PRACTICE EXAM 26: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. According to the Big Bang theory, what was the early universe like in the moments after it began?

A. It was a cold, empty void containing only scattered, fully formed galaxies far apart from one another

B. It was filled with the heavy elements like iron and gold that make up the rocky planets we see today

C. It was a stable, unchanging sea of stars that has looked essentially the same throughout all of time

D. It was extremely hot and dense, then expanded and cooled, allowing matter and later atoms to form

2. A vast, slowly spinning cloud of gas and dust in space begins to contract under its own gravity. As the center grows hot and dense enough to begin fusion, what has formed?

A. A new star, which now generates energy by fusing hydrogen into helium deep within its core

B. A new planet, which is too small and cool to ever generate any energy of its own by fusion

C. A black hole, which forms whenever any cloud of gas and dust in space begins to contract

D. A comet, which is a small icy body that forms in the cold outer regions far from any star

3. Stars produce energy by fusing lighter atomic nuclei into heavier ones. Which process correctly describes the main fusion reaction in a star like the Sun?

A. Iron nuclei are split apart into lighter nuclei, releasing energy in a chain reaction in the core

B. Hydrogen nuclei are fused together to form helium nuclei, releasing energy in the process

C. Helium nuclei are broken down into hydrogen nuclei, which then escape into space as solar wind

D. Carbon and oxygen nuclei are combined to form hydrogen, the lightest element, within the core

4. A planet orbits the Sun at an average distance of 16 AU. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is the planet's approximate orbital period?

A. About 16 years, because the orbital period in years is always equal to the average distance in AU

B. About 4 years, because the orbital period equals the square root of the average distance in AU

C. About 64 years, because 16 cubed is 4,096, and the square root of 4,096 equals 64 years

D. About 48 years, because the orbital period always equals the average distance multiplied by three

5. Earth's axis is tilted about 23.5 degrees relative to the plane of its orbit around the Sun. What is the main effect of this axial tilt?

A. It causes the seasons by changing the angle and the number of daylight hours each hemisphere receives

B. It causes day and night by spinning each hemisphere into and out of the sunlight every 24 hours

C. It causes the phases of the Moon by changing the angle at which we view the sunlit lunar surface

D. It causes ocean tides by varying the strength of the Sun's gravitational pull throughout the year

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

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

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

C. A waxing crescent, the thin sliver phase the Moon passes through just after it leaves the new moon

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

7. All eight planets orbit the Sun in the same direction, and most of their moons orbit in the same direction as well. Which idea best explains this widespread shared direction of motion?

A. The Sun's light physically pushes all the planets and moons to travel in one common direction

B. The whole solar system formed from one spinning cloud, and its objects inherited that spinning motion

C. The planets were each captured separately from space and happened by chance to all move alike

D. Collisions among the planets over billions of years gradually forced them all to move in one direction

8. Earth's shadow falls on the Moon during a lunar eclipse. For this to happen, the Moon must be on the opposite side of Earth from the Sun. During which moon phase do lunar eclipses occur?

A. The full moon phase, when the fully lit Moon lies opposite the Sun and can pass into Earth's shadow

B. The new moon phase, when the Moon lies directly between Earth and the Sun and appears dark to us

C. The first quarter phase, when the Moon appears exactly half illuminated from our view on Earth

D. The waxing crescent phase, when only a thin sliver of the Moon's surface appears to be illuminated

9. At certain times of the month, the difference between high tide and low tide is smaller than usual. These weaker tides, called neap tides, occur during which moon phases?

A. The new moon and full moon, when the Sun and Moon are lined up and their pulls add together

B. The waxing and waning crescent phases, when only a thin part of the Moon's face is illuminated

C. The first quarter and last quarter, when the Sun and Moon pull at right angles and partly cancel out

D. Total lunar eclipse events, when Earth's shadow completely covers the entire face of the full moon

10. The Sun's enormous energy output comes from reactions occurring in which region of the Sun?

A. The corona, the faint, very hot outer atmosphere that streams charged particles out into space

B. The core, the central region where temperatures and pressures are high enough for fusion to occur

C. The photosphere, the visible surface layer where dark, cooler sunspots appear and then fade away

D. The chromosphere, a thin reddish layer that becomes briefly visible during a total solar eclipse

11. Why does the equator receive more intense solar energy throughout the year than the polar regions do?

A. The equator is much closer to the Sun than the poles are because of the Earth's rotation on its axis

B. The Sun deliberately directs more of its radiation toward the equator than toward the polar regions

C. The polar regions are covered in bright ice that creates extra sunlight by reflecting it back and forth

D. Near the equator, sunlight strikes the surface more directly, concentrating its energy on a smaller area

12. A cliff exposes several undisturbed horizontal layers of sedimentary rock. According to the principle of superposition, where is the oldest layer located?

