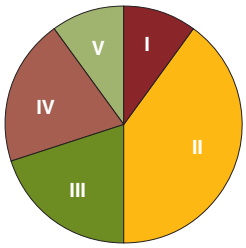
General Science: Content Knowledge (0435)

Test at a Glance

Test Name	General Science: Content Knowledge
Test Code	0435
Time	2 hours
Number of Questions	120
Format	Multiple-choice questions



Content Categories	Approximate Number of Questions	Approximate Percentage of Examination
I. Scientific Methodology, Techniques, and History	12	10%
II. The Physical Sciences	48	40%
III. The Life Sciences	24	20%
IV. The Earth Sciences	24	20%
V. Science, Technology, and Society	12	10%

About This Test

The General Science: Content Knowledge test is designed to measure the knowledge and competencies necessary for a beginning teacher of secondary school General Science. Examinees have typically completed or nearly completed a bachelor's degree program with appropriate coursework in science and education. This test may contain some questions that will not count towards your score.

The development of the test questions and the construction of the test reflect the National Science Education Standards (NSES) and the National Science Teacher Association (NSTA) standards and recognize that there are conceptual and procedural schemes that unify the various scientific disciplines. These fundamental concepts and processes (systems; models; constancy and change; equilibrium; form and function) are useful in understanding the natural world. Insofar as possible, then, the test questions will have the primary objective of evaluating the content areas by using questions that focus on conceptual understanding, critical thinking, and problem solving in science. The test content is developed and reviewed in collaboration with practicing high school science teachers, teacher-educators, and higher education content specialists to keep the test updated and representative of current standards.

The 120 multiple choice questions include concepts, terms, phenomena, methods, applications, data analysis, and problem solving in science, and include an understanding of the impact of science and technology on the environment and human affairs. This also includes the ability to integrate basic topics from Chemistry, Physics, Life Science, and Earth and Space Science which are typically covered in introductory college-level courses in these disciplines, although some questions of a more advanced nature are included, because secondary-school teachers must understand the subject matter from a more advanced viewpoint than that presented to their students.

Examinees will not need to use calculators in taking this test. The test book contains a periodic table of the elements and a table of information that presents various physical constants and a few conversion factors among SI units. Whenever necessary, additional values of physical constants are printed with the text of a question.

Topics Covered

Representative descriptions of topics covered in each category are provided below.

I. Scientific Methodology, Techniques, and History

1. Methods of scientific inquiry and design
   - Identifying problems based on observations
   - Forming and testing hypotheses
   - Development of theories, models, and laws
   - Experimental design, including independent and dependent variables, controls, and sources of error
   - Process skills including observing, comparing, inferring, categorizing, generalizing and concluding
   - Nature of scientific knowledge
     - Subject to change
     - Consistent with evidence
     - Based on reproducible evidence
     - Includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function)
2. Processes involved in scientific data collection and manipulation
   - Common units of measurement (metric and English) including unit conversion and prefixes such as *milli* and *kilo*
   - Scientific notation and significant figures in collected data
   - Organization and presentation of data
   - Basic data and error analysis including determining mean, accuracy, precision, and sources of error
3. Interpret and draw conclusions from data presented in tables, graphs, maps, and charts
   - Trends in data
   - Relationships between variables
   - Predictions based on data
   - Drawing valid conclusions based on the data
4. Procedures for correct preparation, storage, use, and disposal of laboratory materials
   - Appropriate and safe use of materials (e.g., chemicals, lab specimens)
   - Safe disposal of materials
   - Appropriate storage
   - Preparation for classroom or field use (e.g., how to prepare a solution of given concentration, staining slides, labeling samples)
5. How to use standard equipment in the laboratory and the field
   - Appropriate and safe use (e.g., Bunsen burner, glassware, GPS, microscope)
   - Appropriate storage (e.g., pH probes stored in appropriate buffer solution, dissection equipment, glassware)
   - Maintenance and calibration (e.g., cleaning microscopes, calibration of balances)
   - Preparation for classroom or field use (e.g., prelaboratory setup, classroom demonstrations, field research)

