

# PRACTICE EXAM 52: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

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1. The cosmic microwave background radiation fills all of space and has a temperature of only about 2.7 K. What does the existence of this radiation tell scientists about the universe?

A. It shows that the universe is contracting and will eventually collapse back down into a single hot point in the distant future

B. It is the cooled-down afterglow of the hot, dense early universe, which supports the idea that the universe began with a Big Bang

C. It is heat being given off right now by the billions of stars currently shining within our own Milky Way galaxy and nowhere else

D. It proves that empty space contains no matter or energy of any kind and that the universe has always looked exactly as it does today

2. A star like the Sun spends most of its life in a long, stable phase called the main sequence. What keeps such a star stable and unchanging for billions of years during this phase?

A. A balance between the inward pull of gravity and the outward push of pressure from energy released by fusion in the core

B. The complete absence of gravity inside the star, which allows the gas to sit perfectly still without ever collapsing inward

C. A thick outer shell of solid rock that surrounds the star and physically holds all of its hot gas tightly in place for billions of years

D. The steady cooling of the star's core, which slowly freezes the star solid and prevents it from changing in any way over time

3. The carbon in your body, the oxygen you breathe, and the iron in your blood were not present when the universe first began. Where did these elements come from?

A. They were all manufactured by chemical reactions taking place in Earth's oceans shortly after the planet first formed

B. They have always existed in their current amounts, completely unchanged since the very first moment the universe began

C. They were created on the Sun's surface and then carried to Earth by the steady stream of particles in the solar wind

D. They were produced by nuclear fusion inside earlier generations of stars and released into space when those stars died

4. A dwarf planet orbits the Sun at an average distance of 9 AU. Using Kepler's Third Law ( $T^2 = a^3$  in solar units), what is its approximate orbital period?

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

B. About 9 years, because a body's orbital period in years is always exactly equal to its average distance from the Sun in AU

C. About 27 years, because 9 cubed is 729, and the square root of 729 is 27 years

D. About 81 years, because the orbital period is always found by squaring the value of the average distance from the Sun in AU

5. On about March 21 and September 23 each year, day and night are nearly equal in length all over the world, and the Sun's rays strike the equator most directly. What are these two days called?

A. The equinoxes, the two days each year when neither hemisphere is tilted toward or away from the Sun and day and night are nearly equal

B. The solstices, the two days each year when one hemisphere is tilted most directly toward the Sun and receives its longest day of the year

C. The eclipses, the two days each year when the Moon passes between the Earth and the Sun and casts a shadow across the planet's surface

D. The perihelions, the two days each year when the Earth reaches the single closest point to the Sun along its slightly oval-shaped orbit

6. A few days before the new moon, an observer sees only a thin sliver of the Moon lit on its left side, rising shortly before the Sun in the early morning. The lit portion has been shrinking each night. What phase is this?

A. A waxing crescent, the thin sliver phase the Moon passes through just after the new moon, with its lit portion growing each night

B. A waning crescent, the thin sliver phase the Moon passes through just before the new moon, with its lit portion shrinking each night

C. A first quarter, the phase in which exactly the right half of the Moon's visible disk is illuminated in the early evening sky

D. A waxing gibbous, the phase in which more than half of the Moon is lit and the bright portion is growing larger every night

7. The four planets closest to the Sun are small and rocky, while the four farther out are large and gaseous. Which idea best explains why the inner planets are rocky?

A. The inner planets formed much later than the outer planets and simply have not yet had enough time to collect any gas at all

B. The inner planets were originally gas giants but lost all of their gas when they collided violently with one another long ago

C. The Sun's gravity pulled all of the rock outward to the inner region while pushing all of the lighter gas to the outer region

D. Near the hot young Sun, only rock and metal could remain solid, while ice and gas survived only in the cold outer regions

8. Solar and lunar eclipses do not happen every month, even though the Moon passes between the Earth and Sun and behind the Earth each month. What is the main reason eclipses are relatively rare?

A. The Moon's orbit is tilted relative to Earth's orbit, so the three bodies usually do not line up exactly enough for a shadow to fall

B. The Moon is usually too far away from the Earth during most months for its shadow to be able to reach the Earth's surface at all

C. Eclipses can occur only during the few months of the year when the Earth happens to be closest to the Sun along its orbit

D. The Earth stops rotating during most months, which prevents the careful alignment that is needed for an eclipse to take place

9. At the first quarter and last quarter moons, the difference between high and low tide is smaller than usual. What causes these weaker neap tides?

A. The Moon moves much closer to the Earth during the quarter phases, which weakens its gravitational pull on the ocean water

B. The Sun completely blocks the Moon's gravity during the quarter phases, leaving only Earth's own gravity to act on the oceans

C. The Sun and Moon pull on Earth's water at right angles to each other, so their effects partly cancel and produce smaller tides

D. The ocean water freezes solid during the quarter phases, which prevents the tides from rising and falling as much as usual

10. The Sun radiates energy in all directions into space, yet Earth intercepts only a tiny fraction of that energy. Why does Earth receive only a small part of the Sun's total output?