A. At the bottom of the sequence, because in undisturbed layers the lowest one was deposited first

B. At the top of the sequence, because the highest layer is always the first one to be deposited

C. In the exact middle of the sequence, because the central layers always form before the others

D. The oldest layer cannot be identified, since all layers in a cliff are exactly the same age

13. A radioactive isotope has a half-life of 2 billion years. A mineral sample now contains one-eighth of its original amount of this isotope. How old is the mineral sample?

A. About 2 billion years old, because one half-life reduces the isotope to one-eighth of its original amount

B. About 4 billion years old, because two half-lives reduce the isotope to one-eighth of its original amount

C. About 6 billion years old, because three half-lives reduce the isotope to one-eighth of its original amount

D. About 16 billion years old, because eight half-lives reduce the isotope to one-eighth of its original amount

14. Why can two rock layers found on different continents be matched as the same age if they both contain the same species of an extinct, short-lived organism?

A. Because rock layers on different continents are always made of exactly the same minerals and colors

B. Because that organism existed only during one narrow span of time, so both layers formed during that span

C. Because the organism could swim across the ocean, proving the two layers were once joined together

D. Because the organism is still alive today, which means both rock layers must have formed very recently

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

A. A period during which sediment was deposited continuously with no break in the rock record at all

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

C. A place where molten rock pushed upward and cooled between two older layers of sedimentary rock

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

16. A worldwide layer of rock about 66 million years old is unusually rich in the rare element iridium and contains shocked quartz. What event does this evidence most strongly support?

A. A massive asteroid impact, which scattered iridium worldwide and contributed to a major mass extinction

B. A long, gradual cooling of the climate that slowly lowered sea levels over tens of millions of years

C. A series of ordinary volcanic eruptions that produced thick layers of lava across the continents

D. A reversal of Earth's magnetic field, which is recorded in rocks forming on the ocean floor over time

17. Geologists have measured the ages of rocks across the ocean floor. What pattern did they find, and what does it support?

A. The rocks are oldest at the mid-ocean ridges and youngest near the continents, supporting a shrinking ocean

B. The rocks are all exactly the same age everywhere, supporting the idea that the ocean floor never moves

C. The rocks are youngest at the mid-ocean ridges and grow older with distance, supporting seafloor spreading

D. The rocks are oldest in the deepest ocean trenches, supporting the idea that the continents are sinking

18. A rock layer is made of rounded pebbles and cobbles of various sizes cemented together in a sandy matrix. Which past environment is most consistent with this rock?

A. A deep, calm ocean basin where only the very finest clay particles slowly settled to the bottom over time

B. A fast-moving river or streambed where flowing water rounded the pebbles and deposited them together

C. A dry desert where gentle winds slowly piled fine, well-sorted sand into large, sweeping dunes over time

D. A still lagoon where dissolved minerals slowly crystallized out of evaporating seawater to form the rock

19. Off the western coast of South America lies a deep ocean trench, and just inland rises a chain of volcanoes. What plate process produces both the trench and the volcanoes?

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

B. Two plates sliding horizontally past each other along a fault, producing earthquakes but no volcanoes

C. Two plates pulling apart at a divergent boundary, where rising magma creates a long underwater ridge

D. An oceanic plate subducting beneath a continental plate, forming a trench and feeding inland volcanoes

20. S-waves from an earthquake cannot travel through Earth's outer core, while P-waves pass through it but slow down. What do these observations together reveal about the outer core?

A. The outer core is liquid, because S-waves cannot travel through liquids while P-waves can pass through them

B. The outer core is completely solid, because both wave types travel through it without any change at all

C. The outer core is made of gas, because gases are the only materials that can stop S-waves from passing

D. The outer core does not exist, since the waves prove Earth is solid rock all the way to its center

21. Deep underground, intense heat and pressure cause the minerals in an existing rock to recrystallize and form bands, without the rock ever melting. What type of rock results from this process?

