

PRACTICE EXAM 51: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. Astronomers observe that the light from nearly every distant galaxy is shifted toward the red end of the spectrum, and that more distant galaxies show a greater shift. What does this pattern indicate?

- A. The galaxies are all made of unusually red stars, which is why their light naturally appears reddened to observers on Earth
- B. The light from distant galaxies passes through red dust clouds in space, which filters out the bluer colors before it reaches us
- C. The galaxies are all standing perfectly still while the Earth alone races outward away from every one of them in all directions
- D. The universe is expanding, carrying galaxies apart, which stretches their light toward longer, redder wavelengths

2. Two stars form at the same time, but one is far more massive than the other. How does a star's mass affect the way it will eventually end its life?

- A. Mass has no effect on a star's fate; all stars, regardless of size, end their lives in exactly the same quiet way over time
- B. The less massive star will explode violently as a supernova, while the more massive star will simply fade away as a white dwarf
- C. The more massive star will end in a violent supernova, while the lower-mass star will gently shed its layers and become a white dwarf
- D. Both stars will collapse instantly into black holes the moment their nuclear fuel runs out, no matter how much mass they contain

3. Elements heavier than iron, such as gold and uranium, are found in planets and living things. Where were most of these heavy elements originally produced?

- A. They were all created during the Big Bang itself, in the very first few minutes after the universe began to exist
- B. They were forged in the extreme conditions of exploding stars, then scattered into space to become part of new worlds
- C. They formed slowly inside cool planets like Earth over billions of years through ordinary chemical reactions in the crust
- D. They were manufactured by the steady, gentle fusion of hydrogen that powers the cores of ordinary stars like our Sun

4. A comet orbits the Sun with an average distance of 25 AU. Using Kepler's Third Law ($T^2 = a^3$ in solar units), approximately how long is its orbital period?

- A. About 125 years, because 25 cubed is 15,625, and the square root of 15,625 is exactly 125 years
- B. About 25 years, because a planet's orbital period in years is always equal to its average distance from the Sun in AU
- C. About 5 years, because the orbital period is found by taking the square root of the average distance from the Sun in AU
- D. About 50 years, because the orbital period is always equal to exactly twice the average distance from the Sun in AU

5. When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere at the same time. Which statement best explains why the two hemispheres have opposite seasons?

- A. The Northern Hemisphere is always much closer to the Sun than the Southern Hemisphere because of the shape of the Earth
- B. The Sun sends more of its energy toward the Northern Hemisphere and deliberately sends less toward the Southern Hemisphere
- C. Earth's tilted axis means that when one hemisphere is tilted toward the Sun, the other is tilted away from it at the same time
- D. The two hemispheres are at completely different distances from the Sun, so one is always heated far more strongly than the other

6. On a certain night, the Moon cannot be seen in the sky at all, and the next evening only a thin sliver appears low in the west just after sunset. Which Moon phase came just before that thin sliver?

- A. The new moon, when the Moon is between the Earth and the Sun and its lit side faces away from us, making it invisible
- B. The full moon, when the entire near side of the Moon is brightly lit and the Moon rises in the east as the Sun sets
- C. The first quarter, when exactly the right half of the Moon's visible disk appears illuminated in the early evening sky
- D. The waning gibbous, when more than half of the Moon is lit and the bright portion is shrinking a little each night

7. According to the nebular hypothesis, the solar system formed from a collapsing cloud of gas and dust. Where did most of the cloud's material end up, and what did it become?

- A. Most of the material spread out evenly into a thin ring far from the center, where it became the asteroid belt we see today
- B. Most of the material was flung outward to the cold edges of the system, where it froze into the comets of the distant region
- C. Most of the material gathered into many equal-sized clumps, which became the eight planets that all share nearly the same mass
- D. Most of the material collapsed into the dense center, where it became the Sun, which holds the great majority of the system's mass

8. A total solar eclipse occurs when the Moon passes directly between the Earth and the Sun, briefly blocking the Sun's light. During which Moon phase can a solar eclipse take place?

- A. The full moon, when the Earth lies directly between the Sun and the Moon and the Moon is fully illuminated in the night sky
- B. The new moon, when the Moon lies directly between the Earth and the Sun and can cast its shadow onto the Earth's surface
- C. The last quarter, when only the left half of the Moon's visible disk appears illuminated in the early morning hours before dawn

D. Any phase at all, because the alignment needed for a solar eclipse can occur equally during every single phase of the Moon

9. Most coastlines experience two high tides and two low tides each day. What is the primary cause of these regular ocean tides?

A. The steady push of the global winds, which pile ocean water against the shore twice and then let it drain away twice each day

B. The daily heating and cooling of the ocean by the Sun, which makes the water expand at midday and then contract again at night

C. The Moon's gravitational pull, which raises bulges of water on the near and far sides of Earth that coastlines rotate through

D. The melting and refreezing of polar ice, which adds and removes ocean water on a regular cycle throughout each and every day

10. The Sun has been shining steadily for billions of years and will continue for billions more. What is the source of the enormous energy the Sun radiates?

