

PRACTICE EXAM 33: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. What is the main difference between relative dating and absolute (radiometric) dating of rocks?
 - A. Relative dating gives an exact age in years, while absolute dating only gives the order of events
 - B. Relative dating works only on igneous rocks, while absolute dating works only on sedimentary rocks
 - C. Relative dating gives the order of events, while absolute dating provides an age in actual years
 - D. Relative dating and absolute dating are simply two names for the very same method of measuring rock ages

2. A granite body contains fragments of sandstone embedded within it. According to the principle of inclusions, what can be concluded about the relative ages?
 - A. The granite and the sandstone fragments must have formed at exactly the same time together
 - B. The granite is older than the sandstone fragments that it surrounds and completely encloses within it
 - C. The age relationship cannot be determined, because inclusions never reveal anything about relative age
 - D. The sandstone is older than the granite, because the fragments existed before the granite formed around them

3. A radioactive isotope has a half-life of 1.3 billion years. A rock sample contains one-quarter of the original amount of this isotope. Approximately how old is the rock?
 - A. About 1.3 billion years, because one-quarter of the isotope remaining means a single half-life has elapsed
 - B. About 2.6 billion years, because one-quarter of the isotope remaining means two half-lives have elapsed

C. About 3.9 billion years, because one-quarter of the isotope remaining means three half-lives have elapsed

D. About 5.2 billion years, because one-quarter of the isotope remaining means four half-lives have elapsed

4. The Mesozoic Era is often called the "Age of Reptiles." Which group of animals was dominant on land during this era?

A. The dinosaurs, which were the dominant land animals throughout most of the Mesozoic Era

B. The trilobites, which crawled across the shallow sea floors throughout the entire Mesozoic Era

C. Large mammals such as mammoths, which spread widely across the Mesozoic continents

D. Humans and their close ancestors, who first appeared early in the Mesozoic Era on land

5. The supercontinent Pangaea, in which nearly all of Earth's landmasses were joined together, existed during which interval?

A. It exists today, since all of Earth's continents are currently joined into one single landmass

B. It existed only during the Precambrian, before any multicellular life had appeared on the Earth

C. It will form for the very first time millions of years in the future as the continents drift together

D. It existed near the end of the Paleozoic and start of the Mesozoic before later breaking apart

6. The principle of fossil succession states that fossil organisms appear in the rock record in a definite order. Why is this principle useful to geologists?

A. It proves that all fossils across the entire world are exactly the same age regardless of their location

B. It allows the exact age of any fossil to be read directly in years without any other measurement at all

C. It allows rock layers in different places to be placed in correct time order by their fossil content

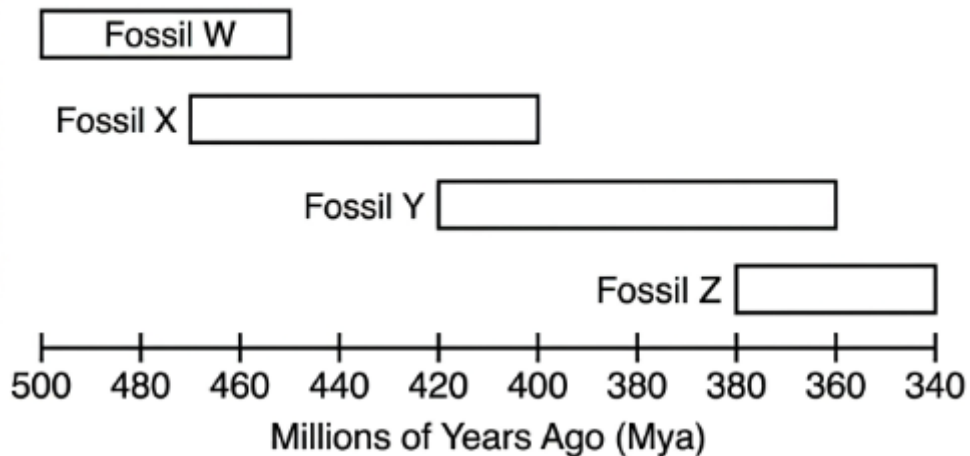
D. It shows that the same species of organism has lived completely unchanged throughout all of Earth's history

7. Ancient banded iron formations, layers of iron-rich rock deposited in the oceans billions of years ago, provide evidence about which major event in Earth's history?

- A. The rise of oxygen in the oceans and atmosphere, which caused dissolved iron to form solid deposits
- B. The collision of a Mars-sized body with the Earth that led to the formation of the Moon long ago
- C. The first appearance of large land plants that spread rapidly across the early continents
- D. A series of giant meteorite impacts that repeatedly melted the surface of the early Earth

8. The chart below shows the time ranges during which four index fossils existed. A rock layer contains both Fossil X and Fossil Y. During which time interval was this layer most likely deposited?

