PRACTICE EXAM 55: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. A galaxy located 100 million light-years away shows a redshift in its spectrum, while a more distant galaxy 500 million light-years away shows a much larger redshift. What general pattern does this illustrate?

A. The more distant a galaxy is from Earth, the smaller the redshift in its light becomes, since light from very far away fades and stretches less over time

B. The redshift of a galaxy depends only on the color of the stars within it, with no relationship at all to the galaxy's distance from the observer on Earth

C. The more distant a galaxy is from Earth, the greater the redshift in its light, indicating that more distant galaxies are receding from us at higher speeds

D. All galaxies show exactly the same redshift no matter how far away they are, because the entire universe is moving away at one single uniform speed

2. Most of the matter in the universe is not the ordinary matter that makes up stars, planets, and people. What is this other major component called, and how is it detected?

A. Antimatter, which is detected because it gives off enormous amounts of bright visible light wherever ordinary matter happens to come near it in space

B. Ordinary gas that is just very dim, which is detected mainly by carefully measuring the temperature of any empty regions found between stars in space

C. Cosmic dust, which is detected by the brilliant light it gives off as it slowly heats up due to its gradual contact with starlight throughout the universe

D. Dark matter, which is detected indirectly through its gravitational effects on stars and galaxies, even though it gives off no light that we can see

3. A star like the Sun spends roughly 90 percent of its life on the main sequence, fusing hydrogen into helium in its core. Which of the following is the primary reason for this long stable lifetime?

A. The star reaches a stable balance between the inward pull of gravity and the outward pressure of energy released by fusion, called hydrostatic equilibrium

B. The star is held together by an extremely thick outer shell of solid rock that prevents any change in its structure for billions of years at a time

C. The star steadily collects new hydrogen from the surrounding interstellar medium, which keeps its fuel supply constant for billions of years on the main sequence

D. The star is completely frozen during its main-sequence stage, with no internal activity of any kind taking place anywhere within it for billions of years

4. Kepler's Second Law states that a planet sweeps out equal areas in equal times as it orbits the Sun. What practical observation does this law explain about a planet's motion?

A. A planet always moves at exactly the same speed at every point along its orbit, regardless of how close or how far it happens to be from the Sun

B. A planet moves faster when it is closer to the Sun and slower when it is farther away, since it must cover more arc near the Sun to sweep equal area

C. A planet moves more slowly when it is closer to the Sun and faster when it is farther away, since it must cover less arc near the Sun to sweep equal area

D. A planet completely stops moving at the far point of its orbit, then suddenly reverses direction and travels back the way it came toward the Sun

5. A planet has an orbital period of 8 years. Using Kepler's Third Law ($T^2 = a^3$ in solar units), what is its average distance from the Sun?

A. About 2 AU, because the average distance from the Sun is always equal to the orbital period divided by 4, regardless of the actual period of the orbit

B. About 8 AU, because the orbital period in years is always equal to the average distance from the Sun in AU, regardless of the actual size of the orbit

C. About 16 AU, because the average distance from the Sun is always equal to two times the orbital period in years for any object in the entire solar system

D. About 4 AU, because 8 squared is 64, and the cube root of 64 is 4 AU

6. On the September equinox, day and night are nearly equal in length all over the world. Which of the following correctly describes the position of Earth's axis on this day?

A. Earth's axis is tilted neither toward nor away from the Sun, so the Sun's rays strike the equator most directly and day length is nearly equal everywhere

B. Earth's axis is tilted directly toward the Sun, so the Northern Hemisphere experiences its longest day of the year and the Southern Hemisphere its shortest

C. Earth's axis is tilted directly away from the Sun, so the Southern Hemisphere experiences its longest day of the year and the Northern Hemisphere its shortest

D. Earth's axis stands perfectly vertical with no tilt at all, which is why the Sun's rays strike the equator most directly and day length is equal everywhere

7. An observer in the Northern Hemisphere sees a Moon that is more than half lit, with the bright portion on its left side, and the lit fraction has been shrinking for several days. Which phase is the Moon in?

A. The waxing gibbous, the phase between first quarter and full moon in which more than half of the Moon is lit and the bright portion is steadily growing

B. The waning gibbous, the phase between full moon and last quarter in which more than half of the Moon is lit and the bright portion is steadily shrinking

C. The waxing crescent, the thin sliver phase between the new moon and the first quarter when the Moon's lit portion is growing larger on its right side

D. The waning crescent, the thin sliver phase between the last quarter and the new moon when the Moon's lit portion is shrinking on its left side

8. A scientist points out that the eight planets, although all orbiting the Sun in nearly the same plane, can be sharply divided into two groups based on their physical properties. Which division correctly describes the two groups?

A. The inner planets are all very large gas giants, while the outer planets are all small, rocky, and dense worlds with thin or no atmospheres at all

B. The inner planets all have many moons each, while the outer planets all have no moons at all, despite their much larger overall sizes in the solar system

C. The inner planets are small, dense, rocky worlds, while the outer planets are large, low-density worlds made mostly of gas, ice, and hydrogen-rich material

D. The inner and outer planets have exactly the same properties as one another, with no measurable difference between the two groups of any kind

9. During the total phase of a solar eclipse, the Sun is completely blocked by the Moon, and the Sun's outer atmosphere becomes briefly visible. What is this faint outer atmosphere called?