A. The Sun deliberately aims most of its energy toward the larger outer planets and sends only a little of it toward the smaller Earth

B. Earth is a small target very far away, so it intercepts only the tiny portion of the Sun's energy that happens to reach its location

C. Earth's atmosphere reflects almost all of the Sun's energy back into space, allowing only a tiny fraction to reach the planet at all

D. The Sun's energy spreads out evenly across the entire surface of the Earth, so every spot on the planet receives the exact same amount

11. At a location in the Northern Hemisphere, the June solstice brings both the longest day of the year and the most direct midday sunlight. How do these two factors together affect the amount of solar energy received that day?

A. They cancel each other out, so the total solar energy received on the solstice is exactly the same as on any other day of the year

B. Only the length of the day matters, so the amount of energy received depends entirely on how many hours of daylight there are

C. Only the angle of the Sun matters, so the length of the day has no effect at all on the total solar energy that is received

D. They combine, so long daylight hours plus direct, high-angle sunlight together produce the greatest solar energy of the year

12. In an undisturbed sequence of sedimentary rock layers, a geologist wants to identify the oldest layer. Where should the geologist look?

A. At the very top of the sequence, because the highest layer is always the first one that was deposited in any rock sequence

B. In the exact middle of the sequence, because deposition always begins in the center of a basin and then spreads both upward and downward

C. At the very bottom of the sequence, because by superposition the lowest undisturbed layer was deposited first and is the oldest

D. The oldest layer cannot be identified, because the layers in any sedimentary sequence are always deposited in a completely random order

13. Carbon-14 has a half-life of about 5,700 years. A piece of ancient charcoal contains about one-fourth of the carbon-14 it had when the wood was alive. About how old is the charcoal?

A. About 11,400 years old, because reaching one-fourth of the original amount requires two half-lives, and two times 5,700 is 11,400

B. About 5,700 years old, because reaching one-fourth of the original amount requires only a single half-life of the carbon-14 isotope

C. About 2,850 years old, because reaching one-fourth of the original amount takes only half of one half-life of the carbon-14 isotope

D. About 22,800 years old, because reaching one-fourth of the original amount requires four full half-lives of the carbon-14 isotope

14. A student claims that finding a particular fossil in a rock layer reveals the exact numerical age of that layer in years. Why is this claim incorrect?

A. Fossils are never found in sedimentary rock, so they can provide no information at all about the age of any rock layer

B. Fossils reveal only the color of a rock layer and tell scientists absolutely nothing about when that layer was originally formed

C. Fossils can give the exact age of a layer to the nearest single year, so the student's claim is actually completely correct as stated

D. Index fossils give relative age by showing which layers are older or younger; numerical ages require radiometric dating of the rock

15. Geologists use the principle that "the present is the key to the past," assuming that the natural processes shaping Earth today also operated in the past. What is this principle called?

A. Catastrophism, the idea that Earth's features were shaped almost entirely by sudden, brief, violent global catastrophes in the past

B. Uniformitarianism, the idea that the same natural processes seen operating today also operated in the past and shaped Earth's features

C. Superposition, the idea that in undisturbed rock layers the oldest layer lies at the bottom and the youngest layer lies at the top

D. Original horizontality, the idea that sedimentary layers are first deposited in flat, horizontal sheets before any later tilting occurs

16. The boundary between the Permian and Triassic periods marks the largest extinction in Earth's history, when an estimated 90 percent of marine species died out. Events like this are known as what?

- A. Mass extinctions, intervals during which a large fraction of Earth's species die out worldwide over a relatively short span of time
- B. Adaptive radiations, intervals during which a single surviving species rapidly evolves into many new species to fill empty niches
- C. Magnetic reversals, intervals during which the north and south magnetic poles of the Earth gradually trade places with one another
- D. Ice ages, intervals during which global temperatures fall sharply and thick sheets of ice spread across large portions of the continents

17. Wegener proposed that all of today's continents were once joined together into a single giant supercontinent that later broke apart. What name is given to this ancient supercontinent?

- A. Gondwana, the name now given to the single ancient landmass from which every one of today's continents is thought to have broken apart
- B. Laurasia, the name now given to the single ancient landmass from which every one of today's continents is thought to have broken apart
- C. Pangaea, the name given to the single ancient supercontinent that contained all of today's landmasses before it later broke apart
- D. Eurasia, the name given to the single ancient supercontinent that contained all of today's landmasses before it later broke apart

18. A deposit contains a chaotic mix of boulders, sand, and clay all jumbled together with no sorting by size and no layering at all. Which past process most likely produced this deposit?

- A. A slow-moving river, which gently sorts its sediment by size and lays it down in neat, well-defined horizontal layers over time
- B. A calm, deep lake, in which only the very finest clay particles slowly settle out and form smooth, evenly layered deposits on the bottom
- C. A windswept desert, in which the wind carefully sorts the sand grains by size and piles only the finest, most uniform sand into dunes
- D. A glacier, which carries and then dumps an unsorted, unlayered mixture of all sizes of rock and sediment as the ice melts away

19. Along the Mid-Atlantic Ridge, two plates pull apart and magma rises to fill the gap, continuously creating new ocean floor. What type of plate boundary is this?