A. A sedimentary rock, formed by the compaction and cementing of loose particles into solid layers

B. An extrusive igneous rock, formed when molten lava erupts at the surface and cools very quickly

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

D. A clastic rock, formed when fragments of older rocks are transported, deposited, and cemented

22. On the Mohs hardness scale, talc has a hardness of 1 and diamond has a hardness of 10. What does a higher number on this scale indicate about a mineral?

A. The mineral is more brightly colored and reflects more light than minerals with lower hardness numbers

B. The mineral is harder and more resistant to being scratched than minerals with lower hardness numbers

C. The mineral is denser and contains more mass in a given volume than minerals with lower numbers

D. The mineral is more common and found in far greater amounts than minerals with lower hardness numbers

23. A coarse-grained igneous rock has large mineral crystals that are easily seen with the unaided eye. What does the large crystal size indicate about how this rock formed?

A. The magma cooled slowly deep beneath the surface, giving the crystals a long time to grow large

B. The lava cooled almost instantly at the surface, freezing the crystals before they could grow at all

C. The rock formed from sediment that was compacted, so its crystals are actually rounded sand grains

D. The rock was squeezed and heated until it melted and then refroze into one single giant crystal

24. When water evaporates from the ocean surface on a sunny day, energy is required to change the liquid water into water vapor. Where does this energy come from?

A. From the Moon's gravity, which lifts the water molecules upward and turns them into vapor in the air

B. From the chemical breakdown of salt in the seawater, which releases the energy needed for evaporation

C. From the rotation of the Earth, which flings water molecules off the ocean surface and into the air

D. From the Sun, whose energy warms the water and provides the heat needed to evaporate it into vapor

25. A geologist is looking for an underground layer that will let water flow easily toward a well. Which property of the rock most directly determines how quickly water can move through it?

A. Color, since darker rocks absorb more heat and therefore allow groundwater to flow through more quickly

B. Permeability, which describes how easily water can pass through the connected pore spaces in the rock

C. Hardness, since harder rocks always allow water to pass through them more easily than softer rocks do

D. Density, since the heaviest rocks per unit volume are always the ones that let water flow the fastest

26. For millions of years, carbon was stored underground in coal, oil, and natural gas. How are humans changing the carbon cycle by burning these fossil fuels?

A. By removing carbon dioxide from the air and locking it back into the ground, cooling the planet steadily

B. By having no effect on atmospheric carbon, since the amount released by burning fuels is far too small

C. By rapidly releasing stored carbon as carbon dioxide, adding it to the atmosphere faster than it is removed

D. By turning atmospheric carbon dioxide into solid rock, permanently burying the carbon deep underground

27. Which of the following is an example of a negative feedback that helps stabilize Earth's climate rather than amplify a change?

A. As carbon dioxide and temperatures rise, plants grow faster and absorb more carbon dioxide, slowing the warming

B. As ice melts, the darker ground absorbs more sunlight, which warms the planet and melts even more ice

C. As permafrost thaws, it releases methane, a greenhouse gas, which traps heat and thaws still more permafrost

D. As the air warms, it holds more water vapor, a greenhouse gas, which traps heat and warms the air further

28. In a region with thick limestone bedrock and abundant rainfall, large underground caves form over long periods of time. What process is mainly responsible for creating these caves?

A. Frost wedging, in which water freezing in cracks expands and physically breaks the limestone into pieces

B. Wind abrasion, in which sand carried by the wind grinds away at the limestone and hollows out the caves

C. Glacial erosion, in which a moving sheet of ice scrapes and carves the underground caves out of the rock

D. Chemical weathering, in which slightly acidic groundwater slowly dissolves the soluble limestone over time

29. After a river overflows its banks during a flood, it spreads across the surrounding low, flat land and drops a layer of fine sediment there. Over many floods, this builds a flat, fertile area beside the river. What is this landform called?

