Curiosityquest — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Curiosityquest.

Write in the book, circle your answers, and check the Answer Key at the back.

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1. Scientific Method

Circle the correct answer

1. What is the first step of the scientific method?
(A) Ask a question (B) Conduct an experiment (C) Form a hypothesis (D) Analyze data

2. What do we call a possible explanation for a scientific question that can be tested?
(A) Theory (B) Hypothesis (C) Observation (D) Conclusion

3. Which of the following best describes a 'variable' in an experiment?
(A) A type of scientific tool (B) The conclusion of an experiment (C) A step in the scientific method (D) Something that can change or be changed in an experiment

4. What is data in a science experiment?
(A) The hypothesis of an experiment (B) The tools used in an experiment (C) The question being investigated (D) Information collected during an experiment

5. A student writes: 'If plants get more sunlight, then they will grow taller.' What part of the scientific method is this?
(A) Hypothesis (B) Observation (C) Research question (D) Conclusion

6. Why do scientists repeat an experiment multiple times?
(A) To make sure the results are reliable and not due to chance (B) Because they enjoy the experiment (C) To use up all their materials (D) To change the hypothesis each time

Write the answer

7. In an experiment testing how temperature affects seed germination, what is the independent variable?
Answer: _____

8. What does it mean when scientists say an experiment should be 'fair'?
Answer: _____

9. A student grows plants in both sunlight and shade using identical pots, soil, and water amounts. She measures height after two weeks. What is she doing?
Answer: _____

10. A scientist records that her plant grew 5 cm in week one and 7 cm in week two. Which scientific skill is she using?
Answer: _____

Match each question to its answer

1. After finishing an experiment, a student finds that her results do NOT support her hypothesis. What should she do? →
2. A student wants to know if music helps students concentrate. She plays music for Group A and silence for Group B, then gives both a quiz. What is one problem with this experiment? →
3. Two students test whether salt water or plain water makes ice melt faster. They use the same amount of water, same-sized ice cubes, and same room temperature. Student A's results show salt water melts ice faster; Student B gets the same result. What can they conclude? →
4. A table shows plant heights after 10 days: fertilized plants averaged 12 cm; unfertilized plants averaged 7 cm. What pattern does this data show? →
5. A student hypothesizes that warmer water dissolves sugar faster. Her experiment shows this is true. Her classmate repeats the experiment and gets the opposite result. What should the students do? →

(A) Review each other's procedures to find differences and repeat the experiment carefully
(B) She did not control the type of quiz or difficulty for both groups
(C) Report the results honestly and consider revising the hypothesis
(D) Fertilized plants grew taller on average than unfertilized plants
(E) Salt water melts ice faster, and their results are reliable because they match

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2. Earth & Space

Circle the correct answer

11. What causes day and night on Earth?
(A) Earth's rotation on its axis (B) The Moon blocking the Sun (C) Earth's revolution around the Sun (D) Clouds covering the Sun

12. How long does it take Earth to complete one full revolution around the Sun?
(A) About 24 hours (B) About 28 days (C) About 365 days (one year) (D) About 10 years

13. Which layer of Earth is found directly beneath the crust?
(A) The inner core (B) The outer core (C) The atmosphere (D) The mantle

14. What causes the seasons on Earth?
(A) The Moon's gravitational pull on Earth (B) Earth moving closer to or farther from the Sun (C) Earth's tilted axis as it revolves around the Sun (D) Changes in the Sun's energy output

15. The Moon appears to change shape over about 29 days. What are these apparent changes called?
(A) Solar cycles (B) Moon rotations (C) Lunar eclipses (D) Phases of the Moon

16. Why does the Moon appear to shine in the night sky?
(A) It produces its own light like a star (B) Its surface is made of a glowing material (C) It reflects light from the Sun (D) It absorbs heat from Earth and glows

Write the answer

17. During a solar eclipse, what is positioned between Earth and the Sun?
Answer: _____

18. What happens to Earth's shadow during a lunar eclipse?
Answer: _____

19. It is summer in the Northern Hemisphere. What season is it at the same time in the Southern Hemisphere?
Answer: _____

20. A student looks at the Moon every night for a month and draws what she sees. After 15 days she sees a full moon. What will she most likely draw on day 22?
Answer: _____

Match each question to its answer

1. A student notices that shadows in her schoolyard are shortest at noon and longest in the morning and afternoon. What causes this pattern? →
2. Earth's inner core is solid even though it is hotter than the outer core. Why is the inner core solid? →
3. A scientist compares rock layers in two different locations. She finds the same type of fossil in the same layer at both locations. What can she most reasonably conclude? →

4. Look at this sequence of moon phases: New → Crescent → Quarter → Gibbous → Full → Gibbous → Quarter → Crescent → New. What pattern does this show? →
5. Cities near the equator experience very little seasonal temperature change throughout the year. Cities near the poles experience extreme seasons. Why? →

(A) The equator always receives fairly direct sunlight year-round; poles receive sunlight at a very low angle, especially in winter
(B) The Sun appears at different heights in the sky as Earth rotates during the day
(C) Those rock layers were formed at about the same time period in both places
(D) The extreme pressure from the weight of layers above compresses the material into a solid
(E) The Moon follows a regular, repeating cycle of phases about every 29 days

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3. Life Science

Circle the correct answer

21. What is the basic unit of life?
(A) The atom (B) The cell (C) The molecule (D) The organ

22. Which organelle controls what enters and exits a cell?
(A) The mitochondria (B) The vacuole (C) The nucleus (D) The cell membrane

23. Where does photosynthesis take place in a plant cell?
(A) Nucleus (B) Chloroplasts (C) Mitochondria (D) Cell wall

24. What is the correct order of organization from smallest to largest in multicellular organisms?
(A) Organism → Cell → Tissue → Organ → Organ system (B) Cell → Tissue → Organ → Organ system → Organism (C) Organ → Tissue → Cell → Organism → Organ system (D) Tissue → Cell → Organ system → Organ → Organism

25. A plant cell and an animal cell are placed under a microscope. The student notices the plant cell has a rigid outer wall that the animal cell lacks. What is this structure and why do plant cells have it?
(A) The vacuole, which stores extra water to keep the plant firm (B) The cell membrane, which allows nutrients to enter plant cells more easily than animal cells (C) The chloroplast, which surrounds the plant cell to protect it from sunlight damage (D) The cell wall, which provides structural support and maintains the plant cell's shape

26. What is the overall chemical equation for photosynthesis?
(A) Carbon dioxide + water + light energy → glucose + oxygen (B) Glucose + oxygen → carbon dioxide + water + energy (C) Water + light energy → glucose + carbon dioxide (D) Carbon dioxide + oxygen → glucose + water

Write the answer

27. How is cellular respiration the opposite of photosynthesis?
Answer: _____

28. Why do organisms need to maintain homeostasis?
Answer: _____

29. A student covers the leaves of a plant with petroleum jelly, which blocks the stomata. What will most likely happen, and why?
Answer: _____

30. A patient with type 1 diabetes cannot produce insulin. Insulin is needed to signal cells to absorb glucose from the blood. What problem does this create at the cellular level?
Answer: _____

Match each question to its answer

1. You shiver when you are cold. Shivering involves your muscles contracting rapidly. How does shivering help maintain homeostasis? →
2. A scientist observes that bacteria in a jar reproduce very rapidly when glucose is plentiful, but slow their reproduction when glucose runs out. What does this suggest about how cells use glucose? →
3. A scientist removes the mitochondria from a muscle cell. What would most likely happen to the cell, and why? →
4. Two types of soil are tested for plant growth. In Soil A, plants average 15 cm tall. In Soil B, plants average 6 cm tall after four weeks. A student concludes that Soil A is better for all plants forever. Is this conclusion valid? →
5. A student measures photosynthesis rate at different light intensities. She finds it increases from dim to bright light, then levels off even as light increases further. What limits photosynthesis at high light intensities? →

(A) Other factors like CO_2 concentration or enzyme availability become limiting at high light levels
(B) Rapid muscle contractions generate heat through cellular respiration, warming the body back toward normal temperature
(C) Glucose is the energy source for cell metabolism and reproduction; without it, cells lack the energy to divide and grow

(D) No — the conclusion is too broad; some plants may prefer Soil B, and conditions can change over time

(E) The cell would lose the ability to produce sufficient ATP, making it unable to contract muscles and eventually dying

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4. Ecosystems & Food Webs

Circle the correct answer

31. What is an ecosystem?

(A) Any place where plants grow (B) A group of animals that live in the same area (C) A community of living organisms interacting with their nonliving environment (D) A type of biome found only in tropical regions

32. What is the role of a producer in a food chain?

(A) It stores water for other organisms (B) It breaks down dead organisms (C) It makes its own food using energy from sunlight (D) It hunts and eats other animals

33. What is a decomposer?

(A) A plant that grows in dark environments (B) An animal that eats only plants (C) A predator at the top of the food chain (D) An organism that breaks down dead matter and returns nutrients to the soil

34. Which of the following is an abiotic factor in an ecosystem?

(A) A mushroom (B) Temperature (C) A hawk (D) A pine tree

35. In a food chain, grass is eaten by a rabbit, and the rabbit is eaten by a fox. Why is the grass considered the most important link?