- A. A divergent boundary, where two plates move apart and rising magma forms new crust along a ridge between them
- B. A convergent boundary, where two plates collide head-on and one plate is forced down beneath the other into the mantle below
- C. A transform boundary, where two plates grind horizontally past each other, producing frequent earthquakes but no new crust at all
- D. A subduction zone, where a dense oceanic plate sinks beneath a lighter continental plate and forms a deep trench along the coast

20. Of Earth's major layers, which one is the thinnest, and on which one do all living things reside?

- A. The mantle, which is the thinnest layer and the solid rocky shell on which all of Earth's living things make their homes
- B. The crust, which is the thinnest layer and the outermost solid rocky shell on which all of Earth's living things reside
- C. The outer core, which is the thinnest layer and the molten metal shell on which all of Earth's living things make their homes
- D. The inner core, which is the thinnest layer and the solid metal sphere on which all of Earth's living things make their homes

21. Deep within a mountain range, a shale rock is subjected to intense heat and pressure over millions of years, and its minerals recrystallize and line up into bands, forming slate and then schist. What type of rock results from this process?

- A. An igneous rock, because the original rock was completely melted into magma and then cooled and crystallized into a brand-new solid rock
- B. A sedimentary rock, because the original rock was broken into small fragments that were then deposited, compacted, and cemented together
- C. A metamorphic rock, because the original rock was changed by intense heat and pressure into a new rock without ever fully melting

D. A volcanic glass, because the original rock was heated until it erupted as lava and then cooled so fast that no crystals had time to form

22. A geologist finds that a mineral can scratch glass but cannot scratch a piece of quartz. Which property is being tested, and what does this tell the geologist?

A. Hardness; the mineral is harder than glass but softer than quartz, placing it at a specific point on the Mohs hardness scale

B. Streak; the mineral leaves a powder that is darker than glass but lighter than quartz when rubbed across an unglazed tile surface

C. Cleavage; the mineral breaks along flat planes that are wider than those of glass but narrower than those of a piece of quartz

D. Luster; the mineral reflects light in a way that is brighter than glass but duller than the reflective surface of a piece of quartz

23. An igneous rock contains a few large crystals surrounded by a background of very tiny crystals. What does this mixed texture most likely indicate about the rock's cooling history?

A. The rock cooled at one single, perfectly steady rate from start to finish, which always produces crystals that are all exactly the same size

B. The rock never cooled at all and is still entirely molten, which is the only way that crystals of two very different sizes can ever form together

C. The rock formed from compacted sediment rather than from any molten material, which is why it contains crystals of two different sizes

D. The magma cooled slowly at first, growing the large crystals, and then erupted and cooled quickly, freezing the tiny crystals around them

24. After a heavy rainstorm, some of the rainwater flows downhill across the surface into streams, while some soaks down into the soil and rock below. What are these two processes called, in order?

A. Evaporation and condensation, the process of water rising into the air as vapor followed by that vapor cooling into liquid droplets

B. Precipitation and transpiration, the process of water falling from clouds followed by plants releasing water vapor through their leaves

C. Runoff and infiltration, the process of water flowing over the surface into streams followed by water soaking down into the ground

D. Sublimation and deposition, the process of ice changing directly into vapor followed by vapor changing directly back into solid ice

25. A rock layer has many pore spaces that hold a large amount of water, but those pores are not well connected, so water cannot move through it easily. How would this rock layer best be described?

A. It has low porosity and high permeability, meaning it holds little water but allows what water it does hold to flow through it very rapidly

B. It has high porosity but low permeability, meaning it holds a lot of water but does not allow that water to flow through it very easily

C. It has high porosity and high permeability, meaning it both holds a great deal of water and allows that water to flow through it very freely

D. It has low porosity and low permeability, meaning it holds almost no water at all and does not allow any water to pass through it whatsoever

26. Besides plants on land, what is the other major natural reservoir that absorbs large amounts of carbon dioxide from the atmosphere?

A. The oceans, which dissolve carbon dioxide from the air into their surface waters, making them a major reservoir of carbon

B. The Moon, which pulls carbon dioxide off the Earth with its gravity and stores that gas permanently on its own dusty surface

C. The upper atmosphere, which destroys carbon dioxide molecules using sunlight so that the gas never returns to the surface again

D. The solid inner core of the Earth, which steadily draws carbon dioxide down from the surface and locks it deep inside the planet

27. Heat from Earth's interior causes hot material in the mantle to rise while cooler material sinks, setting up a slow, circular flow. What is this process called, and what does it help drive?

- A. Conduction, the direct transfer of heat between touching particles, which is the process that directly lifts the continents upward over time
- B. Radiation, the transfer of heat as electromagnetic waves through empty space, which is the process that drives the movement of Earth's plates
- C. Compression, the squeezing of rock under great pressure, which is the process that causes the slow circular flow of material in the mantle
- D. Convection, the transfer of heat by the rising of warm material and sinking of cool material, which helps drive the motion of Earth's plates

28. Over many years, an iron-rich rock exposed at the surface develops a reddish-brown crust as its iron minerals react with oxygen and water. What type of weathering is responsible for this change?