6. Safety and emergency procedures in the laboratory
   - Location and use of standard safety equipment (e.g., eyewash, shower)
   - Laboratory safety rules for students
   - Appropriate apparel and conduct in the laboratory (e.g., wearing goggles)
   - Emergency procedures (e.g., fires, chemical spills, handling of injuries)
7. Major historical developments of science
   - Accepted principles and models develop over time
   - Major developments in science (e.g., atomic theory, plate tectonics)
   - Contributions of major historical figures (e.g., Darwin, Newton)

II. The Physical Sciences

A. Basic Principles

1. Structure of matter
   - Elements, compounds, and mixtures
   - Atoms, molecules, and ions
   - Basic properties of solids, liquids, and gases
2. Basic structure of the atom
   - Atomic models
   - Atomic structure including nucleus, electrons, protons, and neutrons
   - Atomic number, atomic mass, isotopes
   - Electron arrangements (e.g., valence electrons)
3. Basic characteristics of radioactive materials
   - Radioisotopes
   - Radioactive decay processes and half-life
   - Characteristics of alpha particles, beta particles, and gamma radiation
   - Fission and fusion
4. Basic concepts and relationships involving energy and matter
   - Conservation of energy (first law of thermodynamics)
   - Entropy changes (second law of thermodynamics)
   - Conservation of matter in chemical systems
   - Kinetic and potential energy
   - Transformations between different forms of energy (thermal, chemical, radiant, nuclear, mechanical, electrical, electromagnetic)
   - Differences between chemical and physical properties/changes
   - Various temperature scales (Celsius, Fahrenheit, Kelvin)
   - Transfer of thermal energy and its basic measurement
     - Conduction, convection, and radiation
     - Specific heat capacity
     - Calorimetry (e.g., predict heat transfer in various systems)
   - Applications of energy and matter relationships
     - Trophic level
     - Matter cycling (carbon, nitrogen, water)
     - Energy flow in ecosystems
     - Convection currents in atmosphere, ocean, and mantle
     - Conservation of mass in the rock cycle
     - Chemical and physical changes in rocks
     - Impact of solar radiation on Earth and life
     - Energy transformations in living systems (e.g., photosynthesis, cellular respiration)

B. Chemistry

Periodicity and States of Matter

1. Periodic table of the elements
   - Elements arranged in groups and periods
   - Atomic number, atomic mass, and isotopic abundance
   - Symbols of the elements
   - Trends in physical properties based on position of elements on the periodic table (e.g., atomic radius, ionization energy)
   - Trends in chemical reactivity based on position of elements on the periodic table (e.g., metals, nonmetals, noble gases)

2. States of matter and factors that affect phase changes
   - Basic assumptions of the kinetic theory of matter (e.g., particles in constant motion, average speed of gas particles related to temperature)
   - Ideal gas laws (e.g., volume is proportional to temperature, pressure is inversely related to volume)
   - Phase transitions and energy changes (e.g., heat of vaporization, heat of sublimation, phase diagrams, heating curves)

Chemical nomenclature, composition, and bonding

1. Name of simple compounds and their chemical formulas
   - Interpreting chemical formulas
   - Naming compounds based on formula
   - Writing formulas based on name
   - Structural formulas (e.g., electron dot, Lewis structures)
2. Types of chemical bonding
   - Covalent and ionic
3. Mole concept and its applications
   - Avogadro's number
   - Molar mass and percent composition

Chemical Reactions

1. Basic concepts involved in chemical reactions
   - Use and balance equations of simple chemical reactions
     - Balance equations
     - Simple stoichiometric calculations based on balanced equations
   - Endothermic and exothermic reactions
   - Factors that affect reaction rates (e.g., concentration, temperature, pressure, catalysts/enzymes, activation energy)
   - Factors that affect reaction equilibrium (e.g., Le Châtelier's principle)
   - Types of reactions (e.g., combustion, single or double replacement)
   - Simple oxidation-reduction reactions

Acid-Base Chemistry

1. Simple acid-base chemistry
   - Chemical and physical properties of acids and bases
   - pH scale
   - Neutralization
   - Acid-base indicators (e.g., phenolphthalein, pH paper, litmus paper)