(A) It has the most predators (B) It can survive without any other organisms in the chain (C) It is the largest organism in the chain (D) It captures energy from the sun and provides the energy base for the entire chain

36. How is a food web different from a food chain?

(A) A food web shows one straight path of energy while a food chain branches out (B) A food web only includes predators while a food chain includes all organisms (C) A food web is found only in oceans while food chains are on land (D) A food web shows many overlapping food chains and how organisms have multiple food sources

Write the answer

37. Why does only about 10% of energy transfer from one level of a food chain to the next?

Answer: _____

38. What is the difference between a habitat and a niche?
Answer: _____

39. Why do food chains rarely have more than four or five levels?
Answer: _____

40. A pond ecosystem has algae, small fish, large fish, and a heron. If a disease kills most of the small fish, what will most likely happen to the large fish population?
Answer: _____

Match each question to its answer

1. A farmer notices that removing all the hawks from her area caused the rabbit population to explode and damage her crops. Using food web concepts, explain why this happened. →
2. An energy pyramid shows that producers have 10,000 units of energy. How much energy is available to secondary consumers (the third level)? →
3. In a forest ecosystem, deer eat plants, wolves eat deer, and mushrooms decompose dead wolves. If the wolf population suddenly increases, predict what will happen to the plant population and explain why. →
4. Two species of birds in a forest both eat the same type of insect. What type of relationship is this, and what is a likely outcome over time? →
5. A scientist studying a lake ecosystem finds that removing a single species of fish caused five other species to decline. What does this suggest about the removed fish? →

(A) Plant population will increase because more wolves eat more deer, reducing the grazing pressure on plants
(B) Hawks were a predator controlling the rabbit population; without them, rabbits reproduced unchecked
(C) 100 units
(D) Competition — one species may outcompete the other, or they may adapt to use slightly different resources
(E) It was likely a keystone species whose presence supported the balance of the entire ecosystem

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5. Weather Systems

Circle the correct answer

41. What is the difference between weather and climate?
(A) Weather happens in winter and climate happens in summer (B) Weather refers to temperature only, while climate includes rain (C) They mean the same thing but are used in different countries (D) Weather is the day-to-day atmospheric conditions, while climate is the average weather pattern over many years

42. What instrument is used to measure atmospheric pressure?
(A) Thermometer (B) Barometer (C) Rain gauge (D) Anemometer

43. What are the three main types of clouds?
(A) Thunder, rain, and snow clouds (B) Nimbus, foggy, and hazy (C) Low, medium, and high pressure clouds (D) Cumulus, stratus, and cirrus

44. What causes wind?
(A) The Earth's rotation pushes air sideways, and this has been consistently demonstrated in practice (B) Trees and mountains push air around, and this principle applies across similar situations (C) Unequal heating of Earth's surface creates differences in air pressure, and air moves from high to low pressure (D) The Moon's gravity pulls on the atmosphere, and this principle applies across similar situations

45. Warm air rises because it is less dense than cool air. How does this process contribute to cloud formation?
(A) Cool air at the surface traps clouds near the ground (B) Warm air pushes clouds down from space (C) Rising warm air cools as it gains altitude, causing water vapor to condense into tiny droplets that form clouds (D) Clouds form when sunlight heats raindrops in the sky

46. What happens at a cold front?
(A) Two air masses of the same temperature meet and cancel each other out (B) A mass of cold air pushes under warm air, forcing the warm air up rapidly and often causing storms (C) Cold air rises above warm air, creating clear skies (D) Warm air slowly slides over cold air, creating gentle rain

Write the answer

47. Why does humid air feel warmer than dry air at the same temperature?
Answer: _____

48. How does the water cycle connect to weather patterns?
Answer: _____

49. Why is the saying 'heat rises' scientifically incomplete?
Answer: _____

50. A weather map shows a large area of low pressure moving toward your city. Based on this information, what type of weather should you prepare for?

Answer: _____

Match each question to its answer

1. You are planning an outdoor event in three days. The forecast shows a warm front approaching tomorrow followed by a cold front the day after. What weather should you expect on the day of your event? →
2. Using the water cycle, explain why coastal cities tend to get more rainfall than inland desert cities at the same latitude. →
3. A student records the following barometer readings over four days: Monday 1020 mb, Tuesday 1015 mb, Wednesday 1005 mb, Thursday 998 mb. What weather pattern does this data suggest? →
4. Thunderstorms require three ingredients: moisture, instability, and a lifting mechanism. Analyze why thunderstorms are most common on hot summer afternoons. →
5. Cities are often several degrees warmer than surrounding rural areas. Analyze why this 'urban heat island' effect occurs. →

(A) Dark pavement and buildings absorb and retain more heat than natural surfaces, and less vegetation means less cooling from evapotranspiration
(B) Cooler, clearer weather after the cold front passes through
(C) Coastal cities are near large water bodies that provide constant evaporation, supplying moisture for cloud formation and precipitation
(D) Summer heat creates strong surface heating (instability), high humidity provides moisture, and the rising hot air provides the lifting mechanism
(E) Steadily falling pressure indicates a storm system is approaching

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6. Human Body Systems

Circle the correct answer

51. What is the basic structural and functional unit of all living organisms?
(A) The atom (B) The tissue (C) The organ (D) The cell

52. What is the correct order of organization in the human body from simplest to most complex?
(A) Organs, tissues, cells, organ systems, organism (B) Cells, tissues, organs, organ systems, organism (C) Organism, organ systems, organs, tissues, cells (D) Tissues, cells, organs, organism, organ systems

53. What is the primary function of red blood cells?
(A) To carry oxygen from the lungs to the body's tissues and carbon dioxide back to the lungs (B) To help blood clot when you get a cut (C) To fight infections and destroy bacteria (D) To digest food particles in the bloodstream

54. Which organ system is responsible for breaking down food into nutrients the body can absorb?
(A) The digestive system (B) The circulatory system (C) The respiratory system (D) The excretory system

55. How do the circulatory and respiratory systems work together?
(A) They do not interact — each works independently (B) The circulatory system filters air before the respiratory system uses it (C) The respiratory system pumps blood while the circulatory system provides air (D) The respiratory system brings oxygen into the lungs, and the circulatory system transports that oxygen to cells throughout the body

56. Why does your heart rate increase when you exercise?
(A) Adrenaline from exercise directly controls heart speed regardless of oxygen needs (B) The lungs push the heart faster during exercise (C) Exercise makes the heart weaker, so it has to work harder (D) Muscles need more oxygen and energy during exercise, so the heart pumps faster to deliver more blood

Write the answer

57. What role does the small intestine play in digestion that makes it the most important organ for nutrient absorption?
Answer: _____

58. How does the nervous system differ from the endocrine system in the way it sends messages through the body?
Answer: _____

59. Explain why the body needs both the skeletal system and the muscular system to produce movement.
Answer: _____

60. A patient has a disease that damages the villi in their small intestine. Based on the function of villi, predict what health problems this person might experience.
Answer: _____

Match each question to its answer

1. When you touch a hot stove, you pull your hand away before you consciously feel pain. Explain how the nervous system makes this possible. →
2. A doctor tells a patient that their white blood cell count is very low. Predict how this would affect the patient's ability to fight infections. →
3. During intense exercise, your muscles produce lactic acid as a waste product. Trace the path this waste takes to be removed from the body, identifying which organ systems are involved. →
4. The brain uses about 20% of the body's total energy despite being only 2% of body weight. Analyze why the brain requires such a disproportionate amount of energy. →
5. Antibiotics kill bacteria but do not work against viruses. Analyze why this is the case based on structural differences between bacteria and viruses. →

(A) The circulatory system carries lactic acid in the blood to the liver, which breaks it down; the respiratory system helps by increasing breathing to supply oxygen for the process
(B) Neurons constantly fire electrical signals and maintain chemical gradients, which requires enormous amounts of ATP energy even at rest
(C) A reflex arc sends the signal directly to the spinal cord, which commands the muscles to pull away before the signal reaches the brain
(D) The patient would be much more vulnerable to infections because white blood cells are the body's primary defense against pathogens
(E) Antibiotics target structures like cell walls and ribosomes that bacteria have but viruses lack, since viruses are not true cells

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7. Atoms & Molecules

Circle the correct answer

61. What are the three main subatomic particles that make up an atom?
(A) Molecules, compounds, and elements (B) Protons, neutrons, and electrons (C) Photons, quarks, and gluons (D) Atoms, ions, and isotopes

