PRACTICE EXAM 30: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. Which sequence of processes converts an igneous rock directly into a sedimentary rock?

A. Melting followed by slow crystallization deep within Earth's mantle over time

B. Weathering, erosion, deposition, and compaction or cementation of sediments

C. Heat and pressure causing recrystallization without the rock fully melting

D. Rapid cooling of lava at Earth's surface forming fine interlocking crystals

2. A geologist tests an unknown mineral and finds it has a hardness of 2, can be scratched by a fingernail, and splits into thin flexible sheets along one direction of perfect cleavage. Which mineral is this?

A. Quartz, with a hardness of 7, no cleavage, and curved conchoidal fracture surfaces

B. Pyrite, with a hardness of 6, a metallic luster, and a greenish-black powdered streak

C. Garnet, with a hardness of 7, no cleavage, and well-formed twelve-sided crystals

D. Muscovite mica, with a hardness of 2, one perfect cleavage, splitting into thin sheets

3. Which combination of conditions would most increase the rate at which rainwater infiltrates into the ground?

A. A gentle slope covered by coarse, well-sorted sand that is currently unsaturated

B. A steep slope covered by impermeable clay that is already saturated with water

C. A paved urban surface that channels water rapidly into storm drainage systems

D. A steep bedrock surface with thin soil and numerous exposed impermeable rocks

4. What is the primary driving force behind the movement of Earth's tectonic plates?

A. The gravitational pull of the Moon creating tidal forces within the solid mantle

B. The rotation of Earth on its axis generating outward forces within the rigid crust

C. Convection currents in the mantle driven by heat from Earth's hot interior

D. The magnetic field generated by motion within the liquid iron of the outer core

5. At a mid-ocean ridge, two oceanic plates move apart and new crust is created. What type of plate boundary is this, and what landform results?

A. A divergent boundary, where upwelling magma forms new oceanic crust and a ridge

B. A convergent boundary, where one plate subducts beneath another forming a trench

C. A transform boundary, where plates slide past each other producing offset features

D. A collision boundary, where two continental plates crumple upward into mountains

6. A seismologist determines the distance from a recording station to an earthquake epicenter using which measurement?

A. The total number of P-waves that arrive at the station during the first full minute

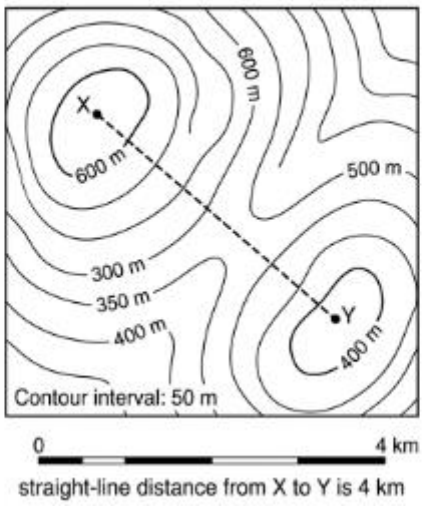
B. The maximum amplitude of the largest surface waves recorded on the seismogram

C. The compass direction from which the first seismic waves arrive at the station

D. The time difference between the arrival of the first P-wave and the first S-wave

7. On the topographic map below, what is the gradient of the slope along the straight line from point X to point Y?

[Figure PQ-1]



A. 25 meters per kilometer along the straight path between the two points

B. 50 meters per kilometer along the straight path between the two points

C. 100 meters per kilometer along the straight path between the two points

D. 200 meters per kilometer along the straight path between the two points

8. As the velocity of a stream increases, how does its ability to transport sediment change?

A. The stream can transport only smaller particles, since faster water carries less mass

B. The stream loses its ability to carry sediment because increased turbulence drops the load

C. The stream can transport larger particles, since faster water carries greater energy

D. The stream transports the same particle sizes regardless of any change in its velocity

9. A fast-moving river flows into a calm lake and deposits its sediment load. How will the sediment most likely be arranged where the river enters the lake?

A. All particle sizes will be mixed together uniformly with no sorting by size at all

B. The smallest particles will settle first, deposited closest to the river's mouth

C. Particles will form vertical layers with the oldest sediment resting near the top

D. The largest, heaviest particles will be deposited first, with finer particles carried farther

10. Which surface feature provides the strongest evidence that a region was once covered by a continental glacier?

A. U-shaped valleys and scattered erratic boulders of rock types foreign to the area

B. V-shaped valleys carved by fast-flowing streams cutting downward through bedrock

C. Rounded sand dunes shaped by prevailing winds in an arid desert environment

D. Deep canyons with steep walls formed by the headward erosion of a large river

11. In which climate would the chemical weathering of exposed bedrock occur most rapidly?

A. A cold, dry polar climate with temperatures remaining below freezing year-round

B. A cool, dry climate with low precipitation and large daily temperature ranges

C. A hot, humid tropical climate with abundant rainfall and high temperatures

D. A temperate climate with moderate rainfall and distinct seasonal temperature shifts

12. Residual soil that forms directly from the bedrock beneath it would most likely have which characteristic?

A. A mineral composition entirely different from the underlying bedrock material

B. A mineral composition closely matching that of the bedrock directly beneath it

C. A composition consisting only of organic material with no mineral content at all

D. A composition identical to soils transported and deposited from distant regions

13. On a humid summer day, the air temperature and the dew point temperature are very close to each other. What does this indicate about the air?

