PRACTICE EXAM 37: EARTH AND SPACE SCIENCES REGENTS SIMULATION (50 QUESTIONS)

1. On a hot summer day, the air directly touching the sun-baked pavement becomes warm. What method of heat transfer warms this thin layer of air in direct contact with the hot pavement?

A. Conduction, the transfer of heat through direct contact between the hot pavement and the air touching it

B. Radiation, the transfer of heat as electromagnetic waves traveling through the empty vacuum of outer space

C. Precipitation, the falling of rain and snow that physically carries warmth down toward the ground surface

D. Evaporation, the process in which liquid water absorbs heat and changes into invisible water vapor in the air

2. On a warm, humid day, beads of water form on the outside of a cold glass of iced tea. What has happened to produce this water on the outside of the glass?

A. Water has leaked outward through tiny invisible cracks in the glass and then collected on its cold outer surface

B. The cold tea has caused the glass itself to slowly melt, releasing some liquid water onto its own outer surface

C. Salt in the air has pulled moisture out of the tea and then deposited it as droplets on the outside of the glass

D. Water vapor in the warm air cooled below its dew point when it touched the cold glass and condensed into liquid

3. A warm, moisture-laden air mass that forms over the Gulf of Mexico moves northward into the United States. Using the standard air mass classification, this air mass would be labeled:

A. Continental polar (cP), because it forms over cold land at high latitudes and brings dry, frigid conditions inland

B. Maritime tropical (mT), because it forms over warm ocean water at low latitudes and brings warm, humid conditions

C. Continental tropical (cT), because it forms over hot, dry desert land and brings hot, parched, dusty conditions inland

D. Maritime polar (mP), because it forms over cold ocean water at high latitudes and brings cool, damp conditions inland

4. A meteorologist measures a large difference between the dry-bulb temperature and the wet-bulb temperature of the air. What does a large difference between these two readings indicate?

A. The air is fully saturated with water vapor, so condensation and fog are already actively occurring at the surface

B. The air pressure is extremely high, which is the only condition that can ever produce a difference between the two readings

C. The relative humidity is low, because rapid evaporation from the wet bulb cools it far below the dry-bulb temperature

D. The air temperature is below freezing, since the two readings can differ only when ice is present on the instrument

5. As a warm front slowly approaches, an observer notices high wispy cirrus clouds first, then gradually lower and thicker clouds, and finally steady rain. Why does the cloud cover change in this orderly sequence?

A. The warm air gradually rises up over the cold air along the gently sloping front, forming clouds at progressively lower heights as the front nears

B. The cold air violently shoves the warm air straight up all at once, which is why the clouds appear in a completely random order

C. The clouds are blown in from several unrelated storms that happen to arrive one after another purely by coincidence

D. The Sun heats the ground more strongly as the front approaches, which builds the clouds upward from the surface into the sky

6. A barometer at a weather station shows air pressure that has been rising steadily for several hours. What weather change does a steadily rising barometer most often indicate is on the way?

A. An approaching low-pressure storm system bringing heavy rain, strong gusty winds, and rapidly worsening conditions

B. A rapid and dramatic drop in air temperature accompanied by a sudden burst of severe thunderstorms and large hail

C. Improving, fairer weather, since rising air pressure is commonly associated with an approaching high-pressure system

D. No change whatsoever, since the reading on a barometer has no useful connection to the weather that follows it

7. Prevailing winds blow from the ocean onto a coast and then up and over a mountain range. On which side of the mountains would you expect the heaviest rainfall, and why?

A. On the downwind (leeward) side, because the air warms and gathers moisture as it descends the far slope of the mountains

B. Equally on both sides, since mountains have no effect at all on where rain falls along the path of the prevailing winds

C. Only at the very highest peaks, where the air is coldest, with no rain at all falling on either slope below the summits

D. On the upwind (windward) side, because the moist ocean air is forced to rise, cool, and release its moisture as rain there

8. During a thunderstorm, a person sees a flash of lightning and then hears the thunder several seconds later. Why is the lightning seen before the thunder is heard?

A. The lightning and the thunder are produced by two completely separate and unrelated events within the storm cloud

B. Light travels much faster than sound, so the flash reaches the observer well before the slower-moving sound of the thunder

C. Sound travels much faster than light, but the thunder takes a long detour around the clouds before reaching the observer

D. The thunder is actually created several seconds after the lightning, which is the reason it is always heard noticeably later

9. Scientists report that global average temperatures have risen and that this warming is linked to increasing greenhouse gases. Which observation would provide additional independent evidence consistent with a warming planet?