A. Nuclear fusion in the core, where hydrogen is fused into helium under crushing heat and pressure, releasing vast energy

B. The slow burning of coal, oil, and other fuels on the Sun's surface, which steadily releases heat and light into space

C. The friction created as the Sun spins rapidly on its axis, which heats the gas and makes the whole surface glow brightly

D. The radioactive decay of uranium throughout the Sun's interior, which is the same reaction used in nuclear power plants

11. In summer, a location in the Northern Hemisphere receives more intense sunlight and longer days than it does in winter. Which factor most directly causes summer days to be warmer?

A. The Earth is much closer to the Sun during the summer months than it is during the cold winter months of the year

- B. The Sun produces noticeably more total energy during the summer season than it produces during the winter season
- C. The Moon blocks a portion of the Sun's rays during winter, which is the reason that winter days turn out to be colder
- D. The Sun is higher in the sky in summer, so its rays strike the ground more directly and heat the surface more effectively

12. A geologist observes a thick sequence of sedimentary rock layers that are now steeply tilted at a 40-degree angle. According to the principle of original horizontality, what does this tell the geologist?

- A. The layers were originally deposited at this same 40-degree tilt, because sediment naturally settles onto steeply sloping surfaces
- B. The layers were originally deposited in flat, horizontal sheets and were later tilted by movements of the Earth's crust
- C. The layers must be extremely young, because only very recently formed rock is ever able to become tilted away from level
- D. The layers could not be sedimentary rock at all, because sedimentary rock is physically incapable of ever becoming tilted

13. A radioactive isotope has a half-life of 5,000 years. A rock sample contains one-half of the original amount of this isotope remaining. How much time has passed since the rock formed?

- A. About 5,000 years, because a single half-life is the time it takes for exactly half of the isotope to decay away
- B. About 10,000 years, because two half-lives are always required before any of the original isotope finally begins to decay
- C. About 2,500 years, because half of one half-life is the time it takes for one-half of the isotope to decay completely away
- D. About 20,000 years, because four full half-lives must pass before one-half of the original isotope has finally decayed

14. A geologist finds the same distinctive trilobite species in rock layers on two different continents. How can this fossil be used?

- A. It proves that the two rock layers must be made of exactly the same minerals and have exactly the same physical composition
- B. It shows that one of the two continents must be far older than the other, since the same fossil cannot appear in two places at once
- C. It indicates that the two layers are likely the same age, because that species lived during the same span of geologic time
- D. It reveals the exact number of years that have passed since each of the two rock layers was originally deposited and buried

15. A fault cuts across and displaces several sedimentary rock layers. According to the principle of cross-cutting relationships, what is the relationship between the fault and the layers?

- A. The fault is older than every one of the layers, because a fault must always exist before any rock layers can form across it
- B. The fault is younger than the layers it cuts through, because the layers had to exist first before the fault could break across them
- C. The fault and the layers are exactly the same age, because faulting and the deposition of sediment always happen at the same time
- D. The fault has no age relationship to the layers at all, because faults and sedimentary layers form completely independently of one another

16. As geologists examine fossils from progressively younger rock layers, they observe that the types of organisms preserved change from one layer to the next. What does this changing fossil record best demonstrate?

- A. That the Earth is only a few thousand years old, since so much change could not possibly occur over any longer span of time
- B. That fossils are deposited completely at random, with no relationship at all between the age of a layer and the fossils it holds
- C. That every species that has ever existed on Earth is still alive somewhere on the planet today and has never gone extinct
- D. That life on Earth has changed over vast spans of geologic time, with different organisms dominating during different periods

17. Wegener proposed that the continents drift, but he could not explain how. Later, scientists discovered the mechanism. What process is now understood to move the continents?

- A. The motion of large plates of Earth's lithosphere, driven by the slow churning of the hot, partly molten mantle beneath them
- B. The steady push of powerful ocean currents against the edges of the continents, which slowly shoves them across the seafloor
- C. The strong pull of the Moon's gravity on the solid rock of the continents, which drags them a little farther apart every year
- D. The expansion of the entire Earth as it heats up over time, which gradually stretches the continents away from one another

18. A limestone layer is full of the fossilized shells of clams, corals, and other marine animals. Which past environment is most consistent with this rock?

- A. A dry, windswept desert where loose sand was piled into large dunes far from any source of standing water
- B. A high mountain peak well above the tree line, where bare rock was exposed to constant freezing and thawing
- C. A warm, shallow sea where marine organisms lived, died, and accumulated their shells on the ocean floor over time
- D. A swift mountain river that tumbled and rounded large boulders as it rushed downhill through a steep rocky canyon

19. Along California's San Andreas Fault, two plates grind horizontally past one another, producing frequent earthquakes but no volcanoes and no new crust. What type of plate boundary is this?

