



National Evaluation Series™

NES

PROFILE

Middle Grades General Science (204)

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NES Profile: Middle Grades General Science (204)

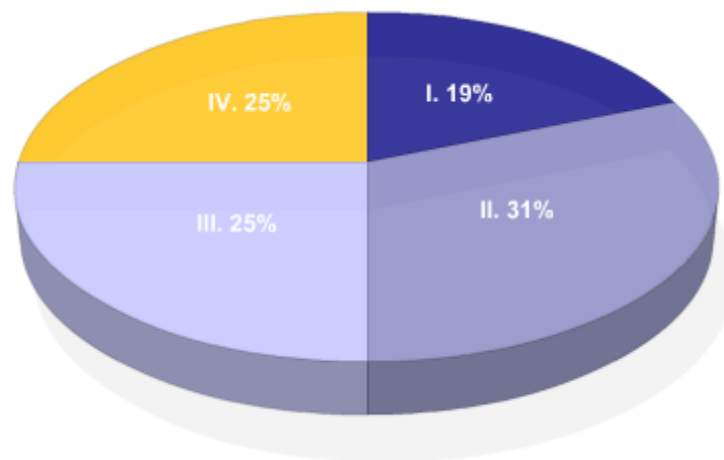
Overview

This *NES Profile* provides information about the test, including the approximate percentage of the total test score derived from each content domain. The complete set of the content domains, the test framework, is provided here and contains all of the competencies and descriptive statements that define the content of the test.

This *NES Profile* includes the following materials:

- » the test competencies associated with each content domain
- » a set of descriptive statements that further explain each competency
- » sample test questions aligned to the competencies
- » any applicable reference materials, as noted below

Test Field	Middle Grades General Science (204)
Test Format	Multiple-choice questions
Number of Questions	Approximately 150
Test Duration	Up to 3 hours
Reference Materials	Periodic Table Formula Pages Scientific Calculator



Key	Approximate Percentage of Test	Content Domain	Range of Competencies
I.	19%	I. Nature of Science	0001–0003
II.	31%	II. Physical Science	0004–0008
III.	25%	III. Life Science	0009–0012
IV.	25%	IV. Earth and Space Science	0013–0016

CONSTANTS AND FORMULAS

Acceleration of gravity on Earth (g)	9.8 m/s^2
Potential energy	$PE = mgh$
Kinetic energy	$KE = \frac{1}{2}mv^2$
Ohm's law	$V = IR$
Electrical power	$P = IV$
Series resistance	$R_{\text{Series}} = R_1 + R_2 + R_3 + \dots$
Parallel resistance	$\frac{1}{R_{\text{Parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
Ideal gas law	$PV = nRT$
Universal gas constant	$R = 8.31 \text{ J/mol}\cdot\text{K} = 0.0821 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$
Pressure	$P = \frac{\text{force}}{\text{area}}$
Frequency of a wave	$f = 1/T$
Velocity of a wave	$v = f\lambda$
Specific heat (s) of water (liquid)	$4.18 \text{ J/g}\cdot\text{K} = 4.18 \text{ J/g}\cdot\text{°C} = 1.0 \text{ cal/g}\cdot\text{°C}$
Standard atmospheric pressure (STP)	$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 101.325 \text{ kPa}$
Speed of light in a vacuum (c)	$3.00 \times 10^8 \text{ m/s}$
1 calorie (cal)	4.184 J
1 watt (W)	1 J/s
1 ampere (A)	1 C/s

Calculator Information

A scientific calculator will be provided with your test. You may not use your own scientific calculator or calculator manual.

Content Domain I: Nature of Science

Competencies:

0001 Understand principles and procedures of scientific inquiry.

Descriptive Statements:

- » Demonstrate knowledge of the principles and procedures for designing and carrying out scientific investigations.
- » Recognize methods and criteria for collecting, organizing, analyzing, and presenting scientific data.
- » Recognize the evidential basis of scientific claims.
- » Demonstrate knowledge of safety procedures and hazards associated with scientific investigations.
- » Demonstrate knowledge of the materials, equipment, and technology used in the sciences.
- » Apply basic mathematical procedures in reporting data and solving problems in the sciences.