[Figure PQ-1]



- A. Between 470 and 450 million years ago, when Fossil X existed but Fossil Y did not yet exist
- B. Between 420 and 400 million years ago, the interval when both Fossil X and Fossil Y existed together
- C. Between 380 and 360 million years ago, when Fossil Y existed but Fossil X had already disappeared
- D. Between 500 and 470 million years ago, when only the earliest Fossil W existed in the oceans

9. During a total solar eclipse, the Moon almost exactly covers the disk of the Sun. This striking coincidence occurs because:

- A. The Sun is about 400 times wider than the Moon but also about 400 times farther away, so the two appear nearly the same size
- B. The Moon is actually the very same physical diameter as the Sun, so the two naturally appear identical in size
- C. The Moon moves directly into the core of the Sun, blocking the Sun's light from the inside during the eclipse
- D. The Sun temporarily shrinks during an eclipse until its disk matches the apparent size of the passing Moon

10. According to Kepler's first law of planetary motion, what is the shape of a planet's orbit around the Sun, and where is the Sun located?

- A. A perfect circle, with the Sun located exactly at the center of the circular orbit
- B. A spiral that slowly tightens over time, with the Sun located at the center of the spiral path
- C. A straight line, with the Sun located at one end and the planet traveling back and forth along it
- D. An ellipse, with the Sun located at one of the two foci of that elliptical orbit

11. Each chemical element produces a unique pattern of bright or dark lines when its light is passed through a spectroscope. How do astronomers make use of this fact?

- A. They identify the elements present in a distant star by matching its spectral lines to known patterns
- B. They measure the exact temperature of a star by counting the total number of lines in its spectrum
- C. They determine a star's age directly by reading the brightness of the lines in its visible spectrum
- D. They calculate the distance to a star by measuring how far apart the spectral lines appear to be

12. Edwin Hubble observed that almost all distant galaxies are moving away from us, and that the more distant ones are moving away faster. What major conclusion did this observation support?

- A. That the Milky Way galaxy is located at the exact center of a small and completely unchanging universe
- B. That all of the galaxies in the universe are completely fixed in place and never actually move at all
- C. That the universe as a whole is expanding, with galaxies moving apart from one another over time

D. That distant galaxies are being pulled toward a single massive object located at the edge of the universe

13. Why is Earth able to retain a substantial atmosphere while the Moon has almost none?

A. The Moon is much closer to the Sun, so the intense solar heat has boiled away all of the Moon's air

B. Earth's greater mass produces stronger gravity, which holds gas molecules near the surface

C. The Moon rotates far too quickly, flinging any atmospheric gases off into space as it spins

D. Earth's magnetic field physically creates new air molecules to constantly replace any lost gas

14. When it is summer in the Northern Hemisphere, what season is it in the Southern Hemisphere, and why?

A. It is also summer, because the entire Earth is closest to the Sun at that same time of the year

B. It is spring, because the Southern Hemisphere is always exactly one season behind the Northern Hemisphere

C. It is autumn, because sunlight takes noticeably longer to reach the more distant Southern Hemisphere

D. It is winter, because the Southern Hemisphere is then tilted away from the Sun while the north is tilted toward it

15. In the core of the Sun, four hydrogen nuclei combine to form one helium nucleus. What happens to the small amount of mass that seems to be lost in this process?

A. The lost mass is permanently destroyed and simply disappears completely from the universe

B. The lost mass is ejected from the Sun as solid particles that slowly drift outward into space

C. The lost mass is converted into a large amount of energy, as described by the equation $E = mc^2$

D. The lost mass sinks to the very center of the Sun and accumulates there as dense leftover material

16. Earth experiences two tidal bulges at once — one on the side facing the Moon and one on the opposite side. What causes the bulge on the side facing away from the Moon?

- A. The Moon's gravity pulls Earth itself more strongly than it pulls the water on the far side, leaving that water bulging outward
- B. The Sun's gravity creates the far bulge while the Moon's gravity creates only the near bulge by itself alone
- C. The rotation of Earth flings the ocean water outward on whichever side happens to face away from the Moon
- D. The far-side bulge is caused entirely by strong surface winds pushing the ocean water away from the Moon

17. A comet's tail always points away from the Sun, regardless of the direction the comet is traveling. What causes the tail to point in this direction?

- A. The tail trails directly behind the comet, always pointing exactly opposite to the comet's direction of motion
- B. The gravity of the nearest planet pulls the tail toward itself, bending it away from the Sun purely by chance
- C. The rotation of the comet's icy nucleus flings the tail outward into a fixed direction that faces the Sun
- D. The solar wind and radiation pressure from the Sun push the gas and dust of the tail away from the Sun

18. Saturn has a lower average density than water, while Earth has an average density more than five times that of water. What best explains this large difference?

- A. Saturn is made almost entirely of solid heavy metals, while Earth is made of light gases throughout its volume
- B. Saturn is composed mostly of light gases like hydrogen and helium, while Earth is made of denser rock and metal
- C. Saturn is completely hollow at its center, while Earth is solid all the way through to its very inner core
- D. Saturn is much closer to the Sun than Earth is, and the Sun's heat reduces Saturn's overall average density

19. A star much more massive than the Sun reaches the end of its life. Compared with a Sun-like star, how is its death most likely to differ?