A. A volcanic plateau, a broad flat area built up from layer upon layer of cooled lava from past eruptions

B. A floodplain, the flat land beside a river that is built up by sediment deposited during repeated floods

C. A glacial moraine, a ridge of unsorted rock debris bulldozed and dropped along the edge of a glacier

D. A sand dune field, an area of wind-piled sand mounds that slowly migrate downwind across the land

30. In winter, a continental polar (cP) air mass moves southward from northern Canada into the northern United States. What temperature and moisture would this air mass bring?

A. Warm and humid air, bringing high humidity and a strong chance of heavy thunderstorms to the region

B. Mild and moist ocean air, bringing long stretches of cloudy skies, fog, and frequent light drizzle

C. Cold and dry air, often bringing clear skies along with sharply colder temperatures across the region

D. Hot and dry desert air, bringing extended drought conditions and clouds of blowing dust to the area

31. A warm front approaches a region as warm air slowly slides up and over a mass of retreating cooler air. What weather is most typical as a warm front passes?

A. A long period of gentle, steady rain or drizzle, followed by warmer, more humid air once the front passes

B. A sudden, violent line of thunderstorms followed within minutes by a sharp drop into cold, dry air behind

C. Several days of completely clear skies and steady high pressure with no clouds or precipitation at all

D. Strong gusty winds and a rapid plunge in temperature as dense cold air pushes in beneath the warm air

32. Two cities report the same air temperature of 25°C. In City X the dew point is 24°C, and in City Y the dew point is 8°C. What can be concluded about the humidity in the two cities?

A. City Y has higher humidity than City X, because a larger gap between temperature and dew point means moister air

B. Both cities have exactly the same humidity, since the air temperature is identical at 25°C in both places

C. Neither city has any humidity, because humidity exists only when the temperature and dew point are far apart

D. City X has higher humidity than City Y, because its dew point is much closer to the actual air temperature

33. Why do hurricanes form over warm tropical oceans and quickly weaken once they move over land?

A. Land is warmer than the ocean, and the extra heat causes the storm to spin apart as soon as it moves ashore

B. The Coriolis effect vanishes completely the moment a hurricane crosses from the open ocean onto the land

C. Warm ocean water supplies the heat and moisture that power the storm, and moving over land cuts off that supply

D. Land is much smoother than the ocean surface, so the reduced friction causes the storm to lose all its energy

34. The two most abundant gases in Earth's atmosphere, nitrogen and oxygen, are not greenhouse gases. Which gases are responsible for most of the natural greenhouse effect?

A. Hydrogen and helium, the two lightest gases, which rise high in the atmosphere and reflect heat downward

B. Carbon dioxide and water vapor, which absorb outgoing infrared energy and re-radiate it back toward the surface

C. Neon and argon, two unreactive gases that trap nearly all of the incoming sunlight before it reaches the surface

D. Ozone and chlorine, two gases that warm the lower atmosphere by speeding up the escape of heat into space

35. Air moves from regions of higher pressure toward regions of lower pressure, but instead of moving in straight lines, large-scale winds curve. What causes global winds to curve as they travel?

A. The Coriolis effect, caused by Earth's rotation, which deflects moving air to one side rather than letting it go straight

B. The gravitational pull of the Moon, which drags the moving air sideways as the Moon orbits around the Earth

C. The friction of the winds against the Sun's radiation, which bends the air toward the warmer parts of the sky

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

36. A meteorologist explains that even as the global climate warms over decades, individual years and seasons will still vary, with some cooler than others. What is the best reason for this?

A. Global warming has actually stopped, which is why some years and seasons still turn out to be cooler than others

B. The global climate is not really warming at all, since a truly warming climate would make every single year warmer

C. Climate is a long-term average, so short-term natural variations cause individual years to rise and fall around the trend

D. Cooler years prove that human activities have no effect on the climate and that all temperature changes are random

37. Which list contains energy resources that are all renewable?

A. Coal, petroleum, and natural gas, all of which are burned in power plants to generate the electricity we use

B. Uranium, coal, and oil, all of which are mined or pumped from underground and are used up once they are consumed

C. Gasoline, diesel, and natural gas, all of which are fuels produced by refining crude oil pumped from the ground

D. Wind, sunlight, and flowing water, all of which are continuously renewed by natural processes on the Earth

38. A power plant lowers its operating costs by releasing pollution into a river, but downstream towns must spend money to clean their water as a result. What term describes the cleanup cost borne by the downstream towns?

