



Preparation Manual Science 4–8 (116)

Overview and Exam Framework

Reference Materials

Sample Selected-Response Questions

Sample Selected-Response Answers and Rationales

Preparation Manual

Section 3: Overview and Exam Framework Science 4–8 (116)

Exam Overview

Exam Name	Science 4–8
Exam Code	116
Time	5 hours
Number of Questions	100 selected-response questions
Format	Computer-administered test (CAT)

The TExES Science 4–8 (116) exam is designed to assess whether an examinee has the requisite knowledge and skills that an entry-level educator in this field in Texas public schools must possess. The 100 selected-response questions are based on the Science 4–8 exam framework and cover grades 4–8. The exam may contain questions that do not count toward the score. Your final scaled score will be based only on scored questions.

The Standards

Standard I

The science teacher manages classroom, field and laboratory activities to ensure the safety of all students and the ethical care and treatment of organisms and specimens.

Standard II

The science teacher understands the correct use of tools, materials, equipment and technologies.

Standard III

The science teacher understands the process of scientific inquiry and its role in science instruction.

Standard IV

The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.

Standard V

The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.

Standard VI

The science teacher understands the history and nature of science.

Standard VII

The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.

Standard VIII

The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.

Standard IX

The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in life science.

Standard X

The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in Earth and space science.

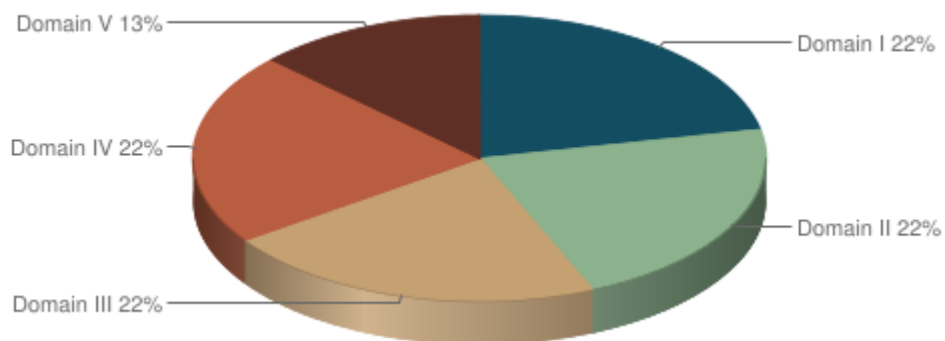
Standard XI

The science teacher knows unifying concepts and processes that are common to all sciences.

Domains and Competencies

Domain	Domain Title	Approx. Percentage of Exam*	Standards Assessed
I	Scientific Inquiry and Processes	22%	Science I–III, VI–VII, XI
II	Physical Science	22%	Science VIII
III	Life Science	22%	Science IX
IV	Earth and Space Science	22%	Science X
V	Science Learning, Instruction and Assessment	13%	Science: III–V

*Percentages do not add up to 100 due to rounding.



The content covered by this exam is organized into broad areas of content called **domains**. Each domain covers one or more of the educator standards for this field. Within each domain, the content is further defined by a set of **competencies**. Each competency is composed of two major parts:

- The **competency statement**, which broadly defines what an entry-level educator in this field in Texas public schools should know and be able to do.
- The **descriptive statements**, which describe in greater detail the knowledge and skills eligible for testing.

Domain I—Scientific Inquiry and Processes

Competency 001—The teacher understands how to manage learning activities to ensure the safety of all students.

The beginning teacher:

- Understands safety regulations and guidelines for science facilities and science instruction.
- Knows procedures for and sources of information regarding the appropriate handling, use, conservation, disposal, recycling, care and maintenance of chemicals, materials, specimens and equipment.
- Knows procedures for the safe handling and ethical care and treatment of organisms and specimens.

Competency 002—The teacher understands the correct use of tools, materials, equipment and technologies.

The beginning teacher:

- Selects and safely uses appropriate tools, technologies, materials and equipment needed for instructional activities.
- Understands concepts of precision, accuracy and error with regard to reading and recording numerical data from a scientific instrument.
- Understands how to gather, organize, display and communicate data in a variety of ways (e.g., construct charts, tables, graphs, maps, satellite images, diagrams, written reports, oral presentations).
- Understands the international system of measurement (i.e., metric system) and performs unit conversions within measurement systems.

Competency 003—The teacher understands the process of scientific inquiry and the history and nature of science.

The beginning teacher:

- Understands the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis).
- Understands how to design, conduct and communicate the results of a variety of scientific investigations.
- Understands the historical development of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge.
- Understands the roles that logical reasoning, verifiable empirical evidence, prediction and peer review play in the process of generating and evaluating scientific knowledge.
- Understands principles of scientific ethics.
- Develops, analyzes and evaluates different explanations for a given scientific result.

- G. Demonstrates an understanding of potential sources of error in inquiry-based investigation and the use of multiple trials to increase reliability.
- H. Demonstrates an understanding of how to communicate and defend the results of an inquiry-based investigation.

Competency 004—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

The beginning teacher:

- A. Understands that decisions about the use of science are based on factors such as ethical standards, economics and personal and societal needs.
- B. Applies scientific principles and the theory of probability to analyze the advantages of, disadvantages of or alternatives to a given decision or course of action.
- C. Applies scientific principles and processes to analyze factors that influence personal choices concerning fitness and health, including physiological and psychological effects and risks associated with the use of substances and substance abuse.
- D. Understands concepts, characteristics and issues related to changes in populations and human population growth.
- E. Understands the types and uses of natural resources (renewable, non-renewable) and the effects of human consumption on the renewal and depletion of resources.
- F. Understands the role science can play in helping resolve personal, societal and global challenges (e.g., recycling, evaluating product claims, alternative energy sources).

Competency 005—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

The beginning teacher:

- A. Understands how the following concepts and processes provide a unifying explanatory framework across the science disciplines: systems, order and organization; evidence, models and explanation; change, constancy and measurements; evolution and equilibrium; and form and function.
- B. Demonstrates an understanding of how patterns in observations and data can be used to make explanations and predictions.
- C. Analyzes interactions and interrelationships between systems and subsystems.
- D. Applies unifying concepts to explore similarities in a variety of natural phenomena.
- E. Understands how properties and patterns of systems can be described in terms of space, time, energy and matter.
- F. Understands how change and constancy occur in systems.
- G. Understands the complementary nature of form and function in a given system.
- H. Understands how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical).

Domain II—Physical Science

Competency 006—The teacher understands forces and motion and their relationships.

The beginning teacher:

- A. Demonstrates an understanding of properties of universal forces (e.g., gravitational, electrical, magnetic).
- B. Understands how to measure, graph and describe changes in motion using concepts of displacement, speed, velocity and acceleration.
- C. Understands the vector nature of force.
- D. Identifies the forces acting on an object and applies Newton's laws to describe the motion of an object.
- E. Analyzes the relationship between force and motion in a variety of situations (e.g., simple machines, blood flow, geologic processes).

Competency 007—The teacher understands physical properties of and changes in matter.

The beginning teacher:

- A. Describes the physical properties of substances (e.g., density, boiling point, melting point, solubility, thermal and electrical conductivity, luster, malleability).
- B. Describes the physical properties and molecular structure of solids, liquids and gases.
- C. Describes the relationship between the molecular structure of materials (e.g., metals, crystals, polymers) and their physical properties.
- D. Relates the physical properties of an element to its placement in the periodic table, including metals, non-metals and metalloids.
- E. Distinguishes between physical and chemical changes in matter.
- F. Applies knowledge of physical properties of and changes in matter to processes and situations that occur in life and earth/space science.