A. The corona, the Sun's hot, faint, outer atmosphere, which can be seen during the total phase of a solar eclipse when the bright disk of the Sun is blocked

B. The photosphere, the very bright visible surface of the Sun, which can be seen during the total phase of a solar eclipse when the disk of the Sun is blocked

C. The core, the central region of the Sun where nuclear fusion takes place, which can be seen during the total phase of a solar eclipse for several seconds

D. The chromosphere only, since this layer is the entire outer atmosphere of the Sun and is the single layer that can possibly be seen during a total eclipse

10. Each year, two slack-tide periods called neap tides occur, during which the difference between high and low water is smaller than usual. During which two Moon phases do neap tides occur?

A. The new moon and the full moon, because the Sun, Earth, and Moon are aligned in a straight line and their gravitational pulls combine to weaken tides

B. The first quarter and the last quarter, because the Sun and Moon pull on Earth's water at right angles to each other, partly canceling their tidal effects

C. The waxing crescent and waning crescent only, because only during these very narrow phases are the Sun and Moon aligned to weaken Earth's tides

D. Only during total lunar eclipses, because tides are very weak only when Earth's shadow happens to fall directly on the surface of the Moon during the eclipse

11. A satellite in low Earth orbit travels in a tight circle around the planet at high speed. Which statement correctly explains how the satellite stays in orbit rather than falling to the ground?

A. Earth's gravity completely turns off above a certain altitude, which is the only reason that satellites and other objects in space do not fall to the ground

B. The Sun's gravity exactly cancels out Earth's gravity at the satellite's altitude, so the satellite experiences no net gravitational force of any kind at all

C. The satellite is held up by the thrust of its rocket engines, which fire continuously throughout the entire time it orbits the Earth to keep it in its orbit

D. Gravity continuously pulls the satellite toward Earth, but its high sideways speed keeps it falling around the Earth rather than down to the surface

12. A geologist studies a thick, undisturbed sequence of sedimentary rock layers and identifies the youngest layer. According to the principle of superposition, where in the sequence is this youngest layer located?

A. At the top of the sequence, because the youngest layer in any undisturbed sequence of sedimentary rocks lies above all of the older layers below it

B. At the bottom of the sequence, because the youngest layer in any undisturbed sequence of sedimentary rocks lies below all of the older layers above it

C. Exactly in the middle of the sequence, because deposition always begins at the middle of any basin and then builds outward in both directions over time

D. The youngest layer cannot be identified from position alone, because the layers in any undisturbed sedimentary sequence are always randomly ordered

13. Two rock samples from different regions both contain the same distinctive fossil. According to the principle of faunal succession, what can a geologist most reliably conclude?

A. The two rocks must be made of exactly the same minerals and have exactly the same physical composition as one another, even though they are far apart

B. The two rocks were likely deposited during the same span of geologic time, because that species existed only during a particular interval of Earth's history

C. The two rocks must have formed at exactly the same physical location, but at very different geologic times, only later separated by continental movement

D. The two rocks cannot have any age relationship at all, because finding the same fossil in two different regions is purely a meaningless coincidence

14. A rock contains both an igneous intrusion that cuts across older sedimentary layers and a fault that cuts across both the layers and the intrusion. Which feature is the youngest, and why?

A. The sedimentary layers are youngest, because they were deposited last, after all of the faulting and intruding had already taken place in the area

B. The igneous intrusion is the youngest, because it cuts across all of the other features in the area, including the fault and the sedimentary layers

C. The fault is the youngest, because by cross-cutting relationships any feature that cuts across other features must be younger than the features it cuts

D. All three features are exactly the same age, because they all appear in the same outcrop and so must have formed at the same time as one another

15. Carbon-14 has a half-life of about 5,700 years. A sample of ancient charcoal has been dated to about 17,000 years old. About what fraction of the original carbon-14 in the sample remains today?

A. About one-eighth of the original amount, because three half-lives have passed, reducing the carbon-14 to one-half, then one-quarter, and then one-eighth

B. About one-quarter of the original amount, because only two half-lives have passed, reducing the original carbon-14 to first one-half and then one-quarter

C. About one-sixteenth of the original amount, because four full half-lives have passed, reducing the original carbon-14 by a series of four full halvings

D. About one-half of the original amount, because only one full half-life has passed during the 17,000 years since the charcoal sample was first formed

16. Why does a geologist generally rely on multiple lines of evidence, rather than a single fossil or rock type, when reconstructing a region's geologic history?

A. Because no single line of evidence is ever helpful at all when reconstructing the history of a region, and only combinations of evidence ever provide any insight

B. Because using more lines of evidence is required only when a geologist is unable to find any rocks at all in the field area being studied for the project

C. Because the geologic record can be incomplete and complex, with gaps and disruptions, so multiple lines of evidence are needed to provide a more reliable picture

D. Because multiple lines of evidence each independently provide a complete reconstruction of the history of the region without requiring any other lines of evidence

17. A sequence of rocks contains, from bottom to top, marine limestones with corals, then shale with land plant fossils, and finally sandstone with desert dune structures. What does this sequence reveal about the area?

A. The area has always been a shallow marine environment, with no change in environmental conditions at any time during the entire span of its history

B. The environment of the area changed over time, shifting from a shallow sea to a coastal land area and then eventually to a dry desert setting

C. The rocks of this region were deposited all at exactly the same time, with no actual change in the environment of the area at any point in its history

D. The fossils have no relationship at all to the environment in which each of the rock layers was originally deposited or formed in the region

18. Wegener's theory of continental drift was initially rejected by many scientists in the early twentieth century, despite the evidence he assembled. What was the main reason for this rejection?