A. A private profit, since it is money that the power plant earns directly by selling the electricity it produces

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

C. A renewable resource, since the downstream towns can keep using their river water over and over without limit

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

39. According to ecological research, what is currently the single largest cause of biodiversity loss worldwide?

A. Habitat destruction, in which natural ecosystems are cleared and converted for farming, cities, and other human uses

B. Light pollution from cities, in which artificial lighting at night disrupts the natural behaviors of nocturnal animals

C. The eruption of volcanoes, in which lava and ash bury ecosystems and wipe out the organisms living within them

D. Natural predators, in which carnivores hunt and reduce the populations of the prey species they feed upon

40. A natural wetland slows down floodwaters and filters pollutants out of the water that passes through it. These benefits are best classified as which type of ecosystem service?

A. A provisioning service, because the wetland directly supplies people with food, timber, and other raw materials

B. A cultural service, because the wetland provides people with recreation, natural beauty, and spiritual inspiration

C. A regulating service, because the wetland moderates flooding and improves water quality through natural processes

D. A nonrenewable resource, because the wetland's ability to filter water is used up completely after a single flood

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

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

B. Average global surface temperatures will soon begin to fall as greenhouse gas concentrations keep increasing

C. The oceans will slowly become more alkaline and basic as they absorb more carbon dioxide from the atmosphere

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

42. The thinning of the protective ozone layer high in the atmosphere over Antarctica was caused mainly by which human-made chemicals?

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

B. Chlorofluorocarbons (CFCs), chemicals once widely used in refrigerators, air conditioners, and aerosol sprays

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

D. Nitrogen fertilizers spread across farm fields that then washed off into nearby rivers, lakes, and oceans

43. A farmer wants to keep the soil on a sloping field from washing away during heavy rains while keeping the field productive. Which practice would best achieve this?

A. Plowing the field in straight rows running straight up and down the slope so that water drains off it quickly

B. Removing every plant and leaving the soil completely bare between growing seasons to make planting easier

C. Planting cover crops and plowing along the curves of the slope to slow runoff and hold the soil in place

D. Clearing all the trees and shrubs from around the field so that even more of the slope can be planted

44. Although water covers most of Earth's surface, fresh water suitable for human use is quite limited. Why is most of Earth's water not usable as fresh drinking water?

A. The vast majority of Earth's water is salt water in the oceans, and most fresh water is frozen in ice or deep underground

B. Most of Earth's water has been used up and permanently destroyed by human activities over the past few centuries

C. Nearly all of Earth's water is locked away inside the bodies of living plants and animals around the world

D. The majority of Earth's water exists only as invisible water vapor floating high above the surface in the atmosphere

45. A coastal city builds higher sea walls and raises its roads to protect against the flooding caused by rising sea levels. Which type of climate change strategy does this best represent?

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

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

C. Prevention, because these actions will completely stop the sea level from ever rising along this coast again

D. Adaptation, because the city is adjusting its infrastructure to cope with climate impacts that are already happening

46. As the ocean absorbs more carbon dioxide from the atmosphere and becomes more acidic, which marine organisms are most directly threatened?

A. Fast-swimming predatory fish that depend mainly on their powerful muscles and gills to chase down their prey

B. Shell-building organisms such as corals, oysters, and clams, which need carbonate minerals to form their shells

C. Large marine mammals such as whales and dolphins, which must surface regularly to breathe air from above

D. Floating seaweeds and kelp near the surface, which rely on sunlight to carry out photosynthesis each day

47. Agriculture, permanent villages, and the first cities all arose during the Holocene Epoch, a span of roughly 11,000 years with an unusually stable climate. Why was this climate stability so important?

A. The stable climate caused brand-new species of humans to evolve rapidly during this very short geologic epoch

B. The stable climate finally raised the level of oxygen in the atmosphere high enough for humans to breathe and survive

C. The stable climate made growing seasons dependable, which allowed reliable farming and the rise of settled communities

D. The stable climate permanently eliminated all droughts, floods, and storms, leaving early farmers with no risks to face

48. A town wants engineers to design a system that will reduce the damage caused by flooding along a local river. Which step should come first in the engineering design process?