Competency 008—The teacher understands chemical properties of and changes in matter.

The beginning teacher:

- A. Describes the structure and components of the atom.
- B. Distinguishes among elements, compounds, mixtures and solutions and describes their properties.
- C. Relates the chemical properties of an element to its placement in the periodic table.
- D. Describes chemical bonds and chemical formulas.
- E. Analyzes chemical reactions and their associated chemical equations.

- F. Explains the importance of a variety of chemical reactions that occur in daily life (e.g., rusting, burning of fossil fuels, photosynthesis, cell respiration, chemical batteries, digestion of food).
- G. Understands applications of chemical properties of matter in physical, life and earth/space science and technology (e.g., materials science, biochemistry, transportation, medicine, telecommunications).

Competency 009—The teacher understands energy and interactions between matter and energy.

The beginning teacher:

- A. Describes concepts of work, power and potential and kinetic energy.
- B. Understands the concept of heat energy and the difference between heat and temperature.
- C. Understands the principles of electricity and magnetism and their applications (e.g., electric circuits, motors, audio speakers, nerve impulses, lightning).
- D. Applies knowledge of properties of light (e.g., reflection, refraction, dispersion) to describe the function of optical systems and phenomena (e.g., camera, microscope, rainbow, eye).
- E. Demonstrates an understanding of the properties, production and transmission of sound.
- F. Applies knowledge of properties and characteristics of waves (e.g., wavelength, frequency, interference) to describe a variety of waves (e.g., water, electromagnetic, sound).

Competency 010—The teacher understands energy transformations and the conservation of matter and energy.

The beginning teacher:

- A. Describes the processes that generate energy in the sun and other stars.
- B. Applies the law of conservation of matter to analyze a variety of situations (e.g., the water cycle, food chains, decomposition, balancing chemical equations).
- C. Describes sources of electrical energy and processes of energy transformation for human uses (e.g., fossil fuels, solar panels, hydroelectric plants).
- D. Understands exothermic and endothermic chemical reactions and their applications (e.g., hot and cold packs, energy content of food).
- E. Applies knowledge of the transfer of energy in a variety of situations (e.g., the production of heat, light, sound and magnetic effects by electrical energy; the process of photosynthesis; weather processes; food webs; food/energy pyramids).
- F. Applies the law of conservation of energy to analyze a variety of physical phenomena (e.g., specific heat, nuclear reactions, efficiency of simple machines, collisions).
- G. Understands applications of energy transformations and the conservation of matter and energy in life and earth/space science.

Domain III—Life Science

Competency 011—The teacher understands the structure and function of living things.

The beginning teacher:

- A. Describes characteristics of organisms from the major taxonomic groups, including domains and kingdoms and uses these characteristics to construct a dichotomous key.
- B. Analyzes how structure complements function in cells.
- C. Analyzes how structure complements function in tissues, organs, organ systems and organisms including both plants and animals.
- D. Identifies human body systems and describes their functions (e.g., digestive, circulatory).
- E. Describes how organisms, including producers, consumers and decomposers obtain and use energy and matter.
- F. Applies chemical principles to describe the structure and function of the basic chemical components (e.g., proteins, carbohydrates, lipids, nucleic acids) of living things and distinguishes between organic and inorganic compounds.

Competency 012—The teacher understands reproduction and the mechanisms of heredity.

The beginning teacher:

- A. Compares and contrasts sexual and asexual reproduction.
- B. Understands the organization of hereditary material (e.g., DNA, genes, chromosomes).
- C. Describes how an inherited trait can be determined by one or many genes and how more than one trait can be influenced by a single gene.
- D. Distinguishes between dominant and recessive traits and predicts the probable outcomes of genetic combinations.
- E. Evaluates the influence of environmental and genetic factors on the traits of an organism.
- F. Describes current applications of genetic research (e.g., related to cloning, reproduction, health, industry, agriculture).

Competency 013—The teacher understands adaptations of organisms and the theory of evolution.

The beginning teacher:

- A. Describes similarities and differences among various types of organisms and methods of classifying organisms (e.g., presence of a nucleus determines if a cell is prokaryotic and eukaryotic).
- B. Describes traits in a population or species that enhance its survival and reproductive success.
- C. Describes how populations and species change through time.
- D. Applies knowledge of the mechanisms and processes of biological evolution (e.g., variation, mutation, environmental factors, natural selection).
- E. Describes evidence that supports the theory of evolution of life on Earth.

Competency 014—The teacher understands regulatory mechanisms and behavior.

The beginning teacher:

- A. Describes how organisms respond to internal and external stimuli.
- B. Applies knowledge of structures and physiological processes that maintain stable internal conditions.
- C. Demonstrates an understanding of feedback mechanisms that allow organisms to maintain stable internal conditions.
- D. Understands how evolutionary history affects behavior.

Competency 015—The teacher understands the relationships between organisms and the environment.

The beginning teacher:

- A. Understands the levels of organization within an ecosystem (organism, population, community) and identifies the abiotic and biotic components of an ecosystem.
- B. Analyzes the interrelationships (food chains, food webs) among producers, consumers and decomposers in an ecosystem.
- C. Identifies factors that influence the size and growth of populations in an ecosystem.
- D. Analyzes adaptive characteristics that result in a population's or species' unique niche in an ecosystem.
- E. Describes and analyzes energy flow through various types of ecosystems.
- F. Knows how populations and species modify and affect ecosystems (e.g., succession), and how biodiversity affects the sustainability of ecosystems.

Domain IV—Earth and Space Science

Competency 016—The teacher understands the structure and function of Earth systems.

The beginning teacher:

- A. Understands the layers and surface features (landforms) of Earth and uses topographic maps and satellite imaging to analyze constructive and destructive processes that produce geologic change.
- B. Understands the form and function of surface and subsurface water (e.g., watershed, aquifer).
- C. Applies knowledge of the composition and structure of the atmosphere and its properties, including characteristics that allow life to exist.
- D. Demonstrates an understanding of the interactions that occur among the biosphere, geosphere, hydrosphere and atmosphere.
- E. Applies knowledge of how human activity and natural processes, both gradual and catastrophic, can alter earth and ocean systems.

- F. Identifies the sources of energy (e.g., solar, geothermal, wind, hydroelectric, biofuels) in earth systems and describes mechanisms of energy transfer (e.g., conduction, convection, radiation).

Competency 017—The teacher understands cycles in Earth systems.

The beginning teacher:

- A. Understands the rock cycle and how rocks, minerals, fossil fuels and soils are formed.
- B. Understands the water cycle and its relationship to weather processes; how the sun and the ocean interact in the water cycle.
- C. Understands the nutrient (e.g., carbon, nitrogen) cycle and its relationship to earth systems.
- D. Applies knowledge of how human and natural processes affect earth systems.
- E. Understands the dynamic interactions that occur among the various cycles in the biosphere, geosphere, hydrosphere and atmosphere.

Competency 018—The teacher understands the role of energy in weather and climate.

The beginning teacher:

- A. Understands the elements of weather (e.g., humidity, wind speed, pressure, temperature) and how they are measured.
- B. Compares and contrasts weather and climate.
- C. Analyzes weather charts and data to make weather predictions based on local and global patterns.
- D. Applies knowledge of how transfers of energy among earth systems affect weather and climate.
- E. Analyzes how Earth's position, orientation and surface features affect weather and climate.

Competency 019—The teacher understands the characteristics of the solar system and the universe.

