the lightest elements formed in the Big Bang. This stellar origin is why we are said to be "made of star stuff."
4. C — Kepler's Third Law gives $a^3 = T^2$, so with T = 27, $T^2 = 729$ and a equals the cube root of 729, which is 9 AU. The cube-root relationship keeps the distance far smaller than the period. This law connects any object's orbital period to its distance from the Sun.
5. B — The short winter day occurs because the Northern Hemisphere is tilted away from the Sun, keeping the Sun low and above the horizon for fewer hours. The tilt, not the Sun's output or Earth's distance, controls day length and seasons. Earth is in fact slightly closer to the Sun during this season.
6. D — When the Moon lies between Earth and the Sun with its dark side facing us, it is the new moon and appears essentially invisible. The sunlit side faces away from Earth. This is also the phase during which solar eclipses can occur.
7. C — Comets and asteroids are leftover material from the solar system's formation, so studying them reveals the materials and conditions present when the planets first formed. They act as time capsules from billions of years ago. This makes them valuable targets for studying early solar system history.
8. A — A solar eclipse can occur only at the new moon phase, when the Moon passes between Earth and the Sun and can block the Sun's light. Only then is the geometry right for the Moon's shadow to reach Earth. A tilted lunar orbit is why eclipses do not happen at every new moon.
9. D — Spring tides, the largest tidal ranges, occur at new moon and full moon, when the Sun, Earth, and Moon line up and the solar and lunar pulls combine. The aligned gravitational forces reinforce each other. This contrasts with the smaller neap tides at the quarter phases.
10. B — Energy crosses the vacuum of space by radiation, traveling as electromagnetic waves that need no medium. Conduction and convection both require matter and cannot work in a vacuum. This is why sunlight can reach Earth across empty space.
11. C — A steep, overhead beam concentrates its energy on a smaller area, while a slanting beam spreads the same energy over a larger area, lowering the energy per unit area. The angle of insolation controls this concentration. This effect explains why high Sun angles produce stronger heating.
12. A — By the principle of superposition, the bottom layer in an undisturbed sequence was deposited first and is therefore the oldest. Layers accumulate from the bottom upward over time. This rule is the foundation of relative dating in horizontal strata.
13. D — The sample halves from 80 to 5 grams in four steps: 80 → 40 → 20 → 10 → 5, which is four half-lives. Four half-lives × 5,000 years equals 20,000 years. Counting the number of halvings is the key to radiometric age problems.

14. C — The best index fossil comes from an organism that was widespread across the globe but lived during only a short, well-defined span of time. Wide distribution allows correlation across regions, and brief existence pins the age precisely. Size or current survival does not confer this usefulness.
15. B — By cross-cutting relationships, a fault that cuts across rock layers must be younger than the layers it breaks, since they had to exist before the fault could offset them. The fault is a later event imposed on the existing rock. This principle establishes the fault's relative age.
16. A — Brief intervals in which a large proportion of Earth's species die out across the globe are called mass extinctions. They are defined by the scale and speed of species loss. Such events have repeatedly reshaped the history of life on Earth.
17. D — The puzzle-piece fit plus aligned mountain belts, matching rock layers, and identical fossils support the idea that the two continents were once joined and have since drifted apart. These features line up only if the landmasses were formerly connected. This was key evidence for continental drift.
18. C — A thick coal seam of compressed, carbon-rich plant material indicates a warm, swampy wetland where dense vegetation accumulated, was buried, and was compressed over time. Such oxygen-poor environments allowed organic matter to build up. The carbon-rich nature of coal reflects this swampy origin.
19. B — The mid-Atlantic ridge, where new ocean crust is continually created, is a divergent boundary, with two plates pulling apart and magma rising to fill the gap. The spreading forms new seafloor along the ridge. This is the classic setting for seafloor spreading.
20. A — From the surface inward, Earth's layers are the crust, the mantle, the liquid outer core, and the solid inner core. The outer core is liquid while the inner core is solid. This layered structure was deduced largely from the behavior of seismic waves.
21. C — Magma that cools slowly underground without reaching the surface forms an intrusive igneous rock, typically with large crystals. Slow cooling allows mineral grains time to grow. Because it solidifies below the surface, it is intrusive rather than extrusive.
22. D — Rubbing a mineral on a tile to observe the consistent color of its powder is testing streak. Streak is often more reliable than surface color, which can vary. It is especially useful for identifying minerals that occur in several colors.
23. B — A fine-grained texture with tiny, invisible crystals indicates the rock formed at or near the surface, where lava cooled quickly and crystals had little time to grow. Rapid cooling limits crystal size. Slow underground cooling, by contrast, produces large, visible crystals.
24. A — Water falling from clouds to the surface as rain, snow, sleet, or hail is precipitation. It occurs when cloud droplets grow heavy enough to fall under gravity. Precipitation returns water from the atmosphere to the land and oceans in the water cycle.
25. C — The upper surface of the fully saturated underground zone is the water table. Above it the pore spaces hold both air and water; below it they are completely filled with water. The water table rises and falls with the balance of recharge and withdrawal.
26. D — The ocean absorbs large amounts of carbon dioxide from the atmosphere, acting as a major carbon reservoir, or sink. This uptake removes some carbon dioxide from the air. It is also what drives ocean acidification as the dissolved gas lowers seawater pH.
27. A — Melting bright sea ice exposes dark ocean water that absorbs more sunlight, causing further warming and more melting, which is a positive feedback. The change reinforces itself rather than counteracting the warming. This ice-albedo feedback accelerates Arctic warming.