Sample Item:

A scientist plants 100 bean seeds to investigate the effect of soil pH on growth rate and flowering. The seeds are planted in two large containers with 50 seeds in each container. The soil in one of the containers has a pH of 4, while the soil in the other container has a pH of 10. Which of the following changes to the experimental design would most improve the usefulness of the results?

- A. increasing the number of plants in each group to reduce the effects of individual variability
- B. limiting the dependent variables to either flowering or growth rate
- C. planting a group of seeds in soil with a neutral pH to serve as a control
- D. placing the seeds in individual pots so they do not crowd each other

Correct Response and Explanation

C. This question requires the examinee to demonstrate knowledge of the principles and procedures for designing and carrying out scientific investigations. In this experiment, since one of the containers contains acidic soil (i.e., soil having a pH of 4) and one of the containers has basic soil (i.e., soil having a pH of 10), an appropriate control would be to include a container that has soil of neutral pH (i.e., soil having a pH of 7).

0002 Understand the history and nature of science.

Descriptive Statements:

- » Demonstrate knowledge of the historical development of major scientific ideas.
- » Demonstrate knowledge of current major theories, models, and concepts in physical science, life science, and Earth and space science.

- » Identify unifying themes, principles, and relationships that connect the different branches of the sciences.
- » Demonstrate knowledge of the nature of science as a system of inquiry.

Sample Item:

In working out the theory of evolution, Charles Darwin was strongly influenced by which of the following developments in the sciences?

- A. the hypothesis that Earth had changed gradually over long periods of time
- B. the discovery that cells were the basic unit of living organisms
- C. the recognition that Earth's crust was composed of shifting tectonic plates
- D. the discovery that ancient humans lived in Africa millions of years ago

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the historical development of major scientific ideas. Darwin's theory of evolution by natural selection requires a long time frame over which to work. The work of two geologists, James Hutton and Charles Lyell, suggested that Earth had changed gradually over long periods of time, supporting Darwin's theory.

0003 Understand the relationships between science, technology, engineering, mathematics, and society.

Descriptive Statements:

- » Analyze the interrelationships between science, technology, engineering, mathematics, and society.
- » Demonstrate scientific literacy in evaluating scientific research and the coverage of science in the media.
- » Analyze social, economic, and ethical issues associated with technological and scientific developments.

Sample Item:

In which of the following scenarios does the government most directly affect the work of scientists?

- A. The Food and Drug Administration evaluates the efficacy of a new medical device.
- B. Politicians running for office debate the potential risks to humanity of global warming.
- C. The governor of a large state announces new energy conservation measures for public buildings.
- D. Congress votes to support increased funding for research at the National Institutes of Health.

Correct Response and Explanation

D. This question requires the examinee to analyze the relationship between science and society. Government funding for research influences the work of scientists by encouraging them to work in funded areas of science and by providing funds for scientists to continue their work.

Content Domain II: Physical Science

Competencies:

0004 Understand the properties and characteristics of matter.

Descriptive Statements:

- » Recognize historic and contemporary theories of atomic structure and the kinetic theory of matter.
- » Demonstrate knowledge of the physical and chemical properties of matter.
- » Recognize the characteristics of different types of chemical bonds and their effects on the properties of matter.
- » Demonstrate knowledge of the organization of the periodic table and its relationship to the structure and behavior of elements.
- » Recognize the characteristics of elements, compounds, and mixtures, including solutions, suspensions, and colloids.
- » Demonstrate knowledge of the nature of radioactive materials.

Sample Item:

Which of the following is predicted by the kinetic theory of matter?

- A. The electrons surrounding an atom are in constant motion.
- B. The pressure of a gas will decrease if its volume is increased.
- C. The density of a solid depends on its composition.
- D. The charge of the atomic nucleus depends on its mass.

Correct Response and Explanation

B. This question requires the examinee to recognize historic and contemporary theories of atomic structure and the kinetic theory of matter. According to the kinetic theory of matter, pressure in a gas-filled container results from collisions between molecules of gas and the sides of the container. If the volume of a container is increased, molecules will travel greater distances before striking the walls, and the collisions will therefore occur less frequently. This will result in a reduced pressure.