- A. The massive star will quietly fade away into a small cool cinder without any dramatic event occurring at all
- B. The massive star will simply expand into a red giant and then remain in that state permanently without changing
- C. The massive star will explode as a supernova and may leave behind a dense neutron star or a black hole
- D. The massive star will split peacefully into several smaller Sun-like stars that continue to shine on for ages

20. Moist air is forced to rise up the windward side of a mountain range, producing heavy rainfall, while the far side stays dry. What is the dry region on the downwind side of the mountains called?

- A. A rain shadow, a dry region that forms where air has lost its moisture climbing over the mountains
- B. A monsoon belt, a region that receives the heaviest seasonal rainfall found anywhere on the continent
- C. A jet stream, a fast-moving ribbon of air that carries all of the moisture away from the mountain range
- D. A temperature inversion, a layer in which the air grows warmer rather than cooler with increasing height

21. On a clear, calm night, the ground loses heat and the air just above it cools, so that fog forms near the surface by morning. What has happened to the air to produce this fog?

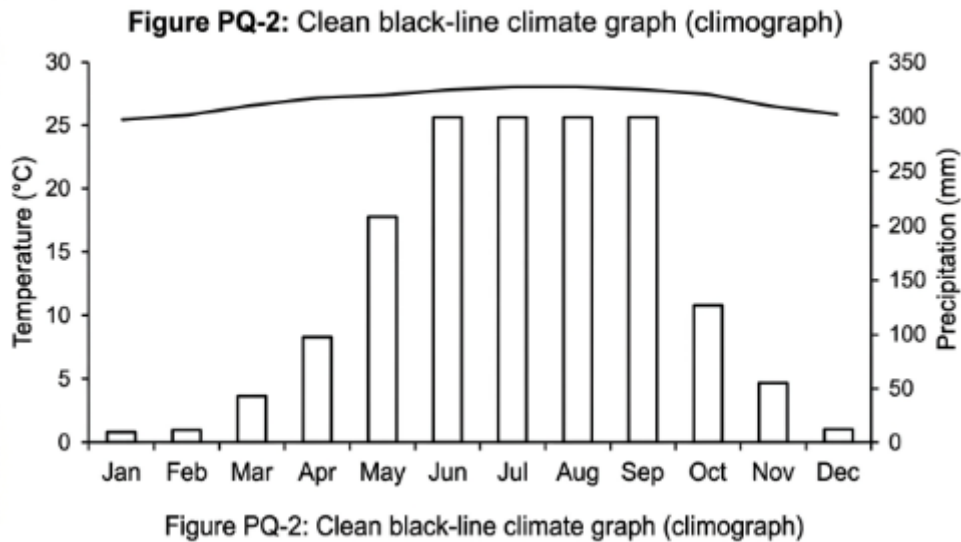
- A. The air has been heated above its boiling point, causing the liquid water in it to turn rapidly into vapor
- B. The air has been blown in from a distant desert, carrying dry dust that scatters the early morning light
- C. The air pressure has risen so high that it has physically squeezed water droplets out of the otherwise dry air
- D. The air has cooled to its dew point, becoming saturated so that the water vapor condenses into tiny droplets

22. In the Northern Hemisphere, winds spiral counterclockwise around a center of low pressure. What two factors combine to produce this rotating pattern?

- A. The pull of the Moon's gravity combined with the steady heating of the air by the midday Sun

- B. Air flowing inward toward the low pressure, combined with the Coriolis deflection to the right
- C. Ocean currents dragging the air around in circles, combined with friction from nearby mountain ranges
- D. The rotation of distant storm systems, combined with the reflection of winds off of the upper atmosphere

23. The climate graph below shows the average monthly temperature and precipitation for a city. Based on the graph, which type of climate does this city most likely have?



- A. A polar climate, with temperatures remaining far below freezing for most of the entire year
- B. A desert climate, with very low precipitation spread evenly across every single month of the year
- C. A tropical climate, with consistently high temperatures and a distinct wet season and dry season
- D. A cold continental climate, with hot summers, freezing winters, and a very large annual temperature range

24. Which type of cloud is most closely associated with thunderstorms and heavy rainfall?

- A. Cumulonimbus, a tall, towering cloud that extends high into the atmosphere and produces storms
- B. Cirrus, a thin, wispy cloud made of ice crystals found high in the sky on otherwise fair-weather days
- C. Stratus, a low, flat, featureless gray layer that usually brings only a light drizzle or a faint mist
- D. Altocumulus, a mid-level cloud appearing as small white patches that generally signal fair weather

25. The Gulf Stream carries warm water from the tropics northward along the eastern coast of North America and toward Europe. What is one major effect of this warm ocean current?

