ARIZONA EDUCATOR PROFICIENCY ASSESSMENTS®

STUDY GUIDE

39 Middle Grades General Science

This AEPA test was replaced by a NES test. Examinees may continue to find this study guide useful as they prepare for the NES, as the previous AEPA test may have covered objectives and content similar to the NES test.

AZ-SG-FLD039-01

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GENERAL INFORMATION ABOUT THE AEPA® AND TEST PREPARATION

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General Information About the AEPA and Test Preparation

PART 2:
FIELD-SPECIFIC INFORMATION

Field 39: Middle Grades General Science

INTRODUCTION

This section includes a list of the test objectives, practice questions, and an answer key for the selected-response questions.

Test objectives. As noted earlier, the test objectives are broad, conceptual statements that reflect the knowledge, skills, and understanding an entry-level educator needs to practice effectively in Arizona schools. The list of test objectives for each test field is the *only* source of information about what a specific test will cover and therefore should be studied carefully.

Practice questions. The practice questions for the selected-response and performance assignment sections included in this section are designed to give you an introduction to the nature of the questions included in the AEPA tests. The practice questions represent the various types of questions you may expect to see on an actual test; however, they are *not* designed to provide diagnostic information to help you identify specific areas of individual strength or weakness or to predict your performance on the test as a whole.

When you answer the practice questions, you may wish to use the sample answer sheet and sample Written Response Booklet provided in Part 1 to acquaint yourself with these materials. Use the answer key located after the practice questions to check your answers. A sample response is provided immediately following the written performance assignment. The sample response in this guide is for illustrative purposes only. Your written response should be your original work, written in your own words, and not copied or paraphrased from some other work.

To help you identify how the test objectives are measured, the objective statement to which the question corresponds is listed in the answer key. When you are finished with the practice questions, you may wish to go back and review the entire list of test objectives and descriptive statements for your test field.

Preparation resources. The list of preparation resources has been compiled to assist you in finding relevant materials as you prepare to take the Middle Grades General Science test. This list is to be considered not as complete, but as representative of the kinds of resources currently available. There may be other materials that may be helpful to you in preparing to take the test.

You may also wish to consult a representative from an Arizona educator preparation program in your area regarding other potential resources specific to this field. Keep in mind that the use of these materials does not guarantee successful performance on the test.

TEST OBJECTIVES

Field 39: Middle Grades General Science

SUBAREAS:

1. Characteristics of Science
2. Life Science
3. Physical Science
4. Earth and Space Science

CHARACTERISTICS OF SCIENCE

0001 Understand the history of science and the nature of scientific inquiry.

For example:

- recognizing the nature, purpose, and characteristics of science, including critical evaluation of scientific claims
- analyzing the historical development and impact of major scientific ideas, including the contributions of individuals from different periods and cultures
- recognizing the process by which scientific knowledge changes over time
- demonstrating knowledge of the reliance of scientific investigations on empirical data, verifiable evidence, and logical reasoning
- identifying strategies for avoiding bias in scientific investigations

0002 Understand the principles and procedures of scientific investigations.

For example:

- demonstrating knowledge of the principles and procedures for designing and conducting scientific investigations
- identifying appropriate resources for use in designing and conducting scientific investigations
- recognizing safe and appropriate procedures for using equipment and materials in scientific investigations
- recognizing the roles of accuracy and precision in the collection of scientific data
- selecting appropriate scientific tools and international system (SI) units to collect and represent data
- demonstrating knowledge of the appropriate use and care of living organisms in scientific investigations
- recognizing appropriate procedures for maintaining a safe and effective learning environment during scientific investigations

0003 Understand processes of analyzing and communicating the results of scientific investigations.

For example:

- demonstrating knowledge of methods (e.g., tables, graphs) for organizing and analyzing data
- applying basic mathematical concepts and computational skills for analyzing experimental data, including the use of simple descriptive statistics
- solving problems involving scientific measurements and experimental data
- demonstrating knowledge of the criteria used to judge the validity and reliability of scientific investigations
- recognizing the procedures and criteria for formally reporting experimental results and data to the scientific community

0004 Understand the relationship of science to contemporary, historical, technological, and societal issues.

For example:

- demonstrating knowledge of the unifying concepts (e.g., systems, models, change) among the life, physical, and Earth sciences
- analyzing the risks and benefits of developments in science and technology
- demonstrating knowledge of the relationships among science, technology, and society
- analyzing the use of technology in science-related careers
- analyzing solutions to environmental problems associated with human activities
- recognizing the importance of ethical issues in scientific endeavors

LIFE SCIENCE

0005 Understand cell theory and the structure and function of cells.

For example:

- demonstrating knowledge of the principles of cell theory
- relating basic cell structures to their functions
- demonstrating knowledge of the differences in the structure and function of plant and animal cells
- analyzing the function of specialized cells in plants and animals

0006 Understand the characteristics and life processes of living organisms.

For example:

- demonstrating knowledge of the growth of multicellular organisms by the process of mitosis
- analyzing the life cycles and reproductive strategies of common organisms
- demonstrating knowledge of how organisms obtain and use energy (e.g., photosynthesis, respiration)
- relating the structures of living organisms (e.g., gills, lungs, stomata, xylem) to their functions
- identifying the behaviors and physiological mechanisms that allow organisms to maintain homeostasis
- recognizing levels of biological organization and interactions between the levels (e.g., cells, tissues, organs, systems)
- analyzing the functions of specialized structures (e.g., bark, fur) and systems (e.g., vascular, circulatory, skeletal)

0007 Understand the basic principles of the inheritance of biological traits and the uses of genetic engineering.

For example:

- recognizing how characteristics, including human traits, are passed from generation to generation and the influence of environmental factors on the inheritance of characteristics
- recognizing the structure and functions of genes and chromosomes
- demonstrating knowledge of the role of DNA and RNA in the transmission of genetic information
- applying the basic principles of inheritance and Mendel's laws
- identifying applications (e.g., agriculture, pest control) of genetic engineering technology

0008 Understand the processes of natural selection and adaptation.

For example:

- identifying behavioral and physiological adaptations that help organisms survive in a variety of environments
- analyzing the roles of variation, natural selection, and adaptation in biological evolution
- recognizing evidence for the evolution of species (e.g., Darwin's finches, fossils, DNA analysis)
- demonstrating knowledge of factors that affect the biological evolution of species (e.g., geographic isolation, genetic mutation)

0009 Understand the interactions among populations, communities, ecosystems, and biomes.

For example:

- analyzing the role of biotic and abiotic factors in a variety of ecosystems and biomes
- demonstrating knowledge of population dynamics
- analyzing the relationships among organisms in an ecological community
- demonstrating knowledge of the flow of matter and energy through an ecosystem
- identifying the roles of producers, consumers, and decomposers in ecosystems
- demonstrating knowledge of how various factors (e.g., natural disasters, human activity, climate change) affect ecosystems

PHYSICAL SCIENCE

0010 Understand the structure and properties of matter.

For example:

- recognizing the characteristics of elements, compounds, mixtures, and solutions
- identifying the component parts of matter (e.g., atoms, ions, molecules)
- distinguishing among the physical, chemical, and nuclear properties of matter (e.g., melting point, reactivity, radioactivity)
- recognizing the patterns of chemical and physical properties underlying the systematic organization of the periodic table
- identifying chemical symbols and interpreting chemical formulas

0011 Understand physical, chemical, and nuclear changes that occur in matter.

For example:

- applying knowledge of the conservation of matter and energy to the analysis of physical, chemical, and nuclear changes
- recognizing the kinds of evidence that indicate a chemical reaction has occurred (e.g., formation of a precipitate, change in pH)
- identifying properties of solutions (e.g., concentration, pH, salinity)
- analyzing factors that affect the rate of a physical change or a chemical reaction (e.g., temperature, catalyst)

0012 Understand relationships among force, mass, and motion.

For example:

- demonstrating knowledge of Newton's three laws of motion and their application to everyday situations, including solving problems involving force, mass, and acceleration
- recognizing the forces (e.g., normal force, gravity, friction) acting on an object in a given situation
- solving problems involving distance, direction, time, and velocity
- analyzing position-time graphs and velocity-time graphs depicting the motion of an object
- demonstrating knowledge of simple machines and their uses

0013 Understand different forms of energy and energy transformations.

For example:

- identifying types, characteristics, and uses of different forms of energy (e.g., kinetic, potential, nuclear, chemical)
- recognizing how the processes by which energy is transferred (e.g., conduction, convection, radiation) can affect the physical and chemical properties of matter
- demonstrating knowledge of the kinetic theory of matter
- recognizing the laws of thermodynamics and their application in physical systems
- interpreting phase-change diagrams
- analyzing energy changes that occur during chemical reactions

0014 Understand the characteristics of waves and the behavior of sound and light.

For example:

- demonstrating knowledge of the characteristics of mechanical waves (e.g., wavelength, frequency, amplitude)
- demonstrating knowledge of the relationships between wave characteristics and the properties of sound and light (e.g., loudness, Doppler effect)
- recognizing how wave interactions (e.g., interference, superposition) affect the character and propagation of waves
- identifying the effects of mirrors, lenses, and prisms on the behavior of light (e.g., reflection, refraction, dispersion)
- demonstrating knowledge of the characteristics and applications of the electromagnetic spectrum

0015 Understand the principles of electricity, magnetism, and electromagnetism.

For example:

- recognizing the characteristics of static electricity and electric fields
- demonstrating knowledge of the characteristics of voltage, current, and resistance in their application to series and parallel circuits (e.g., flashlights, holiday lights)
- identifying properties of magnets and the characteristics of magnetic fields
- demonstrating knowledge of electromagnetism and its application in electric motors and generators

EARTH AND SPACE SCIENCE

0016 Understand the geologic composition, structure, and history of Earth.

For example:

- demonstrating knowledge of the properties and composition of Earth's crust, mantle, and core
- distinguishing igneous, metamorphic, and sedimentary rocks based on their characteristics and formation
- demonstrating knowledge of the strategies used to identify and classify minerals (e.g., hardness, density)
- recognizing theories of Earth's origin and major events in the history of Earth (e.g., mass extinctions, continental glaciations)
- demonstrating knowledge of the conditions under which fossils form and the information fossils provide about ancient environments
- recognizing the evidence supporting the theory of plate tectonics
- demonstrating knowledge of methods for determining the relative and absolute age of Earth (e.g., stratigraphy, radiometric dating)

0017 Understand the geologic processes acting on Earth.

For example:

- demonstrating knowledge of the processes involved in the rock cycle
- demonstrating knowledge of the processes associated with the movement of tectonic plates (e.g., convection, seafloor spreading, subduction)
- analyzing the constructive and destructive processes (e.g., volcanism, meteorite impacts, weathering, erosion, deposition, soil formation) that shape Earth's surface
- relating landforms (e.g., folded mountains, uplifted plateaus, deltas, canyons) to the geologic processes that formed them
- demonstrating knowledge of earthquake measurement

0018 Understand the characteristics and properties of the hydrosphere.

For example:

- analyzing the characteristics of freshwater and salt water (e.g., density, specific heat, salinity)
- demonstrating knowledge of the characteristics of the major reservoirs of water on Earth (e.g., oceans, groundwater, surface water, glaciers)
- analyzing the movement of water through the water cycle and the physical processes involved in phase changes
- demonstrating knowledge of ocean currents and the structure and composition of the oceans
- demonstrating knowledge of the management and conservation of water resources

0019 Understand Earth's weather, climate, and atmosphere.

For example:

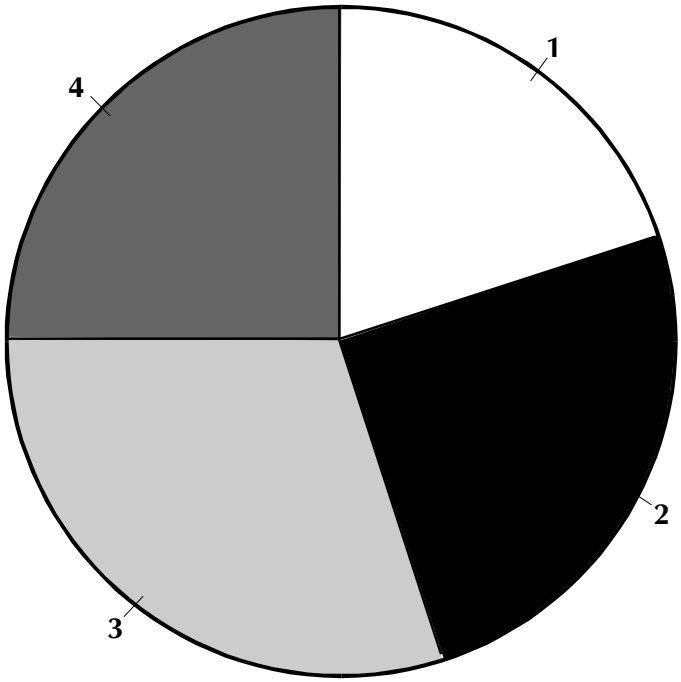
- demonstrating knowledge of the structure, functions, and characteristics of the atmosphere
- recognizing the processes related to cloud formation and precipitation
- analyzing the role of air masses and atmospheric circulation on weather
- analyzing factors that affect climate and weather (e.g., large bodies of water, rain shadows, elevation, ocean currents)
- demonstrating knowledge of the factors that affect Arizona's weather
- identifying evidence of recent and ancient changes in climate (e.g., global warming, ozone depletion, deglaciation, Ice Age)

0020 Understand the relationships between objects in the solar system and the characteristics of the solar system and universe.

For example:

- analyzing theories of the structure, origin, and evolution of the solar system and universe
- recognizing the effects of gravitational force on objects in the solar system and universe (e.g., tides, planetary orbits, black holes)
- recognizing the effects of the relative orientations, positions, and movements of Earth, Moon, Sun, and stars (e.g., seasons, eclipses, phases of the moon, major constellations)
- identifying the characteristics of stars and galaxies (e.g., life cycles of stars, types of galaxies)
- demonstrating knowledge of the methods used to observe and collect data about the solar system and universe

DISTRIBUTION OF SELECTED-RESPONSE ITEMS ON THE TEST FORM



Subarea	Approximate Percentage of Selected-Response Items on Test Form
1. Characteristics of Science	20%
2. Life Science	25%
3. Physical Science	30%
4. Earth and Space Science	25%

PERIODIC TABLE OF THE ELEMENTS

1 **IA**																	18 **VIIIA**
1 **H** 1.01	2 **IIA**											13 **IIIA**	14 **IVA**	15 **VA**	16 **VIA**	17 **VIIA**	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 23.0	12 **Mg** 24.3	3 **IIIB**	4 **IVB**	5 **VB**	6 **VIB**	7 **VIIB**	8 **VIIIB**	9	10	11 **IB**	12 **IIB**	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 39.9
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98.9)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57–71	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89–103	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (271)	111	112	113	114	115	116	117	118

Lanthanide Series	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
Actinide Series	89 **Ac** (227)	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

Some of the elements 111 and above have been reported but not fully authenticated and named.

DEFINITIONS AND PHYSICAL CONSTANTS

The value of 9.8 m/s^2 is used for the acceleration of gravity near the earth's surface.

The ideal gas constant is 8.31 J/K or 0.0821 L•atm/mol•K.

Planck's constant is 6.63×10^{-34} J•s.

Avogadro's number is 6.02×10^{23}.

In questions on electricity and magnetism, the term *current* refers to "conventional current" and the use of the right-hand rule is assumed.

END OF DEFINITIONS AND PHYSICAL CONSTANTS

PRACTICE QUESTIONS

Field 39: Middle Grades General Science

Examinees taking the Middle Grades General Science subject knowledge test will be provided with one of the following models of scientific calculators at the test administration. The models distributed are subject to change; directions for use will not be provided at the test site. You may not use your own calculator or calculator manual for this test.

- Texas Instruments TI-30X
- Texas Instruments TI-30X Solar
- Texas Instruments TI-30Xa
- Texas Instruments TI-30Xs
- Texas Instruments TI-30XIIs

1. Which of the following activities best exemplifies the practice of science as inquiry?

   A. placing different objects in a tank of water to determine which ones float

   B. following directions in constructing an electric motor

   C. figuring out what materials are needed to build a terrarium

   D. assessing the conditions of a road to determine how long a trip will take

2. In the early 1950s, a young researcher named Rosalind Franklin used X-ray diffraction imaging to produce a photograph of the DNA molecule. Two other researchers, James Watson and Francis Crick, used this information to develop a three-dimensional model of the DNA molecule. Their model of the DNA molecule was rapidly accepted by the scientific community following publication of their results. To a great extent, the acceptance of their model of the DNA molecule was based on:

   A. its ability to explain the mechanism of DNA replication and its integration with existing evidence on genetics.

   B. the use of state-of-the-art technology in the analysis of the DNA molecule.

   C. its ability to explain the role of enzymes in DNA transcription and the quality of the researchers' published work.

   D. the use of data on the DNA molecule that was collected before their research was begun.

3. Which of the following strategies would result in a biased interpretation of the results of a scientific investigation?

   A. formulating a hypothesis based on data collected by scientists who did not have modern technological resources available to them

   B. sending an abstract of the data analysis to colleagues for review before submitting an article for publication in a journal

   C. rejecting flawed data that were collected during an extensive research project because of known procedural errors

   D. failing to include experimental data that would cause other scientists in the field to call into question the conclusions of the research

4. A scientist announces that she has discovered a strain of mice that does not develop cancer even after repeated injections with chemical agents known to cause cancer in normal mice. To demonstrate to the scientific community that the discovery is legitimate, it is most important that the scientist:

   A. repeat the experiment with neutral observers present.

   B. explain the mechanism that is involved.

   C. provide verifiable evidence to support her claim.

   D. announce her research at a press conference.

5. A chemist is weighing the products of a chemical reaction. The research design requires that the experimental values collected be determined to a high level of precision. Which of the following will most directly affect the precision of the data the chemist collects?