62. What does the atomic number of an element tell you?
(A) The weight of the atom in grams (B) The number of protons in the nucleus of that element's atoms (C) The number of electrons an atom can gain or lose (D) The total number of particles in the atom

63. What is a molecule?
(A) A charged atom that has gained or lost electrons (B) The smallest particle of matter (C) A single atom of any element (D) Two or more atoms bonded together

64. What is the difference between an element and a compound?
(A) An element is made of only one type of atom, while a compound is made of two or more different types of atoms chemically bonded together (B) An element is always a solid and a compound is always a liquid, as this directly follows from the underlying principles (C) Elements are natural and compounds are man-made, and this is the standard approach used in most cases (D) An element is larger than a compound, making this the most widely accepted explanation

65. Why are the noble gases (helium, neon, argon) so unreactive compared to other elements?
(A) Their outer electron shells are completely full, so they have no need to gain, lose, or share electrons with other atoms (B) They exist only as gases, and gases cannot undergo chemical reactions (C) They are too heavy to react with other elements (D) They were discovered last, so scientists have not found their reactions yet

66. How does an ionic bond form between sodium (Na) and chlorine (Cl)?
(A) Sodium loses one electron to chlorine, creating a positive sodium ion and a negative chloride ion that attract each other (B) Chlorine gives an electron to sodium, making both atoms neutral (C) Sodium and chlorine physically stick together due to gravity (D) Sodium and chlorine share electrons equally between them

Write the answer

67. How is a covalent bond different from an ionic bond?
Answer: _____

68. The periodic table organizes elements into groups (columns). Why do elements in the same group tend to have similar chemical properties?
Answer: _____

69. What does the chemical formula H_2O tell you about the composition of a water molecule?
Answer: _____

70. Carbon dioxide (CO_2) has a mass of 44 atomic mass units (amu). Carbon has an atomic mass of 12 amu and oxygen has an atomic mass of 16 amu. Verify that the formula CO_2 is consistent with this total mass.
Answer: _____

Match each question to its answer

1. An unknown element has 17 protons, 18 neutrons, and 17 electrons. Use the periodic table to identify this element and predict whether it is likely to form ionic or covalent bonds. →
2. Iron (Fe) can rust when exposed to oxygen and water. The chemical equation is: 4Fe + 3O2 + 6H2O -> 4Fe(OH)3. Show that atoms are conserved in this reaction. →
3. Use the periodic table to predict whether magnesium (Mg, Group 2) is more likely to bond with chlorine (Cl, Group 17) or neon (Ne, Group 18). Explain your reasoning. →
4. Diamond and graphite are both made entirely of carbon atoms, yet diamond is the hardest natural substance while graphite is soft enough to use as pencil lead. Analyze what accounts for this dramatic difference. →
5. Salt (NaCl) dissolves easily in water but does not dissolve in oil. Sugar (C12H22O11) also dissolves in water. Analyze what property water has that allows it to dissolve both ionic and certain molecular compounds. →

(A) Left side: 4 Fe, 6 O (from O2) + 6 O (from H2O) = 12 O, 12 H. Right side: 4 Fe, 12 O (from 4x3 OH), 12 H (from 4x3 OH). Atoms balance.
(B) Water is a polar molecule — its partially charged ends attract and pull apart ionic compounds and interact with other polar molecules
(C) The carbon atoms are arranged differently — diamond has a rigid 3D network of bonds, while graphite has layers that slide over each other easily
(D) Magnesium will bond with chlorine because Mg can lose 2 electrons and each Cl can gain 1, forming MgCl2. Neon is a noble gas with a full outer shell and does not bond.
(E) It is chlorine (atomic number 17). With 7 valence electrons, it tends to gain 1 electron from metals (ionic bonds) or share electrons with nonmetals (covalent bonds).

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8. Engineering Design Process

Circle the correct answer

71. What is the first step in the engineering design process?
(A) Define the problem, including criteria for success and constraints (B) Research existing solutions on the internet (C) Build a prototype immediately (D) Test multiple designs against each other

72. What is the difference between criteria and constraints in engineering design?
(A) Criteria are set by engineers and constraints are set by scientists (B) They mean the same thing and are used interchangeably (C) Criteria are the requirements a solution must meet; constraints are the limitations on the design such as cost, time, and materials (D) Criteria are for small projects and constraints are for large projects

73. What is a prototype in the engineering design process?
(A) A list of materials needed for construction (B) The final version of a product ready for sale (C) A drawing or sketch of an idea (D) A working model of a design that is used for testing before creating the final product

74. Why is the engineering design process described as iterative rather than linear?
(A) Linear processes are for science; iterative processes are only for engineering (B) Engineers only go through the process once from start to finish (C) The process is called iterative because it involves iteration, which means counting (D) Engineers repeatedly cycle through designing, testing, and improving — going back to earlier steps based on what they learn

75. Why do engineers typically brainstorm multiple solutions to a problem rather than immediately developing their first idea?
(A) It is required by law to consider at least three designs before building (B) Engineers brainstorm multiple solutions because their first idea is always wrong (C) Different solutions have different strengths and weaknesses; comparing multiple options leads to a better final design (D) Multiple solutions are brainstormed only to impress clients

76. What is a trade-off in engineering design?
(A) When a client trades money for a finished product (B) When two engineers swap their designs with each other (C) When a design fails completely and must be abandoned (D) A compromise where improving one feature of a design requires sacrificing or reducing another feature

Write the answer

77. How does the engineering design process differ from the scientific method?
Answer: _____

78. Why is failure considered valuable in the engineering design process?
Answer: _____

79. What role does a decision matrix play in evaluating competing designs?
Answer: _____

80. A team is designing a water filtration system for a rural community with no electricity. They have three designs: Design A uses an electric pump (fast, expensive), Design B uses gravity (slow, cheap), and Design C uses hand-cranking (medium speed, medium cost). Using the constraint of no electricity, which design should they eliminate first?
Answer: _____

Match each question to its answer

1. A bridge design team tested their prototype and found it could hold 50 kg before collapsing. The criterion was 100 kg. Instead of starting over, what should the team do next in the iterative design process? →
2. Create a decision matrix to compare two backpack designs. Design X weighs 2 lbs, costs $30, and has 5 pockets. Design Y weighs 4 lbs, costs $20, and has 8 pockets. Rate each 1-5 (5 is best) for weight, cost, and storage. Which design scores higher? →
3. An engineer designs a children's playground slide that is extremely fast and exciting. However, safety testing reveals that children land too hard at the bottom. Identify the trade-off and suggest a design modification that balances both fun and safety. →
4. A team of students designs a solar-powered phone charger. Version 1 charged a phone in 8 hours. After modifications, Version 2 charges in 5 hours. Version 3 charges in 4.5 hours. Analyze the pattern of improvement and predict a realistic charging time for Version 4. →
5. Two teams designed earthquake-resistant building models. Team A's building survived a simulated magnitude 6.0 earthquake. Team B's survived 7.0 but cost three times as much. Analyze which design is better and explain why the answer depends on context. →

(A) The trade-off is between speed/excitement and landing safety. A curved deceleration section at the bottom would slow riders gradually, preserving the fun of the fast section while ensuring a safe landing.
(B) Neither is universally better — it depends on the earthquake risk of the location. In a high-risk zone, Team B's stronger design justifies the cost. In a low-risk zone, Team A's cheaper design may be sufficient.
(C) Analyze where and how the bridge failed, then modify the design to reinforce those weak points and test again
(D) Each version improves less than the previous one (3-hour improvement, then 0.5-hour). Version 4 will likely show diminishing returns — perhaps 4 to 4.3 hours. Significant improvement becomes harder as the design approaches physical limits.
(E) Design X: weight=5, cost=3, storage=3, total=11. Design Y: weight=2, cost=5, storage=5, total=12. Design Y scores slightly higher overall.