- A. A convergent boundary, where two plates collide head-on and one plate is forced down beneath the other into the mantle
- B. A transform boundary, where two plates slide horizontally past each other, causing earthquakes without creating or destroying crust
- C. A divergent boundary, where two plates pull apart and rising magma fills the gap to create brand-new crust between them

D. A hotspot, where a plume of hot mantle material rises and burns through the middle of a plate to form a chain of volcanoes

20. Earth's core is divided into two parts. Although both are extremely hot and made mostly of iron and nickel, they differ in one key way. How do the outer core and inner core differ?

A. The outer core is solid while the inner core is liquid, because pressure increases toward the surface and decreases toward the center

B. Both the outer core and the inner core are completely liquid, kept molten by the intense heat found throughout the planet's interior

C. The outer core is made of rock while the inner core is made of gas, which is what allows seismic waves to slow down as they pass

D. The outer core is liquid while the inner core is solid, because the immense pressure at the very center keeps the iron from melting

21. Over millions of years, sand and mud washed into a basin are buried, compacted, and cemented together into solid rock. What type of rock forms through this process?

A. An igneous rock, because it forms when hot molten material from deep within the Earth cools and hardens into solid stone

B. A metamorphic rock, because it forms when intense heat and pressure deep underground transform a pre-existing rock into a new one

C. A sedimentary rock, because it forms when sediments are deposited in layers and then compacted and cemented together over time

D. A volcanic glass, because it forms when erupting lava cools so quickly at the surface that mineral crystals have no time to grow

22. A mineral consistently breaks along smooth, flat surfaces that meet at right angles, producing cube-shaped pieces. Which physical property does this describe?

A. Cleavage, the tendency of a mineral to break along smooth, flat planes determined by the arrangement of its atoms inside the crystal

B. Streak, the color of the fine powder that a mineral leaves behind when it is rubbed across an unglazed white porcelain tile

C. Luster, the way that the surface of a mineral reflects light, described by terms such as metallic, glassy, pearly, or dull

D. Hardness, a measure of how strongly a mineral resists being scratched by another material whose hardness is already known

23. A light-colored igneous rock contains large, easily visible interlocking crystals of several different minerals. What does this coarse-grained texture indicate about the rock's formation?

A. It formed at the surface from fast-cooling lava, which froze so quickly that the crystals had almost no time to grow before solidifying

B. It formed from layers of sediment that were slowly pressed and cemented together rather than from any kind of molten material at all

C. It formed when an older rock was heated and squeezed by tremendous pressure until its minerals were bent into wavy parallel bands

D. It formed deep underground from magma that cooled very slowly, giving the mineral crystals a long time to grow large and visible

24. Warm, moist air rises, cools as it goes higher, and its water vapor changes into tiny liquid droplets that gather to form a cloud. What is this process called?

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

B. Condensation, the process in which water vapor cools and changes into the tiny liquid droplets that collect together to form clouds

C. Precipitation, the process in which water droplets in a cloud grow heavy enough to fall back to the surface as rain, snow, or hail

D. Transpiration, the process in which plants release water vapor into the surrounding air through tiny pores in their leaves and stems

25. After a long summer drought with very little rain, the water level in a town's wells drops noticeably lower than usual. Which statement best explains this change?

- A. The drought caused the underground rock itself to shrink in volume, which physically pushed the well water downward and out of reach
- B. The drought heated the groundwater until much of it boiled away as steam, lowering the level of water remaining in the town's wells
- C. The lack of rainfall reduced the recharge of groundwater, so the water table fell and the wells now reach a lower water level
- D. The drought caused the salt content of the groundwater to rise sharply, which made the water sink to a much greater depth underground

26. Within the carbon cycle, certain natural processes remove carbon dioxide from the atmosphere. Which process removes carbon dioxide from the air?

- A. Photosynthesis, in which green plants take in carbon dioxide and use sunlight to build sugars, storing the carbon in their tissues
- B. Respiration, in which living organisms break down sugars for energy and release carbon dioxide back into the surrounding air
- C. Combustion, in which fuels such as wood, coal, and oil are burned, sending stored carbon into the atmosphere as carbon dioxide
- D. Volcanic eruption, in which gases trapped deep within the Earth are released into the atmosphere as molten rock reaches the surface

27. In a stable climate system, some processes work to counteract a change and bring conditions back toward their original state. Which of the following is an example of a negative (stabilizing) feedback?

- A. Melting bright sea ice exposes dark ocean water, which absorbs more sunlight, causing still more warming and even more ice to melt
- B. Warming increases evaporation and cloud cover, and the added bright clouds reflect more sunlight, which cools the surface again
- C. Thawing permafrost releases methane gas, which traps additional heat, leading to even more permafrost thawing and gas release
- D. Rising temperatures dry out forests, leading to more wildfires, which release carbon dioxide that warms the atmosphere even further

28. In a cold mountain climate, water seeps into cracks in a rock, freezes overnight, expands, and over many cycles splits the rock into angular pieces without changing its mineral composition. What process is this?