The beginning teacher:

- A. Understands the properties and characteristics of celestial objects.
- B. Applies knowledge of the earth-moon-sun system and the interactions among them (e.g., seasons, lunar phases, eclipses).
- C. Identifies properties of the components of the solar system, including systems that allow life to exist.
- D. Recognizes characteristics of stars, nebulae and galaxies and their distribution in the universe.
- E. Demonstrates an understanding of scientific theories of the origin of the universe.

Competency 020—The teacher understands the history of the Earth system.

The beginning teacher:

- A. Understands the scope of the geologic time scale and its relationship to geologic processes.

- B. Demonstrates an understanding of theories about the earth's origin and geologic history.
- C. Demonstrates an understanding of how tectonic forces have shaped landforms over time.
- D. Understands the formation of fossils and the importance of the fossil record in explaining the earth's history.

Domain V—Science Learning, Instruction and Assessment

Competency 021—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

The beginning teacher:

- A. Understands how the developmental characteristics, prior knowledge and experience and attitudes of students influence science learning.
- B. Selects and adapts science curricula, content, instructional materials and activities to meet the interests, knowledge, understanding, abilities, experiences and needs of all students, including English-language learners.
- C. Understands how to use situations from students' daily lives to develop instructional materials that investigate how science can be used to make informed decisions.
- D. Understands common misconceptions in science and effective ways to address these misconceptions.
- E. Understands the rationale for the use of active learning and inquiry processes for students.
- F. Understands questioning strategies designed to elicit higher-level thinking and how to use them to move students from concrete to more abstract understanding.
- G. Understands the importance of planning activities that are inclusive and accommodate the needs of all students.
- H. Understands how to sequence learning activities in a way that allows students to build upon their prior knowledge and challenges them to expand their understanding of science.

Competency 022—The teacher understands the process of scientific inquiry and its role in science instruction.

The beginning teacher:

- A. Plans and implements instruction that provides opportunities for all students to engage in nonexperimental and experimental inquiry investigations.
- B. Focuses inquiry-based instruction on questions and issues relevant to students and uses strategies to assist students with generating, refining and focusing scientific questions and hypotheses.
- C. Instructs students in the safe and proper use of a variety of grade-appropriate tools, equipment, resources, technology and techniques to access, gather, store, retrieve, organize and analyze data.
- D. Knows how to guide and manage students in making systematic observations and measurements.


- E. Knows how to promote the use of critical-thinking skills, logical reasoning and scientific problem solving to reach conclusions based on evidence.
- F. Knows how to teach students to develop, analyze and evaluate different explanations for a given scientific result.
- G. Knows how to teach students to demonstrate an understanding of potential sources of error in inquiry-based investigation.
- H. Knows how to teach students to demonstrate an understanding of how to communicate and defend the results of an inquiry-based investigation.

Competency 023—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

The beginning teacher:

- A. Understands the relationships among science curriculum, assessment and instruction and bases instruction on information gathered through assessment of students' strengths and needs.
- B. Understands the importance of monitoring and assessing students' understanding of science concepts and skills on an ongoing basis.
- C. Understands the importance of carefully selecting or designing formative and summative assessments for the specific decisions they are intended to inform.
- D. Selects or designs and administers a variety of appropriate assessment methods (e.g., performance assessment, self-assessment, formal/informal, formative/summative) to monitor student understanding and progress.
- E. Uses formal and informal assessments of student performance and products (e.g., projects, lab journals, rubrics, portfolios, student profiles, checklists) to evaluate student participation in and understanding of the inquiry process.
- F. Understands the importance of sharing evaluation criteria and assessment results with students.

This reference material will also be available to you during the exam. To access it, click on the

 icon located in the lower-left corner of the screen.

PERIODIC TABLE OF THE ELEMENTS

1 1A												18 8A					
1 H 1.01	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	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 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	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 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

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)

Preparation Manual

Section 4: Sample Selected-Response Questions Science 4–8 (116)

This section presents some sample exam questions for you to review as part of your preparation for the exam. To demonstrate how each competency may be assessed, sample questions are accompanied by the competency that they measure. While studying, you may wish to read the competency before and after you consider each sample question. Please note that the competency statements do not appear on the actual exam.

For each sample exam question, there is a correct answer and a rationale for each answer option. The sample questions are included to illustrate the formats and types of questions you will see on the exam; however, your performance on the sample questions should not be viewed as a predictor of your performance on the actual exam.

The following reference materials will be available to you during the exam:

- Periodic Table (see page 13)

Domain I—Scientific Inquiry and Processes

Competency 001—The teacher understands how to manage learning activities to ensure the safety of all students.

1. Of the following substances, which is safest to use in a fourth-grade lab activity?

- A. Lemon juice
- B. Dilute hydrochloric acid
- C. Laundry chlorine bleach
- D. Ammonia-based window cleaner

Answer _____

Competency 002—The teacher understands the correct use of tools, materials, equipment and technologies.

2. Of the following, which represents the largest distance?

- A. One nanometer
- B. One micrometer
- C. One light-year
- D. One astronomical unit

Answer _____

3. Of the following, which is most appropriate to use to measure atmospheric pressure?

- A. Geiger counter

- B. Barometer
- C. Graduated cylinder
- D. Ohmmeter

Answer _____

Competency 003—The teacher understands the process of scientific inquiry and the history and nature of science.

4. Which THREE of the following are typically done before conducting an experiment in a middle school classroom?
- A. Making observations
 - B. Developing a hypothesis
 - C. Designing an experiment
 - D. Drawing conclusions

Answer _____

5. Which of the following statements about the historical development of science is true?
- A. The major concepts of molecular biology were developed by the ancient Greeks.
 - B. Prior to the development of x-ray technology, little was known about the human skeleton and muscles.
 - C. Although the first lightbulb was developed in the late nineteenth century, many concepts about electricity were known for centuries prior to 1800.
 - D. The concept of atoms was first developed in the twentieth century.

Answer _____

Competency 004—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

6. Carbon dioxide is produced and emitted into the atmosphere during the operation of which of the following?
- A. Combustion engine
 - B. Solar panel
 - C. Wind turbine
 - D. Nuclear reactor

Answer _____

7. Ozone in the stratosphere is most closely associated with which of the following?
- A. Water pollution
 - B. The production of acid rain
 - C. Respiratory health issues

- D. Protection from ultraviolet radiation

Answer _____

Competency 005—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

8. The concept of force is involved in the explanation of which TWO of the following?

- A. Plate tectonics
- B. The color of leaves
- C. Gas pressure
- D. The mass of an atom

Answer _____

Domain II—Physical Science

Competency 006—The teacher understands forces and motion and their relationships.

9. The tendency of an object to resist a change in its motion is known as

- A. gravitational force.
- B. inertia.
- C. linear momentum.
- D. velocity.

Answer _____

10. When a magnetic compass is brought near a wire carrying electric current, the compass needle is deflected from magnetic north. When the current is switched off, the needle points toward magnetic north. Which of the following best explains why this occurs?

- A. Good electrical conductors are also permanent magnetics.
- B. Moving electric charges produce magnetic fields.
- C. The poles of a permanent magnet are regions of excess electric charge.
- D. The magnetic field of the compass needle magnetizes the wire while the current is on.

Answer _____

Competency 007—The teacher understands physical properties of and changes in matter.

11. Which of the following phase transitions involves the release of heat?

- A. Evaporation of liquid water

- B. Sublimation of ice
- C. Melting of ice
- D. Condensation of water vapor

Answer _____

12. Which of the following is the number of neutrons in an atom of chlorine-37 (mass number 37)?

- A. 17
- B. 18
- C. 19
- D. 20

Answer _____

Competency 008—The teacher understands chemical properties of and changes in matter.