- A. It cools the climate of western Europe, producing much colder winters than its latitude would otherwise suggest
- B. It warms the climate of western Europe, producing milder winters than its high latitude would otherwise suggest
- C. It has no measurable effect on climate at all, since ocean currents cannot transfer heat to the atmosphere
- D. It causes a permanent drought across western Europe by blocking all incoming moisture from reaching the land

26. An air mass that forms over a warm tropical ocean would most likely have which set of characteristics?

- A. Cold and dry, bringing clear skies and sharply falling temperatures wherever the air mass happens to travel
- B. Cold and moist, bringing heavy snowfall and freezing conditions to all of the regions it moves across
- C. Hot and dry, bringing cloudless skies and dust storms typical of a continental desert source region
- D. Warm and moist, bringing humid conditions and the potential for heavy rainfall as the air mass moves inland

27. Multiple independent lines of evidence — rising global temperatures, melting glaciers, rising sea levels, and increasing atmospheric carbon dioxide — point to the same conclusion about Earth's climate. Why is agreement among independent lines of evidence important in science?

- A. It is unimportant, because a single measurement from one instrument is always more reliable than many measurements
- B. It proves that the climate is not changing at all, since so many different things are being measured at once
- C. It strengthens confidence in the conclusion, because separate independent observations support the same finding
- D. It shows that scientists are simply repeating the same single measurement over and over without gathering new data

28. A meteorologist observes that air pressure at a station has been falling steadily over several hours. What change in weather does a falling barometer most often indicate is approaching?

- A. Stormy or unsettled weather, since falling pressure is commonly associated with approaching low-pressure systems
- B. A long stretch of clear, dry, and sunny weather, since falling pressure reliably signals fair conditions ahead
- C. A sudden and lasting drop in humidity, since falling pressure always removes moisture from the surrounding air
- D. No change at all, since changes in air pressure have no useful connection to the weather conditions that follow

29. Why are gases such as carbon dioxide, methane, and water vapor described as greenhouse gases, while nitrogen and oxygen are not?

- A. Carbon dioxide, methane, and water vapor are the only gases in the atmosphere that are heavier than ordinary air
- B. Nitrogen and oxygen are found only high in the atmosphere, while the greenhouse gases all stay close to the ground
- C. The greenhouse gases glow and produce their own heat, while nitrogen and oxygen always remain completely cold
- D. Greenhouse gases absorb and re-emit infrared (heat) radiation, while nitrogen and oxygen largely do not

30. Coal forms over millions of years from the buried remains of ancient plants. Why is coal classified as a nonrenewable resource?

- A. Coal can be manufactured quickly in factories, but doing so is simply far too expensive to ever be worthwhile
- B. Coal is replaced by natural processes within just a few years, but humans extract it only slightly faster than that
- C. Coal forms far more slowly than humans consume it, so the supply cannot be replenished on a human timescale

D. Coal is found in essentially unlimited quantities, so the term nonrenewable refers only to its rising market price

31. Overgrazing of livestock and the clearing of vegetation in semi-arid regions can turn once-productive land into barren desert. This process is known as:

A. Eutrophication, the enrichment of a body of water with nutrients that triggers the rapid overgrowth of algae

B. Desertification, the degradation of dryland into desert as soil is lost and the vegetation disappears

C. Salinization, the buildup of salts in the soil from the repeated evaporation of irrigation water over time

D. Sedimentation, the gradual deposition of fine particles that are carried and then dropped by rivers and streams

32. A power plant taps heat from hot rock and steam deep underground to generate electricity. Which energy source does this plant use?

A. Geothermal energy, which draws on the heat stored within Earth's interior to produce electricity

B. Nuclear energy, which splits the nuclei of heavy atoms to release the heat that is used to make steam

C. Fossil fuel energy, which burns coal or natural gas underground to heat the surrounding rock and water

D. Tidal energy, which captures the daily rise and fall of ocean water driven by the gravity of the Moon

33. Why do scientists consider high biodiversity to be important for the health and stability of an ecosystem?

A. High biodiversity guarantees that no species in the ecosystem will ever go extinct under any conditions at all

B. High biodiversity ensures that every single organism in the ecosystem is exactly the same size and shape

C. High biodiversity allows one single species to take over and control all of the ecosystem's resources alone

D. High biodiversity makes an ecosystem more resilient, since varied species help it recover from disturbances

34. Why is access to clean fresh water expected to become a more serious global challenge in the coming decades?

- A. The total amount of water on Earth is rapidly shrinking as water permanently escapes from Earth into outer space
- B. Clean fresh water has become essentially impossible to treat or purify with any current technology available today
- C. A growing population and increasing pollution are raising the demand placed on a limited supply of fresh water
- D. Fresh water is needed only for drinking, so rising industrial and agricultural use has no real effect on the supply

35. Planting and protecting large forests is one proposed strategy for slowing climate change. How do growing forests help reduce atmospheric carbon dioxide?