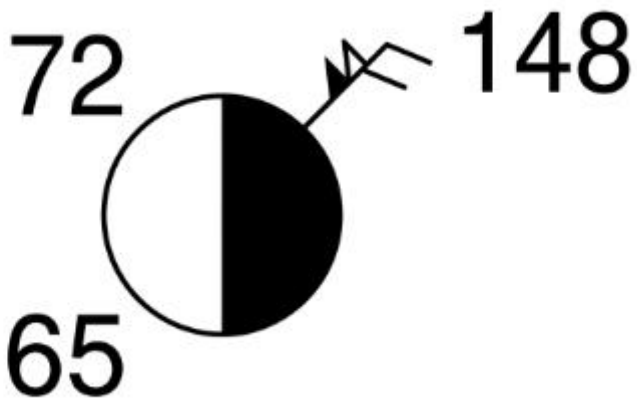
A. The relative humidity is high, and the air is near saturation with water vapor

B. The relative humidity is low, and the air can still hold much more water vapor

C. The air contains almost no water vapor and conditions are extremely dry overall

D. A strong temperature inversion is preventing any vertical mixing of the air mass

14. The weather station model below reports conditions at a station. What barometric pressure is indicated by the coded value 148 shown at the upper right of the model?



A. 148.0 millibars, read directly from the three-digit number printed on the model

B. 914.8 millibars, by placing a 9 before the coded value and inserting a decimal

C. 1148 millibars, by placing an 11 before the value and removing the decimal point

D. 1014.8 millibars, by prefixing a 10 and inserting a decimal before the last digit

15. Which set of weather changes typically accompanies the passage of a cold front?

A. Gradually clearing skies, steadily rising temperatures, and increasing humidity levels

B. Several days of light steady rain followed by warming and a shift to southerly winds

C. Brief heavy precipitation and gusty winds, followed by cooler, drier, clearer conditions

D. Persistent fog with little temperature change as warm air slowly overrides the cold air

16. In the continental United States, weather systems generally move from west to east. This pattern results primarily from which feature of atmospheric circulation?

A. The prevailing westerlies, the dominant wind belt across the mid-latitudes

B. The trade winds, which blow from east to west in the tropics near the equator

C. The polar easterlies, which dominate circulation only in high-latitude polar regions

D. Local sea breezes that reverse direction between day and night near coastlines only

17. On a sunny afternoon at the beach, a cool breeze blows from the ocean toward the land. What causes this sea breeze?

A. The ocean heats faster than the land, causing air to rise rapidly over the water

B. The land heats faster than the ocean, so warm air rises over land and cooler ocean air flows in

C. The Coriolis effect deflects all coastal winds toward the shore during daylight hours

D. Ocean currents physically push surface air toward the land throughout the daytime

18. At a location in New York State, the intensity of insolation reaching the ground is greatest under which condition?

A. At sunrise, when the Sun first appears low on the eastern horizon each morning

B. During the winter solstice, when the Sun follows its lowest path across the sky

C. On a cloudy day at noon, when diffuse light is spread evenly across the surface

D. At solar noon on the summer solstice, when the Sun reaches its highest altitude

19. Which gas is the most significant contributor to the recent human-caused enhancement of Earth's greenhouse effect?

A. Oxygen, which is released in large quantities by the combustion of fossil fuels

B. Nitrogen, which makes up the largest fraction of the lower atmosphere by volume

C. Carbon dioxide, released in large quantities by the burning of fossil fuels worldwide

D. Argon, an inert gas that steadily accumulates from industrial processes over time

20. Two cities lie at the same elevation, but one is near the equator and the other is at 60° N latitude. Why does the equatorial city have a warmer average annual temperature?

A. It receives more concentrated insolation because sunlight strikes it at a higher angle

B. It is significantly closer to the Sun than the high-latitude city throughout the year

C. It sits beneath a thinner section of atmosphere that traps and holds far more heat

D. The high-latitude city loses heat faster because Earth rotates more quickly at the poles

21. Coastal regions tend to have smaller annual temperature ranges than inland regions at the same latitude. Which property of water best explains this moderating effect?