A. The widespread retreat of mountain glaciers and the earlier arrival of spring conditions in many regions

B. A steady year-after-year increase in the total number of hours of darkness experienced during each winter night

C. A gradual strengthening of Earth's magnetic field as measured at observatories around the world over many decades

D. A steady decrease in the total amount of sunlight that the Sun produces and sends toward the Earth each year

10. In the continental United States, a forecaster notices a storm system currently located to the west of a city. Based on the general movement of weather systems across the country, what should the forecaster predict for that city?

A. The storm will move toward the south and will never actually reach the city located directly to its east at all

B. The storm will remain completely stationary, since weather systems over the United States do not move from place to place

C. The storm will likely move eastward and reach the city, since weather systems generally travel from west to east there

D. The storm will reverse course and move back toward the west, away from the city, following the prevailing surface winds

11. A fault cuts across and offsets several sedimentary rock layers. According to the principle of cross-cutting relationships, what can be concluded about the age of the fault?

A. The fault is the same age as the sedimentary layers, since the fault and the layers must always form together at one time

B. The fault is older than all of the sedimentary layers, since the fault must have existed before any of the layers formed

C. The age of the fault cannot be determined in any way, since faults never reveal anything at all about relative ages

D. The fault is younger than the layers it cuts across, since a fault must form after the rocks that it breaks and offsets

12. A radioactive isotope has a half-life of 5,000 years. After 15,000 years, what fraction of the original radioactive isotope will remain?

A. One-half of the original amount will remain, since 15,000 years equals just a single half-life of the isotope

B. One-eighth of the original amount will remain, since 15,000 years equals three half-lives of the isotope

C. One-quarter of the original amount will remain, since 15,000 years equals exactly two half-lives of the isotope

D. None of the original amount will remain, since after 15,000 years the isotope has completely finished decaying away

13. Fossils of coral and other shallow marine organisms are found in rock layers on top of a high mountain, far from any ocean. What is the most reasonable conclusion?

A. The rock formed long ago beneath a shallow sea and was later uplifted to its present elevation high in the mountains

B. The coral animals climbed up the mountain on their own and died there long after the mountain had already fully formed

C. The fossils were carried up to the mountaintop by ancient people who collected them from the distant seashore below

D. Coral has always lived only on mountaintops, and the presence of the ocean far below is simply a complete coincidence

14. If the entire 4.6-billion-year history of Earth were compressed into a single 24-hour day, modern humans, who have existed for only a few hundred thousand years, would appear:

A. At about noon, having existed for roughly half of the entire history of the planet up until the present moment

B. Around sunrise in the early morning, having been present for the great majority of the planet's very long history

C. At about 6:00 in the evening, having existed for roughly one quarter of the total history of the Earth so far

D. Only in the final seconds before midnight, since human history is extremely brief compared with the age of the Earth

15. Based on the fossil record, which group of organisms appeared earliest in the history of life on Earth?

A. Flowering plants, which were the very first living things to appear and which then gave rise to all later forms of life

B. Large land-dwelling reptiles such as the dinosaurs, which were present from the earliest days of life on the planet

C. Simple single-celled organisms, which appeared first and existed alone for billions of years before complex life arose

D. Mammals, which were the original form of life on Earth and from which all of the simpler organisms later descended

16. A geologist observes sedimentary rock layers that are folded into wavy curves and bent sharply. According to the principle of original horizontality, what does this folding indicate?

A. The layers were originally deposited in these folded, wavy shapes exactly as they appear in the rock outcrop today

B. The layers were deposited in flat horizontal sheets and were later folded and bent by powerful forces within the Earth

C. The folding proves that the layers are actually igneous rock, since only cooling lava can ever take on such curved shapes

D. The folding shows that the layers were never truly solid rock and have always remained soft and flexible just like clay

17. The buildup of oxygen in Earth's atmosphere over billions of years was a critical event in the history of life. Why was this rise in atmospheric oxygen so important?

A. The oxygen instantly cooled the entire planet into a deep ice age that wiped out nearly all of the earliest forms of life

B. The oxygen made the oceans far saltier, which is the single change that allowed the very first fish to evolve in the seas

C. The oxygen blocked all sunlight from reaching the surface, which forced every early organism to live deep underground

D. The oxygen supported the energy-rich respiration that complex multicellular life needs and formed the protective ozone layer

18. One of the earliest and simplest observations that led Alfred Wegener to propose continental drift was that:

A. The coastlines of continents such as South America and Africa appear to fit together like the pieces of a jigsaw puzzle

B. Earthquakes were found to occur only in the exact centers of the continents and never anywhere near their outer edges

C. Every continent on Earth was discovered to contain exactly the same kinds of rocks and exactly the same fossils

D. The continents were observed to be physically moving fast enough that their motion could be seen directly by the naked eye

19. On the spring and fall equinoxes, locations all over the Earth experience approximately equal hours of daylight and darkness. What is the position of the Sun relative to the Earth on these two days?