A. Clearly defining the problem, including the goals the solution must meet and the limits the design must work within

B. Immediately building the most expensive flood control system that has ever been used in any other town anywhere

C. Selecting the design that looks the most modern and impressive, without studying the river or the town's needs at all

D. Asking residents only which color they would like the finished flood control structures to be painted in the end

49. Engineers designing a new playground are told it must be safe for young children (a goal the design must achieve) and must cost no more than a set amount of money (a limit it cannot exceed). The safety goal and the cost limit are examples of, in order, which two things?

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

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

C. Two externalities, since both are costs that fall on people who are not involved in building the playground at all

D. Two feedback loops, since each describes the way the playground responds to changes in its surroundings over time

50. Scientists build a computer model to forecast how a city's flood risk would change if it restored nearby wetlands instead of building a concrete wall. What is the main benefit of testing these options with a model first?

A. The model guarantees one exact result that is certain to occur no matter what conditions actually arise in the future

B. The model removes any need to ever collect real measurements of the city's rainfall, river levels, or flooding again

C. The model proves with complete certainty that wetlands and walls will have identical effects on the city's flood risk

D. The model lets scientists compare the likely outcomes of each option before the city spends money to build either one

ANSWERS KEYS WITH EXPLANATIONS

1. D — The Big Bang theory holds that the early universe was extremely hot and dense, then expanded and cooled, allowing matter and eventually atoms to form. Galaxies and heavy elements came later, not at the very start. This hot, dense beginning followed by expansion is the core of the theory.
2. A — When a contracting cloud's center grows hot and dense enough to ignite fusion, a new star has formed and begins fusing hydrogen into helium in its core. Gravitational collapse is what concentrates and heats the matter to fusion temperatures. This marks the birth of a star from a nebula.
3. B — In a star like the Sun, hydrogen nuclei fuse together to form helium, releasing energy in the process. This proton-proton fusion converts a small amount of mass into energy. Fusion of light nuclei, not fission of heavy ones, powers ordinary stars.
4. C — Kepler's Third Law gives $T^2 = a^3$, so with a = 16, $a^3 = 4{,}096$ and T equals the square root of 4,096, which is 64 years. The cube of the distance sets the square of the period. This relationship applies to any planet orbiting the Sun.
5. A — Earth's 23.5-degree axial tilt causes the seasons by changing the angle of sunlight and the number of daylight hours each hemisphere receives as Earth orbits. The hemisphere tilted toward the Sun has summer. The tilt, not distance, is the source of seasonal change.
6. D — The more-than-half, growing phase between first quarter and full moon is the waxing gibbous. "Waxing" means the illuminated portion is increasing, and "gibbous" means more than half lit. This phase precedes the full moon in the lunar cycle.
7. B — The shared direction of planetary and lunar orbits is explained by the whole solar system forming from one spinning cloud, with its objects inheriting that rotational motion. The original spin of the collapsing nebula set the common direction. This is a key prediction of the nebular hypothesis.
8. A — Lunar eclipses occur at the full moon phase, when the fully lit Moon lies opposite the Sun and can pass into Earth's shadow. Only then is the geometry right for Earth's shadow to fall on the Moon. A tilted lunar orbit is why this does not happen every full moon.
9. C — Neap tides, the smallest tidal ranges, occur at first and last quarter, when the Sun and Moon pull at right angles and their effects partly cancel. The misaligned pulls produce weaker bulges. This contrasts with the larger spring tides at new and full moon.
10. B — The Sun's energy is generated in its core, where temperatures and pressures are high enough for nuclear fusion to occur. Only the core has the extreme conditions needed to fuse hydrogen into helium. The energy then slowly travels outward to the surface and into space.
11. D — The equator receives more intense solar energy because sunlight strikes it more directly, concentrating the energy over a smaller surface area. At the poles the same light spreads over a larger area at a low angle. The angle of insolation, not distance to the Sun, controls this difference.
12. A — By the principle of superposition, the oldest layer in an undisturbed sequence is at the bottom, because the lowest layer was deposited first. Sediments accumulate from the bottom upward over time. This rule is the foundation of relative dating in horizontal strata.
13. C — One-eighth remaining means three half-lives have passed, since $1 \rightarrow 1/2 \rightarrow 1/4 \rightarrow 1/8$. Three half-lives × 2 billion years equals 6 billion years. Counting the number of halvings is the key to radiometric age problems.
14. B — Because the organism existed only during one narrow span of time, finding it in layers on different continents means both layers formed during that same span and can be matched in age.