   A. the choice of equipment used for weighing the products

   B. the reliance on accepted standard values for the molecular weight of the products

   C. the preliminary step of zeroing the scale before weighing the products

   D. the use of repeated trials to establish an average weight for the products of the experiment

6. Which of the following procedures would enable a soil scientist to effectively determine the volume of the air spaces in a soil sample that has been placed in a metal container?

   A. observing the change in volume of the soil sample as it is compacted with a heavy object

   B. measuring the volume of water that must be added to saturate the soil sample

   C. comparing the volume of the soil sample with the volume of a rock sample of equal mass

   D. calculating the volume of the soil sample when it is spread out in a thin layer

7. A science teacher is preparing a laboratory activity for an eighth-grade class in which students will be determining the pH of a variety of alkaline, acidic, and neutral substances. Before meeting with the class, which of the following is it most important that the teacher do to maintain a safe learning environment for the laboratory activity?

   A. review the reactions that occur between the chemicals being investigated

   B. make sure electrical devices are removed from work areas

   C. review procedures for handling the chemicals being investigated

   D. develop a list of responsible students to be in charge of handling materials

8. A scientist has a balance and a ruler. In order to determine the magnitude of the unbalanced force acting on an object as it falls, which of the following will the scientist need in addition to the balance and the ruler?

   A. a timer

   B. a graduated cylinder

   C. a protractor

   D. a spring scale

9. Scientists conducted a study of 5000 men over the age of 50 years. The participants filled out a questionnaire about various health issues. Based on the data, the researchers found that those participants who ate a high-fiber diet reported 25% fewer incidents of heart attacks. The scientists concluded that a high-fiber diet prevents heart attacks. The validity of this conclusion is questionable primarily because:

   A. there is no explanation of the mechanism by which high-fiber diets prevent heart attacks.

   B. the research does not show a correlation between high-fiber diets and a lower incidence of heart attacks.

   C. there is no evidence in other studies linking high-fiber diets to the prevention of heart attacks.

   D. the research does not demonstrate a causal relationship between high-fiber diets and a lowered incidence of heart attacks.

10. Professional scientific journals would be most likely to reject an article for publication in which of the following situations?

    A. The results contradict the findings of previous investigations.

    B. The research is not based on the analysis of quantitative data.

    C. The article lacks information about the methods used in the study.

    D. The results are not accompanied by an explanatory theory.

11. A climatologist collected daily air temperature readings from a remote site for a period of one year. Due to limitations in the recording equipment, all readings above 100°F were recorded as being equal to 100°F. Which of the following measures would be *least* likely to be affected by this limitation?

    A. the mean of the recorded daily temperatures

    B. the median of the recorded daily temperatures

    C. the mode of the recorded daily temperatures

    D. the range of the recorded daily temperatures

12. **Use the chart below to answer the question that follows.**

Cell Replication Phase Tally Chart					
	Number of Cells Counted				Percent of Total Cells Counted
	Field 1	Field 2	Field 3	Total	
Interphase	5	3	2	10	
Prophase	2	4	4	10	
Metaphase	3	1	6	10	
Anaphase	9	8	7	24	
Telophase	7	9	3	19	
Total Cells Counted					100%

A biologist uses the chart shown above to calculate the percentage of cells in a sample that are in each of the five phases of replication. The sample is examined on a microscope slide that is divided into three fields. The number of cells in each phase has been entered into the chart and the totals have been calculated. What value should go in the last column of the Telophase row?

A. 14%

B. 26%

C. 33%

D. 37%

13. Which of the following scientists is most likely to use a procedure to determine the amount of carbon-14 in a sample of organic matter?

    A. a biologist establishing the metabolic rate of an animal

    B. a paleontologist estimating when a dinosaur fossil formed

    C. a botanist calculating the age of a living tree

    D. an archaeologist ascertaining how long ago a fire pit was used

14. Which of the following plays the most significant role in the general public's support and appreciation of science?

    A. politicians and civil servants who understand the value of expensive research projects that may have limited short-term benefits

    B. a business community willing to fund research as a way to improve competitiveness

    C. primary and secondary schools that provide students with a broad understanding of the topics and issues related to the sciences

    D. a university system that promotes the integration of pure research and technological applications

15. An astronomer who is determining the composition of a newly discovered star would use a device that:

    A. magnifies an image using a system of multiple lenses.

    B. analyzes the frequency of absorbed or emitted light.

    C. determines the direction and velocity of an object.

    D. calculates the half-life of radioactive elements.

16. **Use the information below to answer the question that follows.**

- A star uses up its nuclear fuel over millions of years.
- A mountain slowly erodes.
- A bottle of ammonia is opened and the molecules spread throughout a room.
- A dead tree falls down and decays.

Which of the following scientific principles is illustrated by the four phenomena described above?

A. chaos

B. feedback

C. entropy

D. equilibrium

17. Which of the following best summarizes a fundamental concept of the cell theory?

A. Cells break down complex molecules to produce energy.

B. Living organisms are composed of one or more cells.

C. Cells are able to regulate their internal environment.

D. Living organisms rely on specialized cells to maintain health.

18. The central vacuole typical of many plant cells serves a function that is distinct from the function of the small vacuoles found in animal cells. Which of the following describes this distinct function in plant cells?

A. maintaining hydrostatic pressure

B. storing energy-rich compounds produced in the cell

C. treating waste from the cytoplasm

D. breaking down carbohydrates into simple sugars

19. The passage of ions and polar molecules in and out of a cell is regulated by:

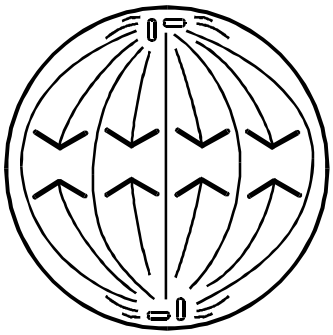
A. the opening and closing of vacuoles adjacent to the membrane.

B. the diffusion gradients between the inside and outside of the membrane.

C. the selective permeability of the membrane's phospholipid bilayer.

D. the carbohydrates that are attached to the membrane's outer surface.

20. **Use the diagram below to answer the question that follows.**



In the diagram above, genetic material is attached to spindle fibers following the breakdown of the nuclear membrane. The stage depicted in this diagram is characteristic of which of the following?

A. crossing over during mitosis

B. separation of sister chromatids during mitosis

C. nondisjunction during meiosis

D. independent assortment of genes during meiosis

21. Which of the following is an example of an organism attempting to maintain homeostasis?

A. A butterfly larva eats plants that make it toxic to predators.

B. An animal seeks a secure site in which to hibernate for the winter.

C. A human sweats on a hot day to lower internal body temperature.

D. A migratory bird returns to its nesting place each year.

22. Animals known as ruminants, such as cows and sheep, have complex digestive systems divided into several different chambers. The ruminant digestive system is adapted to:

A. allow the animal to feed continuously over an extended period before digesting the food that was consumed.

B. synthesize all the animal's protein requirements from simple carbohydrates.

C. extract sufficient water to meet daily needs solely from the vegetable matter that the animal consumes.

D. use microbial action to break down and extract nutrients from hard-to-digest substances such as cellulose.

23. Which of the following best describes the part of a plant's root system where most cell division occurs?

    A. the region just beneath the protective cap of cells at the root tip

    B. the central column of cells that runs the length of the root's interior

    C. the region between the root and the stem just below the ground surface

    D. the outermost layer of cells on the outside of root hairs

24. For most organisms, the energy required for their metabolic activities is generated during which of the following chemical processes?

    A. the breakdown of glucose molecules

    B. the synthesis of lipid molecules

    C. the breakdown of protein molecules

    D. the synthesis of glycogen molecules

25. The primary role of messenger RNA in animal cells is to:

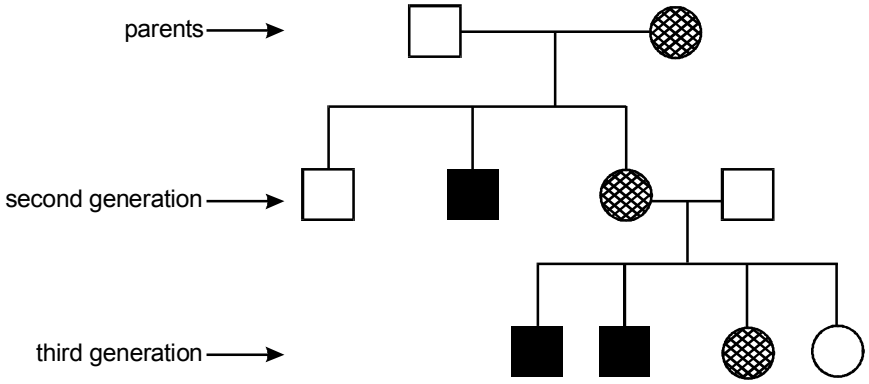
    A. match an amino acid to its proper location during the synthesis of a protein molecule.