A. The North Pole is tilted as directly as possible toward the Sun, giving the Northern Hemisphere its longest day of the year

B. The South Pole is tilted as directly as possible toward the Sun, giving the Southern Hemisphere its longest day of the year

C. The Sun's direct rays fall on the equator, so neither pole is tilted toward or away from the Sun on that particular day

D. The Earth is at its closest point to the Sun in its orbit, which makes the daylight and the darkness exactly equal everywhere

20. The Moon's surface is covered with ancient craters that have remained nearly unchanged for billions of years. Why have these craters been preserved for so long without eroding away?

A. The Moon's surface is constantly resurfaced by flowing lava, which carefully refills each crater back to its original shape

B. The Moon has almost no atmosphere and no liquid water, so there is little wind or water to weather and erode the craters

C. The Moon's powerful magnetic field freezes the surface solid, which permanently prevents any of the craters from eroding

D. The Moon rotates so rapidly that erosion is flung off into space before it can ever wear down any of the old craters

21. A planet orbits its star at a distance of 9 AU. Using Kepler's third law ($T^2 = a^3$ in solar units), what is the planet's orbital period?

A. About 3 years, found by taking the square root of the orbital distance of 9 astronomical units directly

B. About 9 years, found by setting the orbital period equal to the orbital distance of 9 astronomical units

C. About 81 years, found by squaring the orbital distance of 9 astronomical units in order to obtain the period

D. About 27 years, found by taking the square root of 9 cubed, since 9 cubed equals 729 and its square root is 27

22. Two stars have exactly the same surface temperature, but one is far more luminous (gives off much more total light) than the other. What is the most likely reason for the difference in their luminosity?

A. The more luminous star is much larger in size, so its greater surface area emits far more total light than the smaller star

B. The more luminous star is much closer to Earth, which is the only thing that can ever make one star more luminous than another

C. The more luminous star is much older, since stars steadily produce more and more total light with every billion years of age

D. The more luminous star is moving toward Earth while the dimmer star is moving away, which changes their true light output

23. The nearest star to the Sun is about four light-years away. What does this distance tell us about travel and communication across space?

A. A spacecraft could easily reach the nearest star within just a few hours, since four light-years is actually a very short distance

B. The nearest star is so close that radio signals sent from Earth would arrive there almost instantly with no measurable delay

C. Distances between stars are enormous, so even light, the fastest thing known, takes years to travel from one star to the next

D. The nearest star is actually located within our own solar system, just beyond the orbit of the most distant planet, Neptune

24. Earth orbits the Sun within a region sometimes called the "habitable zone." What makes this zone favorable for life as we know it?

A. It is the range of distances from the Sun where temperatures allow liquid water to exist on a planet's surface

B. It is the only region in the entire solar system where any sunlight at all is able to reach a planet's surface

C. It is the zone closest to the Sun, where the intense heat is necessary in order to keep any form of living organism alive

D. It is the band where a planet is completely shielded from all sunlight, which allows it to stay frozen and lifeless

25. Between which two planets is the main asteroid belt, a region containing millions of rocky bodies, located?

A. Between Earth and Venus, in the inner part of the solar system relatively close to the warmth of the Sun

B. Between Mars and Jupiter, separating the inner rocky planets from the outer giant gas planets of the solar system

C. Between Neptune and the edge of the solar system, in the cold and distant outer reaches far beyond all of the planets

D. Between the Sun and Mercury, in the hottest region of the entire solar system nearest to the surface of the Sun

26. Like the Sun, the stars appear to rise in the eastern sky and set in the western sky over the course of the night. What is the cause of this apparent east-to-west motion of the stars?

A. Earth's rotation on its axis from west to east, which makes objects in the sky appear to move in the opposite direction

B. The actual motion of the stars themselves, which all physically travel from east to west around the Earth once each night

C. The revolution of the Earth around the Sun, which causes the stars to shift completely across the sky every single hour

D. The gravitational pull of the Moon, which drags all of the stars across the sky from the eastern to the western horizon

27. In about five billion years, the Sun will exhaust the hydrogen fuel in its core. What is the Sun expected to become as it nears the end of its life?