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9. Advanced Scientific Method

Circle the correct answer

81. A student claims that her experiment proves that eating breakfast always improves test scores. What is one weakness in making this strong claim?
(A) Breakfast cannot affect the brain, so the claim is impossible (B) One experiment with a small group cannot prove something is always true for everyone (C) Test scores are not a scientific measurement (D) The experiment must be wrong because most scientists disagree

82. A student looks at the Moon every night for a month and draws what she sees. After 15 days she sees a full moon. What will she most likely draw on day 22?
(A) Another full moon (B) A crescent moon (a thin sliver) (C) A gibbous moon (more than half lit but not full) (D) A new moon (not visible)

83. Why can't nerve cells in the brain perform photosynthesis, even though they contain the same DNA as leaf cells?
(A) Nerve cells destroy chlorophyll because of the electrical signals they produce (B) Brain cells have different DNA than leaf cells because they evolved separately (C) Different genes are activated in different cell types; brain cells do not express the genes for producing chlorophyll or chloroplasts (D) Brain cells are too small to contain chloroplasts

84. A meadow food web includes: grass, grasshoppers, mice, snakes, rabbits, foxes, and hawks. The grasshoppers eat grass, mice eat grass and grasshoppers, snakes eat mice, rabbits eat grass, foxes eat rabbits and mice, and hawks eat snakes and foxes. If a drought kills most of the grass, which organism will be LEAST affected in the short term?
(A) Rabbits, because they can find other plants to eat (B) Grasshoppers, because they are small and need less food (C) Hawks, because they are furthest from the producers and eat predators that have stored energy (D) Mice, because they eat both grass and grasshoppers

85. Why does humid air feel warmer than dry air at the same temperature?
(A) Water molecules in humid air are warmer than air molecules (B) Humidity blocks sunlight from reaching the ground (C) High humidity slows the evaporation of sweat from skin, making the body less able to cool itself (D) Humid air is heavier and presses down on the body

86. What is the correct order of organization in the human body from simplest to most complex?
(A) Tissues, cells, organs, organism, organ systems (B) Organs, tissues, cells, organ systems, organism (C) Organism, organ systems, organs, tissues, cells (D) Cells, tissues, organs, organ systems, organism

Write the answer

87. A company advertises a supplement claiming it contains 'chemical-free, all-natural ingredients.' Evaluate whether this claim is scientifically accurate.
Answer: _____

88. You are testing three paper airplane designs to see which flies the farthest. You throw Design A once (12 meters), Design B once (15 meters), and Design C once (10 meters). A classmate says Design B is the best. Why is this conclusion unreliable?
Answer: _____

89. A student's graph shows that taller students tend to have longer feet. Her classmate says this proves height causes foot size. Is the classmate correct? Why?
Answer: _____

90. Astronauts on the Moon would not see a blue sky during the day. Why?
Answer: _____

Match each question to its answer

1. A student claims that animals are more complex than plants because animals have more cell types. Evaluate this claim. →
2. Some people argue that protecting endangered predators like wolves is not worth the cost. Using your knowledge of food webs, evaluate whether removing top predators is likely to benefit or harm the ecosystem overall. →
3. Cities are often several degrees warmer than surrounding rural areas. Analyze why this 'urban heat island' effect occurs. →
4. Explain why a person who is dehydrated might also experience a rapid heart rate, even though the heart and the water in their body seem unrelated. →
5. Use the periodic table to predict whether magnesium (Mg, Group 2) is more likely to bond with chlorine (Cl, Group 17) or neon (Ne, Group 18). Explain your reasoning. →

(A) Magnesium will bond with chlorine because Mg can lose 2 electrons and each Cl can gain 1, forming $MgCl_2$. Neon is a noble gas with a full outer shell and does not bond.
(B) Dehydration reduces blood volume, so the heart must beat faster to maintain adequate blood flow and oxygen delivery to tissues
(C) Partially valid — animals do have more specialized cell types, but plants have extraordinary complexity in their chemical processes and structural adaptations
(D) Removing top predators is likely to harm the ecosystem by causing prey populations to explode and overgraze producers
(E) Dark pavement and buildings absorb and retain more heat than natural surfaces, and less vegetation means less cooling from evapotranspiration

10. Engineering Design Process

Circle the correct answer

91. What does it mean when scientists say an experiment should be 'fair'?
(A) Every student gets a turn doing the experiment (B) Only one variable is changed at a time while all others stay the same (C) Results are always positive (D) The hypothesis must be proven right

92. It is summer in the Northern Hemisphere. What season is it at the same time in the Southern Hemisphere?
(A) Winter (B) The same season as the Northern Hemisphere (C) Summer (D) Spring

93. A student covers the leaves of a plant with petroleum jelly, which blocks the stomata. What will most likely happen, and why?
(A) The plant will die because stomata allow CO_2 in and O_2 out; without gas exchange, photosynthesis cannot occur (B) The plant will grow faster because it retains more water inside its leaves (C) Nothing will change because plants absorb gases through their roots instead (D) The plant will thrive because it no longer loses water through transpiration

94. Compare two ecosystems: a tropical rainforest with hundreds of species in its food web and a small island with only a dozen species. Which is more likely to recover from the loss of one species, and why?
(A) The rainforest, because its complex food web provides alternative food sources when one species is lost (B) Both would be equally affected regardless of species count (C) The rainforest, because tropical ecosystems never lose species (D) The island, because fewer species means less disruption

95. The jet stream is a fast-flowing river of air high in the atmosphere. How does the position of the jet stream affect weather in the United States?
(A) It separates cold polar air from warm tropical air and steers storm systems across the country (B) It heats the upper atmosphere, which warms the ground below (C) It only affects airplane routes, not surface weather (D) It creates all precipitation by pushing clouds together

96. Antibiotics kill bacteria but do not work against viruses. Analyze why this is the case based on structural differences between bacteria and viruses.
(A) Antibiotics only work on organisms that are visible under a microscope (B) Antibiotics target structures like cell walls and ribosomes that bacteria have but viruses lack, since viruses are not true cells (C) Viruses are too small for antibiotics to reach them (D) Viruses are actually helped by antibiotics, which is why doctors

avoid prescribing them

Write the answer

97. What does the chemical formula H2O tell you about the composition of a water molecule?
Answer: _____

98. What is a trade-off in engineering design?
Answer: _____

99. A student measures her plant's height every day for a week and records the numbers in a table. Why is a table better than just writing the numbers in a paragraph?
Answer: _____

100. A student notices that shadows in her schoolyard are shortest at noon and longest in the morning and afternoon. What causes this pattern?
Answer: _____

Match each question to its answer

1. A student drops a hot pot. Her hand pulls away before she consciously thinks about it. Which body system is primarily responsible for this rapid response? →
2. What is a decomposer? →
3. Using the water cycle, explain why coastal cities tend to get more rainfall than inland desert cities at the same latitude. →
4. What is the basic structural and functional unit of all living organisms? →
5. What does the atomic number of an element tell you? →

(A) The nervous system, which sends rapid electrical signals from receptors to muscles
(B) Coastal cities are near large water bodies that provide constant evaporation, supplying moisture for cloud formation and precipitation
(C) The cell
(D) The number of protons in the nucleus of that element's atoms
(E) An organism that breaks down dead matter and returns nutrients to the soil

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11. Science & Society

Circle the correct answer

101. A student uses a ruler to measure plant height but always starts measuring from 1

cm instead of 0 cm. How does this affect her data?
(A) Only the first measurement will be wrong (B) The error makes her experiment invalid entirely (C) All measurements will be 1 cm too short, creating consistent error (D) It has no effect because she measures the same way every time

102. Design a model to demonstrate how the positions of the Earth, Moon, and Sun cause a lunar eclipse. Describe what you would use and how you would position each object.
(A) Use a flashlight (Sun), a large ball (Earth), and a small ball (Moon). Position them in a line with Earth between the Sun and Moon so Earth's shadow falls on the Moon. (B) Position the Moon between the flashlight and Earth so the Moon blocks sunlight from Earth (C) Shine the flashlight at the Moon and have Earth block the Moon's light from shining back (D) Place Earth on one side and both the Moon and Sun on the other side

103. Why do organisms need to maintain homeostasis?
(A) To reproduce as quickly as possible (B) To keep internal conditions stable so cells can function properly despite changes in the external environment (C) To grow as large as possible during their lifetime (D) To avoid interacting with other organisms in their environment

104. In a food chain, grass is eaten by a rabbit, and the rabbit is eaten by a fox. Why is the grass considered the most important link?
(A) It is the largest organism in the chain (B) It can survive without any other organisms in the chain (C) It has the most predators (D) It captures energy from the sun and provides the energy base for the entire chain

105. A weather forecaster says: 'Tomorrow's high will be 85 degrees with a heat index of 105 due to high humidity.' Evaluate whether it is safe to hold an outdoor sports practice in these conditions.
(A) It is safe because 85 degrees is not that hot (B) It is unsafe — the heat index of 105 means the body experiences extreme heat stress, risking heat exhaustion or heatstroke (C) It is safe as long as players drink water during breaks (D) The heat index is not a real measurement and can be ignored

106. A person suffers a spinal cord injury that severs the nerves at the mid-back level. Analyze which body functions would be affected and which would still work normally.
(A) They would lose sensation and movement in the legs but retain full use of arms, breathing, and brain function because those are controlled above the injury (B) All body functions below the neck would stop immediately (C) Only walking would be affected; all other functions would be normal (D) The brain would stop working because it is connected to the spinal cord

Write the answer

107. Salt (NaCl) dissolves easily in water but does not dissolve in oil. Sugar ($C_{12}H_{22}O_{11}$) also dissolves in water. Analyze what property water has that allows it to dissolve both ionic and certain molecular compounds.