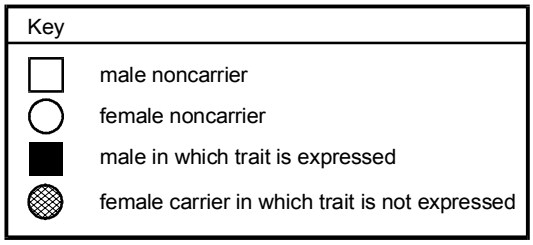
    B. produce the enzymes needed to break the bonds between two complementary strands of DNA.

    C. transfer the information needed to build protein chains from DNA in the nucleus to the ribosomes.

    D. serve as a template for the manufacture of new DNA strands within the cell nucleus.

26. **Use the pedigree chart below to answer the question that follows.**





Color blindness in humans is a condition in which an individual cannot perceive certain colors. The pedigree chart above shows the incidence of the condition in three generations of a family. The pattern of inheritance for color blindness illustrated in the chart results from the fact that the condition is:

A. caused by a dominant gene that masks normal vision.

B. linked to the X chromosome.

C. caused by environmental factors that alter the genome.

D. carried on the Y chromosome.

27. In living organisms a sequence of three nucleotide bases, called a codon, codes for the synthesis of a single amino acid. In some cases, codons composed of different sequences of nucleotide bases can produce the same amino acid. A significant consequence of this redundancy is that:

    A. mutations that produce a different sequence of nucleotides in the codon are less likely to negatively affect the functioning of a gene.

    B. mutation rates of codons are greatly increased when genetic material is exposed to high-energy radiation.

    C. three different nucleotide bases are sufficient to create coded instructions for the full diversity of living organisms.

    D. distinct amino acids and proteins are found in different types of organisms.

28. Which of the following describes how gene replication occurs in a eukaryotic cell prior to cell division?

    A. Strands of messenger RNA transcribed from DNA form complementary pairs.

    B. Nucleotide base pairs are added onto two separated strands of DNA.

    C. Chromosomes separate into two strands of RNA during the early phases of meiosis.

    D. DNA polymerase attaches an amino acid to a new strand of DNA.

29. A population of zebras lives on a savanna. Over millions of years, environmental conditions vary only slightly. Under these conditions, natural selection would most likely affect the population in which of the following ways?

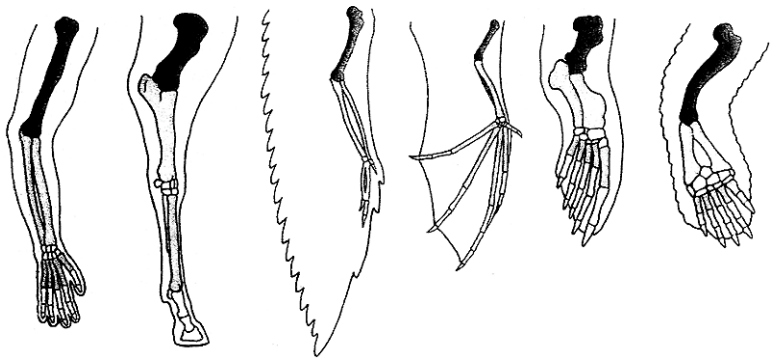
    A. The level of genetic variation within the population will increase significantly.

    B. The number of nonadaptive traits within the population will decrease gradually.

    C. The number of individuals in the population will increase substantially.

    D. The mutation rate within the population will decrease considerably.

30. **Use the diagram below to answer the question that follows.**



The similarity of design in the mammalian appendages shown above is most likely the result of which of the following?

A. common ancestry

B. geographic isolation

C. directional selection

D. evolutionary convergence

31. Which of the following pieces of information provides the strongest evidence that two different species share a common ancestor?

A. Their habitats and ecological niches are similar.

B. Their mating behaviors and rearing practices are similar.

C. Their appendages and organs are similar in function.

D. Their genetic material and proteins are similar in structure.

32. In some species of ground birds, such as peacocks and pheasants, the males have conspicuous markings and behaviors that are useful in attracting mates. Even though such conspicuous sexual characteristics also attract the attention of predators, these types of characteristics have evolved in many species. The evolutionary development of these characteristics can best be explained by the fact that:

    A. the development of sexual differences between the male and female of a species is hard to reverse once it has begun.

    B. the brightly colored males are better able to draw the attention of predators away from females and offspring.

    C. the development of these sexual characteristics is accompanied by a heightened awareness of nearby predators.

    D. the successful attraction of mates is more important for the long-term survival of the species than is the longevity of individual males.

33. Irrigation used over a long period of time has which of the following important consequences for the soils in desert and grassland ecosystems?

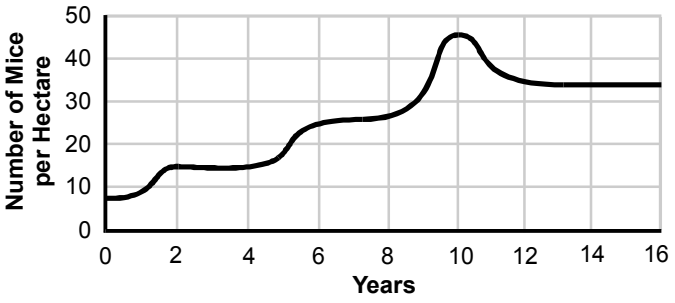
    A. increase of fungal pathogens below the soil surface

    B. accumulation of salts in the upper soil horizons

    C. depletion of natural soil micro-organisms

    D. erosion and consequent loss of topsoil

34. **Use the graph below to answer the question that follows.**



The above graph illustrates change over time in a population of nonnative mice accidentally introduced to the forest ecosystem of a small island. According to the curve on the graph, the ecosystem's carrying capacity for the mouse population is approximately:

A. 10 mice per hectare.

B. 20 mice per hectare.

C. 35 mice per hectare.

D. 45 mice per hectare.

35. The most common factor limiting plant growth in terrestrial ecosystems is the level of:

A. moisture in the soil.

B. carbonates in the soil.

C. nitrogen in the atmosphere.

D. carbon dioxide in the atmosphere.

36. Which of the following statements about competition between organisms is most generally true?

A. Resource partitioning is more characteristic of animal species than of plant species.

B. Competition between members of the same species is more intense than competition between members of different species.

C. Native species typically push out nonnative species when resources are not sufficient for both.

D. Two species that occupy the same niche are more likely to compete than species that are adapted to different niches.

37. The strength of an atom's attraction to the shared electrons in a bond, called electronegativity, affects the polarity of the compound formed by the two elements. The polarity of the covalent bonds in a compound would typically be greatest between elements that are:

A. adjacent to each other in the same row of the periodic table.

B. farthest from each other in the same row of the periodic table.

C. adjacent to each other in the same column of the periodic table.

D. farthest from each other in the same column of the periodic table.

38. **Use the balanced chemical equation below to answer the question that follows.**

$2KNO_3(s) \longrightarrow 2KNO_2(s) + O_2(g)$

The chemical equation above represents the decomposition of potassium nitrate. If six moles of potassium nitrate are reduced during the reaction, how many moles of gaseous oxygen are released?

A. 1 mole

B. 2 moles

C. 3 moles

D. 6 moles

39. Which of the following statements describes the chemical makeup of a saltwater solution?

A. Individual sodium and chloride ions are uniformly distributed among the water molecules.

B. Individual molecules of sodium chloride are uniformly distributed among the water molecules.

C. Clusters of sodium chloride molecules are surrounded by water molecules.

D. Clusters of sodium and chloride crystals are surrounded by water molecules.

40. The atomic number of an element specifies which of the following quantities?

A. the combined number of protons and neutrons in the atom

B. the number of protons in the atom

C. the combined number of protons and electrons in the atom

D. the number of neutrons in the atom

41. Albert Einstein's famous equation $E = mc^2$ led to a reexamination of which of the following scientific concepts?

A. the Bohr model of the atom

B. the law of conservation of matter

C. the distinction between waves and particles

D. the relationship between electricity and magnetism

42. **Use the table below to answer the question that follows.**

Reactants	Observations
P and Q	turns red after 3 hours
P and R	no change
Q and R	no change
P, Q, and R	turns red after 2 minutes

Reactants P, Q, and R are colorless liquids. The table above shows the results of combining them in various ways. Which of the following is the most likely explanation for the observations in the table?

A. R acts as a catalyst in the reaction between P and Q.

B. R reacts with the combined product of P and Q.

C. P acts as a catalyst in the reaction between Q and R.

D. P reacts with the combined product of Q and R.

43. Saltwater fish employ various mechanisms to counteract osmotic pressure due to the fact that their body fluids have a lower salinity than the very salty water of their marine environment. Without such mechanisms, the saltwater fish would be in danger of:

    A. absorbing too much water into their tissues.

    B. losing too much water from their tissues.

    C. absorbing too many minerals into their tissues.

    D. losing too many minerals from their tissues.

44. A rechargeable cordless telephone handset feels warm to the touch after sitting in its charger for a while. Which of the following best explains why the rechargeable battery in the handset warms up as it is charged?