13. Which of the following is best classified as a Brønsted-Lowry base?

- A. $\text{Ca}(\text{OH})_2$
- B. H_2SO_4
- C. NaCl
- D. CCl_4

Answer _____

14. In which of the following compounds is the bonding covalent?

- A. KCl
- B. MgBr_2
- C. CH_4
- D. Na_2O

Answer _____

Competency 009—The teacher understands energy and interactions between matter and energy.

15. Pitch is a characteristic of sound that is related to which of the following properties of a sound wave?

- A. Speed
- B. Frequency
- C. Intensity

D. Amplitude

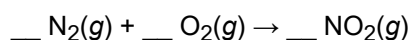
Answer _____

Competency 010—The teacher understands energy transformations and the conservation of matter and energy.

16. Which of the following energy transformations occurs in an alkaline battery while a flashlight is operating?

- A. Mechanical energy to chemical energy
- B. Electrical energy to mechanical energy
- C. Chemical energy to electrical energy
- D. Chemical energy to mechanical energy

Answer _____



17. If the chemical equation above is balanced using the smallest possible whole-number coefficients, the coefficient for $\text{NO}_2(g)$ would be which of the following?

- A. 1
- B. 2
- C. 3
- D. 4

Answer _____

Domain III—Life Science

Competency 011—The teacher understands the structure and function of living things.

18. Which of the following groups of organisms have gills at some point in their life after birth?

- A. Reptiles
- B. Amphibians
- C. Birds
- D. Earthworms

Answer _____

19. In animals, which of the following cell structures is most directly associated with the production of chemical energy?

- A. Plasma membrane
- B. Nucleus

C. Golgi apparatus

D. Mitochondrion

Answer _____

Competency 012—The teacher understands reproduction and the mechanisms of heredity.

20. An organism that is homozygous for the dominant allele (SS) of the gene for skin color has green skin color. An individual of the same species that is homozygous for the recessive allele (ss) of the gene for skin color has gray skin color. When a homozygous individual with green skin mates with a heterozygous individual (Ss), which of the following is expected?

A. A 100% probability that the offspring will have green skin

B. A 75% probability that the offspring will have green skin

C. A 50% probability that the offspring will have green skin

D. A 100% probability that the offspring will have gray skin

Answer _____

21. Which of the following is a true statement about nucleic acids?

A. They produce sugar molecules using light energy.

B. They transport materials from one cell to another.

C. They provide a protective barrier between a cell and the environment.

D. They store and transmit genetic information.

Answer _____

Competency 013—The teacher understands adaptations of organisms and the theory of evolution.

22. Which of the following is an example of homologous structures?

A. A human hand and a human foot

B. A wing flap of a sugar glider and a wing flap of a flying squirrel

C. A bat wing and a human arm

D. A butterfly wing and a bird wing

Answer _____

23. Of the following statements, which best describes natural selection?

A. Natural selection is the process by which adaptations acquired by individuals during their lives are passed down to the next generation.

B. Natural selection is the process by which environmental changes cause mutations to occur.

- C. Natural selection is the process by which better-adapted individuals in a population leave more descendants than do less well-adapted individuals.
- D. Natural selection is the process by which one species competes with another species for the same natural resource.

Answer _____

Competency 014—The teacher understands regulatory mechanisms and behavior.

24. Marine birds use salt glands to remove excess salt from the seawater they drink. The maintenance of a balance between water and salt in marine birds is an example of

- A. metabolism.
- B. homeostasis.
- C. translation.
- D. conservation of energy.

Answer _____

Competency 015—The teacher understands the relationships between organisms and the environment.

25. Certain birds that forage for insects on the ground around grazing animals exhibit much greater success in capturing prey than when they forage alone. The observation described is an illustration of which of the following?

- A. Parasitism
- B. Mutualism
- C. Competition
- D. Commensalism

Answer _____

26. Which of the following is a primary producer in a food chain?

- A. Grass
- B. Cow
- C. Sparrow
- D. Fox

Answer _____

Domain IV—Earth and Space Science

Competency 016—The teacher understands the structure and function of Earth systems.

27. Which of the following were formed primarily by glacial activity?

- A. Mountain ranges
- B. Barrier islands
- C. Fjords
- D. Atolls

Answer _____

28. Of the following gases, which is found in highest abundance in the lowest layer of Earth's atmosphere, the troposphere?

- A. Hydrogen
- B. Helium
- C. Carbon dioxide
- D. Water vapor

Answer _____

Competency 017—The teacher understands cycles in Earth systems.

29. Which of the following is an igneous rock?

- A. Slate
- B. Granite
- C. Shale
- D. Limestone

Answer _____

30. Which of the following is a scale of mineral hardness used to help identify minerals?

- A. Fujita
- B. Mohs
- C. Saffir-Simpson
- D. Richter

Answer _____

Competency 018—The teacher understands the role of energy in weather and climate.

31. At a fixed atmospheric pressure, the temperature at which water vapor in the air condenses at the same rate that liquid water evaporates is called the

- A. dew point.
- B. triple point.

- C. relative humidity.
- D. heat index.

Answer _____

32. Wispy, feathery clouds that form at relatively high altitude are called

- A. cumulus clouds.
- B. cumulonimbus clouds.
- C. nimbostratus clouds.
- D. cirrus clouds.

Answer _____

Competency 019—The teacher understands the characteristics of the solar system and the universe.

33. Which of the following is true about objects in our solar system?

- A. The Sun is one of the largest known stars in the universe.
- B. Neptune is farther from the Sun than any of the other planets.
- C. Although Jupiter has the largest diameter of the planets, it has a smaller mass than Earth, since it is composed largely of hydrogen and helium.
- D. Since Mercury is the closest planet to the Sun, all of its surface is always at an extremely high temperature.

Answer _____

34. Of the following, which best describes a white dwarf?

- A. A large asteroid that is almost the size of a planet
- B. A small comet as it approaches the Sun
- C. A late stage in the life cycle of a low-mass star
- D. The precursor to a black hole

Answer _____

Competency 020—The teacher understands the history of the Earth system.

35. Which of the following is true about radiometric dating?

- A. Since the half-life of carbon-14 is 5,730 years, radiocarbon dating methods are limited to about 60,000 years.
- B. Radiometric dating is a relative dating method that infers the age of a fossil by noting the relative position of the rock layer in which it is found.

- C. Radiometric dating is based on measuring current solar output and comparing it to the amount of carbon in plant fossils that was produced by photosynthesis in the past.
- D. Radiometric dating is dangerous, since the researcher is exposed to high doses of radiation.

Answer _____

Domain V—Science Learning, Instruction and Assessment

Competency 021—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

36. Of the following, which would be most helpful in expanding the students' knowledge after a short introductory lesson about forces?

- A. A video showing how various batting styles affect the distance a baseball travels
- B. A teacher demonstration in which forces are applied to several objects
- C. A homework assignment in which students write examples of forces in everyday life
- D. A lab activity in which students slide objects made from various materials down an inclined plane

Answer _____

37. Which of the following student statements is an example of a student misconception about science?

- A. When a net force is continuously applied to an object, it accelerates.
- B. Objects must have a large amount of air in them in order to float.
- C. Not all animals have a heart as part of their circulatory system.
- D. Many chemical compounds are highly insoluble in water.

Answer _____

Competency 022—The teacher understands the process of scientific inquiry and its role in science instruction.