- A. Frost wedging, a mechanical process in which water freezes within cracks, expands, and physically breaks the rock into smaller pieces
- B. Abrasion, a mechanical process in which wind-blown sand or tumbling rock fragments grind against a rock and slowly wear its surface down
- C. Chemical weathering, in which the iron minerals react with oxygen and water to form new reddish-brown compounds, changing the rock
- D. Exfoliation, a mechanical process in which the outer layers of a rock peel away in curved sheets as overlying pressure is gradually released

29. Which statement correctly distinguishes erosion from deposition?

- A. Erosion is the picking up and carrying away of weathered material, while deposition is the dropping and laying down of that material elsewhere
- B. Erosion is the dropping and laying down of sediment, while deposition is the picking up and carrying away of that same sediment to a new place
- C. Erosion and deposition are two different words for exactly the same process, namely the chemical breakdown of solid rock into loose sediment
- D. Erosion is the freezing of water inside cracks in a rock, while deposition is the melting of that same ice once the temperature rises again

30. In summer, a warm, moisture-laden air mass moves north from over the Gulf of Mexico into the southeastern United States. What kind of weather does this maritime tropical (mT) air mass bring?

- A. Cold, dry air with clear skies and sharply falling temperatures, typical of an air mass that formed over a frozen northern continent
- B. Warm, very humid air with a strong chance of afternoon thunderstorms, typical of an air mass that formed over a warm tropical sea
- C. Cool, foggy, drizzly air with thick low clouds, typical of an air mass that formed over a cold stretch of northern ocean water
- D. Hot, bone-dry desert air with cloudless skies and a high risk of drought, typical of an air mass that formed over an arid continental interior

31. Two air masses meet, but neither one is strong enough to push the other out of the way, so the boundary between them barely moves for several days, bringing a long period of clouds and rain to the same area. What kind of front is this?

- A. A cold front, in which a fast-moving mass of cold air aggressively pushes underneath a warmer air mass and forces it to rise quickly
- B. A warm front, in which a mass of warm air slowly advances and slides up and over a retreating mass of cooler air ahead of it
- C. An occluded front, in which a fast cold front catches up to and overtakes a slower warm front, lifting the warm air completely off the ground
- D. A stationary front, in which two air masses meet but neither advances, so the boundary stalls and brings days of clouds and steady rain

32. A barometer at a weather station shows that the air pressure has been falling steadily over the past several hours. What kind of weather change does falling air pressure most often signal?

- A. The approach of stormy weather, since falling pressure usually indicates rising, moist air and an approaching low-pressure system
- B. The arrival of clear, calm, sunny weather, since falling pressure almost always indicates a strong high-pressure system moving in

C. No change at all in the weather, since the air pressure measured by a barometer has no connection to the weather that follows it

D. A sudden and lasting drop in temperature, since falling air pressure is caused only by the air over the station rapidly cooling down

33. At the very center of a powerful hurricane lies a roughly circular region of calm, clear skies and light winds, surrounded by the storm's most violent winds. What is this calm central region called?

A. The storm surge, the dome of seawater that the hurricane's powerful winds push ashore and that causes much of the coastal flooding

B. The spiral band, one of the long curving arms of clouds and rain that wrap around the outside of the hurricane far from its center

C. The eye, the relatively calm, clear region at the very center of the hurricane, surrounded by the violent winds of the eyewall

D. The jet stream, the fast-moving river of air high in the atmosphere that steers the hurricane along its path across the ocean

34. Western Europe has a much milder climate than other regions at the same high latitude, partly because of a warm ocean current. How do warm ocean currents affect the climate of nearby coastal land?

A. They cool the nearby land sharply by carrying frigid polar water along the coast, which gives those coastal areas much colder winters

B. They warm the nearby land by carrying heat from the tropics toward higher latitudes, which gives those coastal areas milder winters

C. They have no measurable effect at all on the climate of nearby land, because ocean water and the air above the land never exchange any heat

D. They permanently stop all rain from falling on the nearby land, because the warm current pulls every cloud far out over the open ocean

35. Several gases in Earth's atmosphere act as greenhouse gases, trapping heat and warming the planet. Which of the following is a major greenhouse gas?

- A. Nitrogen, which makes up about 78 percent of the atmosphere by volume and is the single most powerful heat-trapping gas in the air
- B. Argon, an inert gas that makes up nearly one percent of the atmosphere and is chiefly responsible for trapping the Earth's outgoing heat
- C. Helium, an extremely light gas that rises to the top of the atmosphere and traps almost all of the heat radiating from Earth's surface
- D. Carbon dioxide, a gas that, though present in small amounts, absorbs outgoing heat radiation and is a major driver of the greenhouse effect

36. A meteorologist explains that the average temperature and rainfall a region experiences over a 30-year period is its climate, while the conditions outside on any given day are its weather. Which statement correctly captures this distinction?