28. B — Water freezing and expanding in cracks until the rock splits is frost wedging, a form of mechanical weathering. The rock breaks into smaller pieces without any change in composition. Repeated freeze-thaw cycles make this process especially active in cold climates.
29. C — A glacier carving a mountain valley produces a broad, U-shaped cross-section by scraping and widening the valley floor and walls. Rivers, by contrast, cut narrow V-shaped valleys. The U-shape is a characteristic signature of past glaciation.
30. D — A maritime tropical air mass from the warm Gulf of Mexico carries warm, humid air, bringing high humidity and a strong chance of afternoon thunderstorms. "Maritime" indicates moisture and "tropical" indicates warmth. This contrasts sharply with cold, dry continental polar air.
31. B — A fast-moving cold front forces warm, moist air upward steeply, producing a narrow band of heavy thunderstorms, followed by clearing skies and cooler, drier air. The steep frontal slope drives quick, vigorous uplift. This abrupt change is characteristic of cold front passage.
32. A — When the air cools to its dew point, it becomes saturated and water vapor begins to condense into liquid, forming dew, fog, or clouds. The dew point is the temperature at which saturation occurs. Nighttime cooling to the dew point is what produces dew and fog.
33. C — A hurricane needs warm ocean water above about 26.5°C, abundant moisture, low wind shear, and some distance from the equator to form and strengthen. Warm water supplies the energy, low shear lets the storm organize, and the Coriolis effect away from the equator provides spin. Cold water or strong shear inhibits development.
34. D — 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. B — A daytime sea breeze forms because the land heats faster than the water, so warm air rises over the land and cooler sea air flows in to replace it. The land-sea temperature difference drives the circulation. This onshore breeze reverses at night as the land cools faster.
36. A — Ice cores preserve ancient ice layers and trapped air bubbles that reveal past atmospheric conditions, including former levels of greenhouse gases like carbon dioxide. Analyzing them lets scientists reconstruct climate over long timescales. Ice cores are a key tool for studying past climate change.
37. C — Coal, petroleum, and natural gas are all nonrenewable fossil fuels that form over millions of years and cannot be replaced once used. The other lists are renewable sources continually replenished by nature. Formation time is what defines a resource as nonrenewable.
38. D — The cleanup cost forced on the downstream town is a negative externality, a cost of the factory's activity borne by people outside the transaction. Externalities are real costs the polluter does not pay. Including them is essential for honest cost-benefit analysis.
39. A — Catching fish faster than the population can reproduce, causing a collapse, illustrates overharvesting. Removing organisms beyond the population's capacity to recover drives the decline. This differs from climate change, habitat loss, or invasive species as a biodiversity threat.
40. B — The recreation, beauty, and inspiration people gain from nature are cultural ecosystem services, the category covering nonmaterial benefits. Cultural services include aesthetic, spiritual, and recreational value. These benefits enrich human well-being without supplying physical goods.
41. C — Strong scientific consensus supports that continued warming will bring more frequent and intense heat waves, droughts, and other extreme weather. Rising temperatures shift conditions toward greater extremes. The other options contradict observed trends and ocean chemistry, which is becoming more acidic, not basic.

42. D — 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. A — Recycling materials such as aluminum, glass, and paper reduces landfill waste while conserving raw materials, since recovered materials are remade into new products. It addresses both goals at once by keeping resources in use. This is a core practice of sustainable waste management.
44. B — Rapid recent population growth was enabled mainly by advances in agriculture, sanitation, and medicine that increased the food supply and lowered the death rate. More people survived while food became more abundant. These improvements, not climate or eliminated disease, drove the surge.
45. C — Restoring wetlands, raising roads, and elevating buildings to cope with impacts already arriving is adaptation, since the community is adjusting to climate change rather than reducing its cause. Adaptation manages consequences; mitigation would cut emissions. These protective measures fit the definition of adaptation.
46. A — Ocean acidification occurs as the ocean absorbs carbon dioxide, which lowers its pH and makes it harder for corals and shellfish to build their carbonate structures. Reduced carbonate availability impairs shell and skeleton formation. This threatens calcifying organisms throughout marine ecosystems.
47. D — The Holocene's relatively warm, stable climate made farming dependable and allowed people to settle in one place, supporting permanent settlements and the first cities. Predictable growing seasons were essential for agriculture. Climatic stability, not an ice age or oxygen changes, enabled civilization.
48. B — A requirement that the bridge "must support a 40-ton truck" is a criterion, because it is a goal a successful design must satisfy. Criteria define what the solution must achieve, while constraints define the limits it must operate within. A load-bearing requirement is a performance goal, making it a criterion.
49. C — When a prototype underperforms, the engineering 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 failed test provides information, not a reason to abandon the project.
50. A — The greatest value of the model is that it lets engineers test different designs and foresee likely problems before spending money to build anything. 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.