38. Of the following, which best illustrates a student inquiry-based activity?

- A. Students conduct an acid-base titration with vinegar and baking soda after developing a hypothesis about neutralization.
- B. Students write the formulas for some compounds based on the location on the periodic table of the elements in the compound.
- C. Students write down observations as the teacher conducts a demonstration of a combustion reaction.
- D. Students use the Internet to research the causes of the outbreak of a disease that has recently been reported in the news.

Answer _____

39. Students are asked to build model windmills using materials found in the home or classroom. Small generators and electrical connectors are provided by the teacher, as well as fans to simulate wind. Once the models have been built and tested, which of the following questions asked by the teacher would best encourage students to develop hypotheses about ways to improve the energy efficiency of their models?

- A. Is your model energy efficient?
- B. How can you determine the energy efficiency of your model?
- C. How would changing the shape or position of the windmill blades affect the energy efficiency of your model?
- D. How would reducing the number of components used to build your model increase the energy efficiency of your model?

Answer _____

Competency 023—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

40. Giving a written multiple-choice final examination at the end of the school year is an example of

- A. a performance assessment.
- B. a formative assessment.
- C. a summative assessment.
- D. an informal assessment.

Answer _____

Preparation Manual

Section 4: Sample Selected-Response Answers and Rationales Science 4–8 (116)

This section presents some sample exam questions for you to review as part of your preparation for the exam. To demonstrate how each competency may be assessed, sample questions are accompanied by the competency that they measure. While studying, you may wish to read the competency before and after you consider each sample question. Please note that the competency statements do not appear on the actual exam.

For each sample exam question, there is a correct answer and a rationale for each answer option. The sample questions are included to illustrate the formats and types of questions you will see on the exam; however, your performance on the sample questions should not be viewed as a predictor of your performance on the actual exam.

The following reference materials will be available to you during the exam:

- Periodic Table (see page 13)

Domain I—Scientific Inquiry and Processes

Competency 001—The teacher understands how to manage learning activities to ensure the safety of all students.

1. Of the following substances, which is safest to use in a fourth-grade lab activity?

- A. Lemon juice
- B. Dilute hydrochloric acid
- C. Laundry chlorine bleach
- D. Ammonia-based window cleaner

Answer

Option A is correct because lemon juice is relatively safe to use in a fourth-grade lab activity. **Options B, C, and D are incorrect** because dilute hydrochloric acid, laundry chlorine bleach, and ammonia-based window cleaner each cause skin irritation.

Competency 002—The teacher understands the correct use of tools, materials, equipment and technologies.

2. Of the following, which represents the largest distance?

- A. One nanometer
- B. One micrometer
- C. One light-year
- D. One astronomical unit

Answer

Option C is correct because a light-year is equal to the distance that light travels in one year, about 9,460,000,000,000,000 meters. **Options A and B are incorrect** because one nanometer is equal to one billionth of a meter and one micrometer is equal to one millionth of a meter. **Option D is incorrect** because an astronomical unit is approximately equal to 149,600,000,000 meters, which is close to the average distance from Earth to the Sun. The AU is hence much shorter than a light-year.

3. Of the following, which is most appropriate to use to measure atmospheric pressure?

- A. Geiger counter
- B. Barometer
- C. Graduated cylinder
- D. Ohmmeter

Answer

Option B is correct because a barometer is used to measure atmospheric pressure. **Option A is incorrect** because a Geiger counter is used to detect radiation such as alpha particles, beta particles, and gamma rays. **Option C is incorrect** because a graduated cylinder is used to measure the volume of liquids. **Option D is incorrect** because an ohmmeter is used to measure resistance in an electrical circuit.

Competency 003—The teacher understands the process of scientific inquiry and the history and nature of science.

4. Which THREE of the following are typically done before conducting an experiment in a middle school classroom?

- A. Making observations
- B. Developing a hypothesis
- C. Designing an experiment
- D. Drawing conclusions

Answer

Options A, B, and C are correct because before conducting an experiment, a hypothesis should be developed based on observations, and then an experiment should be designed to test the hypothesis. **Option D is incorrect** because conclusions are drawn after the experimental data is analyzed.

5. Which of the following statements about the historical development of science is true?

- A. The major concepts of molecular biology were developed by the ancient Greeks.
- B. Prior to the development of x-ray technology, little was known about the human skeleton and muscles.
- C. Although the first lightbulb was developed in the late nineteenth century, many concepts about electricity were known for centuries prior to 1800.

D. The concept of atoms was first developed in the twentieth century.

Answer

Option C is correct because for centuries prior to 1800 many characteristics of electricity were observed along with the development of concepts to explain or use electricity. In the nineteenth century this continued with the development of many applications including the lightbulb. **Option A is incorrect** because the major concepts of molecular biology were developed in the twentieth century. **Option B is incorrect** because many aspects of the human skeletal and muscular systems were studied thousands of years prior to the development of x-ray technology. **Option D is incorrect** because the earliest known concepts about atoms were developed in India and Greece more than 2,500 years ago.

Competency 004—The teacher understands how science impacts the daily lives of students and interacts with and influences personal and societal decisions.

6. Carbon dioxide is produced and emitted into the atmosphere during the operation of which of the following?

- A. Combustion engine
- B. Solar panel
- C. Wind turbine
- D. Nuclear reactor

Answer

Option A is correct because the combustion reaction in a combustion engine produces carbon dioxide that is typically exhausted to the atmosphere. **Options B, C, and D are incorrect** because solar panels, wind turbines, and nuclear reactors do not produce carbon dioxide as they operate.

7. Ozone in the stratosphere is most closely associated with which of the following?

- A. Water pollution
- B. The production of acid rain
- C. Respiratory health issues
- D. Protection from ultraviolet radiation

Answer

Option D is correct because ozone in the upper atmosphere (stratosphere) absorbs a certain amount of the ultraviolet radiation coming from the Sun and other sources in outer space. **Options A and B are incorrect** because ozone in the stratosphere does not contribute to water pollution or acid rain. **Option C is incorrect** because ozone in the atmosphere near Earth's surface can aggravate respiratory health, but ozone in the stratosphere cannot.

Competency 005—The teacher knows and understands the unifying concepts and processes that are common to all sciences.

8. The concept of force is involved in the explanation of which TWO of the following?

- A. Plate tectonics
- B. The color of leaves
- C. Gas pressure
- D. The mass of an atom

Answer

Options A and C are correct because both plate tectonics and gas pressure involve forces. Plate tectonic forces are evident as plates in Earth's crust move. The pressure of a gas is the force per unit area exerted as a result of the collision of gaseous atoms or molecules with a surface. **Option B is incorrect** because the perceived color of a leaf is the result of several phenomena that are not related to force. **Option D is incorrect** because the mass of an atom is based on the material contained in the atom and not on the force of gravity on that material (weight).

Domain II—Physical Science

Competency 006—The teacher understands forces and motion and their relationships.

9. The tendency of an object to resist a change in its motion is known as

- A. gravitational force.
- B. inertia.
- C. linear momentum.
- D. velocity.

Answer

Option B is correct because the inertia of a body is the tendency of a body to resist a change in its motion. **Option A is incorrect** because the gravitational force is the force that two objects exert on each other. **Option C is incorrect** because linear momentum is the product of the mass and velocity of an object. **Option D is incorrect** because velocity is the speed and direction of an object's motion.

10. When a magnetic compass is brought near a wire carrying electric current, the compass needle is deflected from magnetic north. When the current is switched off, the needle points toward magnetic north. Which of the following best explains why this occurs?