A. He could not propose a satisfactory mechanism to explain how solid continents could move through solid oceanic rock across the surface of the Earth

B. He had no real evidence at all to support his theory, which is the only reason that any other scientists in the early twentieth century ever rejected it

C. He was openly opposed to the use of fossils in geology, which is the main reason that many scientists in the early twentieth century rejected his work

D. He claimed that the continents had moved in just a few weeks of time, which was so clearly impossible that the entire scientific community rejected his work

19. A scientist examines the boundary between Earth's mantle and outer core and finds that seismic S-waves do not pass through the outer core. What does this tell the scientist about the outer core?

A. The outer core is composed entirely of rigid solid metal, because S-waves can only pass through rigid solids and are blocked by every other type of material

B. The outer core is composed entirely of a thick gas, because S-waves can only pass through dense gases and are blocked by every other type of material

C. The outer core is composed entirely of fine dust, because S-waves can only pass through dust and are blocked by every other type of material on Earth

D. The outer core is liquid, because S-waves cannot travel through liquids, so the absence of S-waves on the far side of the planet indicates a liquid layer

20. The Pacific Ring of Fire is a region around the edges of the Pacific Ocean that contains most of Earth's volcanoes and is the site of most major earthquakes. Which of the following best explains why this region is so geologically active?

A. The Pacific Ocean is the largest of Earth's oceans, and its sheer size produces volcanoes and earthquakes regardless of any underlying geological feature

B. The Sun's gravitational pull on the Pacific Ocean directly causes the volcanoes and earthquakes that occur along its edges, with no other cause involved

C. The edges of the Pacific Ocean are lined with many subduction zones and transform faults, where active plate boundaries produce volcanoes and earthquakes

D. The Moon's gravitational pull on the Pacific Ocean directly causes the volcanoes and earthquakes that occur along its edges, with no other cause involved

21. A geologist observes a rock that has been heated and squeezed at depth and now shows wavy, parallel bands of dark and light minerals. Which type of rock is this most likely to be?

A. An intrusive igneous rock, formed deep underground from slowly cooling magma, which always contains randomly oriented large interlocking crystals

B. A metamorphic rock with a foliated texture, formed when heat and pressure aligned the platy minerals into wavy, parallel bands of alternating colors

C. An extrusive igneous rock, formed when lava cools rapidly at or near the surface, which always contains glassy or extremely fine-grained mineral textures

D. A sedimentary rock made of compacted layers of fine clay, formed when sediment was deposited and cemented together in still water with no heat at all

22. A geologist tests an unknown mineral by dripping a small amount of dilute hydrochloric acid on its surface. The mineral fizzes vigorously, releasing bubbles of gas. Which mineral is most likely to behave this way?

A. Quartz, a very hard mineral made of silicon and oxygen that is completely unreactive when dilute hydrochloric acid is applied to its surface during a test

B. Pyrite, a brassy yellow mineral made mostly of iron and sulfur that does not react at all with dilute hydrochloric acid when the acid is applied to it

C. Feldspar, a common rock-forming mineral made mostly of silicon, aluminum, and oxygen that does not react with dilute hydrochloric acid when applied to it

D. Calcite, a calcium carbonate mineral that reacts with dilute hydrochloric acid, producing bubbles of carbon dioxide gas as it dissolves on contact with the acid

23. Liquid water can absorb and release a large amount of energy with only a small change in its own temperature. Which property of water does this describe?

A. The freezing point of water, the specific temperature at which water changes its physical state from a liquid into a solid form during cooling at the surface

B. The density of water, a measure of how much mass is packed into a given volume of water under standard conditions of temperature and pressure

C. The high specific heat of water, the relatively large amount of energy water can absorb or release with only a small change in its own temperature

D. The boiling point of water, the specific temperature at which water changes its physical state from a liquid into a gas at standard atmospheric pressure

24. A region experiences a long drought, and the level of water in a nearby lake drops sharply over several years. Where does most of the water that is missing from the lake actually go?

A. Most of the water leaves the lake through evaporation into the atmosphere, where it joins the water vapor that participates in the rest of the water cycle

B. Most of the water leaves the lake by sinking into the very center of the Earth, where it is permanently stored deep within the planet's solid inner core

C. Most of the water leaves the lake by being broken down into hydrogen and oxygen atoms that escape into space, never returning to the lake again

D. Most of the water leaves the lake by being chemically converted into solid rock that then forms thick layers along the bottom of the lake over time

25. A geologist is asked to recommend a location for a new well that needs to supply a steady flow of fresh water. Which of the following types of rock would generally make the best aquifer?

A. A solid, unfractured granite, because granite has no pore spaces but its hardness makes it the ideal rock type for any aquifer that is supplying water

B. A thin layer of dense, fine-grained clay, because the closely packed clay particles always create a rapid flow of fresh water through the rock and into the well

C. A sheet of solid volcanic glass, because the glass forms a smooth surface that drains water very rapidly and steadily into any well drilled into the rock

D. A thick, porous sandstone with well-connected pore spaces, because the connected pores allow groundwater to be stored in the rock and to flow easily into a well

26. A river slows as it enters a calm lake, dropping its sediment to build up a fan-shaped deposit. As the river continues to flow over time, what generally happens to this fan-shaped deposit?