Answer: _____

108. A bridge design team tested their prototype and found it could hold 50 kg before collapsing. The criterion was 100 kg. Instead of starting over, what should the team do next in the iterative design process?

Answer: _____

109. What is data in a science experiment?

Answer: _____

110. A scientist compares rock layers in two different locations. She finds the same type of fossil in the same layer at both locations. What can she most reasonably conclude?

Answer: _____

Match each question to its answer

1. A patient with type 1 diabetes cannot produce insulin. Insulin is needed to signal cells to absorb glucose from the blood. What problem does this create at the cellular level? →
2. A pond ecosystem has algae, small fish, large fish, and a heron. If a disease kills most of the small fish, what will most likely happen to the large fish population? →
3. During a hurricane, the weather suddenly becomes calm with clear skies. What is happening, and what should people do? →
4. During intense exercise, your muscles produce lactic acid as a waste product. Trace the path this waste takes to be removed from the body, identifying which organ systems are involved. →
5. An unknown element has 17 protons, 18 neutrons, and 17 electrons. Use the periodic table to identify this element and predict whether it is likely to form ionic or covalent bonds. →

(A) The circulatory system carries lactic acid in the blood to the liver, which breaks it down; the respiratory system helps by increasing breathing to supply oxygen for the process

(B) It is chlorine (atomic number 17). With 7 valence electrons, it tends to gain 1 electron from metals (ionic bonds) or share electrons with nonmetals (covalent bonds).

(C) They are in the eye of the hurricane — the calm center — and should stay sheltered because the other side of the storm is approaching

(D) The large fish population will decrease because their food source has declined

(E) Cells cannot absorb glucose, so they cannot perform cellular respiration

effectively, leading to energy deficiency

12. Interdisciplinary Science

Circle the correct answer

111. After finishing an experiment, a student finds that her results do NOT support her hypothesis. What should she do?
(A) Report the results honestly and consider revising the hypothesis (B) Change her data so it matches her hypothesis (C) Throw away the experiment and start over (D) Pretend the experiment did not happen

112. The Sun is classified as a medium-sized star. Why is this important for life on Earth?
(A) Medium stars always have planets orbiting them (B) A medium-sized star has a longer, more stable life span, giving life time to evolve over billions of years (C) Size determines whether a star can be seen from Earth (D) A medium star is the only type that produces light

113. Which organelle controls what enters and exits a cell?
(A) The mitochondria (B) The nucleus (C) The vacuole (D) The cell membrane

114. A coral reef ecosystem is experiencing bleaching due to warming ocean temperatures. Explain how this abiotic change could affect the entire food web of the reef.
(A) Fish will simply move to cooler water with no impact on the food web (B) Coral provides habitat and food for many species; its loss cascades through the food web as fish lose shelter and food sources disappear (C) Only the coral is affected because other organisms do not depend on it (D) Warming water makes all organisms grow faster, improving the food web

115. How does the water cycle connect to weather patterns?
(A) Weather creates the water cycle, not the other way around (B) The water cycle stopped millions of years ago and does not affect current weather (C) Evaporation, condensation, and precipitation continuously move water between Earth's surface and atmosphere, driving weather (D) The water cycle only affects rivers and oceans, not weather

116. Explain why the body needs both the skeletal system and the muscular system to produce movement.
(A) Muscles can both push and pull, but bones decide the direction (B) Bones produce movement and muscles just protect the bones (C) The skeletal system is only for protection; muscles do all the moving (D) Muscles can only pull (contract), so

they need bones as rigid levers to push against, and bones cannot move on their own without muscles

Write the answer

117. Iron (Fe) can rust when exposed to oxygen and water. The chemical equation is: 4Fe + 3O2 + 6H2O -> 4Fe(OH)3. Show that atoms are conserved in this reaction.
Answer: _____

118. NASA's Apollo 13 mission experienced an oxygen tank explosion in space. Engineers on the ground had to design a CO2 filter adapter using only materials available on the spacecraft — duct tape, cardboard, plastic bags, and a sock. Analyze what this event demonstrates about the engineering design process under extreme constraints.
Answer: _____

119. What do we call a possible explanation for a scientific question that can be tested?
Answer: _____

120. Cities near the equator experience very little seasonal temperature change throughout the year. Cities near the poles experience extreme seasons. Why?
Answer: _____

Match each question to its answer

1. A plant cell and an animal cell are placed under a microscope. The student notices the plant cell has a rigid outer wall that the animal cell lacks. What is this structure and why do plant cells have it? →
2. A farmer notices that removing all the hawks from her area caused the rabbit population to explode and damage her crops. Using food web concepts, explain why this happened. →
3. Warm air rises because it is less dense than cool air. How does this process contribute to cloud formation? →
4. When you touch a hot stove, you pull your hand away before you consciously feel pain. Explain how the nervous system makes this possible. →
5. How is a covalent bond different from an ionic bond? →

(A) The cell wall, which provides structural support and maintains the plant cell's shape
(B) In a covalent bond, atoms share electrons; in an ionic bond, one atom transfers electrons to another
(C) A reflex arc sends the signal directly to the spinal cord, which commands the muscles to pull away before the signal reaches the brain

(D) Hawks were a predator controlling the rabbit population; without them, rabbits reproduced unchecked

(E) Rising warm air cools as it gains altitude, causing water vapor to condense into tiny droplets that form clouds

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13. Scientific Method

Circle the correct answer

121. A student's experiment shows that plants grow better with fertilizer. She wants to share this finding with the class. Which way of presenting her results shows the MOST scientific thinking?

(A) Share the data table and graph, explain the procedure, and note any limitations of the experiment (B) Show only the graph of the tallest plant (C) Just tell the class that fertilizer helps plants grow (D) Read the hypothesis aloud and say it was proven

122. Earth's inner core is solid even though it is hotter than the outer core. Why is the inner core solid?

(A) Gravity pulls all heat toward the outer core, leaving the inner core cold (B) The extreme pressure from the weight of layers above compresses the material into a solid (C) The inner core is made of a different material that does not melt (D) The inner core is cooler than the outer core so it stays solid

123. A student measures photosynthesis rate at different light intensities. She finds it increases from dim to bright light, then levels off even as light increases further. What limits photosynthesis at high light intensities?

(A) The plant starts cellular respiration instead of photosynthesis at high light (B) The plant produces too much oxygen, which poisons the chloroplasts (C) Other factors like CO_2 concentration or enzyme availability become limiting at high light levels (D) Bright light destroys chlorophyll, stopping photosynthesis

124. Design a weather monitoring station for your school. Choose at least four instruments you would include, explain what each measures, and describe one weather prediction you could make by combining data from multiple instruments.

(A) A single radar system replaces all individual weather instruments, which is the most common explanation for this phenomenon (B) Weather stations cannot predict weather — they only record what already happened, making this the most widely accepted explanation (C) You only need a thermometer because temperature determines all weather (D) Example: thermometer (temperature), barometer (pressure), hygrometer (humidity), anemometer (wind speed). Combining falling pressure with rising humidity and shifting winds could predict an approaching storm system.

125. A patient has a disease that damages the villi in their small intestine. Based on the function of villi, predict what health problems this person might experience.
(A) They would not be able to swallow food, and this is the standard approach used in most cases (B) They would lose the ability to taste food, which is the most common explanation for this phenomenon (C) They would have difficulty absorbing nutrients from food, leading to malnutrition, weight loss, and fatigue despite eating normally (D) Their stomach would produce too much acid, and this principle applies across similar situations

126. A student heats 10 grams of sugar in a sealed container. After the reaction, a black solid and some gas form inside the container. The student weighs the sealed container and finds it weighs exactly the same as before heating. Explain why.
(A) The container absorbed the missing mass, as this is what research and standard practice suggests (B) The total mass is conserved because all atoms are still inside the sealed container — they rearranged into new substances but no atoms were created or destroyed (C) This result is incorrect — the mass should have decreased, which is the most common explanation for this phenomenon (D) The gas weighs nothing, so only the black solid contributes to the mass, and this is the standard approach used in most cases

Write the answer

127. A weather map shows a large area of low pressure moving toward your city. Based on this information, what type of weather should you prepare for?
Answer: _____

128. What happens to Earth's shadow during a lunar eclipse?
Answer: _____

129. A scientist measures the biomass at each trophic level: producers have 1,000 kg, primary consumers have 100 kg, secondary consumers have 10 kg, and tertiary consumers have 1 kg. Is this data consistent with ecological principles?
Answer: _____

130. A student measures the temperature at noon every day for a month and calculates the average. Is this average a measure of weather or climate?
Answer: _____