Solutions and solubility

1. Different types of solutions
   - Dilute and concentrated
   - Saturated, unsaturated, supersaturated
   - Solvent and solute
   - Concentration terms (e.g., molarity, parts per million (ppm))
   - Preparation of solutions of varying concentrations
2. Factors affecting the solubility of substances and the dissolving process
   - Effect of temperature, pressure, particle size, and agitation on the rate of dissolving
   - Effect of temperature and pressure on solubility (e.g., solubility curves)
   - Polar vs. nonpolar solvents and solutes
   - Dissociation of ionic compounds such as salts in water (e.g., ionization, electrolytes)
   - Precipitation
   - Freezing point depression

C. Physics

Mechanics

1. Description of motion in one and two dimensions
   - Speed, velocity, acceleration
   - Displacement
   - Linear momentum
   - Vector and scalar quantities
2. Newton's three laws of motion
   - First law: inertia
   - Second law: F = ma (i.e., net force, mass, and acceleration)
   - Third law: action-reaction forces

3. Mass, weight, and gravity
   - Distinguish between mass and weight
   - Gravitational attraction (force of attraction between masses at various distances)
   - Acceleration due to gravity
4. Analysis of motion and forces
   - Projectile motion
   - Inclined planes
   - Friction
   - Collisions (e.g., elastic, inelastic) and conservation of linear momentum
   - Circular motion (e.g., centripetal acceleration, centripetal force)
   - Center of mass
   - Periodic motion (e.g., pendulums, oscillating springs, planetary orbits, satellites)
   - Conservation of energy
   - Work, energy, and power
   - Basic fluid mechanics (e.g., buoyancy, density, pressure)
5. Simple machines
   - Mechanical advantage
   - Types of simple machines (e.g., wedge, screw, lever)
   - Concept of torque

Electricity and Magnetism

1. Electrical nature of common materials
   - Electric charges
   - Electrostatic force (attraction and repulsion, Coulomb's law)
   - Conductivity, conductors and insulators
2. Basic electrical concepts
   - DC and AC current
   - Current, resistance, voltage, and power
   - Ohm's law
   - Analyze basic series and parallel circuits
   - Voltage sources (e.g., batteries, generators)
3. Basic properties of magnetic fields and forces
   - Magnetic materials
   - Magnetic forces and fields (e.g., magnetic poles, attractive and repulsive forces)
   - Electromagnets

Optics and Waves

1. Electromagnetic spectrum
   - Nature of light (e.g., wave properties, photons)
   - Visible spectrum and color
   - Electromagnetic spectrum (e.g., ultraviolet, microwave, gamma)
2. Basic characteristics and types of waves
   - Transverse and longitudinal
   - Wave characteristics and relationships between them (e.g., frequency, amplitude, wavelength, speed, energy)
3. Basic wave phenomena
   - Reflection, refraction, diffraction, and dispersion
   - Absorption and transmission
   - Interference, scattering, and polarization
   - Total internal reflection
   - Doppler effect (e.g., apparent frequency, moving source or observer, red/blue shift)
4. Basic optics
   - Mirrors
   - Lenses and their applications (e.g., the human eye, microscope, telescope)
   - Prisms
5. Sound
   - Pitch/frequency and loudness/intensity
   - Sound wave production, air vibrations, and resonance (e.g., tuning forks)
   - Application of the Doppler effect to sound