A. It will explode in a brilliant supernova and then collapse directly into a black hole, swallowing the nearby inner planets

B. It will instantly cool down and go completely dark, becoming an invisible cold body within just a few short years' time

C. It will swell into a red giant and later shed its outer layers, leaving behind a small, dense, hot white dwarf

D. It will split into two separate smaller stars that will then continue to orbit each other for many more billions of years

28. A total solar eclipse is visible only from a narrow path across Earth's surface, while a lunar eclipse can be seen from an entire half of the planet at once. Why is the area that can view a total solar eclipse so small?

A. The Sun shrinks dramatically during a solar eclipse, so only the few people standing directly beneath it can see the event

B. The Moon's shadow is small where it reaches Earth, so only the narrow strip of land that the shadow sweeps across sees totality

C. A solar eclipse lasts only a fraction of a second, which is far too brief for more than a handful of observers to ever notice it

D. Solar eclipses occur only at the North and South Poles, where very few people happen to live to observe the rare event

29. Isaac Newton realized that the same force that causes an apple to fall to the ground also keeps the Moon in orbit around the Earth. What was the significance of this realization?

A. It proved that gravity exists only on the surface of the Earth and nowhere else throughout the rest of the entire universe

B. It showed that the Moon is held in place by a special force that is entirely different from the one that affects falling objects

C. It demonstrated that objects out in space are completely weightless and are therefore unaffected by any force of gravity at all

D. It showed that gravity is a universal force acting between all objects, governing both falling bodies and orbiting ones alike

30. A black, layered rock forms over millions of years from the compressed remains of ancient swamp plants and can be burned as a fuel. What type of rock is this, and how is it classified?

A. Coal, an organic sedimentary rock formed from the compacted and altered remains of ancient plant material

B. Basalt, a dark volcanic igneous rock formed when iron-rich lava cooled quickly at the surface of the Earth

C. Marble, a metamorphic rock formed when limestone was recrystallized under conditions of intense heat and pressure

D. Granite, a coarse-grained igneous rock formed when silica-rich magma cooled very slowly deep within Earth's crust

31. A mineral has a shiny, reflective surface that looks like polished metal. How would a geologist describe this property, and what is the property called?

A. The mineral has a dull luster, where luster is the property describing how a mineral's surface reflects light, like unglazed pottery

B. The mineral has a metallic luster, where luster is the property describing the way a mineral's surface reflects light

C. The mineral has perfect cleavage, the property describing how a mineral breaks along smooth, flat, parallel surfaces

D. The mineral has a hardness of ten, the property describing how strongly a mineral resists being scratched by another mineral

32. The deepest places in the world's oceans are long, narrow trenches such as the Mariana Trench. At what kind of plate boundary do these deep ocean trenches form?

A. At a divergent boundary, where two plates pull apart and rising magma forms a tall ridge on the floor of the ocean

B. At a transform boundary, where two plates slide horizontally past each other without creating any vertical features at all

C. At a convergent boundary, where one plate subducts and bends downward beneath another, forming a deep trench

D. At a hot spot, where a plume of rising magma melts through the middle of a plate far from any actual plate boundary

33. After a long period of weathering, a granite rock breaks down and most of its minerals turn into clay, but grains of one mineral remain largely unchanged and accumulate as sand. Which mineral is most resistant to weathering and survives as sand?

A. Calcite, which dissolves readily in even slightly acidic water and therefore rarely survives long at the Earth's surface

B. Halite, which dissolves so easily in water that it is almost never found in surface sediments after any weathering occurs

C. Feldspar, which weathers chemically into clay minerals and therefore does not survive for long as loose grains of sand

D. Quartz, which is hard and chemically stable, so it resists weathering and accumulates as durable grains of sand

34. Waves repeatedly pound against a rocky shoreline, slowly cutting into the base of the rock and causing the overlying rock to collapse, forming a steep face. What landform is produced by this wave erosion?

A. A sea cliff, a steep rock face formed where ocean waves erode and undercut the base of the coastal rock

B. A delta, a fan-shaped deposit of sediment that forms where a river empties into a calm ocean or a large lake

C. A moraine, a ridge of unsorted rock debris deposited along the leading edge of a slowly melting glacier

D. A sand dune, a mound of wind-blown sand piled up and shaped by the prevailing winds in a dry environment

35. In which setting would you most likely find well-sorted sediment, in which nearly all of the grains are about the same size?