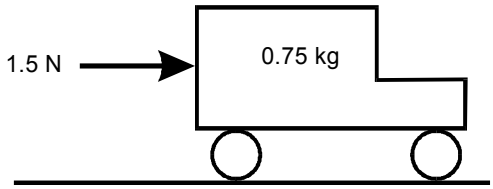
    A. Heat is generated within the battery due to inefficient transformation of electrical energy into chemical potential energy.

    B. Increased electric current in the wiring excites and heats the surrounding molecules.

    C. Heat is generated by the battery as high-energy chemical bonds are formed during the process of charging.

    D. Electric currents produce electromagnetic radiation, which can be felt in the form of heat.

45. **Use the diagram below to answer the question that follows.**



The 0.75 kg toy truck depicted above is being pushed with a constant force of 1.5 N. What is the toy truck's acceleration as it is being pushed?

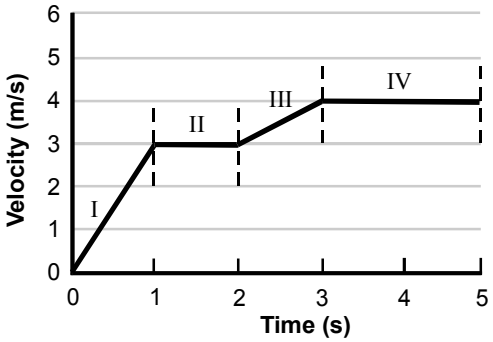
A. 0.5 m/s^2

B. 1.0 m/s^2

C. 2.0 m/s^2

D. 5.0 m/s^2

46. **Use the graph below to answer the question that follows.**



The graph above records the velocity of a toy car over a 5-second period. During which time interval is the toy car's acceleration the greatest?

A. I

B. II

C. III

D. IV

47. A spaceship travels in an orbit around Earth. Occasionally, the spaceship fires rocket engines to adjust its course. Which of the following statements best describes how the rocket engines are able to affect the spaceship's course?

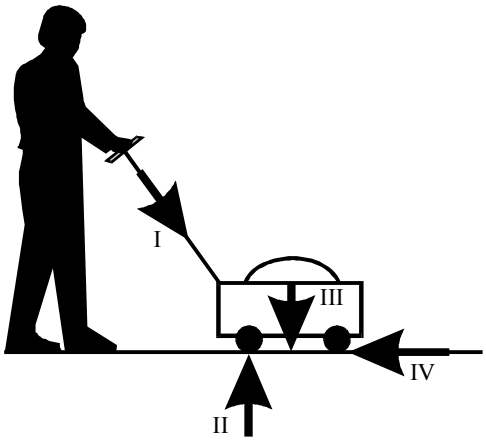
A. Hot gases from the engines push off against the thin air of the atmosphere below and propel the spaceship.

B. When chemical potential energy is released during combustion, air molecules are pulled into the engines, pushing the spaceship forward.

C. Concentrated heat energy is emitted from the rocket engines, increasing the pressure behind the spaceship and moving it forward.

D. When the engines force hot gases away from the spaceship, the gases exert an equal and opposite force on the engines.

48. **Use the diagram below to answer the question that follows.**



The diagram above illustrates some of the forces acting on a lawnmower being pushed at a constant speed. Which of the following vectors in the diagram represents the normal force?

A. I

B. II

C. III

D. IV

49. Wind power is used to rotate a turbine that then rotates loops of wire located between the north and south poles of a magnet. The rotating loops of wire are in contact with terminals of a battery where energy is then stored in the form of:

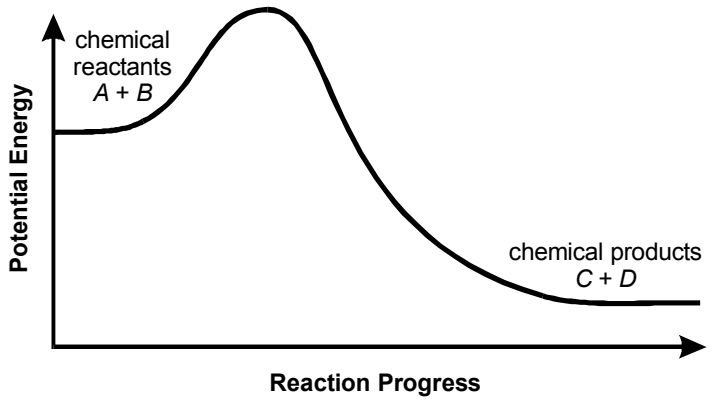
A. solar energy.

B. chemical energy.

C. thermal energy.

D. mechanical energy.

50. **Use the diagram below to answer the question that follows.**



The diagram above shows the potential energy of reactants and products as reactants *A* and *B* are mixed to produce products *C* and *D*. The higher potential energy of the reactants as compared to the products indicates that:

A. heat energy will be absorbed during the reaction.

B. chemical energy will increase as the products form.

C. heat energy will be released during the reaction.

D. kinetic energy will decrease as the reactants combine.

51. As the temperature of a gas increases, the density of the gas will decrease if it is allowed to expand. This property of gases is most directly involved in which of the following?

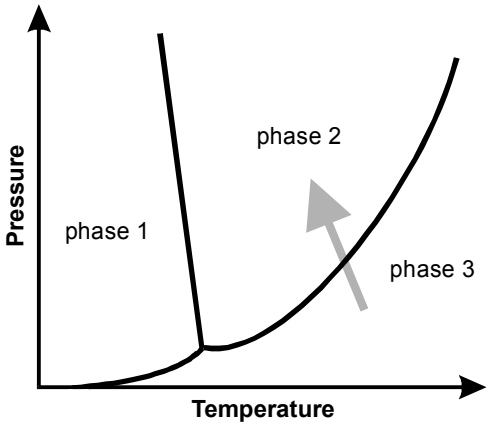
A. convection currents in the atmosphere that occur on warm days

B. condensation of water vapor from moist air on cool nights

C. evaporation of water vapor from lake surfaces on hot days

D. sublimation of water vapor from snow fields on cold dry days

52. **Use the water phase-change diagram below to answer the question that follows.**



Which of the following processes is represented by the gray arrow in the water phase-change diagram above?

A. melting

B. freezing

C. evaporation

D. condensation

53. Which of the following characteristics of an acoustic wave relates to its loudness?

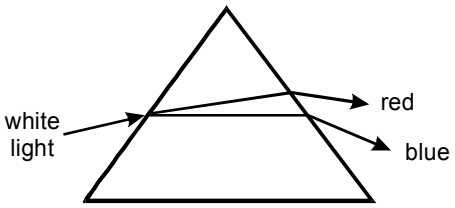
A. the period of wavelengths

B. the magnitude of pressure variations

C. the rate of vibrations

D. the velocity of propagation

54. **Use the diagram below to answer the question that follows.**



Which of the following physical phenomena occurs when light rays pass through a prism as shown in the diagram above?

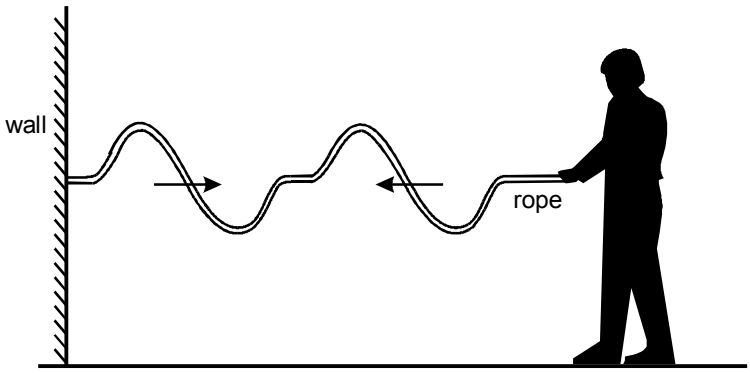
A. reflection

B. superposition

C. dispersion

D. absorption

55. **Use the diagram below to answer the question that follows.**



A person sends a transverse wave along a rope that is attached to a wall, as shown in the diagram above. The wave rebounds from the wall and begins to travel back along the rope in the opposite direction. The person sends a second wave along the rope. Which of the following properties of the waves will increase when the two waves interfere constructively?

A. velocity

B. frequency

C. amplitude

D. wavelength

56. A stone dropped in a pond creates a series of surface waves that propagate away from the point of impact in expanding concentric circles. Each circle represents the crest of a wave and between adjacent wave crests is a trough. Which of the following measurements gives the amplitude of one of the waves generated by the dropped stone?