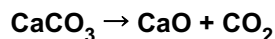
0005 Understand physical and chemical changes in matter.

Descriptive Statements:

- » Demonstrate knowledge of the conservation of matter in chemical reactions and in balancing chemical equations.
- » Apply knowledge of chemical formulas, the mole concept, and chemical equations to solve problems.
- » Analyze phase changes and the characteristics of the different states of matter.
- » Recognize the characteristics of different types of chemical reactions and factors that affect rates of reaction and chemical equilibrium.

Sample Item:

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



What is the mass of calcium oxide (CaO) that is produced by heating 80.0 g of calcium carbonate (CaCO₃)?

- A. 44.8 g
- B. 47.7 g
- C. 65.9 g
- D. 70.2 g

Correct Response and Explanation

A. This question requires the examinee to apply knowledge of chemical formulas, the mole concept, and chemical equations to solve problems. Since the reaction is already written in balanced form, one mole of CaO is produced for each mole of CaCO₃ that reacts. The molecular weight of CaCO₃ is the sum of the atomic weights of the atoms in CaCO₃. The molecular weight of CaCO₃ is 1(40 amu) + 1(12 amu) + 3(16 amu) = 100 amu. This means that CaCO₃ has a mass of 100 g per mole. Therefore, 80.0 g of CaCO₃ represents 0.8 moles of CaCO₃ and must produce 0.8 moles of CaO. CaO has a molecular weight of 1(40 amu) + 1(16 amu) = 56 amu, and 0.8 moles of CaO has a mass of (0.8) × (56) or 44.8 g.

0006 Understand the characteristics and transformations of different forms of energy.

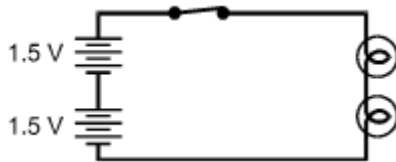
Descriptive Statements:

- » Demonstrate knowledge of the characteristics of different forms of energy and their transformations.
- » Apply knowledge of the law of conservation of energy to the analysis of physical and chemical changes.
- » Demonstrate knowledge of thermal energy and the transfer of energy through conduction, convection, and radiation.
- » Analyze characteristics of electric charge, static electricity, Ohm's law, and series and parallel circuits.
- » Demonstrate knowledge of the relationship between magnetism and electricity as well as the properties of permanent magnets.

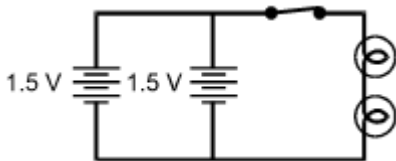
Sample Item:

Which of the electric circuits shown below will have the two brightest lights?

A.



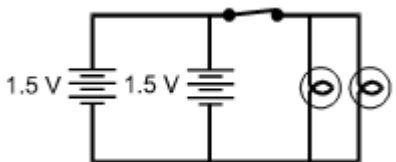
B.



C.



D.



Correct Response and Explanation

C. This question requires the examinee to analyze characteristics of Ohm's law and series and parallel circuits. The brightness of an electric lamp is related to the amount of current through the lamp. Current in a circuit is directly proportional to voltage and inversely proportional to resistance. The circuits in responses A and C have a voltage of 3 V since they each have two 1.5 V cells in series. The difference between these two circuits is that in response A the lamps are in series, and in choice C the lamps are parallel. Two resistances in series have a greater total resistance than the same two resistances in parallel.