A. In glacial till deposited directly by ice, which drops boulders, sand, and clay all jumbled together at one time

B. On a wind-blown desert dune, where the wind carries away the finer dust and leaves behind grains of uniform size

C. At the foot of a steep cliff, where rockfalls pile up a chaotic mix of large boulders and tiny fragments together

D. In a landslide deposit, where all sizes of material slide down a slope and come to rest in a single disordered heap

36. Earth's rigid outer plates ride on a layer of the upper mantle that behaves like a soft, slowly flowing solid. What is this partially soft layer, on which the plates move, called?

A. The inner core, the solid innermost layer of the Earth made of iron and nickel under immense crushing pressure

B. The crust, the thin, brittle, rocky outermost layer that forms the continents and the floors of all of the oceans

C. The outer core, the layer of molten liquid iron and nickel whose churning motion generates Earth's magnetic field

D. The asthenosphere, a partially soft layer of the upper mantle that slowly flows and allows the rigid plates above to move

37. At the base of a hillside, groundwater naturally flows out of the ground and onto the surface, forming a small flowing stream of water. What is this natural feature called?

A. A delta, the fan-shaped pile of sediment that forms where a flowing river enters a calm lake or the open ocean

B. A glacier, a large mass of slowly moving ice that forms on land where snow accumulates faster than it melts away

C. A spring, a place where groundwater flows naturally out onto the surface, often where the water table meets the ground

D. A geyser, a vent that periodically erupts boiling water and steam high into the air from a deep underground reservoir

38. On the Mohs hardness scale, which is used to compare the scratch resistance of minerals, which mineral is assigned the highest hardness value of 10?

A. Talc, an extremely soft mineral that can be easily scratched with a fingernail and is used to make talcum powder

B. Diamond, the hardest naturally occurring mineral, which can scratch every other mineral but cannot itself be scratched by them

C. Quartz, a common and fairly hard mineral that is able to scratch glass but is itself scratched by several harder minerals

D. Gypsum, a soft mineral only slightly harder than talc, that is commonly used to manufacture plaster and wallboard

39. What is the difference between magma and lava?

A. Magma is molten rock located beneath Earth's surface, while lava is molten rock that has erupted onto the surface

B. Magma is molten rock that has erupted onto the surface, while lava is molten rock still located deep underground

C. Magma is a type of solid metamorphic rock, while lava is a completely different type of solid sedimentary rock

D. Magma and lava are simply two different names for exactly the same cooled, solid volcanic rock found at the surface

40. All of the land area that drains its rainfall and snowmelt into a particular river and its tributaries is known as that river's:

A. Floodplain, the flat, low-lying land directly bordering a river that becomes covered with water during a flood

B. Delta, the fan-shaped deposit of sediment that builds up where a river flows into a calm ocean or a large lake

C. Aquifer, an underground layer of permeable rock or sediment that stores and transmits large amounts of groundwater

D. Watershed, the entire land area that collects and drains all of its water into one particular river system

41. On two hillsides covered with the same kind of soil, one slope is gentle and the other is very steep. On which slope will rainwater cause more soil erosion, and why?

A. On the gentle slope, because slow-moving water somehow strips away far more soil than fast-moving water ever could

B. On the steep slope, because water runs downhill faster there, gaining more energy to loosen and carry away the soil

C. Erosion will be exactly equal on both slopes, since the steepness of a slope has no effect at all on the rate of erosion

D. On neither slope, because rainwater always soaks straight down into the soil and never flows downhill to erode anything

42. A city encourages residents to use buses and trains instead of driving private cars. How does increasing the use of public transportation help reduce greenhouse gas emissions?

A. Buses and trains release far more carbon dioxide per passenger than private cars, so the change actually increases emissions

B. Public transportation has no effect at all on emissions, since the total number of vehicles on the road never really changes

C. Moving many people in a single vehicle uses less fuel per person than many individual cars, lowering emissions per traveler

D. Public transportation works only by completely eliminating the need for any electricity or fuel of any kind whatsoever

43. Wetlands are sometimes drained and filled in to create land for farming or building. What is one important environmental service that is lost when a wetland is destroyed?