Match each question to its answer

1. What is a molecule? →
2. Why do engineers typically brainstorm multiple solutions to a problem rather than immediately developing their first idea? →
3. When you dissolve salt in water, the solution conducts electricity, but pure water

and solid salt do not. Analyze why dissolving salt creates this new electrical property. →
4. Why do we always see the same side of the Moon from Earth? →
5. A city needs to design a new pedestrian bridge across a river. List at least four criteria and four constraints that engineers would need to consider. →

(A) Dissolving separates NaCl into free-moving Na+ and Cl- ions in solution, which can carry electrical charge. In solid salt, ions are locked in place; in pure water, there are no charged particles.
(B) Criteria: support a minimum weight load, allow wheelchair access, withstand weather conditions, last at least 50 years. Constraints: budget limit, river width, construction time, building codes, environmental regulations.
(C) Different solutions have different strengths and weaknesses; comparing multiple options leads to a better final design
(D) The Moon rotates once on its axis in the same time it takes to orbit Earth once
(E) Two or more atoms bonded together

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14. Scientific Method

Circle the correct answer

131. Which statement best explains why stars appear to move across the sky during the night?
(A) Stars travel through the galaxy and we see their motion (B) The Sun's gravity moves stars across the sky (C) Earth rotates on its axis, making stars appear to move from east to west (D) Stars orbit Earth once per night

132. What is the correct order of organization from smallest to largest in multicellular organisms?
(A) Tissue → Cell → Organ system → Organ → Organism (B) Cell → Tissue → Organ → Organ system → Organism (C) Organism → Cell → Tissue → Organ → Organ system (D) Organ → Tissue → Cell → Organism → Organ system

133. Why do food chains rarely have more than four or five levels?
(A) Scientists have only observed chains of that length (B) There are not enough species in nature to create longer chains (C) There is not enough energy left to support organisms at higher levels (D) Predators at the top eat too quickly for chains to grow

134. How does the nervous system differ from the endocrine system in the way it sends messages through the body?

(A) The nervous system sends fast electrical signals along nerves, while the endocrine system sends slower chemical signals (hormones) through the bloodstream (B) The nervous system uses hormones while the endocrine system uses electricity (C) The endocrine system is faster because hormones travel through blood (D) Both systems use the same signals but at different times of day

135. The metals in Group 1 (lithium, sodium, potassium) become more reactive as you move down the group. Potassium reacts explosively with water while lithium reacts gently. Analyze why reactivity increases going down the group.

(A) Lower elements have their outer electron farther from the nucleus with more shielding, so the electron is held less tightly and is easier to lose (B) Lower elements are heavier, and heavier atoms always react more violently (C) Lower elements have more protons, which push electrons out faster (D) Potassium is more reactive because it was discovered more recently

136. Two types of soil are tested for plant growth. In Soil A, plants average 15 cm tall. In Soil B, plants average 6 cm tall after four weeks. A student concludes that Soil A is better for all plants forever. Is this conclusion valid?

(A) Yes — data clearly shows Soil A is better for all plant growth in all conditions (B) No — the conclusion is too broad; some plants may prefer Soil B, and conditions can change over time (C) No — the experiment should not be trusted because plants grow differently (D) Yes — averages are always reliable and prove universal truths

Write the answer

137. Compare how the body responds to a pathogen it has never encountered before versus one it has been vaccinated against. Analyze the difference in response time and effectiveness.

Answer: _____

138. Which layer of Earth is found directly beneath the crust?

Answer: _____

139. What is an ecosystem?

Answer: _____

140. Some people claim that a single cold winter disproves global warming. Evaluate this claim using the difference between weather and climate.

Answer: _____

Match each question to its answer

1. Design a simple experiment to demonstrate that a chemical reaction has occurred (not just a physical change). Describe what you would do, what you would observe, and how you would know it is a chemical reaction rather than a physical change. →
2. An engineer designs a children's playground slide that is extremely fast and exciting. However, safety testing reveals that children land too hard at the bottom. Identify the trade-off and suggest a design modification that balances both fun and safety. →
3. What is the first step in the engineering design process? →
4. How do the circulatory and respiratory systems work together? →
5. What causes the seasons on Earth? →

(A) Example: Mix baking soda and vinegar. Observe bubbling (gas production), temperature change, and a new substance (CO_2). Evidence: new substance formed, energy released, and the original substances cannot be easily recovered — all signs of a chemical reaction.
(B) The respiratory system brings oxygen into the lungs, and the circulatory system transports that oxygen to cells throughout the body
(C) The trade-off is between speed/excitement and landing safety. A curved deceleration section at the bottom would slow riders gradually, preserving the fun of the fast section while ensuring a safe landing.
(D) Earth's tilted axis as it revolves around the Sun
(E) Define the problem, including criteria for success and constraints

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15. Scientific Method

Circle the correct answer

141. A scientist records that her plant grew 5 cm in week one and 7 cm in week two. Which scientific skill is she using?
(A) Asking a research question (B) Forming a hypothesis (C) Measuring and recording data (D) Reaching a conclusion

142. Type 1 diabetes occurs when the immune system destroys insulin-producing cells in the pancreas. Analyze how this single organ failure affects multiple body systems.
(A) Without insulin, cells cannot absorb glucose from the blood, leading to high blood sugar, energy starvation of cells, and potential damage to blood vessels, kidneys, nerves, and eyes (B) Only the digestive system is affected because the pancreas is a digestive organ (C) Diabetes only affects blood sugar and has no impact on other body systems (D) The body can function normally without insulin by using other hormones

143. A company designs a biodegradable plastic bag to replace traditional plastic bags. The bag works well but costs 5 times more than a regular plastic bag. Evaluate whether this design should be adopted.

(A) It should not be adopted because it costs too much, since this follows logically from the fundamental principles involved (B) It should be adopted immediately regardless of cost because the environment matters most, which reflects the current consensus among experts in this field (C) It depends on whether the environmental benefits (reduced pollution, landfill waste) outweigh the higher cost, and whether the cost will decrease with mass production. The decision involves environmental, economic, and social trade-offs. (D) The design is a failure because it is more expensive than existing solutions, based on the established understanding in this subject area

144. Two species of birds in a forest both eat the same type of insect. What type of relationship is this, and what is a likely outcome over time?

(A) Predation — one bird will start eating the other bird (B) Mutualism — both birds will benefit from sharing the insects (C) Competition — one species may outcompete the other, or they may adapt to use slightly different resources (D) Parasitism — one bird will take energy from the other

145. What role does the small intestine play in digestion that makes it the most important organ for nutrient absorption?

(A) It contains the most bacteria, which digest all the food (B) Its long length and finger-like villi create a huge surface area for absorbing nutrients into the bloodstream (C) It produces the strongest acid in the body to dissolve food (D) It is the widest part of the digestive tract, allowing more food to pass through

146. How does the engineering design process differ from the scientific method?

(A) They are the same process with different names (B) The scientific method is for adults and the engineering design process is for students (C) The scientific method seeks to understand natural phenomena through investigation; the engineering design process seeks to solve practical problems by creating solutions (D) The engineering design process does not require testing or data collection

Write the answer

147. A student wants to know if music helps students concentrate. She plays music for Group A and silence for Group B, then gives both a quiz. What is one problem with this experiment?

Answer: _____

148. In a forest ecosystem, deer eat plants, wolves eat deer, and mushrooms decompose dead wolves. If the wolf population suddenly increases, predict what will happen to the plant population and explain why.

Answer: _____

149. Explain why ice floats on water, even though ice and water are both made of H2O molecules. Most solids sink in their own liquid — why is water different?

Answer: _____

150. Create a decision matrix to compare two backpack designs. Design X weighs 2 lbs, costs $30, and has 5 pockets. Design Y weighs 4 lbs, costs $20, and has 8 pockets. Rate each 1-5 (5 is best) for weight, cost, and storage. Which design scores higher?