- A. Weather and climate mean exactly the same thing, since both simply describe the temperature and precipitation conditions of a region
- B. Climate refers to the conditions outside at one particular moment, while weather refers to the long-term average conditions over many years
- C. Weather refers to short-term, day-to-day atmospheric conditions, while climate refers to the long-term average of those conditions over many years
- D. Weather can be measured with instruments, but climate can never be measured in any way and can only be guessed at by scientists

37. Why are coal, oil, and natural gas classified as nonrenewable energy resources?

- A. They form over hundreds of millions of years from buried organic matter, so they are used up far faster than natural processes can replace them
- B. They are completely artificial fuels manufactured in factories, so once a factory shuts down there is no way to ever produce any more of them
- C. They are replenished by the Sun within just a few days, so they are technically renewable but are simply mislabeled as nonrenewable by mistake
- D. They exist in truly unlimited supplies deep within the Earth, so the term nonrenewable refers only to how expensive they are to extract and use

38. A city is deciding whether to build a new highway that would ease traffic but would also cut through a public park and increase air pollution. This situation, in which gaining one benefit requires accepting a cost, is best described as which of the following?

- A. A renewable resource, because the highway can be used over and over by drivers for many years without the road ever being used up
- B. A positive feedback, because building the highway will cause even more highways to be built automatically without any further decisions
- C. An ecosystem service, because the highway provides the public with a valuable service that comes directly and freely from the natural world
- D. A trade-off, because gaining the benefit of reduced traffic requires accepting the costs of a smaller park and increased air pollution

39. A large area of tropical rainforest is cleared and converted into farmland, and many of the forest species that lived there disappear from the region. Which driver of biodiversity loss does this best illustrate?

- A. Overharvesting, in which a species is hunted or collected from the wild faster than its population is able to reproduce and recover
- B. Habitat loss, in which the natural living space that organisms depend on is destroyed, leaving them without the resources they need to survive
- C. An invasive species, in which a non-native organism is introduced and then outcompetes or preys upon the region's native organisms
- D. Ocean acidification, in which seawater absorbs carbon dioxide and grows more acidic, harming corals and other shell-building organisms

40. A coastal wetland soaks up floodwaters during storms, filters pollutants out of the water that flows through it, and helps control erosion along the shore. These benefits are best classified as which type of ecosystem service?

- A. A provisioning service, because the wetland is supplying people with material goods such as food, timber, fresh water, and other raw materials
- B. A cultural service, because the wetland is providing people with recreation, natural beauty, and a source of spiritual or artistic inspiration

C. A regulating service, because the wetland is moderating natural processes such as flooding, water quality, and erosion that affect human well-being

D. A supporting service, because the wetland is carrying out the basic underlying processes, such as soil formation, that make other services possible

41. Which of the following is a well-documented consequence of rising global temperatures for low-lying coastal communities?

A. Rising sea levels increase the risk of coastal flooding and erosion, threatening homes, freshwater supplies, and infrastructure in these areas

B. Falling sea levels are exposing vast new areas of dry coastal land, steadily increasing the amount of territory available to these communities

C. Coastal regions are becoming far colder and developing thick permanent sheets of ice, which permanently protect them from any flooding at all

D. Ocean water is becoming far less salty and much more drinkable, completely solving every freshwater shortage that coastal communities once faced

42. Fertilizer runoff loads a lake with extra nutrients, causing a huge bloom of algae. When the algae die and decompose, the oxygen in the water is used up and fish begin to die. What is this process called?

A. Desalination, the process of removing dissolved salt from seawater or brackish water in order to make it fresh enough for people to drink and use

B. Eutrophication, the process in which excess nutrients trigger algae blooms whose decay depletes the water's oxygen and kills aquatic life

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

D. Sublimation, the process in which a solid such as ice changes directly into water vapor without ever passing through the liquid water stage

43. A community wants to reduce the amount of solid waste it sends to its landfill while also conserving raw materials. Which practice would best help it meet both of these goals?

- A. Burning all of its waste in open piles, which makes the trash disappear from sight but releases pollutants into the air and conserves no materials
- B. Sending all of its waste, including glass, metal, and paper, directly to the landfill, which is the simplest way to handle the community's trash
- C. Burying its waste in many new landfills scattered across the surrounding region, which spreads the trash out but still uses up new raw materials
- D. Setting up recycling and composting programs, which divert materials away from the landfill and return them to use, conserving raw materials

44. On a summer night, the downtown area of a large city stays noticeably warmer than the surrounding countryside. What is the main cause of this "urban heat island" effect?

- A. Pavement, concrete, and buildings absorb heat during the day and release it slowly at night, keeping the city warmer than the countryside
- B. Cities are always located at much lower elevations than the surrounding countryside, and lower elevations are always far warmer at night
- C. The bright lights of the city physically heat the surrounding air directly, raising the city's nighttime temperature far above the countryside
- D. Tall city buildings reach up into a permanently warmer layer of the atmosphere that does not exist anywhere over the open countryside

45. A city plants thousands of trees and protects its existing forests specifically to remove carbon dioxide from the air and slow climate change. This strategy is best described as which of the following?