A. The wetland's ability to filter pollutants from water and to absorb floodwaters, reducing downstream flooding and pollution

B. The wetland's ability to generate large amounts of electricity for the entire surrounding region throughout the whole year

C. The wetland's ability to produce all of the oxygen breathed by every living organism across the entire planet each day

D. The wetland's ability to permanently store the world's supply of coal, oil, and natural gas deep beneath its own surface

44. A dam built across a river uses the energy of falling and flowing water to spin turbines and generate electricity. This renewable energy source is known as:

A. Geothermal energy, which draws heat from deep within the Earth's interior to produce the steam that drives the turbines

B. Nuclear energy, which splits the nuclei of heavy atoms such as uranium to release the heat that is used to generate power

C. Solar energy, which uses panels to convert the light arriving directly from the Sun into usable electrical energy

D. Hydroelectric energy, which uses the energy of flowing and falling water to spin turbines and generate electricity

45. Sea otters eat sea urchins, which would otherwise destroy entire underwater kelp forests if their numbers were left unchecked. A species like the sea otter, whose presence is essential to the structure of its whole ecosystem, is called:

A. An invasive species, a non-native organism that spreads rapidly and harms the native ecosystem that it has entered

B. A keystone species, a species whose presence is essential to maintaining the structure and balance of an entire ecosystem

C. An endangered species, a species whose population has fallen so low that it is now at serious risk of going completely extinct

D. A producer, an organism such as a plant or alga that makes its own food using the energy that it captures from sunlight

46. Fertilizer, pesticides, and oil wash off of lawns, farms, and roads across a wide area during a rainstorm and drain into a river. Because this pollution comes from many scattered, hard-to-pinpoint locations, it is classified as:

A. Point-source pollution, which can be traced back to a single identifiable source such as one factory's discharge pipe

B. Natural background pollution, which is always present in the environment and never results from any human activity at all

C. Nonpoint-source pollution, which enters the environment from many widespread, diffuse, and hard-to-identify locations

D. Thermal pollution, the release of heated water into a waterway, which lowers the level of dissolved oxygen in the water

47. Cities are often several degrees warmer than the surrounding countryside, especially at night. This effect, in which urban areas trap and hold more heat than nearby rural areas, is called:

A. The greenhouse effect, the trapping of heat near the entire planet's surface by certain gases throughout the atmosphere

B. Acid rain, precipitation that is made acidic by sulfur and nitrogen compounds released from the burning of fossil fuels

C. Ozone depletion, the thinning of the protective layer of ozone high in the stratosphere caused by certain chemicals

D. The urban heat island effect, in which pavement and buildings absorb and re-radiate heat, keeping cities warmer than rural areas

48. Which of the following would most effectively reduce a society's overall consumption of nonrenewable fossil fuels over the long term?

A. Building many additional coal-burning power plants to ensure that the steadily growing demand for electricity is always met

B. Improving energy efficiency and expanding the use of renewable sources such as solar, wind, and hydroelectric power

C. Encouraging every household to leave its lights, heating, and electronic devices switched on at all hours of the day

D. Replacing electric and hybrid vehicles with older, less efficient vehicles that consume far more gasoline per mile driven

49. After testing a prototype of a new water filter, an engineering team finds that it removes most contaminants but clogs too quickly. According to the engineering design process, what is the best next step?

A. Immediately mass-produce the prototype exactly as it is, since a design never needs any further changes once it is built

B. Abandon the entire project permanently, since the discovery of any single flaw means the design can never possibly succeed

C. Redesign the filter to address the clogging problem and then test the improved version to see whether it performs better

D. Keep the flawed design but simply stop testing it, since further testing of a prototype provides no useful information at all

50. A student wants to test how the steepness of a slope affects the rate of soil erosion. To get reliable results, the student should change the steepness of the slope while keeping which of the following the same in each trial?

A. Only the day of the week on which each separate trial of the erosion experiment happens to be performed by the student

B. Nothing at all, since changing as many different factors as possible all at once produces the most reliable results

C. The steepness of the slope itself, which should be held perfectly constant so that it never changes between the trials

D. All other factors, such as the type of soil and the amount of water used, so that slope steepness is the only variable changed

ANSWERS KEY WITH EXPLANATIONS

1. A — Conduction transfers heat through direct contact, so the hot pavement warms the thin layer of air molecules touching it. This direct molecule-to-molecule transfer is distinct from radiation or convection and is what heats the air immediately above a hot surface.
2. D — Water beads form because warm, humid air cooled below its dew point upon touching the cold glass, causing water vapor to condense into liquid on the outside. This is the same condensation process that forms dew and clouds, occurring whenever air is cooled to saturation.
3. B — Air forming over the warm Gulf of Mexico is maritime tropical (mT), labeled for its warm, low-latitude ocean source and its warm, humid character. Air mass classification uses moisture (maritime versus continental) and temperature (tropical versus polar) of the source region.
4. C — A large spread between dry-bulb and wet-bulb temperatures indicates low relative humidity, because dry air allows rapid evaporation that cools the wet bulb well below the dry bulb. The size of the wet-bulb depression is the basis for reading humidity from a psychrometer.
5. A — Ahead of a warm front, warm air rises gradually over the gently sloping cold air, forming clouds at progressively lower heights, so cirrus give way to thicker clouds and then steady rain. This orderly cloud sequence is characteristic of an approaching warm front.
6. C — A steadily rising barometer usually signals improving, fairer weather, since increasing pressure is associated with an approaching high-pressure system and sinking air. Tracking pressure trends is a basic forecasting tool, with rising pressure indicating settling conditions.
7. D — The windward side receives the heaviest rain because moist ocean air is forced to rise, cool, and release its moisture as it climbs the mountains, leaving the leeward side dry. This orographic lifting explains the wet windward slopes and the rain shadow beyond.
8. B — Lightning is seen before thunder is heard because light travels far faster than sound, so the flash arrives almost instantly while the slower sound lags behind. The time gap can even be used to estimate the distance to the lightning.