A. The deposit gradually shrinks and disappears, because the still water in the lake completely dissolves all of the new sediment that the river deposits there

B. The deposit, called a delta, slowly grows outward into the lake as new layers of sediment are added year after year by the continued flow of the river

C. The deposit instantly disappears every winter, because cold weather causes any new sediment added to the delta to evaporate quickly into the surrounding air

D. The deposit moves rapidly back upstream against the flow of the river, because the still water in the lake somehow pushes the sediment back the way it came

27. Ocean currents driven by differences in water temperature and salinity move heat slowly around the globe. Which of the following best describes the influence of these currents on regional climate?

A. Ocean currents have no measurable effect on regional climate, since the temperature and salinity of seawater never have any influence on the air above

B. Ocean currents make all coastal climates uniformly hot, regardless of latitude, since the ocean is always extremely warm and never able to cool any region

C. Warm ocean currents can keep nearby coasts milder than other locations at the same latitude, while cold currents can keep nearby coasts cooler than expected

D. Ocean currents make all coastal climates uniformly cold, regardless of latitude, since the ocean is always extremely cold and never able to warm any region

28. Soil is more than just broken rock; it also contains organic matter from dead plants and animals. Which of the following statements correctly describes a major role of soil for life on Earth?

A. Soil provides nutrients and physical support for the roots of land plants, which form the base of nearly every terrestrial food web that animals and people depend on

B. Soil has no real biological role at all, since plants and animals do not depend on the soil in any way for any of the resources they need in order to survive on land

C. Soil exists only as a backdrop for human activities such as construction and agriculture and is not actually used by any natural ecosystem on the surface of the Earth

D. Soil produces all of the oxygen in Earth's atmosphere through chemical reactions in the rock fragments it contains, with no involvement from any plants or animals

29. Earth's surface receives more energy from the Sun at the equator than at the poles. Which of the following processes plays the largest role in redistributing this energy from the equator toward the poles?

A. Direct conduction of heat through the solid rock of Earth's lithosphere, which efficiently transports the extra energy at the equator polewards in a steady flow

B. Direct radiation of heat from the equator straight to the poles through the vacuum of empty space above the Earth, bypassing the atmosphere entirely on the way

C. Earthquakes and volcanic eruptions, which physically transport huge amounts of heat from the equatorial regions of the Earth to the polar regions of the planet

D. Movement of warm air and warm ocean water from the equator toward the poles, which transports energy through atmospheric and oceanic circulation

30. A cold front is moving rapidly into a warm, humid region during the late afternoon. Which sequence of weather is most likely to follow the passage of this front?

A. A long period of gentle, steady rainfall lasting for many hours, followed by a gradual warming and increasing humidity for several days after the passage of the front

B. A narrow band of heavy thunderstorms followed within a few hours by clearing skies, falling temperatures, and drier, cooler air behind the passing front

C. Several days of unchanging dense fog that simply sits over the area, with no precipitation and no change in temperature of any kind throughout that time

D. Completely clear skies and a sharp rise in temperature throughout the front's passage, with no clouds or precipitation developing at any point during the day

31. Tropical cyclones are given different names depending on where in the world they form, including hurricanes, typhoons, and cyclones. Which conditions are essential for these storms to develop and intensify?

A. Cold ocean water below about 15°C and very strong winds high in the atmosphere, both of which support the development of intense tropical cyclones around the world

B. Dry desert air over land surfaces in the middle of large continents, where evaporation rapidly supplies the heat and moisture needed to power the developing cyclone

C. Warm ocean water above about 26.5°C, sufficient moisture, low wind shear, and a location far enough from the equator that the Coriolis effect can act on the storm

D. Cold polar air over high-latitude oceans, which provides a strong temperature contrast that supports the formation and rapid intensification of any tropical cyclone

32. A scientist explains that "weather" describes short-term atmospheric conditions, while "climate" describes long-term averages of weather over many years. Which of the following best illustrates this distinction?

A. A rainy afternoon in Boston is an example of weather, while the typical pattern of cool, wet winters and warm, humid summers in Boston is an example of climate

B. A typical pattern of cool, wet winters and warm, humid summers in Boston is an example of weather, while a rainy afternoon in Boston is an example of climate

C. Weather and climate mean exactly the same thing, so a rainy afternoon and a long-term pattern of cool wet winters are simply two ways to describe weather alone

D. A rainy afternoon in Boston is an example of climate, while the long-term pattern of cool, wet winters and warm, humid summers in Boston is an example of weather

33. Volcanic eruptions can have important short-term effects on Earth's climate. Which of the following best describes one such effect from a very large eruption?

A. The eruption causes the Sun to give off more energy for several years, which gradually warms the entire planet by several degrees during that span of time

B. The eruption immediately and permanently shifts Earth's orbit closer to the Sun, which permanently warms the planet by several degrees on the human timescale

C. The eruption permanently shifts Earth's axis to a vertical position with no tilt, which removes seasonal variations across the entire planet for many years

D. The eruption injects sulfur compounds high into the atmosphere, where they form bright particles that reflect sunlight and temporarily cool the surface

34. A meteorologist is using a weather map that shows lines connecting points of equal atmospheric pressure. What are these lines called, and what do they show?