- A. Adaptation, because the city is adjusting its infrastructure and daily life to cope with the climate impacts that are already beginning to occur
- B. Acidification, because the planted trees will gradually lower the rising acidity of the nearby ocean by pulling salt out of the seawater
- C. Mitigation, because the trees remove carbon dioxide from the atmosphere, reducing the greenhouse gas that is a root cause of climate change
- D. Desalination, because the trees will steadily remove dissolved salt from the groundwater and make far more fresh water available to the city

46. A timber company wants to harvest wood from a forest in a way that allows the forest to remain healthy and productive for future generations. Which practice best supports this goal?

- A. Clear-cutting the entire forest all at once and then immediately moving on to a new forest, leaving the cleared land bare and unplanted behind it
- B. Harvesting only a portion of the trees and replanting to allow the forest to regrow, so the resource can be used again in the future
- C. Harvesting every single tree in the forest as quickly as possible to maximize short-term profit before any competitor can reach the same trees
- D. Setting the forest on fire after each harvest so that no trees are ever left standing, which prevents any future regrowth of the woodland at all

47. The human population has grown rapidly, but Earth's resources such as fresh water, fertile soil, and energy are limited. What does this tension between population growth and limited resources suggest?

- A. There is no limit whatsoever to how many people the Earth can support, because human population can keep growing forever with no consequences
- B. The human population will automatically stop growing on its own the very instant it is needed, with no effect on resources or the environment
- C. Earth's resources are completely unlimited, so the size of the human population has no connection to the availability of any natural resources
- D. Continued growth places increasing demands on limited resources, making sustainable use of those resources increasingly important over time

48. An engineering team has developed three possible designs for a water filter, each with different strengths in cost, speed, and effectiveness. According to the engineering design process, how should the team decide which design to pursue?

- A. They should pick the design proposed by whoever on the team has the loudest voice, since the strength of a person's opinion is the best guide to quality
- B. They should systematically evaluate each design against the criteria and constraints, weighing the trade-offs to choose the one that best meets the needs

C. They should always choose the most expensive of the three designs, since a higher cost is a guarantee that a design will perform better than cheaper ones

D. They should select one of the three designs completely at random, since there is no reliable way to compare competing engineering designs to one another

49. Before constructing a full-sized dam, engineers build a small-scale physical model of the dam and the river and run water through it to observe how it behaves. What is the main advantage of testing a small-scale model first?

A. The small model behaves in a way that is completely unrelated to the full-sized dam, so the test results cannot possibly provide any useful information

B. The small model is guaranteed to behave exactly like the full-sized dam in every possible detail, so its results never need to be checked any further

C. The model lets engineers safely and cheaply observe how the design might behave and identify problems before the costly full-sized dam is built

D. The model proves with complete certainty that the full-sized dam will never fail under any conditions whatsoever, removing the need for any later inspections

50. When a government decides how to respond to a problem such as air pollution, scientific research can inform the decision, but the final choice also depends on economic and social factors. What does this best illustrate about the relationship between science and public decision-making?

A. Scientific evidence should be completely ignored when making public decisions, because only economic and social factors should ever matter at all

B. Science alone automatically determines every public decision, leaving absolutely no role for economic, social, or political considerations of any kind

C. Science and public decision-making are entirely unrelated, since scientific research can never provide any information that is useful to decision-makers

D. Science provides evidence that informs decisions, but turning that evidence into policy also involves weighing economic, social, and ethical factors