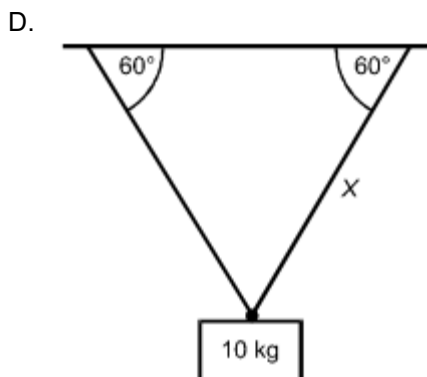
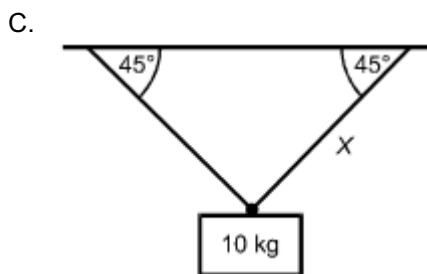
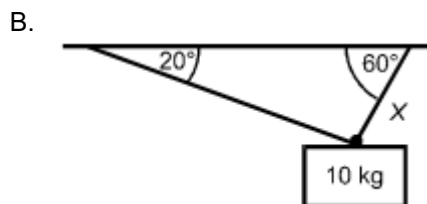
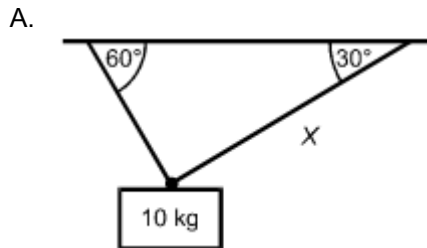
0007 Understand relationships between force, mass, and motion.

Descriptive Statements:

- » Demonstrate knowledge of Newton's three laws of motion in a variety of situations.
- » Solve problems involving force, mass, and motion, including the interpretation of force diagrams.
- » Apply knowledge of gravity, friction, pressure, and buoyancy, in a variety of situations.
- » Demonstrate knowledge of the principles of work and power, including as applied to simple machines.

Sample Item:

A 10 kg mass is suspended by two cables. In which of the following situations will the tension in the cable labeled X be the greatest?



Correct Response and Explanation

B. This question requires the examinee to solve problems involving force, mass, and motion. In response D, the mass is supported symmetrically by two cables of equal length. The two cables must share the load equally. In the case in which the mass is supported by a single vertical cable and hangs straight down (not shown), the cable would support all of the mass. Response B is closest to this situation and therefore has the greatest tension.

0008 Understand characteristics and properties of mechanical and electromagnetic waves.

Descriptive Statements:

- » Apply knowledge of the characteristics of mechanical waves and their behavior as they pass through different media.
- » Analyze the properties and propagation of sound in a variety of situations.
- » Recognize the characteristics of the electromagnetic spectrum.
- » Analyze the effects of mirrors, lenses, and prisms on the behavior of light.
- » Demonstrate knowledge of refraction and reflection in natural phenomena.

Sample Item:

Sound waves travel at a different speed in warm air than they do in colder air. Which of the following explains why sound waves travel differently in warm air as opposed to cold air?

- A. In warmer air, sound waves travel more rapidly because of the greater kinetic energy of the air molecules.
- B. In colder air, sound waves are transmitted more rapidly due to the greater density of the air.
- C. In warmer air, sound waves propagate more slowly because they are disrupted by convection currents.
- D. In colder air, sound waves are transmitted more slowly due to the higher pressure of cool air masses.

Correct Response and Explanation

A. This question requires the examinee to analyze the properties and propagation of sound in a variety of situations. Sound is transmitted as a disturbance of the medium in which it is traveling. The movement of the sound waves is due, in part, to the kinetic energy of the molecules of the conducting medium, in this case air. The molecules in warm air have greater kinetic energy than those in cooler air, and therefore allow the wave to travel at a greater velocity.

Content Domain III: Life Science

Competencies:

0009 Understand the characteristics, organization, and processes of cells.

Descriptive Statements:

- » Analyze the structure and function of cell organelles in eukaryotic and prokaryotic cells.
- » Analyze the processes of respiration and photosynthesis at the cellular level.
- » Recognize how the structure of specialized cells relates to their different functions.
- » Demonstrate knowledge of mitosis and meiosis.

Sample Item:

The folding of the internal membrane of the mitochondria serves which of the following purposes?

- A. increasing the number of separate compartments in which proteins can be assembled
- B. increasing the capacity to filter waste products produced during the process of cellular respiration
- C. increasing the capacity to absorb enzymes needed to regulate cell division
- D. increasing the surface area over which energy-releasing chemical reactions take place

Correct Response and Explanation

D. This question requires the examinee to analyze the structure and function of cell organelles in eukaryotic cells. Many of the reactions involved in cellular respiration occur on the membranes of mitochondria. The folding of the internal membrane serves to increase its surface area, thereby providing more surface on which reactions can take place.