9. A — The retreat of mountain glaciers and the earlier arrival of spring are independent observations consistent with a warming planet. Multiple unrelated indicators pointing to warming strengthen the overall conclusion drawn from temperature records alone.
10. C — Because weather systems over the United States generally move from west to east, a storm to the west of a city is likely to move eastward and reach it. Knowing the prevailing direction of system movement is fundamental to short-term forecasting.
11. D — By cross-cutting relationships, a fault that breaks and offsets rock layers must be younger than those layers, since the rocks had to exist before they could be faulted. This principle lets geologists place a fault correctly in the sequence of events.
12. B — In 15,000 years the isotope passes through three half-lives (15,000 ÷ 5,000), and three halvings leave 1/2 × 1/2 × 1/2 = 1/8 of the original. Counting half-lives and halving repeatedly gives the fraction remaining.
13. A — Marine fossils atop a mountain indicate the rock formed beneath a shallow sea and was later uplifted to its present elevation by Earth's forces. Such fossils are evidence that land now high above sea level was once underwater.
14. D — Compressed into a 24-hour day, Earth's 4.6-billion-year history would place modern humans only in the final seconds before midnight, reflecting how brief human existence is. This analogy conveys the immense scale of geologic time relative to human history.
15. C — Simple single-celled organisms appeared first in the fossil record and existed alone for billions of years before complex multicellular life arose. This ordering reflects the actual sequence of life's development through geologic time.
16. B — By original horizontality, sediments are deposited in flat horizontal layers, so folded and bent layers must have been deformed by powerful forces after they formed. The folding is therefore evidence of later tectonic deformation.
17. D — The rise of atmospheric oxygen was critical because it supported the energy-rich respiration that complex multicellular life requires and produced the ozone layer that shields the surface from harmful radiation. Both effects helped make advanced life possible.
18. A — Wegener was first struck by the jigsaw-like fit of coastlines such as those of South America and Africa, which suggested the continents had once been joined. This simple geographic observation was an early clue that led to the idea of continental drift.
19. C — On the equinoxes the Sun's direct rays fall on the equator and neither pole is tilted toward or away from the Sun, giving nearly equal day and night everywhere. This symmetric Sun position is what produces the balanced daylight of the equinoxes.
20. B — The Moon's craters are preserved because it has almost no atmosphere and no liquid water, so there is little wind or water to weather and erode them. Without these agents of erosion, ancient surface features remain nearly unchanged for billions of years.
21. D — Kepler's third law gives $T^2 = a^3$, so with a = 9, $a^3 = 729$ and T = the square root of 729 = 27 years. Cubing the distance and taking the square root yields the orbital period.
22. A — With equal surface temperatures, the more luminous star must be larger, since greater surface area emits more total light. Luminosity depends on both temperature and size, so size explains the difference when temperatures match.
23. C — A nearest star four light-years away shows that interstellar distances are enormous, since even light, the fastest thing known, takes years to cross them. This vastness makes travel and communication between stars extremely slow by human standards.