## Practice Exam 52: Answer Key with Explanations

1. B — The cosmic microwave background is the cooled-down afterglow of the hot, dense early universe, now stretched and cooled to just 2.7 K as the universe expanded. Its uniform presence across the whole sky strongly supports the Big Bang model. It is one of the most powerful pieces of cosmological evidence.
2. A — A main-sequence star is held stable by hydrostatic equilibrium, a balance between gravity pulling inward and the outward pressure of energy released by core fusion. Each force counters the other, keeping the star steady. This balance lasts as long as the core has hydrogen to fuse.
3. D — Elements like carbon, oxygen, and iron were produced by nuclear fusion inside earlier generations of stars and released into space when those stars died. Supernovae scatter these elements into the gas that forms new stars and planets. This stellar recycling is why such elements exist on Earth.
4. C — Kepler's Third Law gives  $T^2 = a^3$ , so with  $a = 9$ ,  $a^3$  equals 729 and  $T$  is the square root of 729, exactly 27 years. The cube of the distance sets the square of the period. This relationship applies to any object orbiting the Sun.
5. A — The equinoxes are the two days each year when neither hemisphere is tilted toward or away from the Sun, so day and night are nearly equal worldwide and the Sun's rays strike the equator most directly. They mark the transitions between the half-years of opposite tilt. The solstices, by contrast, mark the extremes of tilt.
6. B — A thin sliver lit on the left side, shrinking each night and rising shortly before the Sun, is a waning crescent, the phase between last quarter and new moon. "Waning" means the lit fraction is decreasing, and the leftward illumination is its hallmark. It is the final phase before new moon.
7. D — Near the hot young Sun, only rock and metal could remain solid in the inner disk, while volatile ice and gas survived only in the cold outer regions. This temperature gradient produced small rocky planets close in and gas giants farther out. The frost line separates the two zones.
8. A — Eclipses are rare because the Moon's orbit is tilted about 5 degrees relative to Earth's orbit, so during most months the three bodies do not line up exactly enough for a shadow to fall. The alignment must be very precise. This tilt is why eclipses occur only a few times a year rather than monthly.
9. C — Neap tides at first and last quarter are weaker because the Sun and Moon then pull on Earth's water at right angles, so their gravitational effects partly cancel. This produces a smaller tidal range than at the aligned new and full moons. The Sun-Moon geometry controls tidal strength.
10. B — Earth receives only a tiny fraction of the Sun's output because Earth is a small target very far away, and the Sun radiates in all directions, so only the energy that happens to reach Earth's small cross-section is intercepted. The energy spreads over a vast sphere as it travels outward. This geometric spreading is why distant objects receive so little.
11. D — On the June solstice in the Northern Hemisphere, long daylight hours and direct, high-angle sunlight combine to produce the greatest daily solar energy of the year. Both factors raise the energy received. Together they make the solstice the peak of incoming solar energy.
12. C — By the principle of superposition, the bottom layer in an undisturbed sedimentary sequence was deposited first and is therefore the oldest. Layers accumulate from the bottom upward over time. This rule is the foundation of relative dating in horizontal strata.
13. A — One-fourth remaining means two half-lives have passed, since  $1 \rightarrow 1/2 \rightarrow 1/4$ . Two half-lives  $\times$  5,700 years equals 11,400 years. Counting the number of halvings is the key to radiometric age problems.

14. D — Index fossils give relative age by showing which layers are older or younger than others, while determining the exact numerical age of a rock requires radiometric dating. Fossils alone cannot pin down a precise number of years. Relative and absolute dating answer different questions.
15. B — Uniformitarianism is the principle that the same natural processes seen today also operated in the past, summarized as "the present is the key to the past." It lets geologists infer past events from observable processes. This idea is a foundation of modern geology.
16. A — Intervals during which a large fraction of Earth's species die out worldwide in a short span of geologic time are called mass extinctions. The end-Permian event was the largest in Earth's history. Such events have repeatedly reshaped the course of life on Earth.
17. C — Pangaea is the name given to the single ancient supercontinent that contained all of today's landmasses before it broke apart about 200 million years ago. Wegener identified it from matching coastlines, fossils, and rock units. The continents have been drifting ever since.
18. D — A chaotic, unsorted, unlayered mix of boulders, sand, and clay is characteristic of glacial till, dumped wherever the ice melts. Glaciers carry sediment of all sizes and drop it together without sorting. Water and wind, by contrast, sort sediment by size.
19. A — The Mid-Atlantic Ridge is a divergent boundary, where two plates move apart and rising magma forms new crust along the ridge between them. The seafloor spreads outward from the ridge axis. This continuous addition of new ocean floor is seafloor spreading.
20. B — The crust is Earth's thinnest layer and the outermost solid rocky shell on which all living things reside. It is far thinner than the mantle and the core. All of Earth's surface processes and life take place on or just within it.
21. C — Heat and pressure that recrystallize a rock and develop bands without melting it produce metamorphic rock. The original rock changes in the solid state, gaining new textures like foliation. Slate and schist are classic metamorphic products of shale.
22. A — Comparing which materials a mineral can and cannot scratch is a hardness test, placing the mineral on the Mohs scale. It is harder than glass but softer than quartz, putting it between the two. Hardness is a key diagnostic property for identifying minerals.
23. D — A mix of large crystals in a fine-grained background indicates a two-stage cooling history: slow cooling underground grew the large crystals, then rapid cooling at the surface froze the tiny crystals around them. This porphyritic texture records both stages. The crystal sizes track the cooling rates.
24. C — Rainwater flowing downhill across the surface into streams is runoff, and water soaking into the soil and rock below is infiltration. Both are key parts of the water cycle. Together they distribute precipitation between surface flow and groundwater recharge.
25. B — A rock with abundant but poorly connected pores has high porosity but low permeability, so it holds plenty of water but does not let it flow through easily. Porosity measures storage and permeability measures flow. Some clays show exactly this combination.
26. A — Besides land plants, the oceans are the other major natural reservoir that absorbs large amounts of carbon dioxide from the atmosphere, dissolving it into their surface waters. They store a vast amount of carbon. This uptake also drives ocean acidification.
27. D — Convection in the mantle transfers heat as warm material rises and cool material sinks in a slow circular flow, and this motion helps drive Earth's plates across the surface. Mantle convection is the engine of plate tectonics. The plates move because of the underlying flow.