A. Water reflects nearly all incoming sunlight, keeping coastal air consistently cool

B. Water has a high specific heat, so it warms and cools more slowly than nearby land

C. Water has a low specific heat, allowing it to change temperature quickly each season

D. Water blocks the transfer of heat between the atmosphere and the land along the coast

22. Why do hurricanes rapidly weaken after moving onto a large continent?

A. Increased friction from the land speeds the storm up until it tears itself apart quickly

B. Cooler upper-level winds over land immediately freeze the storm's supply of water vapor

C. The storm is cut off from the warm ocean water that supplies its energy and moisture

D. The Coriolis effect reverses direction over land, forcing the storm to spin itself apart

23. During which configuration does the Northern Hemisphere experience its longest daylight period of the year?

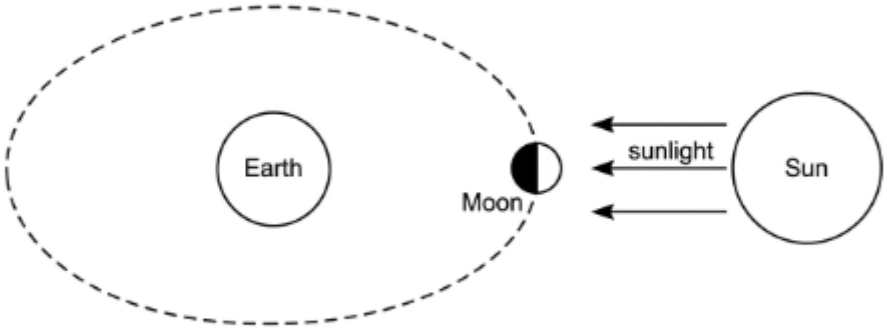
A. The vernal equinox, when day and night are of nearly equal length across the globe

B. The winter solstice, when the North Pole is tilted farthest away from the Sun's rays

C. The autumnal equinox, when the Sun is positioned directly above the equator at noon

D. The summer solstice, when the North Pole is tilted most directly toward the Sun

24. In the diagram below, the Moon is positioned directly between Earth and the Sun. What phase does an observer on Earth see?



A. A new moon, because the Moon's illuminated side faces entirely away from Earth

B. A full moon, because the entire near side of the Moon is brightly illuminated

C. A first quarter moon, because exactly half of the near side appears illuminated

D. A waning gibbous moon, because most but not all of the near side is illuminated

25. A comet has an orbital period of 27 years. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is the comet's average distance from the Sun?

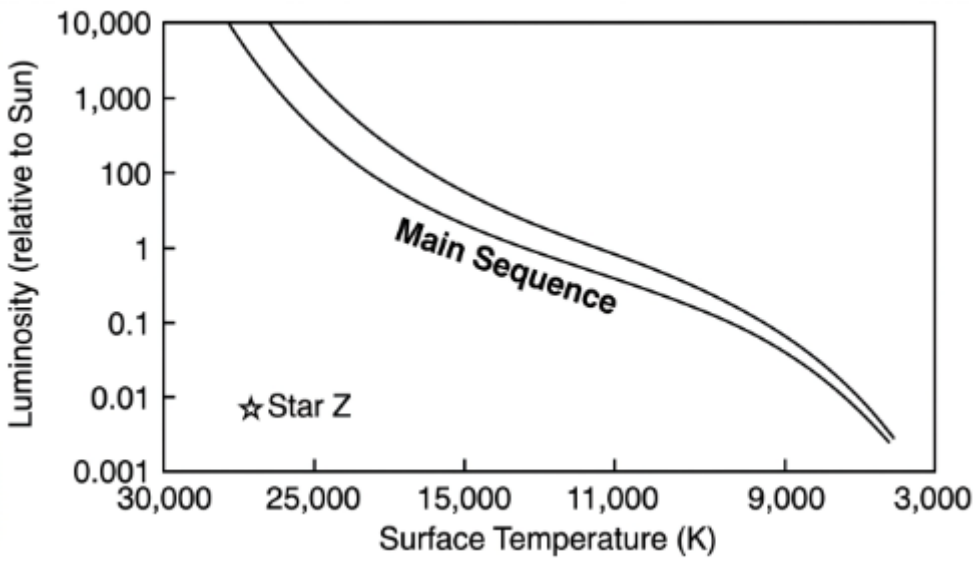
A. 3 astronomical units, found by taking the square root of the orbital period directly

B. 9 astronomical units, found by solving for the cube root of the period squared value

C. 18 astronomical units, found by dividing the orbital period by a factor of one half

D. 27 astronomical units, found by setting the distance equal to the orbital period value

26. On the Hertzsprung-Russell diagram below, a star is located in the lower-left region. Which description best matches this star?