A. Isotherms, which are lines connecting points of equal temperature on a weather map, used to show how temperature varies across the surface of the Earth

B. Isobars, which are lines connecting points of equal atmospheric pressure on a weather map, used to identify regions of high and low pressure and the winds that flow between them

C. Contour lines, which are lines connecting points of equal elevation on a topographic map, used to show how the elevation of the land varies across a region

D. Latitude lines, which are imaginary lines connecting points of equal latitude on a globe, used to identify how far north or south of the equator a place is located

35. Many scientists are concerned about long-term climate change because some of its impacts may be difficult to reverse. Which of the following is an example of such an impact?

A. The disappearance of a few small puddles after a single hot day in summer, which is the only widely cited example of a difficult-to-reverse impact of climate change

B. The natural night-and-day temperature change at any location on the surface of the Earth, which is the only widely cited example of a difficult-to-reverse impact

C. The melting of large ice sheets and the resulting sea-level rise, which would take many centuries to reverse even if greenhouse gas emissions stopped today

D. A brief change in the weather over a single weekend in a single city, which is the only widely cited example of a difficult-to-reverse impact of climate change

36. Which of the following best describes the long-term trend in Earth's average global temperature over the past century, according to multiple lines of scientific evidence?

A. Earth's average global temperature has risen, especially over recent decades, with the rate of warming linked to the increasing concentration of greenhouse gases

B. Earth's average global temperature has fallen by several degrees over the past century, despite the increasing concentration of greenhouse gases in the atmosphere

C. Earth's average global temperature has remained completely unchanged over the past century, with no measurable variation from year to year at any location

D. Earth's average global temperature has varied so randomly over the past century that no overall trend can be identified from any of the available data sets

37. A nation imports most of its energy from other countries because it has very limited fossil fuel resources of its own. Which of the following actions would most directly reduce this country's dependence on imported energy in a sustainable way?

A. Drilling for oil in environmentally sensitive areas at home, even though doing so would deplete those limited reserves quickly and damage important ecosystems

B. Building many new coal-fired power plants that burn imported coal, since this approach would maintain rather than reduce the country's dependence on imports

C. Returning entirely to traditional firewood burning for all heating and cooking needs, which would not actually meet the country's modern energy demands at all

D. Investing in domestic renewable energy sources such as wind, solar, and hydroelectric power, which can supply long-term energy without burning imported fuels

38. Plastic waste washed from land into the ocean breaks down into tiny particles called microplastics. Which of the following best describes a likely environmental consequence of this microplastic pollution?

A. The microplastics permanently and instantly stop all ocean currents from circulating around the globe, which leads to a sharp drop in all global ocean temperatures

B. The microplastics are mistaken for food and ingested by marine organisms, which can harm the animals and concentrate plastics and contaminants in the food web

C. The microplastics directly cause a sharp reduction in the amount of salt dissolved in the ocean's water, which makes the seawater fresh enough for drinking by people

D. The microplastics fertilize all marine plants, which makes the ocean far more productive than ever and permanently solves all problems related to overfishing of fisheries

39. A national park is established to protect a unique ecosystem and the species that live there. Which of the following is a likely environmental benefit of creating such a park?

A. The park guarantees that no species in the region will ever go extinct again, regardless of any environmental changes that may occur anywhere on the planet

B. The park makes it possible to develop the surrounding region without any environmental review, since the protected park itself fully compensates for any damage that may occur

C. The park preserves habitat for native species, supports biodiversity, and provides space for natural ecological processes such as predation and nutrient cycling

D. The park has no relationship at all to biodiversity, since protecting one small area never has any effect on the long-term survival of any species in that region

40. A community wants to manage its local groundwater so that it remains available for future generations. Which of the following practices would best support this goal of sustainable groundwater use?

A. Withdrawing groundwater at a rate at or below the rate at which the aquifer recharges naturally from rainfall and other water sources over time

B. Withdrawing groundwater as quickly as possible at all times in order to maximize the community's short-term water supply before any competitor can use it

C. Pumping the aquifer dry on purpose and then refilling it with seawater piped in from the coast, which has been shown to permanently improve the long-term water supply

D. Replacing all of the groundwater in the aquifer with seawater piped in from the coast, since seawater is generally cleaner than groundwater in most communities

41. A coastal city, expecting more frequent flooding due to a warming climate, raises its main roads, strengthens its sea wall, and restores its protective wetlands. This combination of actions is best classified as which type of climate response?

A. Mitigation, because the city is reducing the greenhouse gas emissions that are the underlying cause of the warming and the rising sea level along its coast

B. Restoration, because the city is rebuilding ecosystems that have already been damaged or destroyed by previous human activity along its low-lying coastline

C. Acidification, because the city is taking steps to reduce the rising acidity of the nearby ocean by removing carbon dioxide from the seawater near its shoreline

D. Adaptation, because the city is adjusting its infrastructure to better cope with climate impacts that are already starting to occur in the region

42. Which of the following best describes the relationship between human population growth and demand for natural resources?

A. As the human population grows, the demand for natural resources such as food, fresh water, and energy generally increases, which puts more pressure on the environment

B. As the human population grows, the demand for natural resources steadily falls, since more people automatically and always means lower per-person resource consumption

C. The human population and the demand for natural resources are completely unrelated to each other, since human numbers have no effect at all on resource use anywhere

D. The demand for natural resources falls to zero whenever the human population grows above a certain size, because people no longer need any resources at that point

43. Wind energy, generated by spinning turbines, is considered a renewable energy source. Which of the following best explains why this is the case?