Such short-lived, widespread species make excellent index fossils. This allows correlation of rocks across great distances.

15. D — An unconformity represents a gap in the rock record, a span of time when rock was eroded away or never deposited. The eroded surface separates older rock below from younger rock above. Unconformities show that the geologic record is often incomplete.
16. A — The worldwide iridium layer and shocked quartz point to a massive asteroid impact, which scattered iridium globally and contributed to a major mass extinction. Iridium is rare in Earth's crust but common in asteroids, and shocked quartz forms under impact pressures. This evidence links the impact to the end-Cretaceous extinction.
17. C — Seafloor rocks are youngest at the mid-ocean ridges and grow older with distance, which supports seafloor spreading. New crust forms at the ridge and moves outward in both directions over time. This age pattern is direct evidence of plate divergence.
18. B — Rounded pebbles and cobbles of various sizes cemented together indicate a fast-moving river or streambed, where flowing water rounded the fragments and deposited them. The rounding comes from tumbling in moving water. This forms the sedimentary rock conglomerate.
19. D — A deep trench paired with inland volcanoes forms where an oceanic plate subducts beneath a continental plate. The trench marks the subduction zone, and the sinking plate melts to feed the volcanoes. This oceanic-continental convergence created features like the Andes.
20. A — The blocking of S-waves while P-waves pass through reveals that the outer core is liquid, since S-waves cannot travel through liquids but P-waves can. The S-wave shadow zone is direct evidence of this liquid layer. Seismic wave behavior is how scientists mapped Earth's interior.
21. C — Heat and pressure recrystallizing and banding a rock without melting it produces a metamorphic rock. Metamorphism alters existing rock in the solid state, developing new textures like foliation. Because there is no melting, it is metamorphic rather than igneous.
22. B — On the Mohs scale, a higher number means the mineral is harder and more resistant to scratching. Hardness is determined by which minerals a sample can scratch and be scratched by. The scale ranks minerals from soft talc at 1 to hard diamond at 10.
23. A — Large, easily visible crystals indicate that the magma cooled slowly deep beneath the surface, giving the crystals a long time to grow. Slow cooling is the signature of intrusive igneous rocks. Rapid surface cooling, by contrast, produces fine-grained or glassy textures.
24. D — The energy that evaporates ocean water comes from the Sun, whose warmth supplies the heat needed to change liquid water into vapor. Solar energy drives evaporation and the entire water cycle. Without the Sun's input, this phase change would not occur.
25. B — Permeability, which describes how easily water passes through the connected pore spaces, most directly determines how quickly water moves through rock. A material can hold water yet transmit it slowly if its pores are poorly connected. High permeability is essential for a productive aquifer.
26. C — Burning fossil fuels rapidly releases stored carbon as carbon dioxide, adding it to the atmosphere faster than natural processes remove it. This releases carbon that was locked away for millions of years. The resulting buildup is the main driver of human-caused climate change.
27. A — Faster plant growth that absorbs more carbon dioxide and slows the warming is a negative feedback, because it counteracts the original change and helps stabilize the climate. Negative feedbacks dampen disturbances. The other options describe positive feedbacks that amplify warming.