A. A red supergiant with very high luminosity and a low surface temperature value

B. A cool main sequence red dwarf with low luminosity and a low surface temperature

C. A bright blue giant with both very high luminosity and very high surface temperature

D. A white dwarf with a high surface temperature but low luminosity due to its small size

27. Astronomers determine the chemical composition of a distant star primarily by analyzing which property of its light?

A. The total brightness of the star as measured by a telescope over many clear nights

B. The apparent shift in the star's position against background stars over the course of a year

C. The pattern of absorption lines in the star's spectrum, which identify specific elements

D. The speed at which the star appears to drift across the night sky relative to other stars

28. The cosmic microwave background radiation detected throughout the universe is interpreted as which kind of evidence?

A. Residual thermal radiation left over from the hot, dense early state of the universe

B. Light currently being emitted by the most distant active galaxies in all directions

C. Radiation produced continuously by ongoing nuclear fusion within nearby stars today

D. Heat generated by the gravitational collapse of dust clouds into new solar systems

29. A star similar in mass to our Sun has exhausted the hydrogen fuel in its core. What is the most likely sequence of stages it will pass through next?

A. It will immediately explode as a supernova and then collapse directly into a black hole

B. It will remain a stable main sequence star indefinitely by fusing helium endlessly

C. It will contract into a neutron star after ejecting most of its outer mass violently

D. It will expand into a red giant, then shed its outer layers and become a white dwarf

30. Astronomers measure the distance to a nearby star by observing its apparent shift in position against more distant stars as Earth orbits the Sun. This method is known as:

A. Spectroscopy, which separates starlight into a spectrum to reveal its chemical makeup

B. Stellar parallax, which uses the star's apparent shift against more distant background stars

C. Redshift measurement, which determines how fast a star is receding from the observer

D. Radiometric dating, which uses radioactive decay to determine the absolute age of a star

31. During which two lunar phases do neap tides, which have the smallest difference between high and low tide, occur?

A. The new moon and full moon, when the Sun, Earth, and Moon are aligned in a row

B. Only during the new moon, when the Moon lies directly between Earth and the Sun

C. The first quarter and last quarter, when the Sun and Moon pull at right angles to Earth

D. Only during the full moon, when Earth lies directly between the Sun and the Moon

32. Why does the Sun appear to move across the sky from east to west during the course of a day?

A. Earth rotates on its axis from west to east, making the Sun appear to move the opposite way

B. The Sun physically orbits the stationary Earth once during each twenty-four hour period

C. Earth revolves around the Sun once each day, rapidly changing the Sun's apparent position

D. The Moon's gravity pulls the Sun across the sky in a predictable daily east-to-west arc

33. According to the nebular hypothesis, the planets of our solar system formed from what material?

A. Debris ejected from the Sun after a massive collision with a passing rogue star

B. Material captured by the Sun's gravity from interstellar space long after the Sun formed

C. Fragments left over from the breakup of a single large planet that once orbited the Sun

D. A rotating disk of gas and dust around the young Sun that gradually clumped together

34. A sample of organic material originally contained 16 grams of carbon-14, which has a half-life of about 5,700 years. If only 2 grams of the original carbon-14 remain, approximately how old is the sample?

A. About 5,700 years, since one half-life has passed to reduce the original amount of carbon-14

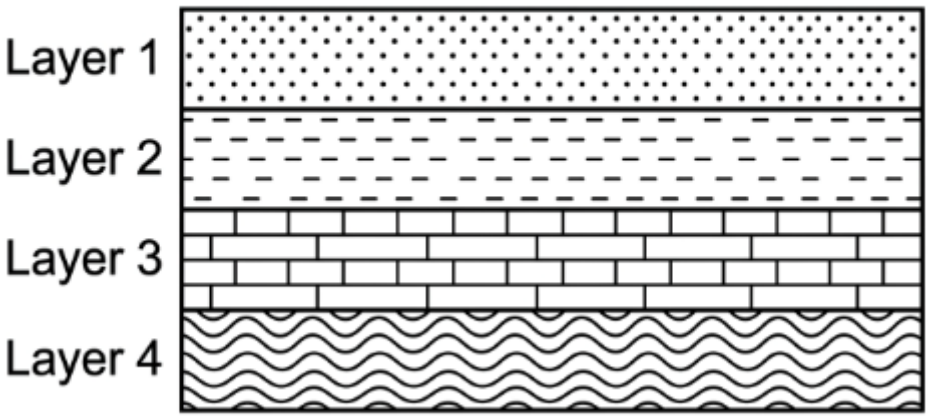
B. About 11,400 years, since two half-lives have passed to reach the remaining amount