A. Wind energy is renewable because every wind turbine produces an unlimited amount of energy from a fixed amount of wind, which never runs out

B. Wind energy is renewable because the wind is created entirely by the spinning of the wind turbines themselves, which continuously replenish their own fuel source

C. Wind energy is renewable because moving air is continuously replenished by the Sun's uneven heating of the atmosphere, so the resource is not used up over time

D. Wind energy is renewable because all turbines run on stored coal hidden inside their bases, which is somehow always restored each night to be used again

44. A study finds that a stretch of forest has been broken up by roads, fields, and housing developments into many small, isolated patches. Which of the following is a likely consequence of this habitat fragmentation?

A. Populations of forest species become much larger and more stable than before, since each new small patch always offers far more resources than the original large forest

B. Populations of forest species may become smaller, more isolated, and more vulnerable to local extinction, because individuals cannot easily move between the patches

C. Populations of forest species are completely unaffected by habitat fragmentation, since species in fragmented habitats always behave exactly like species in intact habitats

D. Populations of forest species spontaneously develop new beneficial mutations within a few generations, which is the only consequence of habitat fragmentation in any region

45. When a community installs solar panels on its public buildings and replaces older streetlights with energy-efficient LEDs, both actions are part of an effort to combat climate change. Which type of climate strategy do these actions represent?

A. Adaptation, because the community is adjusting its infrastructure to better cope with climate impacts that are already starting to occur in the region

B. Acidification, because the community is taking steps to lower the rising acidity of the nearby ocean by removing carbon dioxide from local seawater

C. Restoration, because the community is rebuilding ecosystems that have already been damaged or destroyed by previous human activity in the region

D. Mitigation, because the community is reducing the greenhouse gas emissions that are the underlying cause of climate change, by lowering its energy use and shifting to cleaner power

46. Which of the following best describes the goal of recycling materials such as paper, glass, and metals in a community?

A. Recycling conserves natural resources and reduces the energy needed to make new products, while also reducing the amount of waste sent to landfills each year

B. Recycling increases the total amount of waste sent to landfills, since collecting and sorting recyclables adds new categories of trash to the community's landfill stream

C. Recycling has no measurable effect on resource use, since making new products from recycled materials always requires exactly the same energy as from raw materials

D. Recycling permanently eliminates all environmental problems caused by manufacturing and waste, so once a community recycles everything no other action is ever needed

47. A region experiences a long heat wave during which daytime temperatures repeatedly exceed local records. Which of the following is the best example of a public health response to such an event?

A. Closing all parks, beaches, and shaded outdoor recreation areas to ensure that no residents are able to spend any time outdoors at any point during the heat wave

B. Limiting all access to drinking water for residents, since drinking more water during a heat wave has been shown to make heat-related illnesses much more common

C. Opening public cooling centers, distributing information on heat safety, and checking on elderly or isolated residents to reduce the risk of heat-related illness

D. Discouraging residents from seeking any medical care during the heat wave, since most heat-related illnesses are best treated by simply remaining at home in the heat

48. When an engineering team is given a problem with no obvious single solution, the design process typically begins with brainstorming many possible solutions. Which of the following best describes the purpose of brainstorming at this stage?

A. To choose the very first idea that the engineering team thinks of and commit to it immediately, regardless of any criteria, constraints, or input from any team member

B. To generate a wide variety of possible solutions so that the engineering team has a strong pool of options to evaluate, compare, and refine in later steps of design

C. To eliminate the need for any later testing, since brainstorming alone is always enough to identify the very best possible solution to any engineering problem

D. To select the most expensive solution from among the available choices, since higher cost is always a guarantee that a solution will perform better than less expensive ones

49. An engineering team designs a new water filter for a remote community. After testing the first prototype, the team discovers that the filter clogs too quickly. Which of the following is the most appropriate next step in the engineering design process?

A. Release the original prototype to the community immediately, since prototypes are always ready for everyday use as soon as they are first built without any testing

B. Permanently abandon the project, since the discovery of a single problem during testing always proves that the design can never be made to work under any conditions

C. Conceal the clogging problem from the community and ship the original prototype as is, since hiding flaws in tested designs is the standard practice in engineering work

D. Analyze why the filter is clogging, modify the design to address the problem, and then test the modified prototype to see whether the change has been effective

50. Engineering decisions often involve trade-offs between competing criteria, such as cost, performance, and safety. Which of the following best describes how engineers handle these trade-offs?

A. Engineers always choose the lowest-cost option, regardless of how poorly it performs or how unsafe it is, since cost is always the single most important factor in any design

B. Engineers always choose the highest-performing option, regardless of how expensive or unsafe it is, since performance is always the single most important factor in any design

C. Engineers weigh the competing criteria and constraints, considering factors such as cost, performance, safety, and impact on people, to choose a design that best balances these factors

D. Engineers never face any trade-offs in real engineering projects, since every design problem always has one option that is best in all possible respects with no trade-offs at all