- A. Good electrical conductors are also permanent magnetics.
- B. Moving electric charges produce magnetic fields.
- C. The poles of a permanent magnet are regions of excess electric charge.
- D. The magnetic field of the compass needle magnetizes the wire while the current is on.

Answer

Option B is correct because moving electric charges produce magnetic fields. The compass needle is deflected by that magnetic field when the compass is brought near the wire carrying the electric current. **Option A is incorrect** because the conducting material that the wire is made of is not a permanent magnet. A magnetic field is produced only when electric charge is flowing. **Option C is incorrect** because the poles of permanent magnets, such as the compass needle, are not regions of excess electric charge. **Option D is incorrect** because the wire is not magnetized by the magnetic field of the compass needle.

Competency 007—The teacher understands physical properties of and changes in matter.

11. Which of the following phase transitions involves the release of heat?

- A. Evaporation of liquid water
- B. Sublimation of ice
- C. Melting of ice
- D. Condensation of water vapor

Answer

Option D is correct because during condensation individual gaseous water molecules lose energy as they come together to form liquid water. Hence energy is released during the process. **Options A, B, and C are incorrect** because evaporation, sublimation, and melting are phase transitions that each absorb energy. Liquid water is converted to gas during evaporation, solid ice is converted to gas during sublimation, and solid ice is converted to liquid during melting.

12. Which of the following is the number of neutrons in an atom of chlorine-37 (mass number 37)?

- A. 17
- B. 18
- C. 19
- D. 20

Answer

Option D is correct because there are 20 neutrons in an atom of chlorine-37 (mass number equal to 37). The mass number is equal to the number of protons plus the number of neutrons in an atom. The number of protons in an atom of chlorine is equal to the atomic number, which is 17, and can be found on the periodic table. Hence the number of neutrons in an atom of this isotope of chlorine must be 20 since 17 plus 20 equals 37. **Options A, B, and C are incorrect** because they do not represent the correct number of neutrons in an atom of chlorine-37.

Competency 008—The teacher understands chemical properties of and changes in matter.

13. Which of the following is best classified as a Brønsted-Lowry base?

- A. Ca(OH)_2

- B. H_2SO_4
- C. NaCl
- D. CCl_4

Answer

Option A is correct because $\text{Ca}(\text{OH})_2$ acts as a Brønsted-Lowry base, since the OH^- ions from $\text{Ca}(\text{OH})_2$ accept H^+ ions and form H_2O when $\text{Ca}(\text{OH})_2$ reacts with an acid like HCl . The neutralization reaction is: $\text{Ca}(\text{OH})_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$. **Option B is incorrect** because H_2SO_4 is an acid. **Options C and D are incorrect** because NaCl and CCl_4 are not Brønsted acids or Brønsted bases.

14. In which of the following compounds is the bonding covalent?

- A. KCl
- B. MgBr_2
- C. CH_4
- D. Na_2O

Answer

Option C is correct because in CH_4 molecules the C–H bonds are covalent. **Option A is incorrect** because the compound KCl has ionic bonding between metallic K^+ ions and nonmetallic Cl^- ions. **Option B is incorrect** because the compound MgBr_2 has ionic bonding between metallic Mg^{2+} ions and nonmetallic Br^- ions. **Option D is incorrect** because the compound Na_2O has ionic bonding between metallic Na^+ ions and nonmetallic O^{2-} ions.

Competency 009—The teacher understands energy and interactions between matter and energy.

15. Pitch is a characteristic of sound that is related to which of the following properties of a sound wave?

- A. Speed
- B. Frequency
- C. Intensity
- D. Amplitude

Answer

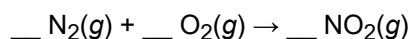
Option B is correct because pitch is a characteristic of sound that is related to the frequency of the sound wave. **Options A, C, and D are incorrect** because pitch is not related to speed, intensity, or amplitude of the sound wave.

Competency 010—The teacher understands energy transformations and the conservation of matter and energy.

16. Which of the following energy transformations occurs in an alkaline battery while a flashlight is operating?
- A. Mechanical energy to chemical energy
 - B. Electrical energy to mechanical energy
 - C. Chemical energy to electrical energy
 - D. Chemical energy to mechanical energy

Answer

Option C is correct because chemical reactions in the alkaline battery produce electrical energy that is used by the flashlight. **Options A, B, and D are incorrect** because they do not represent correct energy transformations that occur in an alkaline battery.



17. If the chemical equation above is balanced using the smallest possible whole-number coefficients, the coefficient for $\text{NO}_2(g)$ would be which of the following?
- A. 1
 - B. 2
 - C. 3
 - D. 4

Answer

Option B is correct because the balanced equation is $\text{N}_2(g) + 2 \text{O}_2(g) \rightarrow 2 \text{NO}_2(g)$. This indicates that the coefficient for NO_2 is 2. Conservation of mass requires that for each element the number of atoms on the product side of the equation be equal to the number of atoms on the reactant side of the equation. **Options A, C, and D are incorrect** because they do not balance the equation using the smallest possible whole-number coefficients.

Domain III—Life Science

Competency 011—The teacher understands the structure and function of living things.

18. Which of the following groups of organisms have gills at some point in their life after birth?
- A. Reptiles
 - B. Amphibians
 - C. Birds
 - D. Earthworms

Answer

Option B is correct because the larval forms of amphibians all live in water and have gills. **Options A, C, and D are incorrect** because reptiles, birds and earthworms do not have gills.

19. In animals, which of the following cell structures is most directly associated with the production of chemical energy?

- A. Plasma membrane
- B. Nucleus
- C. Golgi apparatus
- D. Mitochondrion

Answer

Option D is correct because mitochondria in cells generate most of the cell's supply of ATP, which is used as a source of chemical energy. **Option A is incorrect** because the plasma membrane (or cell membrane) which separates the interior and exterior of the cell has a variety of functions, but none of those include the production of chemical energy. **Option B is incorrect** because a cell's nucleus stores genetic material and is primarily a control center. **Option C is incorrect** because the Golgi apparatus is involved in the processing of some newly synthesized proteins.

Competency 012—The teacher understands reproduction and the mechanisms of heredity.

20. An organism that is homozygous for the dominant allele (SS) of the gene for skin color has green skin color. An individual of the same species that is homozygous for the recessive allele (ss) of the gene for skin color has gray skin color. When a homozygous individual with green skin mates with a heterozygous individual (Ss), which of the following is expected?

- A. A 100% probability that the offspring will have green skin
- B. A 75% probability that the offspring will have green skin
- C. A 50% probability that the offspring will have green skin
- D. A 100% probability that the offspring will have gray skin

Answer

Option A is correct because in complete dominance, a cross between a homozygous individual (SS) and a heterozygous individual (Ss) is predicted to produce offspring with green skin (100%). The possible genotypes of offspring produced by the cross are SS and Ss, both of which have the phenotype of green skin. **Options B and C are incorrect** because 100% of the offspring are predicted to have green skin. **Option D is incorrect** because in order for any of the offspring to have gray skin, each parent must have at least one recessive allele.

21. Which of the following is a true statement about nucleic acids?

- A. They produce sugar molecules using light energy.

- B. They transport materials from one cell to another.
- C. They provide a protective barrier between a cell and the environment.
- D. They store and transmit genetic information.

Answer

Option D is correct because nucleic acids store the genetic information of a cell, and use the information to direct normal cell function and to transmit the information to daughter cells. **Option A is incorrect** because nucleic acids do not produce sugar molecules. **Option B is incorrect** because nucleic acids do not transport materials between cells. **Option C is incorrect** because there are no nucleic acids in the cell membranes and cell walls that protect cells.