C. About 17,100 years, since three half-lives have passed to leave the remaining amount

D. About 22,800 years, since four half-lives have passed to leave the remaining amount

35. In the undisturbed sequence of sedimentary rock layers shown below, which layer is the oldest?

Figure PQ-5



A. Layer 1, because the topmost layer was deposited first in an undisturbed sequence

B. Layer 4, because the bottom layer was deposited first according to superposition

C. Layer 2, because layers near the top always represent the earliest deposition events

D. All layers are the same age because they were deposited together in one rapid event

36. Which characteristics make an organism a good index fossil for correlating rock layers across wide areas?

A. It existed for a geologically short time but was geographically widespread and abundant

B. It survived for a very long span of geologic time and lived only in one small region

C. It was a large, slow-moving organism that lived only in deep ocean trench environments

D. It lived exclusively on land in a single isolated location for hundreds of millions of years

37. A rock layer contains fossils of early mammals and flowering plants but no fossils of dinosaurs or trilobites. During which interval of geologic time was this layer most likely deposited?

A. The Precambrian, when only simple single-celled life existed in Earth's early oceans

B. The early Paleozoic, when trilobites dominated the warm shallow seas of the period

C. The Cenozoic, after the extinction of the dinosaurs, when mammals diversified widely

D. The Hadean, before any solid crust or liquid water had yet formed on Earth's surface

38. Earth's early atmosphere contained almost no free oxygen gas. Which process was primarily responsible for adding large amounts of oxygen to the atmosphere over time?

A. Volcanic outgassing that released oxygen trapped deep within Earth's molten interior

B. The breakdown of water molecules by ultraviolet radiation high in the upper atmosphere

C. Meteorite impacts that delivered oxygen-rich material from elsewhere in the solar system

D. Photosynthesis by early cyanobacteria and later plants, which released oxygen as a byproduct

39. A thin worldwide clay layer rich in the rare element iridium marks the boundary between the Mesozoic and Cenozoic eras. This layer is most often cited as evidence for which event?

A. A large asteroid impact that contributed to the extinction of the non-avian dinosaurs

B. A sudden reversal of Earth's magnetic field that disrupted global ecosystems severely

C. A long episode of continuous gentle sediment deposition with no unusual disturbances

D. A worldwide ice age that slowly froze the oceans and killed most marine organisms

40. Identical fossils of the freshwater reptile Mesosaurus are found in rocks of both South America and Africa, but nowhere else. How does this finding support the theory of continental drift?

A. It proves that Mesosaurus was able to swim across the entire width of the Atlantic Ocean

B. It indicates the two continents were once joined, letting the land animal live across both

C. It shows that identical species evolved completely independently on the two separate landmasses

D. It demonstrates that the fossils were carried between continents by strong ocean currents

41. The principle that the same natural processes operating today also operated throughout Earth's past — often summarized as "the present is the key to the past" — is known as:

A. The principle of superposition, used to determine the relative ages of rock layers

B. The principle of cross-cutting relationships, used to date faults and igneous intrusions

C. The principle of uniformitarianism, the foundation for interpreting the rock record

D. The principle of original horizontality, describing how sediments are first deposited

42. Which of the following is classified as a nonrenewable energy resource?

A. Wind energy, captured by turbines and replenished by ongoing atmospheric circulation

B. Solar energy, collected by panels and continuously supplied by radiation from the Sun

C. Hydroelectric energy, generated by flowing water within the ongoing water cycle

D. Natural gas, a fossil fuel that forms over millions of years and is consumed far faster

43. As the oceans absorb increasing amounts of atmospheric carbon dioxide, the seawater becomes more acidic. Which group of marine organisms is most directly threatened by this change?

A. Large predatory sharks that depend on keen senses to locate their prey in open water

B. Shell-forming organisms such as corals and clams that build structures from calcium carbonate

C. Fast-swimming fish that migrate long distances between feeding and breeding grounds

D. Marine mammals such as seals and whales that must surface regularly to breathe air

44. In many agricultural regions, groundwater is pumped from aquifers faster than rainfall can recharge them. What is the most likely long-term consequence of this practice?

A. The water table drops over time, and wells may run dry as the aquifer is depleted

B. The aquifer refills more rapidly because pumping creates additional space for new water

C. Surface rivers and lakes in the region overflow as the displaced water rises upward

D. The mineral content of the remaining groundwater steadily decreases until it is pure

45. A coastal city raises the height of its roads and buildings to cope with rising sea levels that are already occurring. This response is best classified as which climate strategy?

A. Mitigation, because the city is reducing the greenhouse gas emissions that drive warming

B. Geoengineering, because the city is deliberately altering the global climate system itself

C. Adaptation, because the city is adjusting to changes in the climate that are already happening

D. Prevention, because the action completely stops sea level from rising any further at all

46. How does large-scale deforestation most directly contribute to rising atmospheric carbon dioxide levels?

A. Cleared land reflects more sunlight, which warms the atmosphere and releases stored carbon

B. Removing trees increases rainfall, which washes additional carbon dioxide out of the air

C. Bare soil releases nitrogen compounds that chemically convert into carbon dioxide gas

D. Fewer trees remove less carbon dioxide through photosynthesis, and burning trees releases it

47. Coastal wetlands and mangrove forests reduce the damage caused by storm surges during hurricanes. This benefit is an example of which type of ecosystem service?