Practice Exam 55: Answer Key with Explanations

1. C — Hubble's Law states that more distant galaxies show greater redshift, indicating they are receding from us at higher speeds. Greater distance means more intervening space being stretched by cosmic expansion. This relationship is central evidence for the expanding universe.
2. D — Dark matter is the major component detected indirectly through its gravitational effects on stars and galaxies, even though it gives off no light we can see. Its pull explains galaxy rotation and gravitational lensing. It outweighs ordinary matter by a wide margin.
3. A — A main-sequence star is held stable by hydrostatic equilibrium, the 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.
4. B — Kepler's Second Law means a planet moves faster when closer to the Sun and slower when farther away, because covering equal areas in equal times requires more arc near the Sun. Speed adjusts so the sweep rate stays constant. This explains the changing pace along an elliptical orbit.
5. D — Kepler's Third Law gives $T^2 = a^3$, so with T = 8, T^2 equals 64 and a is the cube root of 64, exactly 4 AU. The square of the period sets the cube of the distance. This relationship applies to any object orbiting the Sun.
6. A — On the September equinox, Earth's axis is tilted neither toward nor away from the Sun, so the Sun's rays strike the equator most directly and day length is nearly equal worldwide. The axis stays tilted ~23.5°, but its orientation to the Sun is sideways. The equinoxes mark the transitions between half-years of opposite tilt.
7. B — A Moon more than half lit on its left side, with the bright portion shrinking, is a waning gibbous, the phase between full moon and last quarter. "Waning" means the lit fraction is decreasing. Left-side illumination is its hallmark in the Northern Hemisphere.
8. C — The inner planets are small, dense, rocky worlds, while the outer planets are large, low-density worlds made mostly of gas, ice, and hydrogen-rich material. The frost line during solar system formation separated these two regions. Composition and density differ sharply between the groups.
9. A — During totality, the Sun's hot, faint outer atmosphere—the corona—becomes briefly visible because the Moon blocks the bright photosphere. The corona extends millions of kilometers into space but is normally drowned out by the Sun's glare. Total eclipses are prime opportunities to study it.
10. B — Neap tides occur at first and last quarter, when the Sun and Moon pull on Earth's water at right angles to each other and their tidal effects partly cancel. This produces a smaller tidal range than at the aligned new and full moons. The Sun-Moon geometry controls tidal strength.
11. D — Gravity continuously pulls the satellite toward Earth, but its high sideways speed keeps it falling around the Earth rather than to the surface. The satellite is in free fall, continually missing the ground. This continuous fall is what an orbit really is.
12. A — By the principle of superposition, the youngest layer in an undisturbed sedimentary sequence lies at the top, above all the older layers below. Layers accumulate from the bottom upward over time. This rule is the foundation of relative dating in horizontal strata.
13. B — Faunal succession states that fossil species appear and disappear in a definite order in the rock record, so two rocks containing the same distinctive fossil were likely deposited during the same span of geologic time. This lets geologists correlate strata across regions. It is a foundation of biostratigraphy.

14. C — By cross-cutting relationships, any feature that cuts across other features must be younger than what it cuts. Since the fault cuts both the intrusion and the layers, it is the youngest. The disrupting feature always postdates what it disrupts.
15. A — Three half-lives × 5,700 years equals 17,100 years, close to 17,000 years. Three halvings reduce the original carbon-14 to one-eighth (1 → 1/2 → 1/4 → 1/8). Counting halvings is the key to radiometric age problems.
16. C — The geologic record can be incomplete and complex, with gaps and disruptions, so multiple lines of evidence are needed to provide a more reliable reconstruction. Each line fills different gaps and cross-checks the others. Convergent evidence strengthens conclusions in geology.
17. B — A sequence shifting from marine limestone with corals up through shale with land plants and on to desert sandstone records changing environments over time, from shallow sea to coastal land to dry desert. Sedimentary rocks preserve the conditions of their formation. Such transitions are common in the rock record.
18. A — Wegener's theory was rejected mainly because he could not propose a satisfactory mechanism for how continents could move through solid oceanic rock. Without a plausible driver, many scientists found drift hard to accept. The mantle-convection mechanism of plate tectonics came decades later.
19. D — The outer core is liquid because S-waves cannot travel through liquids, so the absence of S-waves on the far side of the planet indicates a liquid layer. Seismic wave behavior is how Earth's internal structure was mapped. This is direct evidence for a molten outer core.
20. C — The Pacific Ring of Fire is geologically active because its edges are lined with subduction zones and transform faults, where active plate boundaries produce volcanoes and earthquakes. Tectonic activity, not ocean size or tidal pull, drives the pattern. Most of Earth's seismic and volcanic activity concentrates there.
21. B — A rock that has been heated and squeezed at depth and now shows wavy parallel bands of dark and light minerals is a foliated metamorphic rock, formed when heat and pressure aligned platy minerals. Foliation is the defining texture. Examples include gneiss and schist.
22. D — Calcite is a calcium carbonate mineral that reacts with dilute hydrochloric acid, producing bubbles of carbon dioxide gas as the acid dissolves the rock. The fizz test is a standard diagnostic for carbonates. Quartz, pyrite, and feldspar do not react this way.
23. C — Water's high specific heat lets it absorb or release a large amount of energy with only a small temperature change. This property moderates climate near large bodies of water. It is why coastal areas have milder seasonal swings than inland regions.
24. A — During a drought, lake water leaves mainly by evaporation into the atmosphere, joining the water vapor of the water cycle. Reduced inflow and ongoing evaporation lower the level. Water is not destroyed; it cycles into the air.
25. D — A thick, porous sandstone with well-connected pore spaces makes the best aquifer, because the connected pores both store groundwater and allow it to flow easily to a well. Permeability and porosity together support reliable supply. Granite, clay, and volcanic glass make poor aquifers.
26. B — A river depositing sediment where it slows entering a lake builds a delta, which grows outward over time as new layers are added by continued flow. Deposition exceeds erosion at the river's mouth. The Mississippi Delta is a classic example.
27. C — Warm ocean currents can keep nearby coasts milder than other places at the same latitude, while cold currents can keep nearby coasts cooler than expected. Ocean currents redistribute heat globally and influence regional climates. The North Atlantic Current warming western Europe is a familiar example.