III. The Life Sciences

1. Basic structure and function of cells and their organelles
   - Structure and function of cell membranes (e.g., phospholipid bilayer, passive and active transport)
   - Structure and function of animal and plant cell organelles
   - Levels of organization (cells, tissues, organs, organ systems)
   - Major features of common animal cell types (e.g., blood cells, muscle, nerve, epithelial, gamete)
   - Prokaryotes (bacteria) and eukaryotes (animals, plants, fungi, protists)
2. Key aspects of cell reproduction and division
   - Cell cycle
   - Mitosis
   - Meiosis
   - Cytokinesis
3. Basic biochemistry of life
   - Cellular respiration
   - Photosynthesis
   - Biological molecules (e.g., DNA, carbohydrates, proteins, lipids, enzymes)
4. Basic genetics
   - Structure (double helix, single stranded, and base pairs) and function of DNA and RNA (replication, transcription, and translation)
   - Chromosomes, genes, alleles
   - Dominant and recessive traits
   - Mendelian inheritance (e.g., genotype, phenotype, use of Punnett squares, pedigrees)
   - Mutations, chromosomal abnormalities, and common genetic disorders
5. Theory and key mechanisms of evolution
   - Mechanisms of evolution (e.g., natural selection)
   - Isolation mechanisms and speciation
   - Supporting evidence (e.g., fossil record, comparative genetics, homologous structures)
6. Hierarchical classification scheme
   - Classification schemes (e.g., domain, class, genus)
   - Characteristics of bacteria, animals, plants, fungi, and protists
7. Major structures of plants and their functions
   - Characteristics of vascular and nonvascular plants
   - Structure and function of roots, leaves, and stems (e.g., stomata, xylem, phloem)
   - Asexual (budding) and sexual reproduction (flowers, fruit, seeds, spores)
   - Growth (e.g., germination, elongation)
   - Uptake and transport of nutrients and water
   - Responses to stimuli (e.g., light, temperature, water, gravity)
8. Basic anatomy and physiology of animals, including the human body
   - Response to stimuli and homeostasis
   - Exchange with the environment (e.g., respiratory, excretory, and digestive systems)
   - Internal transport and exchange (e.g., heart, arteries, veins, capillaries)
   - Control systems (e.g., nervous and endocrine systems)
   - Movement and support (e.g., skeletal and muscular systems)
   - Reproduction and development
   - Immune system (e.g., antibodies, autoimmune disorders)
9. Key aspects of ecology
   - Population dynamics
     - Growth curves and carrying capacity
     - Behavior (e.g., territoriality)
     - Intraspecific relationships (e.g., mating systems, social systems, competition)
   - Community ecology
     - Niche
     - Species diversity
     - Interspecific relationships (e.g., predator-prey, parasitism)
   - Ecosystems
     - Biomes
     - Stability and disturbances (e.g., glaciation, climate change, succession)
     - Energy flow (e.g., trophic levels, food webs)
     - Biogeochemical cycles (e.g., water, nitrogen, and carbon cycles, biotic/abiotic interaction)

IV. The Earth Sciences

Physical geology

1. Types and basic characteristics of rocks and minerals and their formation processes
   - The rock cycle
   - Characteristics of rocks and their formation processes (i.e., sedimentary, igneous, and metamorphic rock)
   - Characteristics of minerals and their formation processes (e.g., classes of minerals, crystals, hardness)
2. Processes involved in erosion, weathering, and deposition of Earth's surface materials and soil formation
   - Erosion and deposition (e.g., agents of erosion)
   - Chemical and physical (mechanical) weathering
   - Characteristics of soil (e.g., types, soil profile)
   - Porosity and permeability
   - Runoff and infiltration
3. Earth's basic structure and internal processes
   - Earth's layers (e.g., lithosphere, mantle, core)
   - Shape and size of Earth
   - Geographical features (e.g., mountains, plateaus, mid-ocean ridges)
   - Earth's magnetic field
   - Plate tectonics theory and evidence
     - Folding and faulting (e.g., plate boundaries)
     - Continental drift, seafloor spreading, magnetic reversals
     - Characteristics of volcanoes (e.g., eruptions, lava, gases, hot spots)
     - Characteristics of earthquakes (e.g., epicenters, faults, tsunamis)
     - Seismic waves and triangulation
4. The water cycle
   - Evaporation and condensation
   - Precipitation
   - Runoff and infiltration
   - Transpiration

Historical Geology

1. Historical geology
   - Principle of uniformitarianism
   - Basic principles of relative age dating (e.g., superposition, stratigraphic correlation, fossil succession)
   - Absolute (radiometric) dating
   - Geologic time scale (e.g., age of Earth, scope of time)
   - Fossil record as evidence of the origin and development of life (e.g., fossilization methods, mass extinctions, ice ages, meteor impacts)

Earth's Bodies of Water

1. Characteristics and processes of Earth's oceans and other bodies of water
   - Distribution and location of Earth's water
   - Seawater composition
   - Coastline topography and topography of ocean floor
   - Tides, waves, currents
   - Estuaries and barrier islands
   - Islands, reefs, and atolls
   - Polar ice, icebergs, and glaciers
   - Lakes, ponds, and wetlands
   - Streams, rivers, and river deltas
   - Groundwater, water table, wells, and aquifers
   - Geysers and springs
   - Properties of water that affect Earth systems (e.g., density changes on freezing, high heat capacity, polar solvent, hydrogen bonding)