Competency 013—The teacher understands adaptations of organisms and the theory of evolution.

22. Which of the following is an example of homologous structures?

- A. A human hand and a human foot
- B. A wing flap of a sugar glider and a wing flap of a flying squirrel
- C. A bat wing and a human arm
- D. A butterfly wing and a bird wing

Answer

Option C is correct because in evolutionary biology a bat wing is homologous to a human arm. Homologous structures are adapted to different purposes as a result of descent with modification from a common ancestor. **Option A is incorrect** because a human hand is not homologous to a human foot. **Options B and D are incorrect** because in evolutionary biology they arose from convergent evolution from different ancestors and are examples of analogous structures.

23. Of the following statements, which best describes natural selection?

- A. Natural selection is the process by which adaptations acquired by individuals during their lives are passed down to the next generation.
- B. Natural selection is the process by which environmental changes cause mutations to occur.
- C. Natural selection is the process by which better-adapted individuals in a population leave more descendants than do less well-adapted individuals.
- D. Natural selection is the process by which one species competes with another species for the same natural resource.

Answer

Option C is correct because in natural selection better-adapted individuals in a population leave more descendants than do less well-adapted individuals. **Option A is incorrect** because the concept that adaptations acquired by individuals during their lives can be passed down to the next generation is not a mechanism of

natural selection but is known as Lamarckism. **Option B is incorrect** because the occurrence of a new mutation is not the equivalent of natural selection. **Option D is incorrect** because species competing for the same natural resource is not a description of natural selection.

Competency 014—The teacher understands regulatory mechanisms and behavior.

24. Marine birds use salt glands to remove excess salt from the seawater they drink. The maintenance of a balance between water and salt in marine birds is an example of

- A. metabolism.
- B. homeostasis.
- C. translation.
- D. conservation of energy.

Answer

Option B is correct because homeostasis is a process that maintains the stability of internal conditions such as the maintenance of a balance between salt and water in a marine bird. **Option A is incorrect** because metabolism is a set of life-sustaining chemical reactions within the cells of organisms. **Option C is incorrect** because translation is the process of producing proteins based on an mRNA template. **Option D is incorrect** because there is a net expenditure of energy in the maintenance of a balance between salt and water in a marine bird.

Competency 015—The teacher understands the relationships between organisms and the environment.

25. Certain birds that forage for insects on the ground around grazing animals exhibit much greater success in capturing prey than when they forage alone. The observation described is an illustration of which of the following?

- A. Parasitism
- B. Mutualism
- C. Competition
- D. Commensalism

Answer

Option D is correct because in commensalism an organism of one species benefits from an organism of another species without affecting the other. **Option A is incorrect** because in parasitism an organism of one species benefits to the detriment of an organism of another species. The birds benefit, but not at the expense of the grazing animals. **Option B is incorrect** because in mutualism interacting organisms of two different species benefit. In this example, there is no indication that the grazing animals benefit from the birds. **Option C is incorrect** because competition involves organisms competing for the same resource. The birds and the grazing animals eat different food.

26. Which of the following is a primary producer in a food chain?

- A. Grass
- B. Cow
- C. Sparrow
- D. Fox

Answer

Option A is correct because grass is a primary producer. Primary producers are the organisms in an ecosystem that produce biomass from inorganic compounds. **Option B is incorrect** because a cow is a primary consumer. **Option C is incorrect** because a sparrow is a primary consumer when it eats plants and a secondary consumer when it eats insects. **Option D is incorrect** because a fox is a secondary consumer.

Domain IV—Earth and Space Science

Competency 016—The teacher understands the structure and function of Earth systems.

27. Which of the following were formed primarily by glacial activity?

- A. Mountain ranges
- B. Barrier islands
- C. Fjords
- D. Atolls

Answer

Option C is correct because fjords (narrow inlets of the sea between steep slopes) were created by glacial erosion. **Option A is incorrect** because mountain ranges were not formed by glacial activity but by several different plate tectonic processes, depending on the particular mountain range (e.g., collision of continental plates or volcanism). **Option B is incorrect** because barrier islands are found along coastlines and are formed by a variety of processes that do not typically include glacial activity (e.g., wave action). **Option D is incorrect** because an atoll is formed when a coral reef grows around a volcanic island, which then disappears.

28. Of the following gases, which is found in highest abundance in the lowest layer of Earth's atmosphere, the troposphere?

- A. Hydrogen
- B. Helium
- C. Carbon dioxide
- D. Water vapor

Answer

Option D is correct because water vapor constitutes approximately 0.3–4.0% of the gases in the troposphere. The amount of water vapor varies, but is more than the amount of hydrogen, helium, and carbon dioxide. **Options A and B are incorrect** because there are only trace amounts of hydrogen and helium in the troposphere. **Option C is incorrect** because carbon dioxide constitutes approximately 0.04% of the gases in the troposphere.

Competency 017—The teacher understands cycles in Earth systems.

29. Which of the following is an igneous rock?

- A. Slate
- B. Granite
- C. Shale
- D. Limestone

Answer

Option B is correct because granite is an igneous rock. **Option A is incorrect** because slate is a metamorphic rock. **Options C and D are incorrect** because shale and limestone are sedimentary rocks.

30. Which of the following is a scale of mineral hardness used to help identify minerals?

- A. Fujita
- B. Mohs
- C. Saffir-Simpson
- D. Richter

Answer

Option B is correct because the Mohs scale is a mineral hardness scale used to help identify minerals. **Option A is incorrect** because the Fujita scale is used to describe tornado intensity. **Option C is incorrect** because the Saffir-Simpson scale is used to describe hurricane wind speed. **Option D is incorrect** because the Richter scale is used to describe earthquake magnitude.

Competency 018—The teacher understands the role of energy in weather and climate.

31. At a fixed atmospheric pressure, the temperature at which water vapor in the air condenses at the same rate that liquid water evaporates is called the

- A. dew point.
- B. triple point.
- C. relative humidity.
- D. heat index.

Answer

Option A is correct because at the dew point, the air is saturated with water vapor (relative humidity is 100%) and the rate of condensation equals the rate of evaporation. Below the dew point, there will be noticeable condensation appearing, often called dew. **Option B is incorrect** because the triple point of water is the temperature and pressure at which solid, liquid, and gaseous water are in equilibrium. **Option C is incorrect** because relative humidity is a ratio between the water vapor pressure of the atmosphere and the saturation water vapor pressure at a particular temperature and pressure. **Option D is incorrect** because the heat index, typically used when the temperature is high, combines air temperature and relative humidity in a way that provides a human-perceived “temperature”.

32. Wispy, feathery clouds that form at relatively high altitude are called

- A. cumulus clouds.
- B. cumulonimbus clouds.
- C. nimbostratus clouds.
- D. cirrus clouds.

Answer

Option D is correct because cirrus clouds are wispy, feathery clouds that form at relatively high altitude. **Option A is incorrect** because cumulus clouds are generally dense and detached clouds that develop vertically in the form of rising mounds with bulging upper parts. **Option B is incorrect** because cumulonimbus clouds are thunderstorm clouds that are heavy and dense clouds in the form of a mountain or tower. **Option C is incorrect** because nimbostratus clouds are continuous rain clouds that are dark gray and can be thick enough to blot out the Sun.

Competency 019—The teacher understands the characteristics of the solar system and the universe.