- A. Forests reflect incoming sunlight back into space, which directly removes carbon dioxide from the atmosphere
- B. Trees absorb carbon dioxide during photosynthesis and store the carbon in their wood, leaves, and roots
- C. Forests release large amounts of oxygen that chemically destroy the carbon dioxide molecules in the air
- D. Forests physically block carbon dioxide from rising up into the upper layers of the atmosphere above them

36. Open-pit mining for metals and minerals provides materials that society depends on, but it also has significant drawbacks. Which is a common environmental impact of large open-pit mines?

- A. The complete and permanent elimination of all earthquakes in the region surrounding the open-pit mine
- B. A guaranteed long-term increase in the biodiversity of the local plant and animal communities nearby
- C. The natural cooling of the global climate caused by the dust that the mining releases into the atmosphere
- D. The destruction of habitat and the pollution of nearby soil and water by mining waste and runoff

37. A government must decide whether to approve a new dam that would provide clean hydroelectric power but would also flood a river valley and displace wildlife. This decision is best described as:

- A. A trade-off, in which the benefits of the project must be carefully weighed against its costs and drawbacks
- B. A guarantee, in which a project that offers any benefit at all should always be approved without any question
- C. An impossibility, since no single project can ever provide both energy benefits and environmental benefits together
- D. A certainty, in which the outcome of the project can be known exactly with no risk or uncertainty involved at all

38. Scientists place sensors throughout a river system to continuously measure pollution levels over many years. How does collecting this long-term monitoring data help protect the environment?

- A. The data instantly removes all of the pollution from the river the very moment each measurement is recorded
- B. The data replaces the need for any laws or regulations, since simply measuring pollution is enough to stop it
- C. The data reveals trends and sources of pollution, helping guide decisions and evaluate the success of cleanup efforts
- D. The data proves that pollution can never be reduced, so no further action by people is ever worth attempting at all

39. A rock is made of rounded pebbles and gravel cemented together within a finer matrix. How is this rock classified, and how did it form?

- A. As granite, an igneous rock that formed from the slow cooling of magma deep underground over a long time
- B. As conglomerate, a sedimentary rock formed when rounded gravel and pebbles were cemented together
- C. As marble, a metamorphic rock that formed when limestone recrystallized under intense heat and pressure
- D. As obsidian, a volcanic glass that formed when silica-rich lava cooled almost instantly at Earth's surface

40. The Himalaya Mountains, the tallest range on Earth, are still slowly rising today. Which plate tectonic process is responsible for building these mountains?

- A. A divergent boundary, where two plates pull apart and magma rises to create new crust between them
- B. A transform boundary, where two plates slide past one another horizontally without forming any mountains
- C. A hot spot, where a rising plume of magma melts through the middle of a plate far from any boundary
- D. The collision of two continental plates, which crumples and uplifts the crust into towering mountains

41. A geologist is searching for an economically valuable concentration of a metal-bearing mineral that can be profitably mined. Such a deposit is called:

- A. A fossil, the preserved remains or traces of an organism that lived during a past geologic time period
- B. An aquifer, a body of permeable rock or sediment that is capable of storing and transmitting groundwater
- C. An ore, a naturally occurring rock or mineral deposit that contains enough metal to be mined for a profit
- D. A sediment, the loose particles of rock and mineral material that have been transported and then deposited

42. After several days of heavy rain, a steep hillside suddenly gives way and a large mass of soil and rock slides rapidly downslope. This event is an example of:

- A. Mass wasting, the downslope movement of rock and soil under the direct influence of gravity
- B. Deposition, the process by which a stream drops the sediment that it has been carrying downstream
- C. Glaciation, the slow carving of the land surface by the grinding movement of thick sheets of ice
- D. Crystallization, the process by which atoms in a cooling magma arrange themselves into solid mineral grains

43. Plants absorb water through their roots and release water vapor into the atmosphere through tiny openings in their leaves. What is this process in the water cycle called?

- A. Condensation, in which water vapor in the cooling air changes back into many tiny liquid water droplets
- B. Transpiration, in which plants release water vapor into the atmosphere through openings in their leaves
- C. Precipitation, in which water returns from the atmosphere to the surface as rain, snow, sleet, or hail
- D. Infiltration, in which water sitting at the surface soaks downward into the soil and the rock beneath it