Meteorology and Climate

1. Basic structure and composition of Earth's atmosphere
   - Layers (e.g., stratosphere)
   - Composition of atmosphere (e.g., percent oxygen and nitrogen)
   - Atmospheric pressure and temperature

2. Basic concepts of meteorology
   - Relative humidity
   - Dew point
   - Wind (e.g., how it is generated and modified)
   - Cloud types and formation
   - Types of precipitation (e.g., hail, rain)
   - Air masses, fronts, storms, and severe weather (e.g., hurricanes, tornadoes)
   - Development and movement of weather patterns
3. Major factors that affect climate and seasons
   - Effects of latitude, geographical location, and elevation (e.g., mountains and oceans)
   - Effects of atmospheric circulation (e.g., trade winds, jet stream)
   - Effects of ocean circulation
   - Characteristics and locations of climate zones (e.g., Tropics, Arctic)
   - Effect of the tilt of Earth's axis on seasons
   - Effects of natural phenomena (e.g., volcanic eruptions, solar radiation variations)
   - El Niño, La Niña

Astronomy

1. Major features of the solar system
   - Structure of the solar system
   - Laws of motion (e.g., gravitation, planetary orbits, satellites)
   - Characteristics of the Sun, Moon, and planets
   - Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
   - Theories of origin of the solar system
2. Interactions of the Earth-Moon-Sun system
   - Earth's rotation and orbital revolution around the Sun
   - Effect on seasons
   - Phases of the Moon
   - Effect on tides
   - Solar and lunar eclipses
   - Time zones
   - Effect of solar wind on Earth
3. Major features of the universe
   - Galaxies (e.g., definition, relative size, Milky Way)
   - Characteristics of stars and their life cycles
     - Life cycle of star (e.g., white dwarf, red giant, supernova, nebulae, black holes)
     - Color, temperature, apparent brightness, absolute brightness, luminosity
     - Hertzsprung-Russell diagrams
   - Dark matter
   - Theories about the origin of the universe (e.g., big bang)
4. Contributions of space exploration and technology to our understanding of the universe
   - Remote sensing devices (e.g., satellites, space probes, telescopes, spectral analysis)
   - Search for water and life on other planets

V. Science, Technology, and Society

1. Impact of science and technology on the environment and society
   - Air and water pollution (e.g., acid rain, eutrophication, groundwater pollution)
   - Climate change and greenhouse gases
   - Irrigation
   - Reservoirs and levees
   - Depletion of aquifers
   - Ozone layer depletion
   - Loss of biodiversity
   - Space exploration
   - Waste disposal (e.g., landfills)
   - Recycling
   - Environmentally friendly consumer products (e.g., biodegradable materials)
2. Major issues associated with energy production and the management of natural resources
   - Renewable and nonrenewable energy resources
   - Conservation and recycling
   - Pros and cons of power generation based on various resources including fossil and nuclear fuel, hydropower, wind power, solar power, geothermal power and alternative energy sources
   - Issues associated with the use and extraction of Earth's resources (e.g., mining, land reclamation, deforestation)

3. Applications of science and technology in daily life
   - Chemical properties of household products
   - Communication (e.g., wireless devices, GPS, satellites)
   - Science principles applied in commonly used consumer products (e.g., batteries, lasers, polarized sunglasses, and fiber optic cables)
   - Water purification
   - Common agricultural practices (e.g., genetically modified crops, use of herbicides and insecticides)
   - DNA evidence in criminal investigations
   - Nanotechnology
4. Is familiar with the impact of science on public health issues
   - Nutrition, disease, and medicine (e.g., vitamins, viruses, vaccines)
   - Biotechnology (e.g., genetic engineering, *in vitro* fertilization)
   - Medical technologies (e.g., medical imaging, X-rays, radiation therapy)

Sample Test Questions

The sample questions that follow illustrate the kinds of questions in the test. They are not, however, representative of the entire scope of the test in either content or difficulty. Answers with explanations follow the questions.