33. Which of the following is true about objects in our solar system?

- A. The Sun is one of the largest known stars in the universe.
- B. Neptune is farther from the Sun than any of the other planets.
- C. Although Jupiter has the largest diameter of the planets, it has a smaller mass than Earth, since it is composed largely of hydrogen and helium.
- D. Since Mercury is the closest planet to the Sun, all of its surface is always at an extremely high temperature.

Answer

Option B is correct because Neptune is the farthest planet from the Sun, at a distance of approximately 4.5 billion kilometers. **Option A is incorrect** because the Sun is an average-size star. **Option C is incorrect** because Jupiter has a mass that is about 318 times as great as Earth's mass. **Option D is incorrect** because although temperatures on many parts of Mercury can be very high, the poles are very cold all the time, and temperatures in other areas vary widely from nighttime to daytime, since Mercury has no atmosphere and rotates on its axis very slowly.

34. Of the following, which best describes a white dwarf?

- A. A large asteroid that is almost the size of a planet
- B. A small comet as it approaches the Sun
- C. A late stage in the life cycle of a low-mass star
- D. The precursor to a black hole

Answer

Option C is correct because white dwarf is a late stage in the life cycle of a low-mass star. **Options A and B are incorrect** because a white dwarf is a type of star, not an asteroid or comet. **Option D is incorrect** because a black hole is usually the last stage in the life cycle of a star with a very large mass, much greater than that of the Sun.

Competency 020—The teacher understands the history of the Earth system.

35. Which of the following is true about radiometric dating?

- A. Since the half-life of carbon-14 is 5,730 years, radiocarbon dating methods are limited to about 60,000 years.
- B. Radiometric dating is a relative dating method that infers the age of a fossil by noting the relative position of the rock layer in which it is found.
- C. Radiometric dating is based on measuring current solar output and comparing it to the amount of carbon in plant fossils that was produced by photosynthesis in the past.
- D. Radiometric dating is dangerous, since the researcher is exposed to high doses of radiation.

Answer

Option A is correct because after about ten half-lives (about 60,000 years) the amount of carbon-14 in the sample being analyzed would be less than 0.1% of the amount in the original sample 60,000 years ago. During each half-life, half of the remaining carbon-14 radioactively decays. So after 10 half-lives, the amount of carbon-14 in the sample is equal to $(1/2)^{10}$ times the original amount of carbon-14. **Option B is incorrect** because radiometric dating is an absolute dating method. **Option C is incorrect** because radiometric dating is based on decay rates of radioactive isotopes of certain elements that were in the original sample. **Option D is incorrect** because the samples being tested emit very small amounts of radioactive decay products and are within safe ranges for human exposure under appropriate testing conditions.

Domain V—Science Learning, Instruction and Assessment

Competency 021—The teacher has theoretical and practical knowledge about teaching science and about how students learn science.

36. Of the following, which would be most helpful in expanding the students' knowledge after a short introductory lesson about forces?

- A. A video showing how various batting styles affect the distance a baseball travels
- B. A teacher demonstration in which forces are applied to several objects
- C. A homework assignment in which students write examples of forces in everyday life
- D. A lab activity in which students slide objects made from various materials down an inclined plane

Answer

Option D is correct because the activity will give the students a first-hand opportunity to observe the effect of gravitational and frictional forces on the motion of objects. **Option A is incorrect** because the students cannot analyze all the components that determine the distance a ball travels by watching the video. **Option B is incorrect** because the students can only infer what forces may have been involved in the demonstration and cannot directly analyze the effect of forces on objects of varying mass and made of varying materials. **Option C is incorrect** because although observing and noting examples of forces in their daily life will be helpful to the students, it will not provide as much opportunity to explore the effect of forces as the lab activity will.

37. Which of the following student statements is an example of a student misconception about science?

- A. When a net force is continuously applied to an object, it accelerates.
- B. Objects must have a large amount of air in them in order to float.
- C. Not all animals have a heart as part of their circulatory system.
- D. Many chemical compounds are highly insoluble in water.

Answer

Option B is correct because the student statement that objects must have a large amount of air in them to float is a misconception. The upward buoyant force experienced by a submerged object is equal to the weight of the liquid displaced by the object. The density of the object will be a good predictor of whether an object will float. Although objects with large amounts of air in them are often seen floating, that observation does not contradict the fact that objects with no air in them that have a lower density less than the density of the liquid will float. **Option A is incorrect** because the student statement that an object will accelerate when a net force is applied to it is not a misconception and is correct based on Newton's second law of motion. **Option C is incorrect** because the student statement that not all animals have a heart as part of their circulatory systems is true and is not a misconception. For example, jellyfish and starfish do not have a heart. **Option D is incorrect** because the student statement that many chemical compounds are highly insoluble in water is true and is not a misconception. For example, silver chloride and paraffin are highly insoluble in water.

Competency 022—The teacher understands the process of scientific inquiry and its role in science instruction.

38. Of the following, which best illustrates a student inquiry-based activity?

- A. Students conduct an acid-base titration with vinegar and baking soda after developing a hypothesis about neutralization.
- B. Students write the formulas for some compounds based on the location on the periodic table of the elements in the compound.

- C. Students write down observations as the teacher conducts a demonstration of a combustion reaction.
- D. Students use the Internet to research the causes of the outbreak of a disease that has recently been reported in the news.

Answer

Option A is correct because a student inquiry-based activity involves the students generating and testing hypotheses. **Option B is incorrect** because although an assignment to write formulas based on periodic trends is a good activity to reinforce and apply concepts learned in class, it is not an example of a student inquiry-based activity. **Option C is incorrect** because although writing down observations is a preliminary step in the inquiry process, by itself it is not a student inquiry-based activity. **Option D is incorrect** because although looking up information about something on the Internet can be helpful, it is not an example of a student inquiry-based activity.

39. Students are asked to build model windmills using materials found in the home or classroom. Small generators and electrical connectors are provided by the teacher, as well as fans to simulate wind. Once the models have been built and tested, which of the following questions asked by the teacher would best encourage students to develop hypotheses about ways to improve the energy efficiency of their models?

- A. Is your model energy efficient?
- B. How can you determine the energy efficiency of your model?
- C. How would changing the shape or position of the windmill blades affect the energy efficiency of your model?
- D. How would reducing the number of components used to build your model increase the energy efficiency of your model?

Answer

Option C is correct because this question will encourage students to develop hypotheses about what shapes or positions of the windmill blades can increase the efficiency of the windmill by capturing more of the kinetic energy of the wind. **Options A and B are incorrect** because these questions will encourage students to find a way to collect data to determine the efficiency of the windmill rather than to develop hypotheses about how to improve the energy efficiency. **Option D is incorrect** because this question will not encourage the students to develop hypotheses about how to improve the energy efficiency. The question focuses on other issues such as reducing cost by reducing materials used.

Competency 023—The teacher knows the varied and appropriate assessments and assessment practices to monitor science learning in laboratory, field and classroom settings.

40. Giving a written multiple-choice final examination at the end of the school year is an example of

- A. a performance assessment.
- B. a formative assessment.
- C. a summative assessment.
- D. an informal assessment.

Answer

Option C is correct because a summative assessment occurs after completion of learning and assesses what has been learned and how well it has been learned. **Option A is incorrect** because a performance assessment involves evaluating a student's performance of a task, such as a lab activity, to assess how well the student understands concepts he or she has learned. **Option B is incorrect** because a formative assessment is used to monitor student progress and to inform both student and teacher of areas that need additional work. **Option D is incorrect** because a written multiple-choice final exam is a formal assessment.