- A. Chemical weathering, in which acidic water reacts with the rock's minerals and dissolves them, changing the rock's composition entirely
- B. Deposition, in which sediment carried by wind or water is dropped and laid down in a new location far from where it first originated
- C. Erosion, in which broken rock fragments are picked up and physically carried away from one place to another by water, wind, or ice
- D. Frost wedging, a form of mechanical weathering in which freezing water expands within cracks and breaks the rock into smaller pieces

29. Where a fast-moving river flows into a calm lake, it suddenly slows down and drops its load of sediment, building up a fan-shaped deposit of sand and mud at the river's mouth. What is this landform called?

- A. A delta, a fan-shaped deposit that forms where a river slows as it enters a standing body of water and drops its sediment
- B. A moraine, a ridge of unsorted rock and soil that is bulldozed into place and left behind along the edges of a moving glacier
- C. A sand dune, a mound of loose sand that is piled up and shaped by the wind in dry regions where vegetation is sparse or absent
- D. A canyon, a deep, narrow valley with steep rock walls that is slowly carved out by a river cutting downward into the bedrock

30. An air mass forms over the cold North Pacific Ocean and then moves onto the coast of the Pacific Northwest. What kind of weather would this maritime polar (mP) air mass most likely bring?

- A. Hot, bone-dry air with cloudless skies and a serious risk of drought, typical of air that has formed over a scorching desert
- B. Bitterly cold, very dry air with crystal-clear skies, typical of an air mass that has formed over a frozen continental interior

C. Cool, moist air with low clouds, fog, and steady drizzle, typical of an air mass that has formed over a cold stretch of ocean

D. Warm, extremely humid air carrying the threat of powerful afternoon thunderstorms, typical of air formed over a warm tropical sea

31. A fast-moving cold front advances into a warm, humid region. What sequence of weather is most typical as this cold front passes through?

A. A long, slow drizzle lasting for a day or more, followed by a gradual warming and increasing humidity once the front has gone by

B. A narrow band of heavy showers and thunderstorms, followed by clearing skies, falling temperatures, and drier, cooler air behind it

C. Several days of unchanging thick fog that simply sits over the area, with no precipitation and no real change in temperature at all

D. Completely clear skies and rising temperatures throughout the front's passage, with no clouds or precipitation developing at any point

32. On a humid summer evening, the air temperature falls until it reaches the dew point, and a layer of fog forms near the ground. What does reaching the dew point mean?

A. The air has become completely dry, having lost all of its water vapor, which is the condition required for fog to begin forming

B. The air pressure has dropped to its lowest possible value, which forces the surrounding water vapor to condense into fog at the surface

C. The wind has stopped blowing entirely, which is the only condition under which water vapor in the air is able to condense into fog

D. The air has cooled to the temperature at which it becomes saturated, so water vapor begins condensing into liquid droplets

33. Hurricanes develop only over certain parts of the ocean and during certain times of year. Which condition is essential for a hurricane to form and grow stronger?

- A. Cold ocean water below about 20°C, which supplies the dense, sinking air that a developing hurricane needs in order to organize
- B. Strong winds that change speed and direction sharply with height, which help to spin the developing storm up into a hurricane
- C. Warm ocean water above about 26.5°C, which evaporates and supplies the heat and moisture that power the developing storm
- D. A location directly on the equator, where the Coriolis effect is strongest and most effectively sets the storm spinning into rotation

34. Locations near the equator generally have hot climates, while locations near the poles have cold climates. Which factor is the main reason for this large difference in climate?

- A. Latitude, because the angle at which sunlight strikes the surface changes with latitude, concentrating energy near the equator
- B. Longitude, because places located farther east always receive far more direct and intense sunlight than places located to the west
- C. Elevation, because every location near the equator sits at a very low elevation while every polar location sits at a very high one
- D. The time zone, because regions in earlier time zones receive sunlight for many more total hours each day than regions in later ones

35. Earth's natural greenhouse effect keeps the planet warm enough to support life as we know it. How does this natural greenhouse effect work?

- A. Greenhouse gases reflect incoming sunlight back into space before it reaches the ground, which keeps the planet at a steady temperature
- B. Greenhouse gases generate their own heat through chemical reactions in the atmosphere, directly warming the air all around the planet
- C. Greenhouse gases block sunlight from leaving the atmosphere during the day and then release that stored sunlight again at night
- D. Greenhouse gases absorb heat radiated from Earth's surface and re-emit some of it back downward, keeping the lower atmosphere warm

36. Scientists conclude that Earth's climate is warming based on many independent lines of evidence gathered over many decades. Which of the following is a line of evidence supporting this conclusion?