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

1. Which of the following poses the greatest safety risk while being heated in a school laboratory?

   (A) A mixture of iron and sulfur

   (B) Mercury(II) oxide

   (C) Sodium chloride

   (D) Copper(II) sulfate hydrate

2. A piece of paper that appears blue in sunlight is illuminated solely by a red light that is passed through a green filter. What color does the paper appear under this illumination?

   (A) Blue

   (B) Green

   (C) Red

   (D) Black

3. What quantity of oxygen, O_2, contains very nearly the same number of molecules as 36.0 grams of water, H_2O?

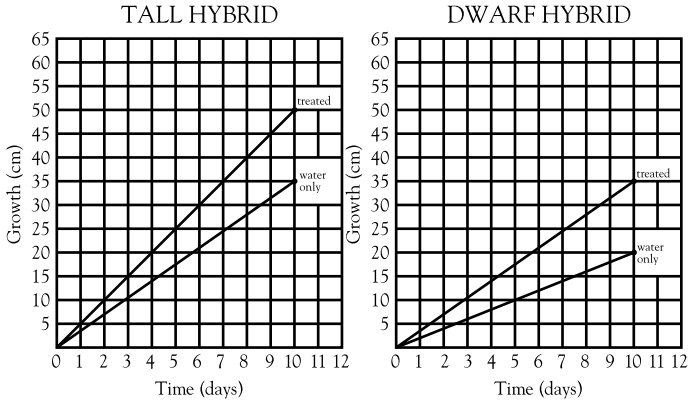
   (A) 64.0 grams

   (B) 32.0 grams

   (C) 16.0 grams

   (D) 8.0 grams

In an experiment to study the effect of a new fertilizer on the growth of tall hybrid corn and dwarf hybrid corn, from immediately after germination to ten days of growth, the data below were obtained. Other growing conditions such as water and sunlight were the same for both groups.



4. Which of the following is the most reasonable conclusion that can be drawn from the data above?

   (A) The new fertilizer influences the growth of both corn varieties tested.

   (B) The new fertilizer causes faster growth rate for both varieties than do other fertilizers.

   (C) The new fertilizer improves the root system of the tall hybrid to a greater extent than it does that of the dwarf hybrid.

   (D) The new fertilizer is effective in producing faster growth for both varieties for the first ten days only.

5. A person heterozygous for the recessive gene for cystic fibrosis marries a person who does not carry or have the trait (homozygous dominant). What is the probability that the couple's first child will be a carrier?

   (A) 0.0

   (B) 0.25

   (C) 0.50

   (D) 1.0

6. Which of the following is matched with its correct function?

   (A) Ovule ..... production of pollen

   (B) Vascular cambium ..... formation of apical meristem

   (C) Xylem ..... transport of sugars

   (D) Guard cell ..... regulation of transpiration rate

7. Scientists believe that a worldwide catastrophic event occurred during the late Cretaceous period and that this event likely caused which of the following?

   (A) The movement of aquatic animals onto land

   (B) The sudden demise of the dinosaurs

   (C) The emergence of Homo sapiens on the grasslands of Africa

   (D) The first appearance of mammals

8. Earth's seasons are caused by which of the following?

   (A) The tilt of the Earth's axis of rotation relative to the ecliptic as Earth revolves around the Sun

   (B) The varying amount of sunspot activity

   (C) The Earth's orbit about the Sun as an ellipse rather than a circle

   (D) The rotation of the Earth during a 24-hour day

9. If each of the following meals provides the same number of calories, which meal requires the most land to produce the food?

   (A) Red beans and rice

   (B) Steak and a baked potato

   (C) Corn tortilla and refried beans

   (D) Lentil soup and brown bread

10. Which of the following is most likely to cause a rise in the average temperature of Earth's atmosphere in the future?

    (A) Atomic warfare

    (B) CO_2 from fossil fuels

    (C) Dust clouds from volcanoes

    (D) Depletion of the Earth's ozone layer

11. The symbol for a specific isotope of gold is $^{197}_{79}\text{Au}$. Which of the following is consistent with this symbol?

    (A) 197 neutrons in the nucleus

    (B) 79 neutrons in the nucleus

    (C) 118 protons in the nucleus of each of its atoms

    (D) 79 electrons in a neutral atom

12. Which of the following statements is correct about a trophic structure in which a leaf-eating grasshopper is eaten by a frog, which in turn is eaten by a snake?