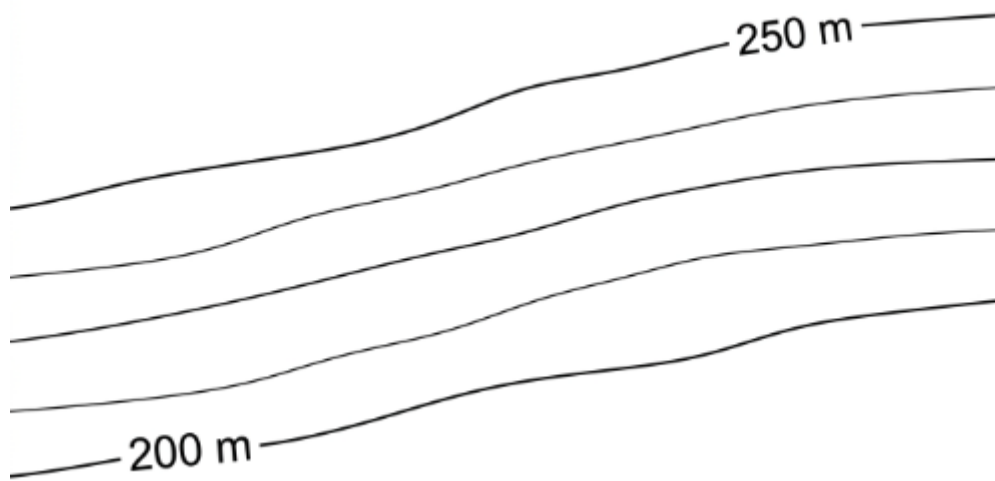
44. Scientists have learned about the structure of Earth's deep interior, which no one can directly observe, primarily by studying:

- A. Deep boreholes that have been drilled all the way through the crust and the mantle down to the outer core
- B. Samples of mantle and core rock carried up to the surface by deep ocean currents over very long periods
- C. Photographs taken by special cameras lowered through natural cracks that reach down into the lower mantle
- D. How earthquake (seismic) waves change speed and direction as they pass through Earth's different layers

45. Iron-rich rocks exposed at the surface gradually develop a reddish-brown crust of rust. Which type of weathering does this rusting represent?

- A. Physical weathering, because the rock is broken into smaller fragments without any change in its composition
- B. Frost wedging, because water has frozen within cracks in the rock and pried the pieces apart over time
- C. Chemical weathering, because the iron in the rock has reacted with oxygen and water to form a new substance
- D. Erosion, because the rust-colored material has been physically transported away from the rock by wind and water

46. On the topographic map below, the labeled contour lines are 200 m and 250 m, with four evenly spaced unlabeled contour lines between them. What is the contour interval of this map?



- A. 5 meters, found by dividing the 50-meter difference between the labeled lines by ten equal spaces
- B. 10 meters, found by dividing the 50-meter difference between the labeled lines by five equal spaces
- C. 25 meters, found by dividing the 50-meter difference between the labeled lines by two equal spaces
- D. 50 meters, taken directly as the difference between the two labeled contour lines themselves

47. What is the fundamental difference between a mineral and a rock?

- A. A mineral is a naturally occurring solid with a definite chemical composition, while a rock is a solid made of one or more minerals
- B. A mineral is always a mixture of many different substances, while a rock is always a single pure chemical compound
- C. A mineral can be formed only by living organisms, while a rock can be formed only from nonliving materials
- D. A mineral and a rock are essentially identical, since the two words describe exactly the same kind of material

48. Water passes much more quickly through a layer of coarse gravel than through a layer of fine clay. Which property of the gravel best explains this faster flow?

- A. The gravel has a much lower porosity than the clay, leaving very little room for any water to enter at all

- B. The gravel particles are far smaller than the clay particles, which creates many more tiny passages for water
- C. The gravel is chemically attracted to water, actively pulling it downward far faster than the clay ever could
- D. The gravel has larger, well-connected pore spaces, giving it a higher permeability than the fine-grained clay

49. An engineering team tests two different designs for a water filter and carefully records how much contaminant each one removes. Why is collecting this data an important part of the design process?

- A. Collecting data is unnecessary, since the more expensive of the two filter designs is always the better choice
- B. The data is used only to advertise the finished product and plays no real role in actually improving the design
- C. The data allows the team to compare the designs objectively and then choose or improve the better-performing one
- D. The data guarantees that the chosen filter design will work perfectly forever under every single possible condition

50. Engineers designing a flood-control system study how a river, its floodplain, wetlands, and rainfall all interact before proposing a solution. Why is it important to consider the whole system rather than just one part?

- A. Considering the whole system is a waste of effort, since changing one part of a system never affects any other part
- B. A change to one part of a connected system can affect the other parts, so understanding these links leads to better solutions
- C. Studying the whole system guarantees that the final design will be the single cheapest option that could possibly be built
- D. Considering the whole system removes all uncertainty, making it possible to predict the future of the river exactly