- A. A single record-breaking blizzard that struck one city during one especially cold and snowy week of one particular winter season
- B. Long-term records showing rising global average temperatures, shrinking glaciers, and rising sea levels measured over many decades
- C. The fact that the weather forecast for next weekend in one town happens to predict that it will be warmer than the weekend before
- D. A brief cold snap that lasted for only a few days and caused temperatures in one region to fall well below their seasonal average

37. A community wants to build a power source that relies on a resource which will not run out and is naturally replenished. Which energy source best fits this description?

- A. A coal-fired power plant, which burns a fuel that took hundreds of millions of years to form and cannot be replaced once it is used up
- B. A natural gas plant, which relies on a fossil fuel pumped from underground reserves that are steadily being depleted and not refilled
- C. A wind farm, which generates electricity from moving air, a resource that is continuously renewed by the Sun's heating of the atmosphere
- D. A nuclear plant, which depends on mined uranium, a finite element that exists in limited amounts and is gradually being used up over time

38. Before approving a large new dam, decision-makers carefully compare the project's expected benefits, such as electricity and water storage, against its expected costs, such as flooded land and lost habitat. This process is called a cost-benefit analysis. What is its main purpose?

- A. To weigh the advantages of a project against its disadvantages so that a more informed and balanced decision can be made
- B. To guarantee that the project will be built no matter what, by listing only the benefits while completely ignoring any of the costs

C. To calculate the exact profit the project will earn each year, while deliberately leaving out every environmental and social effect

D. To delay the project indefinitely by producing endless paperwork, which prevents the dam from ever actually being constructed at all

39. A non-native fish is introduced into a lake, where it has no natural predators and quickly multiplies, outcompeting and replacing several native fish species. Which driver of biodiversity loss does this illustrate?

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

B. An invasive species, in which an introduced organism with no natural controls spreads rapidly and displaces the native organisms

C. Habitat destruction, in which the physical living space of native organisms is bulldozed, paved over, or otherwise eliminated entirely

D. Ocean acidification, in which seawater absorbs carbon dioxide and becomes more acidic, harming shell-building marine organisms

40. A forest supplies a community with timber for building, wild plants for food, and fresh water from its streams. These tangible products that people take directly from nature are best classified as which type of ecosystem service?

A. A regulating service, because these are processes that control flooding, filter pollutants from the air and water, and moderate the local climate

B. A cultural service, because these are the recreational, spiritual, and aesthetic benefits that people gain from spending time in nature

C. A supporting service, because these are the basic underlying processes, like soil formation and nutrient cycling, that sustain all the others

D. A provisioning service, because these are the material goods, such as food, fresh water, timber, and fiber, that people obtain from nature

41. Which of the following is a consequence of global warming that is supported by strong scientific evidence?

- A. Heat waves and droughts are becoming more frequent and more intense in many regions as average global temperatures continue to rise
- B. The total area of polar sea ice is steadily expanding each year as the warming climate causes the polar oceans to freeze more solidly
- C. Average global temperatures are gradually falling as the rising level of carbon dioxide in the atmosphere cools the surface of the planet
- D. The world's oceans are steadily becoming more alkaline and basic as they continue to absorb carbon dioxide from the atmosphere above

42. Fertilizer and pesticides wash off many separate farm fields across a wide region and drain into a river, but no single pipe or outlet can be identified as the origin. This kind of pollution is best described as which of the following?

- A. Point-source pollution, because it enters the river from one clearly identifiable location such as a single factory pipe or drainage outlet
- B. Thermal pollution, because the main problem is the heated water being discharged into the river, which raises the river's temperature
- C. Nonpoint-source pollution, because it comes from many scattered, diffuse sources spread across the land rather than one single outlet
- D. Biodegradable pollution, because the fertilizer and pesticides will all break down harmlessly on their own within a few hours of entering the water

43. A farmer wants to keep the soil productive year after year without exhausting its nutrients. Which practice best supports this goal of sustainable agriculture?

- A. Planting the exact same single crop in the same field every year, which steadily draws the same nutrients out of the soil season after season
- B. Removing every tree and hedgerow around the fields to maximize planting area, leaving the bare soil fully exposed to wind and rainfall
- C. Applying the maximum possible amount of chemical fertilizer every season regardless of need, so that excess nutrients run off into nearby streams
- D. Rotating different crops between seasons and planting cover crops, which helps replenish soil nutrients and reduce erosion over time

44. When a natural area is paved over and developed into a city, rainwater can no longer soak into the ground as easily. What is one direct environmental effect of replacing soil and plants with pavement and buildings?

A. Rainwater soaks into the ground far more quickly than before, which sharply raises the local water table and refills underground aquifers

B. More rainwater runs off the hard surfaces instead of soaking in, which increases the risk of flooding and carries pollutants into waterways

C. The total amount of rain that falls on the region drops dramatically, because pavement and buildings prevent clouds from forming overhead

D. The pavement absorbs and permanently stores all of the rainwater that lands on it, so essentially no runoff reaches the local rivers at all

45. A national government, aiming to slow climate change, invests heavily in solar and wind power and sets strict limits on carbon dioxide emissions from factories. Which type of climate strategy is this?