    (A) The frog is a herbivore.

    (B) The snake is a secondary consumer.

    (C) The grasshopper is a primary consumer.

    (D) The snakes outnumber the grasshoppers in the community.

13. The accumulation of stress along the boundaries of lithospheric plates results in which of the following?

    (A) Earthquakes

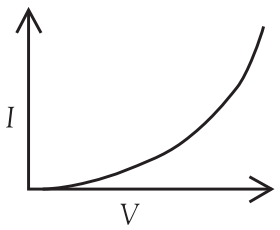
    (B) Magnetic reversals

    (C) Hurricanes

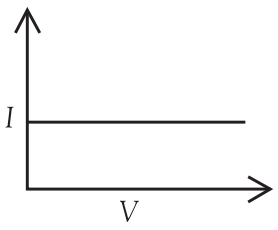
    (D) Increased deposition of deep-sea sediments

14. Which of the following graphs illustrates the operation of Ohm's law for a conductor that has constant resistance?

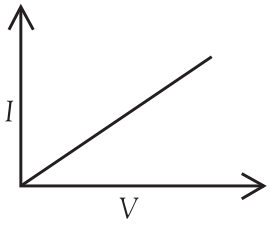
(A)



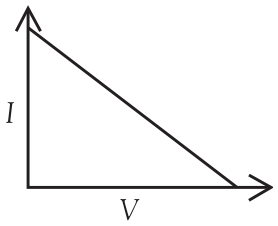
(B)



(C)



(D)



15. Which of the following elements is a metal?

(A) S
(B) Se
(C) I
(D) Ga

16. How many moles of HCl must be added to sufficient water to form 3 liters of a 2 M HCl solution?

(A) 1 mol
(B) 2 mol
(C) 3 mol
(D) 6 mol

17. When a gas turns into a liquid, the process is called

(A) condensation
(B) evaporation
(C) deposition
(D) sublimation

18. When cool air flows from a high mountain region to a region of lower elevation, the air will

(A) increase in moisture content
(B) condense, forming large amounts of dew
(C) undergo adiabatic warming
(D) undergo adiabatic cooling

19. Animals in which of the following groups may have a backbone and a spinal cord?

(A) Mollusks
(B) Chordates
(C) Invertebrates
(D) Echinoderms

20. Polarized sunglasses are used to cut glare from sunlight reflected at a glancing angle off cars, water, and other surfaces. Such sunglasses are a practical application of which of the following physical principles?

(A) Brewster's law
(B) Lenz's law
(C) Coulomb's law
(D) Snell's law

21. Which of the following parts of the Sun is easily visible only during a total solar eclipse?

(A) Core
(B) Photosphere
(C) Sunspots
(D) Corona

22. If equal and opposite charges are placed on the two plates of a parallel plate capacitor and the plates are then moved apart, which of the following remain(s) constant?

I. Voltage
II. Capacitance
III. Charge

(A) I only
(B) II only
(C) III only
(D) I and II only

23. The true length of a block of wood is 1.010 cm. Three measurements of this block produced the following values: 1.4 cm, 1.2 cm, and 0.9 cm. Which of the following statements is true concerning these measurements?

(A) They are precise and accurate.
(B) They are precise but not accurate.
(C) The are accurate but not precise.
(D) They are neither precise nor accurate.

24. Which of the following items will be attracted to the north pole of a permanent magnet by a magnetic force?

(A) The north pole of another permanent magnet
(B) A piece of iron that is not a permanent magnet
(C) A positively charged glass rod
(D) A negatively charged rubber rod

Answers

1. The best answer is B. Mercury(II) oxide breaks down on heating to metallic mercury and oxygen. Mercury vapor that is given off is highly toxic when inhaled or absorbed through the skin, and exposure to mercury in a school should be greatly limited if not eliminated altogether.

2. The correct answer is D. The green filter absorbs all colors except green, which it passes. Therefore, the red light will be absorbed by the filter, which will pass no light. The paper will not be illuminated, and so it will appear black, regardless of its initial color.

3. The correct answer is A. 36 grams of water is 2 moles (2 X 18 grams). A 2-mole sample of O_2 contains the same number of molecules as does 2 moles of any other substance. A 2-mole sample of O_2 would have a mass of 2 X 32.0 grams = 64.0 grams.