28. D — Caves in limestone form by chemical weathering, as slightly acidic groundwater slowly dissolves the soluble rock. The reaction removes rock by dissolving it rather than breaking it physically. This process creates the cave systems typical of limestone regions.
29. B — Flat, fertile land built up beside a river by sediment dropped during repeated floods is a floodplain. Each flood spreads a fresh layer of fine sediment across the low ground. Floodplains are classic features of river deposition.
30. C — A continental polar air mass forms over cold, dry land in northern Canada, so it brings cold, dry air that often produces clear skies and sharply colder temperatures. "Continental" indicates dryness and "polar" indicates cold. This contrasts with warm, moist maritime air masses.
31. A — A warm front, with warm air sliding gently up over retreating cool air, typically brings a long period of light, steady rain or drizzle, followed by warmer, more humid air. The gentle frontal slope produces widespread, prolonged precipitation. This differs from the abrupt storms of a cold front.
32. D — City X has higher humidity because its dew point (24°C) is much closer to the air temperature (25°C), meaning the air is near saturation. A small temperature–dew point spread indicates moist air. City Y's large spread indicates much drier air.
33. C — Warm ocean water supplies the heat and moisture that power a hurricane, and moving over land cuts off that supply, so the storm weakens. The warm, moist air feeding the storm is essential to its strength. This dependence on warm water explains why hurricanes fade inland.
34. B — Carbon dioxide and water vapor are the main greenhouse gases, absorbing outgoing infrared energy and re-radiating it back toward the surface. The abundant gases nitrogen and oxygen do not trap heat this way. This absorption and re-emission produces the natural greenhouse effect.
35. A — The Coriolis effect, caused by Earth's rotation, deflects moving air to one side, causing global winds to curve rather than travel straight. Without rotation the winds would flow directly between pressure zones. This deflection shapes the major global wind belts.
36. C — Because climate is a long-term average, short-term natural variations cause individual years and seasons to rise and fall around the warming trend. A single cool year does not reverse the decades-long average. Distinguishing short-term weather from long-term climate is key to interpreting trends.
37. D — Wind, sunlight, and flowing water are all renewable because they are continuously renewed by natural processes and not used up. The other lists are fossil fuels or uranium, which are finite. Continuous natural replenishment is what defines a renewable resource.
38. B — The cleanup cost forced on downstream towns is a negative externality, a cost of the power plant's activity that falls on people outside the transaction. Externalities are real costs the polluter does not pay. Including them is essential for honest cost-benefit analysis.
39. A — Habitat destruction, the clearing and conversion of natural ecosystems for human uses, is currently the single largest cause of biodiversity loss worldwide. Removing habitat eliminates the places species need to live. This makes it the leading driver of species decline.
40. C — A wetland that slows floodwaters and filters pollutants provides a regulating service, the category covering processes that moderate hazards and improve environmental quality. Regulating services control flooding, water quality, and similar conditions. This illustrates the practical value of intact ecosystems.
41. D — Strong scientific consensus supports continued sea level rise as ocean water warms and expands and land-based ice melts. Both thermal expansion and ice loss add water to the oceans. The other options contradict observed trends and ocean chemistry, which is becoming more acidic, not basic.

42. B — Ozone depletion over Antarctica was caused mainly by chlorofluorocarbons (CFCs), once used in refrigerators, air conditioners, and aerosols. CFCs release chlorine that destroys ozone in the stratosphere. Phasing them out under the Montreal Protocol allowed the ozone layer to begin recovering.
43. C — Planting cover crops and plowing along the slope's curves (contour plowing) slows runoff and holds soil in place while keeping the field productive. These practices protect against erosion during heavy rain. They preserve the land's long-term productivity, supporting sustainable agriculture.
44. A — Most of Earth's water is salt water in the oceans, and most fresh water is frozen in ice or locked deep underground, leaving little accessible for human use. Only a tiny fraction is readily available fresh water. This scarcity makes water conservation important.
45. D — Building sea walls and raising roads to cope with flooding already occurring is adaptation, since the city is adjusting to climate impacts rather than reducing their cause. Adaptation manages consequences; mitigation would cut emissions. These protective measures fit the definition of adaptation.
46. B — A more acidic ocean most directly threatens shell-building organisms such as corals, oysters, and clams, because acidification reduces the carbonate minerals they need to form shells. Without enough carbonate, they struggle to build and maintain their structures. This threat ripples through marine food webs.
47. C — The stable Holocene climate made growing seasons dependable, allowing reliable farming and the rise of settled communities and cities. Predictable conditions were essential for agriculture and permanent settlement. Climatic stability, not evolution or oxygen changes, enabled civilization.
48. A — The first step in the engineering design process is clearly defining the problem, including the goals the solution must meet and the limits the design must work within. A precise definition guides every later stage. Skipping it risks building a solution that fails to address the real need.
49. B — The child-safety goal is a criterion, defining what the design must achieve, while the cost limit is a constraint, a fixed restriction the design cannot exceed. Criteria define success; constraints set boundaries. Distinguishing the two is fundamental to framing an engineering problem.
50. D — The main benefit is that the model lets scientists compare the likely outcomes of each option before the city spends money to build either one. Models allow ideas to be tested safely and cheaply in advance. They guide decisions while acknowledging uncertainty, and they support rather than replace real measurements.