A. Mitigation, because these actions reduce the greenhouse gas emissions that are the underlying cause of climate change

B. Adaptation, because these actions adjust society to better cope with the impacts of a climate that is already changing

C. Restoration, because these actions are focused on rebuilding ecosystems that have already been damaged or destroyed

D. Acidification, because these actions are designed to lower the rising acidity of the ocean by removing carbon from seawater

46. Which everyday action by individuals most directly helps conserve a nonrenewable resource?

A. Leaving lights, computers, and appliances switched on at all times so that they never have to be turned back on again later

B. Choosing to drive alone on every trip rather than walking, biking, or sharing rides with others who are heading the same way

C. Improving home insulation and switching to efficient appliances, which reduces the fossil-fuel energy needed to heat and power the home

D. Setting the heating and air conditioning to run constantly at extreme settings throughout the day and night in every season of the year

47. In ecology, an environment can support only a certain maximum population of a species over the long term, given its available resources. What is this maximum sustainable population called?

A. The biodiversity index, a single number that summarizes how many different species live together within a particular ecosystem

B. The carrying capacity, the largest population of a species that an environment can support indefinitely with its available resources

C. The trophic level, the position that an organism occupies in a food chain based on what it eats and what eats it in turn

D. The keystone value, a measure of how essential a single species is to holding together the structure of an entire ecosystem

48. An engineering team is asked to design a device to remove plastic waste from a river. According to the engineering design process, what should the team do first, before sketching any possible solutions?

A. Immediately begin building a full-sized working version of the first idea anyone suggests, so that no time at all is wasted on planning

B. Choose the single most expensive material available, since the costliest option is always guaranteed to produce the best possible result

C. Release the very first prototype to the public right away, even before any testing is done, to find out whether people happen to like it

D. Clearly define the problem, including the criteria the device must meet and the constraints it must work within, before generating solutions

49. Scientists use a computer model to predict how a coastline will change as sea level rises over the next century. Which statement best describes an important limitation of such a model?

A. A model is completely useless for studying the future, because it can never provide any helpful information about events that have not yet happened

B. A model always predicts the future with perfect, flawless accuracy, so its results never need to be checked against any real-world observations

C. A model is a simplified representation of reality, so its predictions depend on the assumptions and data used and carry some uncertainty

D. A model can only ever describe events that have already happened in the past and can never be used to make any prediction about the future

50. Science and engineering are closely related but have different goals. Which statement best describes the primary goal of engineering, as opposed to science?

A. Engineering aims to design solutions to practical problems, applying scientific knowledge to meet human needs within real-world constraints

B. Engineering aims only to discover new laws of nature through experiments, with no concern for whether the knowledge is ever put to practical use

C. Engineering aims to avoid using any scientific knowledge whatsoever, relying instead purely on guesswork and on random trial and error alone

D. Engineering aims simply to describe and explain natural phenomena, leaving the building of any actual useful devices entirely to other fields

Practice Exam 51: Answer Key with Explanations

1. D — Redshift that increases with distance shows that galaxies are receding faster the farther away they are, which is the expansion of the universe stretching their light to longer wavelengths. This Hubble relationship is central evidence for the Big Bang. Expansion, not motion through space, causes the stretch.
2. C — A star's mass determines its fate: a high-mass star ends in a violent supernova, while a low-mass star like the Sun gently sheds its outer layers and becomes a white dwarf. Greater mass means greater core pressure and a more dramatic collapse. Mass, not age, sets the endpoint.
3. B — Elements heavier than iron are forged in the extreme conditions of supernova explosions and then scattered into space, where they become part of new planets and living things. Ordinary fusion in stars cannot build these heavy elements. This is why such elements exist on Earth at all.
4. A — Kepler's Third Law gives $T^2 = a^3$, so with $a = 25$, a^3 equals 15,625 and T is the square root of 15,625, exactly 125 years. The cube of the distance sets the square of the period. This relationship applies to any object orbiting the Sun.
5. C — The hemispheres have opposite seasons because Earth's axis is tilted, so when one hemisphere leans toward the Sun the other leans away at the same time. The orientation of the tilt, not distance

from the Sun, governs the seasons. This is why summer in one hemisphere coincides with winter in the other.