Answer: _____

Match each question to its answer

1. What is the first step of the scientific method? →
2. A scientist studying ancient rock layers notices they get progressively older as she digs deeper. Which scientific principle explains this pattern? →
3. Which organ system is responsible for breaking down food into nutrients the body can absorb? →
4. Organ transplant patients must take immunosuppressant drugs for life to prevent rejection. Analyze the trade-off this creates for the patient's health. →
5. When the Mars Pathfinder team designed the airbag landing system for the Sojourner rover in 1997, they could not test it in actual Mars conditions on Earth. Analyze how engineers can design for environments they cannot fully replicate during testing. →

(A) Ask a question

(B) They use computer simulations, mathematical models, partial testing (vacuum chambers, drop tests), and build in safety margins to account for unknowns

(C) The drugs prevent the immune system from attacking the new organ, but they also weaken the body's defense against infections and cancer

(D) The digestive system

(E) The Law of Superposition — in undisturbed layers, older rocks are found below younger rocks

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16. Scientific Method

Circle the correct answer

151. A biology teacher asks her class to design a multicellular organism that lives deep in the ocean where sunlight cannot reach. What type of energy strategy should the organism use, and what cellular structures should it have?
(A) It should not have mitochondria since the ocean pressure provides energy for cells (B) It should have both chloroplasts and mitochondria to survive in multiple conditions (C) It should be a heterotroph using cellular respiration; it needs mitochondria but not chloroplasts since photosynthesis is impossible without light (D) It should have chloroplasts that convert heat energy from hydrothermal vents into glucose

152. A wetland ecosystem provides flood control, water filtration, and wildlife habitat. A developer wants to drain it for a shopping center. Analyze the trade-offs of this decision.
(A) The wetland has no value since it is not farmland (B) The community gains economic benefits but loses natural flood protection, clean water, and biodiversity (C) There are no trade-offs because shopping centers are always better than wetlands (D) Draining the wetland would improve the area because wetlands are useless

153. Why is the saying 'heat rises' scientifically incomplete?
(A) Heat does not rise — warm air rises because it is less dense than surrounding cooler air (B) Heat actually sinks because it is heavier than cold (C) Heat rises only in a vacuum, not in the atmosphere (D) The saying is completely accurate and needs no correction

154. Why is failure considered valuable in the engineering design process?
(A) Failures are only valuable if they happen during brainstorming (B) Failure is not valuable — it means the engineer made mistakes (C) Engineers are trained to never fail, so this question is incorrect (D) Failures reveal weaknesses in a design and provide specific information about what needs to be improved in the next iteration

155. What is the role of a producer in a food chain?
(A) It breaks down dead organisms (B) It stores water for other organisms (C) It hunts and eats other animals (D) It makes its own food using energy from sunlight

156. A student records the following barometer readings over four days: Monday 1020 mb, Tuesday 1015 mb, Wednesday 1005 mb, Thursday 998 mb. What weather pattern does this data suggest?
(A) Steadily falling pressure indicates a storm system is approaching (B) The barometer is broken because pressure should not change this much (C) Rising pressure means sunny weather is coming (D) The pressure is stable so weather will not change

Write the answer

157. A geologist finds a rock layer with sharp, angular fragments mixed with fine dust. This pattern suggests the rocks were formed by which process?

Answer: _____

158. A friend says: 'I do not need to get a flu vaccine every year because I got one last year and my immune system should remember.' Evaluate whether this reasoning is correct.

Answer: _____

159. Diamond and graphite are both made entirely of carbon atoms, yet diamond is the hardest natural substance while graphite is soft enough to use as pencil lead. Analyze what accounts for this dramatic difference.

Answer: _____

160. Why are the noble gases (helium, neon, argon) so unreactive compared to other elements?

Answer: _____

Match each question to its answer

1. In an experiment testing how temperature affects seed germination, what is the independent variable? →
2. El Nino is a climate pattern where the Pacific Ocean near the equator becomes unusually warm. How can an ocean temperature change thousands of miles away affect weather in North America? →
3. You are planning an outdoor event in three days. The forecast shows a warm front approaching tomorrow followed by a cold front the day after. What weather should you expect on the day of your event? →
4. A plant grows toward a light source over several days. Which characteristic of living things does this demonstrate? →
5. The periodic table organizes elements into groups (columns). Why do elements in the same group tend to have similar chemical properties? →

(A) Response to stimuli
(B) They have the same number of electrons in their outer shell, which determines how they bond with other atoms
(C) Temperature
(D) Cooler, clearer weather after the cold front passes through
(E) The warm water alters atmospheric circulation patterns, shifting the jet stream and changing storm tracks across North America

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Answer Key

1. A — Ask a question
2. B — Hypothesis
3. D — Something that can change or be changed in an experiment
4. D — Information collected during an experiment
5. A — Hypothesis
6. A — To make sure the results are reliable and not due to chance
7. Temperature
8. Only one variable is changed at a time while all others stay the same
9. Conducting a controlled experiment
10. Measuring and recording data
    Matching (Scientific Method): 1→C, 2→B, 3→E, 4→D, 5→A
11. A — Earth's rotation on its axis
12. C — About 365 days (one year)
13. D — The mantle
14. C — Earth's tilted axis as it revolves around the Sun
15. D — Phases of the Moon
16. C — It reflects light from the Sun
17. The Moon
18. Earth's shadow falls on the Moon, making it look darker or reddish
19. Winter
20. A gibbous moon (more than half lit but not full)
    Matching (Earth & Space): 1→B, 2→D, 3→C, 4→E, 5→A
21. B — The cell
22. D — The cell membrane
23. B — Chloroplasts
24. B — Cell → Tissue → Organ → Organ system → Organism
25. D — The cell wall, which provides structural support and maintains the plant cell's shape

26. A — Carbon dioxide + water + light energy → glucose + oxygen
27. Cellular respiration breaks down glucose using oxygen to release energy, producing CO_2 and water
28. To keep internal conditions stable so cells can function properly despite changes in the external environment
29. The plant will die because stomata allow CO_2 in and O_2 out; without gas exchange, photosynthesis cannot occur
30. Cells cannot absorb glucose, so they cannot perform cellular respiration effectively, leading to energy deficiency
    Matching (Life Science): 1→B, 2→C, 3→E, 4→D, 5→A
31. C — A community of living organisms interacting with their nonliving environment
32. C — It makes its own food using energy from sunlight
33. D — An organism that breaks down dead matter and returns nutrients to the soil
34. B — Temperature
35. D — It captures energy from the sun and provides the energy base for the entire chain
36. D — A food web shows many overlapping food chains and how organisms have multiple food sources
37. Most energy is used by the organism for life processes and lost as heat
38. A habitat is where an organism lives, while a niche is its role and how it fits into the ecosystem
39. There is not enough energy left to support organisms at higher levels
40. The large fish population will decrease because their food source has declined
    Matching (Ecosystems & Food Webs): 1→B, 2→C, 3→A, 4→D, 5→E
41. D — Weather is the day-to-day atmospheric conditions, while climate is the average weather pattern over many years
42. B — Barometer
43. D — Cumulus, stratus, and cirrus
44. C — Unequal heating of Earth's surface creates differences in air pressure, and air moves from high to low pressure

45. C — Rising warm air cools as it gains altitude, causing water vapor to condense into tiny droplets that form clouds
46. B — A mass of cold air pushes under warm air, forcing the warm air up rapidly and often causing storms
47. High humidity slows the evaporation of sweat from skin, making the body less able to cool itself
48. Evaporation, condensation, and precipitation continuously move water between Earth's surface and atmosphere, driving weather
49. Heat does not rise — warm air rises because it is less dense than surrounding cooler air
50. Cloudy skies, possible rain or storms, and warmer temperatures
    Matching (Weather Systems): 1→B, 2→C, 3→E, 4→D, 5→A
51. D — The cell
52. B — Cells, tissues, organs, organ systems, organism
53. A — To carry oxygen from the lungs to the body's tissues and carbon dioxide back to the lungs
54. A — The digestive system
55. D — The respiratory system brings oxygen into the lungs, and the circulatory system transports that oxygen to cells throughout the body
56. D — Muscles need more oxygen and energy during exercise, so the heart pumps faster to deliver more blood
57. Its long length and finger-like villi create a huge surface area for absorbing nutrients into the bloodstream
58. The nervous system sends fast electrical signals along nerves, while the endocrine system sends slower chemical signals (hormones) through the bloodstream
59. Muscles can only pull (contract), so they need bones as rigid levers to push against, and bones cannot move on their own without muscles
60. They would have difficulty absorbing nutrients from food, leading to malnutrition, weight loss, and fatigue despite eating normally
    Matching (Human Body Systems): 1→C, 2→D, 3→A, 4→B, 5→E
61. B — Protons, neutrons, and electrons

62. B — The number of protons in the nucleus of that element's atoms
63. D — Two or more atoms bonded together
64. A — An element is made of only one type of atom, while a compound is made of two or more different types of atoms chemically bonded together
65. A — Their outer electron shells are completely full, so they have no need to gain, lose, or share electrons with other atoms
66. A — Sodium loses one electron to chlorine, creating a positive sodium ion and a negative chloride ion that attract each other
67. In a covalent bond, atoms share electrons; in an ionic bond, one atom transfers electrons to another
68. They have the same number of electrons in their outer shell, which determines how they bond with other atoms
69. Each water molecule contains exactly 2 hydrogen atoms and 1 oxygen atom
70. Yes — 1 carbon (12 amu) + 2 oxygen atoms (16 x 2 = 32 amu) = 44 amu total, which matches
    Matching (Atoms & Molecules): 1→E, 2→A, 3→D, 4→C, 5→B
71. A — Define the problem, including criteria for success and constraints
72. C — Criteria are the requirements a solution must meet; constraints are the limitations on the design such as cost, time, and materials
73. D — A working model of a design that is used for testing before creating the final product
74. D — Engineers repeatedly cycle through designing, testing, and improving — going back to earlier steps based on what they learn
75. C — Different solutions have different strengths and weaknesses; comparing multiple options leads to a better final design
76. D — A compromise where improving one feature of a design requires sacrificing or reducing another feature
77. The scientific method seeks to understand natural phenomena through investigation; the engineering design process seeks to solve practical problems by creating solutions
78. Failures reveal weaknesses in a design and provide specific information about what needs to be improved in the next iteration