4. The correct answer is A. The graphs indicate more rapid growth for the treated samples than for the untreated samples in both corn varieties. The other options describe results not tested in the experiments and so not indicated by the data.

5. The correct answer is C. One parent will have the genotype CC and the other parent will have the genotype Cc. The possible genotypes of the offspring are, therefore, CC, CC, Cc, and Cc. Thus, 50 percent of the offspring will be homozygous dominant and 50 percent will be heterozygous and carriers.

6. The correct answer is D. Stomata open and close due to the changing shape of the guard cells. Water exits freely through the stomata when they are open.

7. The correct answer is B. The sudden disappearance of 90 percent of the dinosaur species occurred about 60 million years ago. Recent chemical evidence points to a catastrophic event, such as a large impact, occurring at that time.

8. The correct answer is A. Seasons are best explained as resulting from the Earth's axial tilt and not from distance variations, sunspot activity, atmospheric transparency, or rotation.

9. The correct answer is B. Energy is lost as matter is transferred from one trophic level to another. It takes more land to produce the energy in steak than it does to produce the same amount of energy in food from plants. Therefore, choices A, C, and D are incorrect because these foods are derived from the primary producers (plants) only.

10. The correct answer is B. Increased carbon dioxide (a greenhouse gas) in the atmosphere will probably result in global warming. Atomic warfare would more likely result in a "nuclear winter." Volcanoes would probably cause cooling due to high atmospheric dust absorbing the Sun's rays so they cannot reach the ground. The depletion of the ozone layer will let more ultraviolet radiation through the atmosphere but in itself should not cause warming.

11. The correct answer is D. The numbers before the symbol for an element have the following meanings:

Top number: isotopic mass = the sum of the number of protons plus the number of neutrons in the nucleus of each of its atoms.

Bottom number: atomic number = the number of protons in the nucleus of each of its atoms.

Thus, each nucleus of this isotope contains 79 protons and 197 – 79 = 118 neutrons. In a neutral atom, the number of electrons is equal to the number of protons, 79 in this case.

12. The correct answer is C. The grasshopper is the herbivore and thus the primary consumer.

13. The correct answer is A. Earthquakes are the abrupt release of energy that occurs when a rock under stress fractures and displacement occurs.

14. The correct answer is C. Ohm's law is stated V = IR or I = V/R, which is the equation of a straight line through the origin, with I increasing as V increases.

15. The correct answer is D. The element Ga is a metal. S, Se, and I are nonmetals.

16. The correct answer is D. A concentration of 2 M means there are 2 moles of HCl per liter of water. So 6 moles of HCl must be added to sufficient water to form 3 liters of a 2 M HCl solution.

17. The correct answer is A. When a gas turns into a liquid, the process is called condensation.

18. The correct answer is C. When cool air flows from a high mountain region to a region of lower elevation, the air undergoes adiabatic warming. Adiabatic warming occurs as the pressure of the air is increased as it descends.

19. The correct answer is B. Most chordates posses a vertebral column (backbone) that surrounds a dorsal nerve cord. Mollusks (e.g., clams and mussels) and echinoderms (e.g., sea stars and sea urchins) are invertebrates that lack a vertebral column and dorsal nerve cord.

20. The correct answer is A. According to Brewster's law, reflected light will always be polarized in a horizontal direction, parallel to the reflecting surface. Polarized sunglasses are constructed to block this reflected light and to transmit light polarized only in the vertical direction.

21. The correct answer is D. The Sun's corona has extremely low density and is visible only during a total solar eclipse.

22. The correct answer is C. The capacitance C of a parallel plate capacitor decreases as the distance between the plates increases. The charge Q on the plates is isolated and will not change. By the definition of capacitance, namely $C = Q/V$, the voltage V will increase, since C decreases and Q remains constant.

23. The correct answer is D. The measurements differ from the true length by 0.39 cm, 0.19 cm, and -0.11 cm. Thus, the measurements are quite different in value from the true value, which means that they are not accurate. The measurements are also quite different in value from one another (not repeatable), which means that they are not precise.

24. The correct answer is B. Iron is easily magnetized. When iron is brought close to a permanent magnet, the iron will become magnetized in such a way as to be attracted to the permanent magnet.

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