6. A — A Moon that is invisible, followed the next evening by a thin western sliver after sunset, has just passed through new moon, when the Moon sits between Earth and Sun with its lit side facing away. The thin sliver is the young waxing crescent that follows. New moon is the start of the lunar cycle.
7. D — In the nebular hypothesis, most of the collapsing cloud's material fell into the dense center to form the Sun, which holds the great majority of the system's mass. Only a small fraction remained in the surrounding disk to form planets. This is why the Sun dominates the solar system.
8. B — A solar eclipse can occur only at new moon, when the Moon lies directly between Earth and the Sun and can cast its shadow onto Earth. Only then is the geometry right to block the Sun. The Moon's tilted orbit is why eclipses do not happen every new moon.
9. C — Two daily tides result from the Moon's gravity raising water bulges on the near and far sides of Earth, which each rotating coastline passes through. The near bulge faces the Moon and the far bulge arises from inertia. Rotating through both produces two highs and two lows per day.
10. A — The Sun's energy comes from nuclear fusion in its core, where hydrogen fuses into helium under crushing heat and pressure, converting mass into vast energy. Only the core has the conditions for fusion. This process, not chemical burning or decay, powers the Sun's long, steady output.
11. D — Summer is warmer mainly because the Sun is higher in the sky, so its rays strike the ground more directly and concentrate their energy on a smaller area. A steeper Sun angle heats the surface more effectively. This effect, plus longer days, makes summer warmer than winter.
12. B — By the principle of original horizontality, sedimentary layers are deposited in flat, horizontal sheets, so steeply tilted layers must have been moved into that position by later crustal movement. The original flat layering is the starting assumption. The tilt records deformation after deposition.
13. A — One-half of the isotope remaining means exactly one half-life has passed, since a half-life is defined as the time for half to decay. One half-life \times 5,000 years equals 5,000 years. Counting the number of halvings is the key to radiometric age problems.
14. C — The same distinctive fossil species found on two continents indicates the two rock layers are likely the same age, because that organism lived during the same short span of geologic time. This use of fossils is called correlation. It lets geologists match rock layers across great distances.
15. B — By cross-cutting relationships, a fault that cuts and displaces rock layers must be younger than those layers, because the layers had to exist before the fault could break across them. The disrupting feature always postdates what it disrupts. This establishes the fault's relative age.
16. D — A fossil record that changes steadily from older to younger layers demonstrates that life on Earth has changed over vast spans of geologic time, with different organisms dominating different periods. The orderly change reflects evolution and extinction. This is a foundation of the geologic time scale.
17. A — The continents move because Earth's lithosphere is broken into large plates driven by the slow churning of the hot, partly molten mantle beneath them. This mantle convection supplies the mechanism Wegener lacked. Plate tectonics explains drifting continents, seafloor spreading, and earthquakes together.
18. C — Limestone full of marine shells indicates a warm, shallow sea where marine organisms lived, died, and accumulated their carbonate shells on the seafloor over time. The fossils reveal the environment of deposition. Desert, mountain, and river settings would not produce shell-rich limestone.

19. B — The San Andreas Fault is a transform boundary, where two plates slide horizontally past each other, producing frequent earthquakes without creating or destroying crust. The horizontal grinding releases energy as quakes. The absence of volcanoes and new crust distinguishes it from convergent and divergent boundaries.
20. D — The outer core is liquid while the inner core is solid, because the immense pressure at Earth's very center raises iron's melting point enough to keep it solid despite the extreme heat. Pressure increases toward the center, not away from it. Seismic-wave behavior revealed this two-part structure.
21. C — Sand and mud that are deposited, buried, compacted, and cemented form sedimentary rock. The layering, compaction, and cementing of sediment are the defining steps. This contrasts with igneous rock from melt and metamorphic rock from heat and pressure.
22. A — Breaking along smooth, flat planes that meet at right angles to form cubes is cleavage, which is controlled by the orderly arrangement of atoms within the mineral. Cleavage reflects planes of weak bonding in the crystal. It is a key property for identifying minerals.
23. D — Large, visible interlocking crystals indicate the rock cooled very slowly deep underground, giving the crystals a long time to grow. Slow cooling produces a coarse-grained, intrusive igneous texture. Rapid surface cooling, by contrast, yields tiny or invisible crystals.
24. B — Water vapor cooling and changing into tiny liquid droplets that gather into a cloud is condensation. Rising moist air cools until its vapor condenses around particles. Condensation is the opposite of evaporation, which turns liquid water into vapor.
25. C — Lower well levels after a drought occur because reduced rainfall cut the recharge of groundwater, so the water table fell and wells now reach a lower level. The water table rises and falls with the balance of recharge and withdrawal. Less rain means less replenishment.
26. A — Photosynthesis removes carbon dioxide from the air as plants take it in and use sunlight to build sugars, storing the carbon in their tissues. This is the main natural pathway that draws down atmospheric carbon. Respiration, combustion, and volcanism all release it instead.
27. B — Warming that increases bright cloud cover, which reflects more sunlight and cools the surface again, is a negative feedback because it counteracts the original change. Stabilizing feedbacks push the system back toward its starting state. The other options describe amplifying, positive feedbacks.
28. D — Water freezing and expanding in cracks until the rock splits, with no change in composition, is frost wedging, a form of mechanical weathering. The rock breaks physically into smaller pieces. Repeated freeze-thaw cycles make this especially active in cold climates.
29. A — A fan-shaped deposit of sediment built where a river slows as it enters a standing body of water is a delta. The drop in speed reduces the river's ability to carry sediment, so it is deposited. Deltas are classic landforms of deposition at river mouths.
30. C — A maritime polar air mass forms over a cold ocean and brings cool, moist air with low clouds, fog, and drizzle. "Maritime" indicates moisture and "polar" indicates cold origins. This contrasts with dry continental air and warm tropical air.
31. B — A fast cold front forces warm, humid air upward steeply, producing a narrow band of heavy showers and thunderstorms, followed by clearing skies and cooler, drier air. The steep frontal slope drives quick, vigorous uplift. This abrupt change is characteristic of cold front passage.
32. D — Reaching the dew point means the air has cooled to the temperature at which it becomes saturated, so its water vapor begins condensing into liquid droplets such as fog or dew. At that temperature the air can hold no more vapor. Further cooling forces condensation.