A. A regulating service, because the wetland buffers and moderates a natural hazard

B. A provisioning service, because the wetland supplies food and raw materials to people

C. A cultural service, because the wetland offers recreation and scenic beauty to visitors

D. A supporting service, because the wetland only provides the basis for nutrient cycling

48. Thawing permafrost in the Arctic releases methane, a greenhouse gas, which causes additional warming that thaws even more permafrost. This relationship is an example of:

A. A negative feedback loop, which counteracts the original warming and stabilizes the system

B. A positive feedback loop, which amplifies the original warming and accelerates further change

C. An external forcing, which is completely independent of the warming already taking place

D. A steady-state equilibrium, in which the climate system returns to its original condition

49. An engineering team must design a flood barrier that is both inexpensive and highly durable, but the most durable materials are also the most expensive. This situation best illustrates which feature of the engineering design process?

A. The requirement that the cheapest possible option must always be chosen in every case

B. The rule that durability must always be prioritized above every other design consideration

C. The reality that design solutions usually involve trade-offs among competing criteria and constraints

D. The principle that a design problem can have only one correct and optimal solution overall

50. A scientific team builds a computer model to predict how a coastline will change over the next fifty years. Which statement best describes the proper role of such a model?

A. The model produces an exact and certain prediction of the future that cannot be wrong

B. The model provides a useful projection based on current data and assumptions, refined as new data arrive

C. The model should replace all direct field measurements, which become unnecessary once it exists

D. The model has no scientific value because future coastline changes can never be estimated at all

ANSWERS KEY WITH EXPLANATIONS

1. B — The rock cycle converts an igneous rock to a sedimentary rock through weathering, erosion, transport, deposition, and then compaction or cementation of the resulting sediments. Melting (option A) and heat/pressure (option C) lead to igneous and metamorphic rocks respectively, so only the surface-process pathway yields a sedimentary rock.
2. D — Muscovite mica is defined by a hardness near 2, one direction of perfect cleavage, and the tendency to split into thin, flexible, transparent sheets. These diagnostic properties separate it cleanly from the hard, cleavage-free quartz and garnet and from metallic pyrite, making the sheet-splitting behavior the deciding clue.
3. A — Infiltration is fastest where the surface is gently sloped, the material is coarse and well-sorted (high permeability), and the ground is unsaturated so pore space is available. Steep slopes, impermeable clay, saturation, and paved surfaces all reduce infiltration, which is why the gentle, coarse, unsaturated condition wins.
4. C — Plate motion is driven primarily by convection currents in the mantle powered by Earth's internal heat, which drag and push the overlying lithospheric plates. Tidal forces, axial rotation, and the core's magnetic field do not supply the sustained force needed to move continents, so mantle convection is the correct mechanism.

5. A — Where two oceanic plates pull apart, magma rises to fill the gap and solidifies into new oceanic crust, building a mid-ocean ridge — the defining features of a divergent boundary. Subduction, lateral sliding, and continental collision describe convergent and transform settings, not the spreading process described.
6. D — Epicenter distance is found from the lag between the faster P-wave and the slower S-wave: the greater the separation in arrival times, the farther the station is from the epicenter. Amplitude relates to magnitude and arrival direction does not give distance, so the P–S interval is the key measurement.
7. B — Gradient equals change in elevation divided by distance: (600 m − 400 m) ÷ 4 km = 200 m ÷ 4 km = 50 m/km. Reading both contour elevations correctly and dividing by the map-scale distance is the essential skill this question tests.
8. C — As stream velocity increases, the water carries more energy and can transport larger and heavier particles, increasing both the size of material moved and the total load. This relationship between velocity and competence explains why fast floodwaters can move boulders that calm water cannot.
9. D — When a fast river enters still water, the largest and heaviest particles drop out first because they need the most energy to stay suspended, while finer particles are carried farther before settling. This produces the size-sorted, graded pattern typical of deltas and explains why coarse sediment marks the river mouth.
10. A — U-shaped valleys and erratic boulders made of rock foreign to the local bedrock are classic signatures of continental glaciation, since ice carves broad valleys and transports rock far from its source. V-shaped valleys, dunes, and river canyons point to streams or wind instead, making the glacial features the strongest evidence.
11. C — Chemical weathering accelerates with both heat and moisture, so a hot, humid tropical climate maximizes reaction rates such as dissolution and hydrolysis. Cold or dry climates slow these reactions, which is why tropical bedrock breaks down chemically far faster than polar or desert bedrock.
12. B — Residual soil forms in place from the bedrock directly beneath it, so its mineral composition closely matches that parent rock. Transported soils differ from the underlying bedrock, making the close compositional match the defining trait of residual soil.
13. A — When air temperature and dew point are nearly equal, the air is close to saturation and relative humidity is high, because only a slight cooling would trigger condensation. A large spread between the two values would indicate dry air, so a small spread signals high humidity.
14. D — Station-model pressure is coded by dropping the leading 9 or 10 and the decimal; the value 148 decodes to 1014.8 mb by prefixing 10 and inserting a decimal before the final digit. Choosing 9 versus 10 is settled by picking the value nearest typical sea-level pressure, which makes 1014.8 mb correct.
15. C — A passing cold front lifts warm air abruptly, producing a narrow band of brief, heavy precipitation and gusty winds, followed by cooler, drier, clearing conditions behind the front. This sharp, short-lived pattern distinguishes a cold front from the prolonged light rain of a warm front.
16. A — Mid-latitude weather systems across the continental United States are steered west to east by the prevailing westerlies, the dominant wind belt at these latitudes. Trade winds and polar easterlies operate in the tropics and polar zones, so the westerlies account for the observed motion.
17. B — During the day, land heats faster than water, so air rises over the warmer land and cooler, denser air from over the ocean flows inland to replace it, creating a sea breeze. The different heating rates of land and water, driven by water's high specific heat, are the cause.