ANSWERS KEY WITH EXPLANATIONS

1. C — Relative dating establishes only the order in which events occurred, using principles like superposition, while absolute (radiometric) dating provides a numerical age in years from radioactive decay. Both are needed because relative methods sequence events and absolute methods pin them to actual dates.
2. D — By the principle of inclusions, fragments enclosed within a rock must be older than the rock that surrounds them, so the sandstone fragments predate the granite. The granite magma engulfed pieces of preexisting sandstone, which means the sandstone formed first.
3. B — One-quarter remaining means the sample has passed through two half-lives, since each half-life halves the amount ($1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4}$). Two half-lives of 1.3 billion years gives $2 \times 1.3 = 2.6$ billion years, the age of the rock.
4. A — The Mesozoic Era is called the Age of Reptiles because dinosaurs were the dominant land animals throughout most of it. Trilobites belong to the Paleozoic and large mammals to the Cenozoic, so dinosaurs are the group that defines this era.
5. D — Pangaea assembled near the end of the Paleozoic and the start of the Mesozoic before breaking apart into today's continents. Placing this supercontinent at that interval is key to understanding the matching coastlines, fossils, and rock structures across separated landmasses.
6. C — Fossil succession lets geologists place rock layers in different locations into correct time order by comparing the fossils they contain. Because organisms appear and disappear in a fixed sequence, their fossils act as reliable markers for relative age and correlation.
7. A — Banded iron formations record the rise of free oxygen, which reacted with iron dissolved in the early oceans and caused it to precipitate as solid iron-rich layers. These deposits are therefore key evidence of the Great Oxygenation of Earth's oceans and atmosphere.
8. B — A layer containing both Fossil X (470–400 Mya) and Fossil Y (420–360 Mya) must have formed during the interval when their ranges overlap, which is 420 to 400 million years ago. Overlapping fossil ranges narrow the possible age to the time both organisms coexisted.
9. A — A total solar eclipse fits so precisely because the Sun is about 400 times wider than the Moon but also about 400 times farther away, making their angular sizes nearly equal. This coincidence of relative size and distance is why the Moon can just cover the Sun's disk.
10. D — Kepler's first law states that each planet orbits in an ellipse with the Sun at one of the two foci, not at the center. This elliptical shape explains why a planet's distance from the Sun varies over the course of its orbit.
11. A — Each element produces a unique spectral line pattern, so astronomers identify the elements in a distant star by matching its observed lines to known laboratory patterns. This spectral fingerprinting is how the composition of objects far beyond reach is determined.
12. C — Hubble's finding that more distant galaxies recede faster supports the conclusion that the universe is expanding, with galaxies moving apart over time. This expansion is a cornerstone of the Big Bang model of cosmic history.
13. B — Earth retains an atmosphere because its greater mass produces stronger surface gravity, which holds gas molecules near the surface, while the low-mass Moon cannot. Gravitational strength tied to mass is what determines whether a body keeps an atmosphere.
14. D — The hemispheres have opposite seasons because of Earth's axial tilt: when the Northern Hemisphere tilts toward the Sun for summer, the Southern Hemisphere tilts away and has winter. The tilt, not distance from the Sun, drives this seasonal opposition.

15. C — The mass that appears lost when hydrogen fuses into helium is converted into energy according to $E = mc^2$, releasing the enormous power that makes the Sun shine. This mass-to-energy conversion is the fundamental source of stellar energy.
16. A — The far-side tidal bulge forms because the Moon's gravity pulls the solid Earth more strongly than it pulls the water on the opposite side, leaving that water bulging outward. This differential pull across Earth produces two bulges and therefore two high tides.
17. D — A comet's tail points away from the Sun because the solar wind and the Sun's radiation pressure push the released gas and dust outward, regardless of the comet's travel direction. The Sun, not the comet's motion, controls the tail's orientation.
18. B — Saturn's very low density results from its composition of mostly light hydrogen and helium gas, while Earth's much higher density comes from its rock and metal makeup. The difference in materials, not structure or distance, accounts for the large density gap.
19. C — A star far more massive than the Sun ends its life by exploding as a supernova, often leaving behind a dense neutron star or a black hole. The greater mass drives a far more violent death than the quiet red-giant-to-white-dwarf fate of a Sun-like star.
20. A — The dry downwind region is a rain shadow, formed because air loses its moisture as heavy rain while climbing the windward slope, leaving little for the leeward side. This explains why one side of a mountain range can be lush while the other is arid.
21. D — Radiational cooling lowers the air temperature to its dew point, at which the air becomes saturated and water vapor condenses into the tiny droplets that form fog. Cooling to saturation, not heating or compression, is what produces this overnight fog.
22. B — Counterclockwise flow around a Northern Hemisphere low results from air moving inward toward the low pressure combined with the Coriolis deflection to the right of that motion. These two factors together bend the inflow into a counterclockwise spiral.
23. C — Consistently high temperatures near 26°C all year with a pronounced wet season and dry season indicate a tropical climate. The small temperature range plus strongly seasonal rainfall is the signature of a tropical wet-and-dry climate rather than a polar, desert, or continental one.
24. A — Cumulonimbus clouds are the tall, towering clouds that extend high into the atmosphere and produce thunderstorms and heavy rain. Their great vertical development, driven by strong updrafts, is what makes them the storm-producing cloud type.
25. B — The Gulf Stream carries tropical warmth toward western Europe, giving it milder winters than its high latitude would otherwise produce. This transport of ocean heat shows how currents moderate the climates of the coasts they reach.
26. D — An air mass forming over a warm tropical ocean takes on warm, moist characteristics and can bring humid conditions and heavy rainfall as it moves inland. The temperature and moisture of an air mass reflect the source region where it formed.
27. C — Agreement among independent lines of evidence strengthens confidence in a conclusion because separate, unrelated observations converging on the same finding are unlikely to all be wrong. This convergence is why multiple consistent measurements make a scientific conclusion more robust.
28. A — A steadily falling barometer usually signals approaching stormy or unsettled weather, because dropping pressure is associated with incoming low-pressure systems. Tracking pressure trends is therefore a basic tool for short-term forecasting.
29. D — Carbon dioxide, methane, and water vapor are greenhouse gases because they absorb and re-emit infrared radiation, trapping heat, while nitrogen and oxygen largely do not. This selective absorption of heat radiation is what makes a gas a greenhouse gas.