    A. half of the horizontal distance between the tops of two adjacent crests

    B. half of the vertical distance between the top of a crest and the bottom of an adjacent trough

    C. the total horizontal distance between the tops of two adjacent crests

    D. the total vertical distance between the top of a crest and the bottom of an adjacent trough

57. A sheet of paper is placed on top of a bar magnet. Iron filings are spread onto the sheet of paper, and they move until they are aligned along magnetic field lines. Which of the following principles best explains this phenomenon?

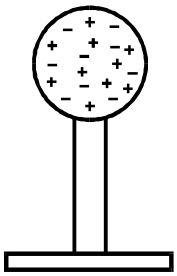
    A. The filings are natural permanent magnets.

    B. The magnetic field induces an electric current in the filings.

    C. The magnetic field ionizes the filings.

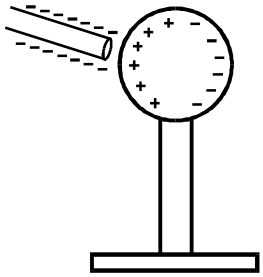
    D. The filings are magnetized by the magnetic field.

58. **Use the diagram below to answer the question that follows.**

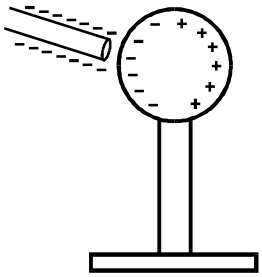


A metal ball with a net charge of zero is mounted on an insulated stand as shown in the diagram above. Which of the following diagrams best represents the charge distribution that develops when a negatively charged rod is brought near the metal ball?

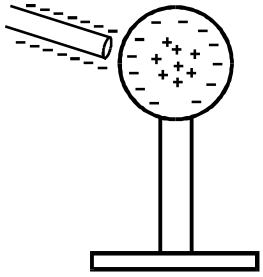
A.



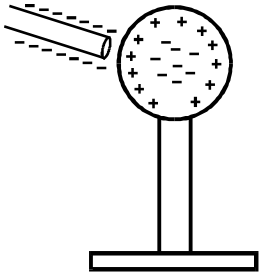
B.



C.



D.



59. Which of the following pieces of copper wire in a closed electric circuit has the *lowest* electrical resistance?

A. a piece with a large diameter and a long length

B. a piece with a small diameter and a long length

C. a piece with a large diameter and a short length

D. a piece with a small diameter and a short length

60. Charged particles from outer space, known as cosmic rays, would be very harmful to life on Earth if they reached Earth's surface at the same intensity as they have in space. Which of the following best describes the mechanism that protects Earth's surface from the full intensity of these charged particles?

A. Frictional heating causes the charged particles to burn up as they enter Earth's upper atmosphere.

B. The density of Earth's lower atmosphere reflects most of the charged particles back into space.

C. Chemical reactions with gases in Earth's atmosphere neutralize the electric charge of the particles.

D. The magnetic field generated by Earth deflects the charged particles along the magnetic field lines.

61. A geologist is trying to identify a rock and suspects that it is metamorphic. Which of the following characteristics of the rock would support the geologist's suspicion?

A. interlocking minerals with some foliation

B. aggregate of discrete particles formed in layers

C. glassy surface with no crystalline structure

D. fine-grained texture with fossil fragments

62. During the early 1900s, Alfred Wegener first proposed the theory of continental drift. Which of the following pieces of evidence did Wegener use to support this theory?

A. the location of volcanoes around the Pacific Ocean basin

B. mountain building on the continental margins

C. the similarity of plant fossils on different continents

D. faulting of geologic formations caused by earthquakes

63. Which of the following best describes the mechanism that scientists believe is the source of Earth's magnetic field?

A. Earth's orbit passes through a stream of charged particles emitted by the sun, producing a fluctuating magnetic field.

B. A current of charged particles moves around Earth's outer core, generating a magnetic field that varies over time.

C. A large quantity of charged particles in Earth's core produces a permanent magnetic field.

D. Iron-rich magma in the mantle and crust contains charged particles that generate a fixed magnetic field as Earth revolves.

64. The Triassic Chinle formation in Arizona is known for a variety of cycad fossils. These fossils would be most directly useful for providing information about which of the following subjects?

A. the ancient environment of the region

B. the precise age of the rock formation that contains the cycads

C. the location of the North American tectonic plate at that time

D. the relationship between cycads and insect pollinators

65. Which of the following processes is primarily responsible for initiating the formation of soils in mountainous regions?

A. the erosion and deposition of sediments

B. the chemical and mechanical weathering of rock

C. the decay of matter by fungi and bacteria

D. the movement of land as it is uplifted and subsides

66. Which of the following features is formed when two tectonic plates of different densities converge?

A. an oceanic ridge

B. a transform fault

C. a rift valley

D. a deep-sea trench

67. Rocks formed from previously existing rocks that have been modified by temperature, pressure, and mechanical stress are called:

A. igneous rocks.

B. sedimentary rocks.

C. metamorphic rocks.

D. basaltic rocks.

68. Primary and secondary seismic waves arrive at a seismological station. To determine the distance of the earthquake from the station, it is necessary to determine the difference in the waves':

    A. horizontal or vertical displacements.

    B. times of arrival.

    C. wavelengths.

    D. frequencies.

69. Approximately 3% of the water on Earth is freshwater. Most of this freshwater is found in:

    A. the atmosphere.

    B. lakes and ponds.

    C. groundwater.

    D. ice caps and glaciers.

70. Which of the following best describes an energy change that occurs as water evaporates from a pond on a warm day?

    A. The water molecules located on the surface are pulled into the gaseous phase by air molecules, increasing the total kinetic energy of the air.

    B. Faster-moving water molecules break free from the water's surface, reducing the average kinetic energy of the water.

    C. The average kinetic energy of the air is lower than that of the water, causing water molecules to move into the lower energy state.

    D. Slower-moving water molecules on the surface are absorbed by the atmosphere, decreasing the average kinetic energy of the overlying air.

71. Large sections of the west coasts of North and South America have cold near-shore waters as a result of the upwelling of water from the deep ocean. The primary cause of the upwelling of cold water in these regions is:

    A. the movement of water away from the coast due to prevailing wind patterns.

    B. the rapid evaporation of surface water caused by solar heating.

    C. the reduction in density of deep-ocean water caused by the respiration of microorganisms.

    D. the steep offshore topography that forces deep water currents upward.

72. The flow of ocean surface currents are affected by several factors, one of which is the Coriolis force. The primary effect that the Coriolis force has on ocean surface currents is to:

A. cause the currents to curve from a straight path.

B. decrease the speed of the currents relative to adjacent ocean waters or land masses.

C. cause the currents to expand as they enter cool waters.

D. increase the friction acting on the currents where they come in contact with the ocean floor or land areas.

73. Information about which of the following weather phenomena would be most useful in predicting whether the skies will change from clear to cloudy?

A. wind speed

B. relative humidity

C. barometric pressure

D. temperature

74. Average annual temperatures vary significantly throughout Arizona. Which of the following is the primary factor responsible for this variability in average annual temperatures?

A. the range in elevation in different parts of the state

B. the extent of the rain shadows that exist on the leeward sides of some mountains

C. the intense radiational cooling that occurs in some locations in the state

D. the extreme changes in wind direction that occur over the course of the year

Read the passage below; then answer the two questions that follow.

During the spring and early summer in Arizona, the weather is normally dry. By mid-July, however, moist winds from the south become more common, as do the occasional afternoon thunderstorms and showers. Climatologists refer to this as a monsoon climate pattern.

75. The passage above describes an annual change in Arizona's prevailing weather conditions between the dry season and the monsoon season. Which of the following changes in the atmosphere is primarily responsible for this annual change?

    A. Heating of the interior south-western United States produces low atmospheric pressure that draws in moisture from the Pacific Ocean and the Gulf of Mexico.

    B. A southward shift in the position of the jet stream brings Pacific Ocean moisture over the Sierra Nevada range into Nevada, Arizona, and New Mexico.

    C. High pressure associated with the cold waters of the northern Pacific Ocean increases the flow of moist air from the Northwest.

    D. The melting and subsequent evaporation of snow cover in the mountains puts more water vapor into the upper atmosphere.

76. Which of the following factors is most likely to trigger the formation of thunderstorms over Arizona when the monsoon-like conditions described in the passage have developed?

    A. extreme changes between day and night temperatures

    B. high winds triggered by the rapid passage of warm fronts

    C. convection currents produced by solar heating of Earth's surface

    D. rapid descent of cool air masses from the mountains into valleys

77. The moon orbits Earth about every 28 days, and yet lunar eclipses occur much less frequently than this. This is primarily because:

A. the plane of the moon's orbit around Earth is tilted relative to the plane of Earth's orbit around the sun.

B. the speed of Earth's orbit around the sun is greater than the moon's orbital speed around Earth.

C. the tilt of Earth's axis relative to the sun changes regularly as Earth orbits the sun.

D. the distance from Earth to the sun is greater than the distance from Earth to the moon.

78. The planet Venus has been called the morning star because it appears in the east around sunrise. It has also been called the evening star because it appears in the west around sunset. The timing of Venus's appearance at dawn and dusk is most directly related to which of the following characteristics of Venus?