24. A — The habitable zone is the range of distances from a star where temperatures allow liquid water to exist on a planet's surface. Liquid water's possibility in this zone is what makes it favorable for life as we know it.
25. B — The main asteroid belt lies between Mars and Jupiter, separating the inner rocky planets from the outer gas giants. Knowing its location helps place this band of rocky debris within the structure of the solar system.
26. A — Stars appear to rise in the east and set in the west because Earth rotates on its axis from west to east, making sky objects seem to move the opposite way. This apparent motion is a reflection of Earth's spin, not actual stellar movement.
27. C — A Sun-like star will swell into a red giant and later shed its outer layers, leaving a small, dense, hot white dwarf. This red-giant-to-white-dwarf path is the expected fate of stars of the Sun's mass.
28. B — A total solar eclipse is seen only along a narrow path because the Moon's shadow is small where it reaches Earth, so only the strip the shadow sweeps across experiences totality. The small shadow is why the zone of a total solar eclipse is so limited.
29. D — Newton's insight that the force pulling an apple down also holds the Moon in orbit showed that gravity is a universal force acting between all objects. This unification of falling and orbiting motion under one law was a landmark in understanding the universe.
30. A — Coal is an organic sedimentary rock formed from the compacted and altered remains of ancient swamp plants, and it can be burned as fuel. Its plant origin and layered, combustible nature define it as an organic sedimentary rock.
31. B — A shiny, metal-like reflective surface describes metallic luster, where luster is the property that describes how a mineral's surface reflects light. Luster is a useful identification clue distinct from color, cleavage, or hardness.
32. C — The deepest ocean trenches form at convergent boundaries, where one plate subducts and bends downward beneath another, creating a deep trough. This subduction process is what produces features such as the Mariana Trench.
33. D — Quartz is hard and chemically stable, so it resists weathering and accumulates as durable sand grains while less stable minerals like feldspar break down into clay. This durability is why quartz dominates many sandy deposits.
34. A — Waves undercutting and collapsing coastal rock produce a sea cliff, a steep rock face formed by wave erosion at the base of the coast. This landform results directly from the repeated pounding and undercutting action of waves.
35. B — Wind-blown desert dunes are well sorted because the wind carries away finer dust and leaves behind grains of nearly uniform size. Sorting by a transporting agent like wind produces sediment with grains of consistent size.
36. D — The asthenosphere is the partially soft layer of the upper mantle that flows slowly and allows the rigid plates of the lithosphere above it to move. Plate motion is possible because the plates ride on this weak, deformable layer.
37. C — Groundwater flowing naturally out onto the surface, often where the water table meets the ground, forms a spring. Springs are a natural discharge point for groundwater and a common source of surface streams.
38. B — Diamond is assigned a hardness of 10, the highest on the Mohs scale, and can scratch every other mineral while resisting scratching by them. Its position at the top of the scale makes it the hardness reference for the hardest materials.

39. A — Magma is molten rock beneath Earth's surface, while lava is molten rock that has erupted onto the surface. The location relative to the surface is the distinction between the two terms.
40. D — A watershed is the entire land area that collects and drains its rainfall and snowmelt into one particular river system. Understanding watersheds is key to managing water supply and tracing how pollution reaches a river.
41. B — Erosion is greater on the steep slope because water runs downhill faster there, gaining more energy to loosen and carry away soil. Slope steepness strongly controls runoff speed and therefore the rate of erosion.
42. C — Public transportation reduces emissions because moving many people in one vehicle uses less fuel per person than many individual cars, lowering emissions per traveler. Higher occupancy is what makes transit more carbon-efficient than solo driving.
43. A — Destroying a wetland removes its ability to filter pollutants from water and absorb floodwaters, increasing downstream flooding and pollution. These natural services make wetlands valuable, and their loss has real environmental costs.
44. D — A dam using flowing and falling water to spin turbines generates hydroelectric energy, a renewable source powered by the water cycle. The energy of moving water, continually renewed by the Sun-driven cycle, is what drives the turbines.
45. B — A species like the sea otter, whose presence is essential to the structure of its whole ecosystem, is a keystone species. Removing such a species can collapse the ecosystem, as unchecked urchins would destroy the kelp forest.
46. C — Pollution washing off lawns, farms, and roads across a wide area is nonpoint-source pollution, entering from many scattered, hard-to-identify locations. Its diffuse origin makes it harder to control than pollution from a single point source.
47. D — Cities staying warmer than surrounding rural areas, especially at night, is the urban heat island effect, in which pavement and buildings absorb and re-radiate heat. Recognizing this effect helps explain and address elevated urban temperatures.
48. B — Improving energy efficiency and expanding renewable sources such as solar, wind, and hydroelectric power most effectively reduces long-term fossil fuel use. Using less energy and shifting to renewables together cut dependence on finite fossil fuels.
49. C — When a prototype works but clogs too quickly, the engineering design process calls for redesigning to fix the problem and then retesting the improved version. This iterative refine-and-retest cycle is how a flawed design is improved toward success.
50. D — To test how slope steepness affects erosion, the student should change only the steepness while keeping all other factors, such as soil type and water amount, the same. Holding other variables constant ensures that any difference in erosion is due to the slope alone.