30. C — Coal is nonrenewable because it forms over millions of years yet is consumed far faster than that, so its supply cannot be replenished on any human timescale. The mismatch between slow formation and rapid use is the basis for the nonrenewable classification.
31. B — Desertification is the degradation of semi-arid land into desert as vegetation is lost and soil erodes, often driven by overgrazing and clearing. Identifying this process highlights how human land use can permanently reduce a region's productivity.
32. A — A plant using underground heat and steam to generate electricity is using geothermal energy, which draws on heat stored within Earth's interior. This source is renewable because Earth's internal heat is continuously available.
33. D — High biodiversity makes an ecosystem more resilient because a variety of species helps it absorb and recover from disturbances such as disease or climate stress. A diverse community provides more pathways for the system to remain stable when conditions change.
34. C — Clean fresh water is becoming a greater challenge because a growing population and increasing pollution raise demand on a limited freshwater supply. The combination of rising use and contamination, not a loss of total water, is what strains availability.
35. B — Growing forests reduce atmospheric carbon dioxide because trees absorb it during photosynthesis and store the carbon in their wood, leaves, and roots. This uptake and storage make forests important natural carbon sinks for slowing climate change.
36. D — A common impact of large open-pit mines is the destruction of habitat and the pollution of nearby soil and water by mining waste and runoff. Recognizing these effects underscores the environmental trade-offs of extracting needed mineral resources.
37. A — Approving a dam that provides clean power but floods a valley and displaces wildlife is a trade-off, in which benefits must be weighed against costs and drawbacks. Most resource and engineering decisions involve such balancing of competing outcomes.
38. C — Long-term monitoring data reveals pollution trends and identifies sources, which helps guide management decisions and measure whether cleanup efforts are working. The value of the data lies in informing action, not in removing pollution by itself.
39. B — A rock of rounded pebbles and gravel cemented in a finer matrix is conglomerate, a clastic sedimentary rock formed by the deposition and cementing of coarse rounded sediment. The rounded clasts indicate transport by water before burial and cementation.
40. D — The Himalayas are built by the collision of two continental plates, which crumples and uplifts the crust into towering mountains and continues to raise them today. Continental collision, unlike subduction or spreading, produces the planet's highest ranges.
41. C — An economically valuable mineral deposit containing enough metal to mine profitably is called an ore. Distinguishing ore from ordinary rock is central to locating the resources society relies on for metals.
42. A — A rain-triggered hillside collapse is mass wasting, the downslope movement of rock and soil under the direct influence of gravity. Saturated soil loses strength, allowing gravity to pull the slope material rapidly downhill.
43. B — Plants releasing water vapor to the atmosphere through openings in their leaves is transpiration, a key pathway in the water cycle. Transpiration returns substantial amounts of soil water to the air, linking vegetation to atmospheric moisture.
44. D — Earth's deep interior is mapped mainly by studying how seismic waves change speed and direction as they pass through layers of differing composition and state. These changes in wave behavior reveal boundaries and properties that cannot be observed directly.

45. C — The rusting of iron-rich rock is chemical weathering, because the iron reacts with oxygen and water to form a new compound rather than merely breaking apart. The change in chemical composition is what distinguishes chemical from physical weathering.
46. B — With 200 m and 250 m labeled and four unlabeled lines between them, the 50-meter difference is divided into five equal spaces, giving a contour interval of 10 meters. Counting the spaces between labeled lines is the method for finding the interval.
47. A — A mineral is a naturally occurring solid with a definite chemical composition, while a rock is a solid composed of one or more minerals. This distinction clarifies that rocks are aggregates built from individual minerals.
48. D — Coarse gravel transmits water faster because its larger, well-connected pore spaces give it high permeability, whereas fine clay's tiny pores resist flow. Permeability depends on how easily water moves through connected spaces, which favors the gravel.
49. C — Recording how much contaminant each filter removes lets the team compare the two designs objectively and choose or improve the better performer. Data-driven evaluation is essential to the engineering process of refining a solution.
50. B — Considering the whole system matters because a change to one part of a connected system can affect the others, so understanding those links leads to better solutions. Systems thinking helps engineers anticipate side effects that a narrow focus would miss.