28. A — Soil provides nutrients and physical support for plant roots, which form the base of nearly every terrestrial food web. Without soil, land-based ecosystems and agriculture would collapse. This makes soil one of the most important natural resources.
29. D — The movement of warm air and warm ocean water from the equator toward the poles redistributes solar energy through atmospheric and oceanic circulation. Winds, ocean currents, and storms all participate. Without this transport, equator-pole temperature contrasts would be far more extreme.
30. B — A fast cold front lifts warm, humid air steeply, producing a narrow band of heavy thunderstorms followed by clearing skies, falling temperatures, and drier, cooler air. The steep frontal slope drives vigorous uplift. This sequence is characteristic of cold-front passage.
31. C — Tropical cyclones require warm ocean water above ~26.5°C, sufficient moisture, low wind shear, and enough distance from the equator for the Coriolis effect to spin the storm. All four conditions are needed together. This is why they form mainly over tropical seas in summer and fall.
32. A — A rainy afternoon in Boston is short-term weather, while the typical pattern of cool, wet winters and warm, humid summers is long-term climate. Weather is what's happening; climate is the long-term average. The distinction is in time scale.
33. D — A very large eruption injects sulfur compounds high into the atmosphere, where they form bright sulfate particles that reflect sunlight and temporarily cool the surface. The effect can last a year or two before the particles settle out. Mount Pinatubo in 1991 is a well-documented example.
34. B — Isobars are lines connecting points of equal atmospheric pressure on a weather map, used to identify high- and low-pressure regions and the winds that flow between them. Their spacing indicates pressure gradient and wind strength. Tightly packed isobars mean strong winds.
35. C — Melting large ice sheets and the resulting sea-level rise would take many centuries to reverse even if emissions stopped today. The ice sheets respond slowly, and the warming oceans hold heat for a long time. This long timescale is what makes such impacts difficult to reverse.
36. A — Earth's average global temperature has risen, especially over recent decades, with the rate of warming linked to increasing greenhouse gas concentrations. Multiple independent records confirm the trend. The link between CO_2 and warming is well established by physics and observation.
37. D — Investing in domestic renewable energy sources such as wind, solar, and hydroelectric most sustainably reduces dependence on imported energy, supplying long-term power without burning imported fuels. Renewables are replenished on human timescales. They also cut greenhouse gas emissions.
38. B — Microplastics are mistaken for food and ingested by marine organisms, harming the animals and concentrating plastics and contaminants up the food web. The pollution is widespread and persistent. It poses risks to wildlife and ultimately to human consumers of seafood.
39. C — A national park preserves habitat for native species, supports biodiversity, and provides space for natural ecological processes such as predation and nutrient cycling. Protected areas are key tools for conservation. They cannot prevent every extinction but greatly improve the odds.
40. A — Sustainable groundwater use means withdrawing water at or below the rate at which the aquifer recharges naturally from rainfall and other sources. Matching extraction to recharge prevents long-term decline. This protects the supply for future generations.
41. D — Raising roads, strengthening sea walls, and restoring wetlands to cope with flooding is adaptation, because the city is adjusting infrastructure to climate impacts that are already

occurring. Adaptation manages effects, while mitigation cuts the emissions causing them. Coping with unavoidable impacts is the defining feature of adaptation.

42. A — As the human population grows, demand for natural resources such as food, fresh water, and energy generally increases, putting more pressure on the environment. More people require more of everything. This makes resource efficiency increasingly important.
43. C — Wind energy is renewable because moving air is continuously replenished by the Sun's uneven heating of the atmosphere, so the resource is not used up. The Sun powers atmospheric circulation indefinitely on human timescales. Turbines tap this ongoing flow without depleting it.
44. B — Habitat fragmentation tends to make populations smaller, more isolated, and more vulnerable to local extinction, because individuals cannot easily move between patches. Limited movement restricts breeding, feeding, and recolonization. Fragmentation is a major driver of biodiversity loss.
45. D — Installing solar panels and switching to LED lights are mitigation, because they reduce the greenhouse gas emissions that are the underlying cause of climate change. Mitigation targets the cause, while adaptation copes with impacts. Cutting emissions at the source is the defining feature of mitigation.
46. A — Recycling conserves natural resources and reduces the energy needed to make new products, while also reducing the amount of waste sent to landfills. Recovered materials replace virgin inputs. It is a core part of sustainable waste management.
47. C — A public health response to a heat wave includes opening cooling centers, distributing information on heat safety, and checking on vulnerable residents to reduce heat-related illness. These measures protect those most at risk, such as the elderly. Hydration and access to cool spaces are essential.
48. B — Brainstorming generates a wide variety of possible solutions so the team has a strong pool of options to evaluate, compare, and refine in later steps. Quantity of ideas supports quality of the final choice. Early divergent thinking is key to good design.
49. D — When testing reveals a problem, the next step is to analyze why it occurred, modify the design to address it, and then test the modified prototype. Iteration—testing, refining, and retesting—is central to good engineering. A flaw found in testing is information, not a reason to abandon the project.
50. C — Engineers weigh competing criteria and constraints, considering factors such as cost, performance, safety, and impact on people, to choose a design that best balances them. Trade-offs are unavoidable in real projects. Balancing them is the heart of engineering judgment.