A. The plane of Venus's orbit is tilted relative to the plane of the orbit of Earth.

B. Venus is one of the brightest objects in the sky.

C. Venus has a slower rotation time than any other planet in the solar system.

D. The orbit of Venus is between the sun and the orbit of Earth.

79. Which of the following statements best explains why astronomical telescopes designed to receive radio signals often have larger surface areas than optical telescopes?

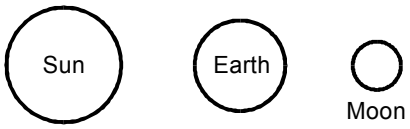
A. Radio waves are refracted less than visible light as they pass through Earth's atmosphere.

B. Radio waves have less energy and a lower frequency than visible light.

C. Interference from Earth-based sources is greater for radio waves than for visible light.

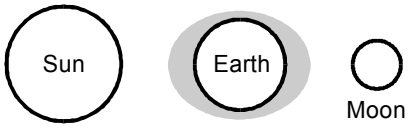
D. Light waves travel in straight lines, while radio waves do not.

80. **Use the diagram below to answer the question that follows.**

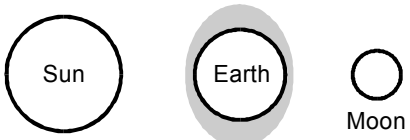


When the sun, Earth, and the moon are in the relative positions indicated in the diagram above, which of the following diagrams best represents the bulges produced by high tides on the surface of Earth?

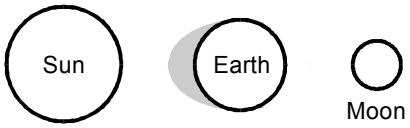
A.



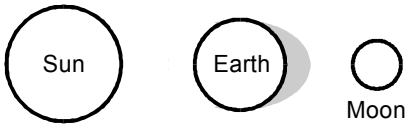
B.



C.



D.



Below are the directions for the Middle Grades General Science performance assignment.

DIRECTIONS FOR THE PERFORMANCE ASSIGNMENT

This section of the test consists of a performance assignment. **The assignment can be found on the next page.** You are asked to prepare a written response of approximately 2–3 pages on the assigned topic. You should use your time to plan, write, review, and edit your response for the assignment.

Read the assignment carefully before you begin to work. Think about how you will organize your response. You may use any blank space in this test booklet to make notes, write an outline, or otherwise prepare your response. **However, your score will be based solely on the version of your response written in Written Response Booklet B.**

As a whole, your response must demonstrate an understanding of the knowledge and skills of the field. In your response to the assignment, you are expected to demonstrate the depth of your understanding of the content area through your ability to apply your knowledge and skills rather than merely to recite factual information.

Your response will be evaluated based on the following criteria.

- **PURPOSE:** the extent to which the response achieves the purpose of the assignment
- **SUBJECT MATTER KNOWLEDGE:** accuracy and appropriateness in the application of subject matter knowledge
- **SUPPORT:** quality and relevance of supporting details
- **RATIONALE:** soundness of argument and degree of understanding of the subject matter

The performance assignment is intended to assess subject knowledge content and skills, not writing ability. However, your response must be communicated clearly enough to permit scorers to make a valid evaluation of your response according to the criteria listed above. Your response should be written for an audience of educators in this field. The final version of your response should conform to the conventions of edited American English. This should be your original work, written in your own words, and not copied or paraphrased from some other work.

Be sure to write about the assigned topic. Please write legibly. You may not use any reference materials during the test. Remember to review your work and make any changes you think will improve your response.

Below is the scoring scale for the Middle Grades General Science performance assignment.

SUBJECT TESTS—PERFORMANCE ASSIGNMENT SCORING SCALE

Score Point	Score Point Description
4	**The "4" response reflects a thorough knowledge and understanding of the subject matter.** • The purpose of the assignment is fully achieved. • There is a substantial, accurate, and appropriate application of subject matter knowledge. • The supporting evidence is sound; there are high-quality, relevant examples. • The response reflects an ably reasoned, comprehensive understanding of the topic.
3	**The "3" response reflects an adequate knowledge and understanding of the subject matter.** • The purpose of the assignment is largely achieved. • There is a generally accurate and appropriate application of subject matter knowledge. • The supporting evidence is adequate; there are some acceptable, relevant examples. • The response reflects an adequately reasoned understanding of the topic.
2	**The "2" response reflects a limited knowledge and understanding of the subject matter.** • The purpose of the assignment is partially achieved. • There is a limited, possibly inaccurate or inappropriate, application of subject matter knowledge. • The supporting evidence is limited; there are few relevant examples. • The response reflects a limited, poorly reasoned understanding of the topic.
1	**The "1" response reflects a weak knowledge and understanding of the subject matter.** • The purpose of the assignment is not achieved. • There is little or no appropriate or accurate application of subject matter knowledge. • The supporting evidence, if present, is weak; there are few or no relevant examples. • The response reflects little or no reasoning about or understanding of the topic.

U	**The response is unrelated to the assigned topic, illegible, primarily in a language other than English, not of sufficient length to score, or merely a repetition of the assignment.**
B	**There is no response to the assignment.**

Practice Performance Assignment

81. **Read the information below; then complete the exercise that follows.**

A middle school science teacher is planning an activity related to heat and temperature. The teacher will have students submerge heated nails in water in insulated cups and measure the resulting increase in water temperature. Students will investigate the relationship between the number of nails submerged and the temperature increase. Write an essay describing how you would design a laboratory activity appropriate for this investigation. In your essay:

- describe an appropriate experimental design for the activity, including the use of controls, variables, and safety considerations;
- describe the type of data that will need to be collected and how the data should be collected;
- describe how the data should be presented (e.g., graphs, tables, charts) and why that method of presentation would be effective; and
- explain how the experiment would help illustrate the relationships among internal energy, heat transfer, and temperature change.

Sample Performance Assignment Response: Score Point 4

This experiment will measure the flow of energy from hot nails to colder water. To properly carry out the experiment all but one of the variables involved must be held constant, while the remaining variable is systematically changed.

Materials needed for this experiment include three insulated cups containing equal volumes of water, a large beaker for boiling water, six identical large iron nails of known mass, three thermometers, tongs for transferring the heated nails from the boiling water to the insulated cups, eye and hand protection, and an electric hot plate.

The experimental procedure is as follows. First, a beaker of water is heated to boiling on the hot plate. The six nails are then submerged in the boiling water until they reach thermal equilibrium with the water (about five minutes). While the nails are being heated to 100°C in the beaker, fill three insulated cups with the same volume of water at room temperature. There must be enough water in the cups to fully cover the nails. Record the volume and initial temperature of water and confirm that these variables are equal in the three insulated cups. Place thermometers in each of the three cups. Using the tongs, carefully transfer three of the nails from the beaker to one of the insulated cups and record the temperature of the water in the cup every 30 seconds until the temperature of the water stops increasing and begins to fall. Repeat this procedure with the remaining two cups, but instead transfer two nails to the second cup and one nail to the third cup. Measure the peak temperature of the water in the second and third cups the same way it was measured in the first cup.

To verify the experimental results it is a good idea to complete a second trial, using the exact same procedure. Small differences should be expected, but if the data gathered during the second trial are very different from the data from the first trial, it is important to determine what may have gone wrong and carry out a third trial.

The volume and initial temperature of the water in the cups are controlled variables, as are the mass of the individual nails and their temperature after being heated to 100°C. An experimental variable is the different number of nails used in each of the three different cups.

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Sample Performance Assignment Response: Score Point 4 *(continued)*

The use of a hot plate and boiling water make the experiment potentially dangerous, requiring eye protection and attention to potential fire hazards and skin burns.

Data that need to be collected for the experiment include:

- The temperature of the water in the insulated cups recorded at 30 second intervals following the submergence of the nails.
- The mass of the water in the insulated cups. This can be calculated from the volume of water (1 mL of water = 1 g of water).
- The mass of the nails should be determined with a scale and recorded.

The three sets of data from the three different insulated cups can be effectively represented with a bar graph containing three bars. The peak temperatures that the water in each of the three cups reach would be indicated by the height of each of the three bars (the temperature would be on the *Y* axis). The results of the second trial can be graphed on the same graph by adding three additional bars that are shaded. This would make it easy to compare the results of the first and second trials. A line graph showing the temperature change in the water every 30 seconds would also present the data in a way that would illustrate the rate that the water temperature in each of the three cups changed. The temperature change in each cup would be graphed separately, but all three cups could be represented by different colored lines on one graph for easy comparison.

This experiment shows how differences in the internal energies of two adjacent substances (i.e., the water and the nails) result in the transfer of energy between the two substances. This transfer of energy is what people experience as heat when they touch something hot. Although the initial temperature of the nails is the same, the final temperature of the water in the cup with more nails will be higher than it will be in the cups with fewer nails, showing that the heat exchanged from the nails to the water depends on both the temperature of the nails and the number (or total mass) of the nails. These results would help illustrate the relationship between heat, temperature, and internal energy.