28. C — Iron minerals reacting with oxygen and water to form reddish-brown compounds is chemical weathering, because the rock's composition changes. This oxidation alters minerals at the molecular level. Mechanical weathering, by contrast, breaks rock without changing its chemistry.
29. A — Erosion is the picking up and carrying away of weathered material, while deposition is the dropping and laying down of that material in a new place. The two processes are opposite ends of sediment transport. Both shape landscapes, but they are distinct steps.
30. B — A maritime tropical air mass forms over warm tropical seas and brings warm, very humid air, often with afternoon thunderstorms. "Maritime" indicates moisture and "tropical" indicates warmth. This contrasts sharply with cold, dry continental polar air.
31. D — When two air masses meet but neither advances, the boundary stalls, and the front is called a stationary front. The stalled front can bring days of clouds and steady rain to the same area. Movement of either air mass would convert it into a cold or warm front.
32. A — Falling air pressure usually signals the approach of stormy weather, because lower pressure indicates rising, moist air and an approaching low-pressure system. Air rises, cools, and condenses into clouds and precipitation. Rising pressure, by contrast, typically indicates fair weather.
33. C — The eye is the relatively calm, clear region at the very center of a hurricane, surrounded by the violent winds of the eyewall. Air descends gently within the eye. The eyewall just outside it contains the storm's strongest winds and heaviest rain.
34. B — Warm ocean currents warm nearby coastal land by carrying heat from the tropics toward higher latitudes, giving those coasts milder winters than other regions at the same latitude. The North Atlantic Current does this for western Europe. Cold currents, by contrast, cool nearby coasts.
35. D — Carbon dioxide is a major greenhouse gas because, though present in small amounts, it strongly absorbs outgoing infrared radiation and re-emits part of it downward. Nitrogen, argon, and helium do not absorb infrared and are not greenhouse gases. CO<sub>2</sub> is a key driver of climate change.
36. C — Weather refers to short-term, day-to-day atmospheric conditions, while climate refers to the long-term average of those conditions over many years. The two differ in time scale, not in what they measure. Distinguishing them is essential for interpreting climate trends.
37. A — Coal, oil, and natural gas form over hundreds of millions of years from buried organic matter, so they are used up far faster than natural processes can replace them. That mismatch is what makes them nonrenewable. Their finite supply is the central reason for seeking alternatives.
38. D — Gaining the benefit of reduced traffic at the cost of a smaller park and increased air pollution is a trade-off, in which one gain must be balanced against losses. Trade-offs are unavoidable in real environmental decisions. Recognizing them is essential to honest decision-making.
39. B — Clearing tropical rainforest and converting it to farmland is habitat loss, the destruction of the natural living space organisms depend on. Without their habitat, species cannot survive there. Habitat loss is the leading driver of biodiversity loss worldwide.
40. C — A wetland that absorbs floodwaters, filters pollutants, and controls erosion is providing a regulating service, the category covering processes that moderate hazards and improve environmental quality. Regulating services protect human well-being. This illustrates the practical value of intact ecosystems.
41. A — Rising sea levels increase the risk of coastal flooding and erosion, threatening homes, freshwater supplies, and infrastructure in low-lying communities. Both thermal expansion and melting land ice are driving the rise. The other options contradict observed trends.

42. B — Excess nutrients triggering algae blooms whose decay depletes oxygen and kills aquatic life is called eutrophication. Fertilizer runoff is a major cause. The resulting low-oxygen "dead zones" are a serious threat to lakes and coastal waters.
43. D — Setting up recycling and composting programs diverts materials away from the landfill and returns them to use, conserving raw materials at the same time. Both goals are met by the same practice. Reducing waste at the source is the foundation of sustainable waste management.
44. A — The urban heat island effect occurs because pavement, concrete, and buildings absorb heat during the day and release it slowly at night, keeping cities warmer than surrounding countryside. Dark surfaces and limited vegetation amplify the effect. It can raise nighttime temperatures by several degrees.
45. C — Planting trees and protecting forests to remove carbon dioxide is mitigation, because it reduces the greenhouse gas concentration that is a root cause of climate change. Mitigation targets the underlying cause, while adaptation copes with impacts. Forest carbon storage is a recognized mitigation tool.
46. B — Harvesting only a portion of the trees and replanting allows the forest to regrow, so timber can be taken again in the future. This is sustainable forestry, matching harvest rates to regrowth. The other options exhaust the resource and prevent recovery.
47. D — Continued population growth with limited resources places increasing demands on finite supplies, making sustainable use of those resources increasingly important. Resources like fresh water and fertile soil are finite. Sustainability seeks to meet present needs without compromising the future.
48. B — Engineers should systematically evaluate each design against the criteria and constraints, weighing the trade-offs to choose the one that best meets the needs. Structured evaluation is central to the engineering design process. Loud opinions, high cost, and random choice are all poor guides.
49. C — A scale model lets engineers safely and cheaply observe how the design might behave and identify problems before the costly full-sized dam is built. Models allow ideas to be tested in advance. They guide decisions while acknowledging uncertainty and the need for further checks.
50. D — Science provides evidence that informs public decisions, but turning that evidence into policy also involves weighing economic, social, and ethical factors. Science and decision-making are linked but not identical. Recognizing both inputs leads to better-informed policy.