33. C — A hurricane requires warm ocean water above about 26.5°C, which evaporates and supplies the heat and moisture that power the storm. This is why hurricanes form over tropical seas and weaken over cold water or land. Cold water and strong wind shear actually inhibit development.
34. A — Latitude is the main control on climate because the angle at which sunlight strikes the surface changes with latitude, concentrating energy near the equator and spreading it thin near the poles. Direct equatorial rays bring heat, while slanting polar rays bring cold. This sets the basic global climate pattern.
35. D — The greenhouse effect works because greenhouse gases absorb heat radiated from Earth's surface and re-emit some of it back downward, keeping the lower atmosphere warm. They act on outgoing infrared rather than reflecting incoming sunlight. This natural warming makes Earth habitable.
36. B — Long-term records of rising global temperatures, shrinking glaciers, and rising seas, gathered over decades, are valid evidence of climate warming because they reveal a sustained trend. Climate is judged by long-term averages, not single events. A lone blizzard or cold snap is short-term weather.
37. C — A wind farm relies on moving air, a renewable resource continuously replenished by the Sun's heating of the atmosphere, so it will not run out. Renewable sources are naturally restored on human timescales. Coal, gas, and uranium are all finite and nonrenewable.
38. A — The purpose of a cost-benefit analysis is to weigh a project's advantages against its disadvantages so a more informed, balanced decision can be made. Considering both sides, including environmental and social effects, leads to better choices. Ignoring costs or benefits would defeat its purpose.
39. B — A non-native organism that spreads rapidly with no natural predators and displaces native species illustrates an invasive species. Lacking natural controls, it outcompetes the natives. Invasive species are a major driver of biodiversity loss.
40. D — Timber, wild food, and fresh water are provisioning services, the tangible material goods people obtain directly from nature. Provisioning services are the physical products of ecosystems. They differ from regulating, cultural, and supporting services, which provide processes rather than goods.
41. A — Strong evidence supports that heat waves and droughts are becoming more frequent and intense as global temperatures rise. Warming shifts conditions toward greater extremes. The other options contradict observed trends and ocean chemistry, which is becoming more acidic, not basic.
42. C — Pollution that drains from many scattered fields across a wide area, with no single identifiable outlet, is nonpoint-source pollution. Its diffuse origin makes it hard to trace and control. This contrasts with point-source pollution from one identifiable pipe or outlet.
43. D — Rotating crops between seasons and planting cover crops supports sustainable agriculture by replenishing soil nutrients and reducing erosion. Varying crops avoids draining the same nutrients repeatedly, and cover crops protect and enrich the soil. These practices keep land productive over the long term.
44. B — Paving over land sends more rainwater running off hard surfaces instead of soaking in, which increases flooding risk and carries pollutants into waterways. Impervious surfaces reduce infiltration and increase runoff. This is a direct environmental effect of urbanization.
45. A — Investing in solar and wind and limiting carbon dioxide emissions is mitigation, because it reduces the greenhouse gases that cause climate change. Mitigation targets the underlying cause, while adaptation copes with impacts. Cutting emissions at the source is the defining feature of mitigation.

46. C — Improving insulation and using efficient appliances most directly conserves nonrenewable resources by reducing the fossil-fuel energy needed to heat and power a home. Using less energy means burning less finite fuel. The other options waste energy rather than conserving it.
47. B — The largest population an environment can support indefinitely with its available resources is its carrying capacity. It is set by limits such as food, water, and space. Populations that exceed carrying capacity cannot be sustained over the long term.
48. D — The engineering design process begins by clearly defining the problem, including the criteria the solution must meet and the constraints it must work within, before any solutions are sketched. A well-defined problem guides all later steps. Skipping this leads to wasted effort on poorly aimed designs.
49. C — A key limitation is that a model is a simplified representation of reality, so its predictions depend on the assumptions and data used and carry some uncertainty. Models approximate, rather than perfectly reproduce, the real world. Their results must be checked against observations.
50. A — Engineering aims to design solutions to practical problems, applying scientific knowledge to meet human needs within real-world constraints. Its goal is useful design, whereas science seeks to explain natural phenomena. The two fields complement each other but pursue different ends.