79. It systematically scores each design against weighted criteria, allowing objective comparison and reducing bias
80. Design A, because it requires electricity and the constraint states there is no electricity available
    Matching (Engineering Design Process): 1→C, 2→E, 3→A, 4→D, 5→B
81. B — One experiment with a small group cannot prove something is always true for everyone
82. C — A gibbous moon (more than half lit but not full)
83. C — Different genes are activated in different cell types; brain cells do not express the genes for producing chlorophyll or chloroplasts
84. C — Hawks, because they are furthest from the producers and eat predators that have stored energy
85. C — High humidity slows the evaporation of sweat from skin, making the body less able to cool itself
86. D — Cells, tissues, organs, organ systems, organism
87. The claim is scientifically inaccurate — everything is made of chemicals, including water, vitamins, and all natural substances. 'Chemical-free' is a meaningless marketing term.
88. One trial per design is insufficient — variation in throwing force, angle, and air currents means a single throw does not reliably represent each design's true performance. Multiple trials are needed.
89. No — correlation does not prove causation; both could be caused by growth
90. The Moon has no atmosphere to scatter sunlight, so the sky appears black even in daytime
    Matching (Advanced Scientific Method): 1→C, 2→D, 3→E, 4→B, 5→A
91. B — Only one variable is changed at a time while all others stay the same
92. A — Winter
93. A — The plant will die because stomata allow CO_2 in and O_2 out; without gas exchange, photosynthesis cannot occur
94. A — The rainforest, because its complex food web provides alternative food sources when one species is lost
95. A — It separates cold polar air from warm tropical air and steers storm systems across the country

96. B — Antibiotics target structures like cell walls and ribosomes that bacteria have but viruses lack, since viruses are not true cells
97. Each water molecule contains exactly 2 hydrogen atoms and 1 oxygen atom
98. A compromise where improving one feature of a design requires sacrificing or reducing another feature
99. A table organizes data so patterns and changes are easier to see
100. The Sun appears at different heights in the sky as Earth rotates during the day
Matching (Engineering Design Process): 1→A, 2→E, 3→B, 4→C, 5→D
101. C — All measurements will be 1 cm too short, creating consistent error
102. A — Use a flashlight (Sun), a large ball (Earth), and a small ball (Moon). Position them in a line with Earth between the Sun and Moon so Earth's shadow falls on the Moon.
103. B — To keep internal conditions stable so cells can function properly despite changes in the external environment
104. D — It captures energy from the sun and provides the energy base for the entire chain
105. B — It is unsafe — the heat index of 105 means the body experiences extreme heat stress, risking heat exhaustion or heatstroke
106. A — They would lose sensation and movement in the legs but retain full use of arms, breathing, and brain function because those are controlled above the injury
107. Water is a polar molecule — its partially charged ends attract and pull apart ionic compounds and interact with other polar molecules
108. Analyze where and how the bridge failed, then modify the design to reinforce those weak points and test again
109. Information collected during an experiment
110. Those rock layers were formed at about the same time period in both places
Matching (Science & Society): 1→E, 2→D, 3→C, 4→A, 5→B
111. A — Report the results honestly and consider revising the hypothesis
112. B — A medium-sized star has a longer, more stable life span, giving life time to evolve over billions of years
113. D — The cell membrane

114. B — Coral provides habitat and food for many species; its loss cascades through the food web as fish lose shelter and food sources disappear
115. C — Evaporation, condensation, and precipitation continuously move water between Earth's surface and atmosphere, driving weather
116. D — Muscles can only pull (contract), so they need bones as rigid levers to push against, and bones cannot move on their own without muscles
117. Left side: 4 Fe, 6 O (from O2) + 6 O (from H2O) = 12 O, 12 H. Right side: 4 Fe, 12 O (from 4x3 OH), 12 H (from 4x3 OH). Atoms balance.
118. It shows that engineering is fundamentally about creative problem-solving within constraints. Limited materials, limited time, and life-or-death stakes forced rapid iteration with available resources — the core of engineering.
119. Hypothesis
120. The equator always receives fairly direct sunlight year-round; poles receive sunlight at a very low angle, especially in winter
    Matching (Interdisciplinary Science): 1→A, 2→D, 3→E, 4→C, 5→B
121. A — Share the data table and graph, explain the procedure, and note any limitations of the experiment
122. B — The extreme pressure from the weight of layers above compresses the material into a solid
123. C — Other factors like CO_2 concentration or enzyme availability become limiting at high light levels
124. D — Example: thermometer (temperature), barometer (pressure), hygrometer (humidity), anemometer (wind speed). Combining falling pressure with rising humidity and shifting winds could predict an approaching storm system.
125. C — They would have difficulty absorbing nutrients from food, leading to malnutrition, weight loss, and fatigue despite eating normally
126. B — The total mass is conserved because all atoms are still inside the sealed container — they rearranged into new substances but no atoms were created or destroyed
127. Cloudy skies, possible rain or storms, and warmer temperatures
128. Earth's shadow falls on the Moon, making it look darker or reddish
129. Yes — it follows the 10% rule where each level has roughly one-tenth the biomass of the level below

130. Weather — one month of data is too short to represent climate, which requires at least 30 years of data
Matching (Scientific Method): 1→E, 2→C, 3→A, 4→D, 5→B
131. C — Earth rotates on its axis, making stars appear to move from east to west
132. B — Cell → Tissue → Organ → Organ system → Organism
133. C — There is not enough energy left to support organisms at higher levels
134. A — The nervous system sends fast electrical signals along nerves, while the endocrine system sends slower chemical signals (hormones) through the bloodstream
135. A — Lower elements have their outer electron farther from the nucleus with more shielding, so the electron is held less tightly and is easier to lose
136. B — No — the conclusion is too broad; some plants may prefer Soil B, and conditions can change over time
137. The first encounter produces a slow primary immune response; vaccination creates memory cells that enable a fast, strong secondary response that prevents illness
138. The mantle
139. A community of living organisms interacting with their nonliving environment
140. The claim is incorrect — one cold winter is weather (short-term), while global warming refers to climate (long-term average trends over decades)
Matching (Scientific Method): 1→A, 2→C, 3→E, 4→B, 5→D
141. C — Measuring and recording data
142. A — Without insulin, cells cannot absorb glucose from the blood, leading to high blood sugar, energy starvation of cells, and potential damage to blood vessels, kidneys, nerves, and eyes
143. C — It depends on whether the environmental benefits (reduced pollution, landfill waste) outweigh the higher cost, and whether the cost will decrease with mass production. The decision involves environmental, economic, and social trade-offs.
144. C — Competition — one species may outcompete the other, or they may adapt to use slightly different resources
145. B — Its long length and finger-like villi create a huge surface area for absorbing nutrients into the bloodstream

146. C — The scientific method seeks to understand natural phenomena through investigation; the engineering design process seeks to solve practical problems by creating solutions
147. She did not control the type of quiz or difficulty for both groups
148. Plant population will increase because more wolves eat more deer, reducing the grazing pressure on plants
149. Water molecules in ice form a crystalline structure with spaces between them, making ice less dense than liquid water where molecules are more tightly packed
150. Design X: weight=5, cost=3, storage=3, total=11. Design Y: weight=2, cost=5, storage=5, total=12. Design Y scores slightly higher overall.
Matching (Scientific Method): 1→A, 2→E, 3→D, 4→C, 5→B
151. C — It should be a heterotroph using cellular respiration; it needs mitochondria but not chloroplasts since photosynthesis is impossible without light
152. B — The community gains economic benefits but loses natural flood protection, clean water, and biodiversity
153. A — Heat does not rise — warm air rises because it is less dense than surrounding cooler air
154. D — Failures reveal weaknesses in a design and provide specific information about what needs to be improved in the next iteration
155. D — It makes its own food using energy from sunlight
156. A — Steadily falling pressure indicates a storm system is approaching
157. Volcanic eruption (ash and rock debris deposited together)
158. The reasoning is flawed — the flu virus mutates rapidly each year, so last year's vaccine may not match this year's dominant strains
159. The carbon atoms are arranged differently — diamond has a rigid 3D network of bonds, while graphite has layers that slide over each other easily
160. Their outer electron shells are completely full, so they have no need to gain, lose, or share electrons with other atoms
Matching (Scientific Method): 1→C, 2→E, 3→D, 4→A, 5→B