0010 Understand characteristics and life processes of living organisms.

Descriptive Statements:

- » Analyze the reproduction, development, and life cycles of representative organisms.
- » Demonstrate knowledge of the structures and functions of plant and animal systems, including the different levels of biological organization.
- » Demonstrate knowledge of the structures and functions of human body systems.
- » Analyze how organisms obtain, use, and store matter and energy.
- » Analyze how organisms both maintain homeostasis and fight diseases.

Sample Item:

Many reef-forming corals form a symbiotic relationship with unicellular algae. Which of the following best describes the primary benefit to the corals from this relationship?

- A. The corals obtain much of their energy from photosynthetic activity of the algae.
- B. The algae are toxic to most fish and reduce predation by small fish on coral populations.
- C. The corals can maintain a higher internal temperature due to heat generated by metabolic processes of the algae.
- D. The algae attract small herbivorous fish and invertebrates, which are a major food source of the corals.

Correct Response and Explanation

A. This question requires the examinee to analyze how organisms obtain, use, and store matter and energy. Photosynthetic algae called zooxanthellae live within coral polyps and produce oxygen and nutrients needed by the coral.

0011 Understand the concepts and principles related to genetics, the theory of evolution, and the classification of organisms.

Descriptive Statements:

- » Recognize the basic principles of heredity, the nature of the genetic code, the basic processes of DNA replication and protein synthesis, and the methods and uses of genetic engineering.
- » Apply knowledge of the principles and evidence of biological evolution to explain how species change over time.
- » Demonstrate knowledge of the major events in the history of life, including mass extinctions and the evolution of organisms that characterize specific periods in Earth's history.
- » Demonstrate knowledge of the principles of biological classification.

Sample Item:

In which of the following scenarios is a species most likely to undergo evolutionary change?

- A. A small population of a species of rodent is isolated permanently from the rest of its species by a natural disaster.
- B. A migratory species of caribou is substantially reduced by predators during a very cold winter.
- C. A species of invasive weed spreads rapidly along highways after being accidentally introduced.
- D. A species of insect experiences rapid population growth during an unusually warm summer.

Correct Response and Explanation

A. This question requires the examinee to apply knowledge of the principles and evidence of biological evolution to explain how species change over time. Geographic isolation of a species separates the species reproductively from other members of the species. This results in the isolated population taking a different evolutionary path than the main population due to genetic drift and differences in environmental pressures.

0012 Understand characteristics of different biomes, relationships between organisms, population dynamics, and the flow of matter and energy through ecosystems.

Descriptive Statements:

- » Recognize the characteristics of terrestrial and aquatic biomes, including representative species of plants and animals that inhabit them.
- » Analyze the relationships between organisms in a variety of ecosystems.
- » Demonstrate knowledge of biotic and abiotic factors that affect population dynamics in ecosystems, including competition, resource availability, and niche and habitat requirements.
- » Recognize the ways both human activities and climate change affect ecosystems.
- » Recognize strategies used by different organisms to obtain the basic needs for life.
- » Analyze the cycling of matter and the flow of energy through different types of ecosystems.

Sample Item:

Plants of the pea family use which of the following strategies to obtain a portion of their nitrogen requirement?

- A. absorbing atmospheric nitrogen through the stomata in their leaves and stems
- B. breaking down amino acids found in decaying soil humus into elemental nitrogen
- C. hosting bacteria in their roots that transform gaseous nitrogen into useable nitrogen compounds
- D. taking in rainwater that contains dissolved elemental nitrogen through leaf pores

Correct Response and Explanation

C. This question requires the examinee to demonstrate knowledge of biotic and abiotic factors that affect population dynamics in ecosystems, including competition, resource availability, and niche and habitat requirements. Although approximately 78% of the atmosphere is made up of nitrogen, that nitrogen is not in a form that is useable by most organisms. Many plants, including pea plants, have close biological relationships with bacteria that are able to use atmospheric nitrogen, and in the process they convert the nitrogen to a form useful to the host plant.