18. D — Insolation intensity is greatest when the Sun is highest in the sky, which at a New York location occurs at solar noon on the summer solstice. A high Sun angle concentrates energy over the smallest surface area, maximizing intensity compared with sunrise, winter, or cloudy conditions.
19. C — Carbon dioxide released by burning fossil fuels is the leading human contributor to the enhanced greenhouse effect because of the large volumes emitted and its strong absorption of outgoing infrared radiation. Oxygen, nitrogen, and argon are not significant greenhouse gases, leaving carbon dioxide as the primary driver.
20. A — The equatorial city is warmer because sunlight strikes it at a higher angle, concentrating insolation over a smaller area than the oblique rays reaching 60° N. The tiny difference in Sun distance is negligible, so the angle of incidence, not proximity to the Sun, explains the temperature gap.
21. B — Water's high specific heat lets it absorb and release large amounts of heat with only small temperature changes, so coastal areas warm and cool slowly and have smaller annual temperature ranges. This thermal inertia of nearby water is what moderates coastal climates relative to inland sites.
22. C — Hurricanes draw their energy from warm ocean water, so once a storm moves over land it is cut off from that moisture and heat source and weakens rapidly. Friction adds to the decay, but loss of the warm-water energy supply is the primary reason landfalling hurricanes fade.
23. D — The longest day in the Northern Hemisphere occurs at the summer solstice, when the North Pole tilts most directly toward the Sun, giving the highest Sun path and the most daylight hours. The equinoxes give equal day and night, and the winter solstice gives the shortest day.
24. A — When the Moon sits directly between Earth and the Sun, its sunlit side faces away from Earth and its near side is dark, producing a new moon. The geometry of the illuminated hemisphere facing the Sun rather than the observer is what defines this phase.
25. B — Kepler's Third Law gives $a^3 = T^2$, so with T = 27 years, $T^2 = 729$ and a = the cube root of 729 = 9 AU. Recognizing that distance comes from the cube root of the period squared is the core skill, yielding an average distance of 9 astronomical units.
26. D — A star in the lower-left of an H-R diagram is hot (high temperature) yet dim (low luminosity), which describes a white dwarf — small and faint despite its high surface temperature. Supergiants sit at upper right and bright blue giants at upper left, so the lower-left position identifies a white dwarf.
27. C — A star's chemical composition is read from the absorption lines in its spectrum, since each element absorbs light at characteristic wavelengths that act as a fingerprint. Brightness, parallax, and apparent motion reveal distance or position but not composition, leaving spectral absorption lines as the key.
28. A — The cosmic microwave background is the cooled, leftover thermal radiation from the hot, dense early universe, now stretched into the microwave range as space expanded. Its uniform presence in every direction is strong evidence for the Big Bang model of an expanding universe.
29. D — A Sun-like star, after exhausting core hydrogen, expands into a red giant, then sheds its outer layers and leaves behind a hot, dense white dwarf. Supernova and neutron-star or black-hole endings require far greater mass, so the red-giant-to-white-dwarf path fits a low-mass star.
30. B — Stellar parallax measures distance from the apparent back-and-forth shift of a nearby star against distant background stars as Earth orbits the Sun. The larger the parallax shift, the closer the star, making this the standard geometric method for nearby stellar distances.