ANSWER KEY

Field 39: Middle Grades General Science

Question Number	Correct Response	Objective
1.	**A**	Understand the history of science and the nature of scientific inquiry.
2.	**A**	Understand the history of science and the nature of scientific inquiry.
3.	**D**	Understand the history of science and the nature of scientific inquiry.
4.	**C**	Understand the history of science and the nature of scientific inquiry.
5.	**A**	Understand the principles and procedures of scientific investigations.
6.	**B**	Understand the principles and procedures of scientific investigations.
7.	**C**	Understand the principles and procedures of scientific investigations.
8.	**A**	Understand the principles and procedures of scientific investigations.
9.	**D**	Understand processes of analyzing and communicating the results of scientific investigations.
10.	**C**	Understand processes of analyzing and communicating the results of scientific investigations.
11.	**B**	Understand processes of analyzing and communicating the results of scientific investigations.
12.	**B**	Understand processes of analyzing and communicating the results of scientific investigations.
13.	**D**	Understand the relationship of science to contemporary, historical, technological, and societal issues.
14.	**C**	Understand the relationship of science to contemporary, historical, technological, and societal issues.
15.	**B**	Understand the relationship of science to contemporary, historical, technological, and societal issues.
16.	**C**	Understand the relationship of science to contemporary, historical, technological, and societal issues.
17.	**B**	Understand cell theory and the structure and function of cells.
18.	**A**	Understand cell theory and the structure and function of cells.
19.	**C**	Understand cell theory and the structure and function of cells.
20.	**B**	Understand cell theory and the structure and function of cells.
21.	**C**	Understand the characteristics and life processes of living organisms.
22.	**D**	Understand the characteristics and life processes of living organisms.
23.	**A**	Understand the characteristics and life processes of living organisms.
24.	**A**	Understand the characteristics and life processes of living organisms.
25.	**C**	Understand the basic principles of the inheritance of biological traits and the uses of genetic engineering.
26.	**B**	Understand the basic principles of the inheritance of biological traits and the uses of genetic engineering.

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Question Number	Correct Response	Objective
27.	**A**	Understand the basic principles of the inheritance of biological traits and the uses of genetic engineering.
28.	**B**	Understand the basic principles of the inheritance of biological traits and the uses of genetic engineering.
29.	**B**	Understand the processes of natural selection and adaptation.
30.	**A**	Understand the processes of natural selection and adaptation.
31.	**D**	Understand the processes of natural selection and adaptation.
32.	**D**	Understand the processes of natural selection and adaptation.
33.	**B**	Understand the interactions among populations, communities, ecosystems, and biomes.
34.	**C**	Understand the interactions among populations, communities, ecosystems, and biomes.
35.	**A**	Understand the interactions among populations, communities, ecosystems, and biomes.
36.	**D**	Understand the interactions among populations, communities, ecosystems, and biomes.
37.	**B**	Understand the structure and properties of matter.
38.	**C**	Understand the structure and properties of matter.
39.	**A**	Understand the structure and properties of matter.
40.	**B**	Understand the structure and properties of matter.
41.	**B**	Understand physical, chemical, and nuclear changes that occur in matter.
42.	**A**	Understand physical, chemical, and nuclear changes that occur in matter.
43.	**B**	Understand physical, chemical, and nuclear changes that occur in matter.
44.	**A**	Understand physical, chemical, and nuclear changes that occur in matter.
45.	**C**	Understand relationships among force, mass, and motion.
46.	**A**	Understand relationships among force, mass, and motion.
47.	**D**	Understand relationships among force, mass, and motion.
48.	**B**	Understand relationships among force, mass, and motion.
49.	**B**	Understand different forms of energy and energy transformations.
50.	**C**	Understand different forms of energy and energy transformations.
51.	**A**	Understand different forms of energy and energy transformations.
52.	**D**	Understand different forms of energy and energy transformations.
53.	**B**	Understand the characteristics of waves and the behavior of sound and light.
54.	**C**	Understand the characteristics of waves and the behavior of sound and light.
55.	**C**	Understand the characteristics of waves and the behavior of sound and light.
56.	**B**	Understand the characteristics of waves and the behavior of sound and light.
57.	**D**	Understand the principles of electricity, magnetism, and electromagnetism.
58.	**A**	Understand the principles of electricity, magnetism, and electromagnetism.

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Question Number	Correct Response	Objective
59.	**C**	Understand the principles of electricity, magnetism, and electromagnetism.
60.	**D**	Understand the principles of electricity, magnetism, and electromagnetism.
61.	**A**	Understand the geologic composition, structure, and history of Earth.
62.	**C**	Understand the geologic composition, structure, and history of Earth.
63.	**B**	Understand the geologic composition, structure, and history of Earth.
64.	**A**	Understand the geologic composition, structure, and history of Earth.
65.	**B**	Understand the geologic processes acting on Earth.
66.	**D**	Understand the geologic processes acting on Earth.
67.	**C**	Understand the geologic processes acting on Earth.
68.	**B**	Understand the geologic processes acting on Earth.
69.	**D**	Understand the characteristics and properties of the hydrosphere.
70.	**B**	Understand the characteristics and properties of the hydrosphere.
71.	**A**	Understand the characteristics and properties of the hydrosphere.
72.	**A**	Understand the characteristics and properties of the hydrosphere.
73.	**C**	Understand Earth's weather, climate, and atmosphere.
74.	**A**	Understand Earth's weather, climate, and atmosphere.
75.	**A**	Understand Earth's weather, climate, and atmosphere.
76.	**C**	Understand Earth's weather, climate, and atmosphere.
77.	**A**	Understand the relationships between objects in the solar system and the characteristics of the solar system and universe.
78.	**D**	Understand the relationships between objects in the solar system and the characteristics of the solar system and universe.
79.	**B**	Understand the relationships between objects in the solar system and the characteristics of the solar system and universe.
80.	**A**	Understand the relationships between objects in the solar system and the characteristics of the solar system and universe.

PREPARATION RESOURCES

Field 39: Middle Grades General Science

The resources listed below may help you prepare for the AEPA® test in this field. These preparation resources have been identified by content experts in the field to provide up-to-date information that relates to the field in general. You may wish to use current issues or editions to obtain information on specific topics for study and review.

Online Sources:

Arizona Collaborative for Excellence in the Preparation of Teachers. Arizona State University.
http://acept.la.asu.edu

Arizona Department of Education. Content Standards: *Science Standard Articulated by Grade Level.*
http://www.azed.gov/standards/science/articulated.asp

Arizona Department of Education. Science Resource Page.
http://www.azed.gov/SBTL/sdi/science.asp

The Biology Project: The University of Arizona
http://www.biology.arizona.edu

Center for Science Teaching and Learning. Northern Arizona University.
http://www4.nau.edu/cstl/cstl/index.html

Coconino County Math and Science Teachers Resources
http://co.coconino.az.us/schools.aspx?id=534

Project 2061, Benchmarks for Science Literacy On-line: American Association for the Advancement of Science.
http://project2061.org

MadSci Library
http://www.madsci.org/libs/index.html

Journals:

Science & Children, National Science Teachers Association.

Science Scope, National Science Teachers Association.

The Science Teacher, National Science Teachers Association.

Science News, Science Service.

Instructor, Scholastic.

Other Sources:

Arny, T. T. *Explorations: An Introduction to Astronomy,* 4th Ed. Boston: McGraw-Hill, 2005.

Campbell, N. A., & Reece, J. B. *Biology,* 7th ed. Upper Saddle River, NJ: Prentice Hall, 2005.

Chang, R. *General Chemistry: The Essential Concepts,* 4th Ed. New York: McGraw-Hill, 2005.

Cunningham, W. P., Cunningham, M.A., & Saigo, B. W. *Environmental Science: A Global Concern,* 9th ed. Dubuque, IA: McGraw Hill, 2005.

Hewitt, P. G., Suchocki, J., & Hewitt, L. *Conceptual Physical Science,* 3rd ed. Boston: Pearson Addison-Wesley, 2004.

Hewitt, P. G. *Conceptual Physics: The High School Physics Program.* Upper Saddle River, NJ: Prentice Hall, 2002.

National Committee on Science Education Standards and Assessment, National Research Council. *National Science Education Standards* 1996.

Shipman, J., Wilson, J., & Todd, A. *An Introduction to Physical Science,* 11th ed. Boston: Houghton Mifflin, 2006.

Starr, C., & Taggart, R. *Biology: The Unity and Diversity of Life,* 11th ed. New York: Wadsworth, 2005.

Tarbuck, E. J., Lutgens, F. K., & Tasa, D. *Earth Science,* 11th ed. Upper Saddle River, NJ: Prentice Hall, 2006.

Trefil, J., & Hazen, R. M. *The Sciences: An Integrated Approach,* 4th ed. New York: John Wiley, 2003.