Content Domain IV: Earth and Space Science

Competencies:

0013 Understand the history of Earth, characteristics of Earth materials and resources, and the geologic processes that shape Earth.

Descriptive Statements:

- » Demonstrate knowledge of Earth's formation, history, and structure, as well as the supporting geologic evidence.
- » Analyze tectonic processes, the mechanisms driving plate movements, and the landforms and geologic phenomena produced by movement at plate boundaries.
- » Demonstrate knowledge of the processes involved in the rock cycle and of the characteristics of igneous, metamorphic, and sedimentary rocks.
- » Analyze the constructive and destructive processes that shape Earth's surface, including weathering, erosion, transportation, and deposition.
- » Recognize the characteristics and origins of common rocks, minerals, and fossils, as well as mineral, geothermal, and fossil fuel resources.

Sample Item:

The conclusion that Earth's outer core is liquid is based on which of the following evidence?

- A. the characteristics of minerals retrieved from deep-ocean drilling
- B. the changes in Earth's magnetic field recorded over the past century
- C. the composition of igneous rocks from major volcanic eruptions
- D. the behavior of seismic waves as they travel through Earth's interior

Correct Response and Explanation

D. This question requires the examinee to demonstrate knowledge of Earth's formation, history, and structure, as well as supporting geologic evidence. Since seismic waves behave differently in different materials, the behavior of the waves can be used to deduce geologic structure. The behavior of these waves indicates that Earth's outer core is liquid.

0014 Understand characteristics and properties of the hydrosphere.

Descriptive Statements:

- » Analyze the physical processes of the hydrologic cycle.
- » Identify the processes and characteristics of marine and freshwater systems, including oceans, rivers, lakes, and glaciers.
- » Demonstrate knowledge of groundwater aquifers as well as their use and recharge.
- » Analyze coastal processes, the formation of barrier islands, and the physical characteristics of deltas and estuaries.

Sample Item:

Which of the following factors is primarily responsible for the worldwide change in sea level that has occurred in the past 15,000 years?

- A. thermal expansion of the oceans
- B. tectonic uplift of continental shelves
- C. isostatic uplift of coastal regions
- D. melting of continental glaciers

Correct Response and Explanation

D. This question requires the examinee to identify the processes and characteristics of marine and freshwater systems, including oceans and glaciers. Sea level has been rising at a slow rate for approximately 15,000 years, and over the past 100 years this rise has been accelerating. The change in sea level over the past 15,000 years has been due primarily to the melting and retreating of continental glaciers.

0015 Understand Earth's atmosphere, weather, and climate.

Descriptive Statements:

- » Demonstrate knowledge of the structure and characteristics of the different layers of the atmosphere.
- » Analyze atmospheric conditions and geographic factors that produce weather in different parts of the world.
- » Analyze weather maps and data to predict and explain weather events.
- » Recognize factors controlling regional climate conditions and the causes for the changes in climate that occurred during the Pleistocene and Holocene epochs.
- » Recognize how current changes in global climate are affecting ecosystems, the hydrosphere, coastal processes, and agriculture.

Sample Item:

The polar front jet stream and the subtropical jet stream are located in which layer of the atmosphere?

- A. the lower mesosphere
- B. the tropopause
- C. the upper stratosphere
- D. the stratopause