31. C — Neap tides, with the smallest difference between high and low tide, occur at the first and last quarter when the Sun and Moon pull at right angles and their tidal effects partly cancel. Alignment at new and full moon instead produces the larger spring tides, so the quarter phases give neaps.
32. A — The Sun's daily east-to-west path is an apparent motion caused by Earth rotating west to east on its axis, which makes celestial objects seem to move the opposite way. Earth's rotation, not actual solar movement or a daily revolution, accounts for day and night.
33. D — The nebular hypothesis holds that the solar system formed from a rotating disk of gas and dust around the young Sun, with material gradually clumping into planets. The shared orbital plane and direction of the planets support formation from a single spinning disk rather than capture or collision debris.
34. C — Starting at 16 g and decaying to 2 g passes through three half-lives ($16 \rightarrow 8 \rightarrow 4 \rightarrow 2$), so the age is $3 \times 5{,}700 \approx 17{,}100$ years. Counting the number of halvings and multiplying by the half-life is the essential dating calculation here.
35. B — By the principle of superposition, in an undisturbed sequence the bottom layer was deposited first and is therefore the oldest, making Layer 4 the oldest. The topmost layer is youngest, so reading the sequence from bottom up gives the correct age order.
36. A — A good index fossil comes from an organism that existed for only a short span of geologic time but was geographically widespread and abundant, allowing rock layers in distant places to be correlated to the same narrow time interval. Long-lived or geographically restricted species cannot pin down a precise age.
37. C — Fossils of early mammals and flowering plants without dinosaurs or trilobites place the layer in the Cenozoic, the era after the dinosaur extinction when mammals diversified. Trilobites mark the Paleozoic and dinosaurs the Mesozoic, so their absence alongside mammals points to the Cenozoic.
38. D — Free oxygen accumulated in the atmosphere chiefly through photosynthesis, first by cyanobacteria and later by plants, which release oxygen as a byproduct of converting carbon dioxide and water. This biological source, not volcanism or impacts, drove the long-term rise of atmospheric oxygen.
39. A — A thin, worldwide iridium-rich clay layer at the Mesozoic–Cenozoic boundary is best explained by a large asteroid impact, since iridium is rare in Earth's crust but common in asteroids. This impact evidence is tied to the extinction of the non-avian dinosaurs.
40. B — Identical Mesosaurus fossils on both South America and Africa, and nowhere else, indicate the continents were once joined, allowing this freshwater reptile to range across what is now two landmasses. A small freshwater animal could not cross a wide ocean, so the joined-continents explanation supports continental drift.
41. C — Uniformitarianism is the principle that the natural processes operating today also operated in the past, summarized as "the present is the key to the past," and it underpins all interpretation of the rock record. Superposition and cross-cutting deal with relative age, not with the constancy of processes.
42. D — Natural gas is a fossil fuel that forms over millions of years and is consumed far faster than it can be replaced, making it nonrenewable. Wind, solar, and hydroelectric energy are continuously replenished by ongoing natural processes, so only natural gas fits the nonrenewable category.
43. B — Ocean acidification most directly threatens shell- and skeleton-building organisms such as corals and clams, because more acidic water hinders their ability to form structures from calcium carbonate. Sharks, fish, and air-breathing mammals are far less directly affected by the change in seawater chemistry.

44. A — Pumping groundwater faster than rainfall can recharge it lowers the water table over time, and wells may run dry as the aquifer is depleted. Overdraft does not speed recharge or flood surface waters, so a falling water table and well failure are the expected long-term outcome.
45. C — Raising roads and buildings to cope with sea-level rise that is already happening is adaptation, since the community is adjusting to existing climate change rather than reducing its causes. Mitigation would target emissions, so the act of accommodating current impacts is adaptation.
46. D — Deforestation raises atmospheric carbon dioxide because fewer trees remove less carbon dioxide through photosynthesis, and burning or decay of the removed trees releases stored carbon back to the air. This loss of a carbon sink combined with carbon release is the direct mechanism.
47. A — Storm-surge buffering by coastal wetlands and mangroves is a regulating service, because the ecosystem moderates a natural hazard and reduces its impact on people. Provisioning, cultural, and supporting services describe other benefits, so hazard buffering falls under regulation.
48. B — Methane released by thawing permafrost causes warming that thaws still more permafrost, a positive feedback loop that amplifies the initial change. A negative feedback would dampen the warming, so the self-reinforcing cycle described is positive feedback.
49. C — Needing a barrier that is both cheap and highly durable when durable materials cost more illustrates that engineering design involves trade-offs among competing criteria and constraints. Real designs balance such conflicting requirements rather than optimizing a single factor or finding one perfect solution.
50. B — A coastline model provides a useful projection based on current data and assumptions and is refined as new data arrive, rather than delivering a certain prediction or replacing field measurement. Recognizing models as evidence-based tools with limitations is the proper scientific stance.