Correct Response and Explanation

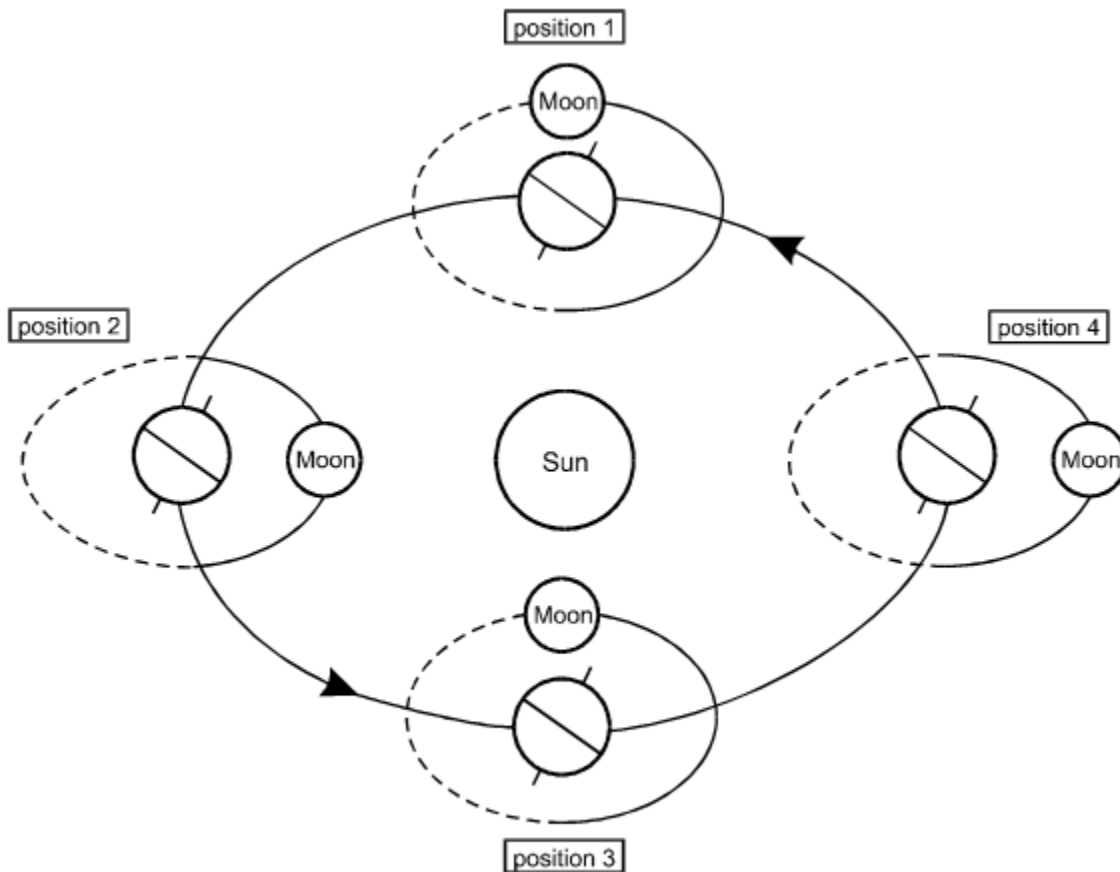
B. This question requires the examinee to demonstrate knowledge of the structure and characteristics of the different layers of the atmosphere. The polar front jet stream is at an elevation of approximately 7 km to 12 km above sea level. The subtropical jet stream is at an elevation of approximately 10 km to 16 km above sea level. Since the troposphere extends from Earth's surface to approximately 20 km above sea level, the polar front and subtropical jet streams are within the tropopause.

0016 Understand characteristics of the solar system and the universe.

Descriptive Statements:

- » Demonstrate knowledge of the characteristics of objects in the solar system.
- » Analyze the interactions of the sun, moon, and Earth and the effects of these interactions on Earth.
- » Recognize the characteristics and evolution of stars and galaxies, including theories on the origin and nature of the universe.
- » Demonstrate knowledge of evidence supporting the current understanding of the solar system and universe and of the technology used to gather that evidence.
- » Demonstrate knowledge of the role of gravity in the solar system and the universe.

Sample Item:



Note: Not to Scale

The orbit of the moon is inclined 5 degrees from the plane that contains the sun and Earth. The moon is below the Earth-sun plane in those parts of the moon's orbit that are shown with a dashed line in the diagram above. Given the moon's inclined orbit, a solar eclipse would most likely occur in which of the positions shown in the diagram?

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

Correct Response and Explanation

C. This question requires the examinee to analyze the interactions of the sun, moon, and Earth and the effects of these interactions on Earth. The moon will cast its shadow on Earth, producing a solar eclipse when the moon is between the sun and Earth and in the Earth-sun plane. In the diagram, the moon is in the Earth-sun plane when it is passing from the part of its orbit indicated by the dashed line (i.e., below the plane) to the part of its orbit indicated by the solid line (i.e., above the plane). The response that shows the moon in this position and between the sun and Earth is response C.

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