

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 Questions
	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. The development of the test questions and the construction of the test reflect the National Science Education Standards and recognize that there are conceptual and procedural schemes that unify the various scientific disciplines. The 120 multiple-choice questions assess knowledge of fundamental scientific concepts, principles, phenomena, and interrelationships. Some questions may integrate concepts from more than one category. In general, questions focus on examinees' ability to define terms, comprehend critical concepts, apply knowledge, and analyze content to address and solve problems.

The test covers scientific methodology, techniques, and history; the physical sciences, the life sciences; the earth sciences; and science, technology, and society.

To communicate an accurate understanding of various science fields to secondary school students, teachers need to understand the subject matter from a more advanced viewpoint than that actually presented to the students. Accordingly, some questions of a more advanced nature are included. These questions cover topics that examinees will have studied in freshman college-level courses in physics, chemistry, life science, and earth science.

This test may contain some questions that will not count toward your score.

Topics Covered

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

I. Science Methodology, Techniques, and History

- Nature of scientific knowledge, inquiry, and historical perspectives: scientific methods and processes; facts, models, theories, and laws; historical roots of science, and contributions made by major historical figures
- Mathematics, measurement, and data manipulation: measurement and notation systems; data presentation and interpretation, including error analysis
- Laboratory procedures and safety: techniques of safe preparation, storage, use, and disposal of laboratory and field materials; selection and use of appropriate laboratory equipment

II. The Physical Sciences

Basic Principles

- Matter and energy: structure and properties of matter, occurrence and abundance of elements, physical and chemical changes, forms and transformations of energy, conservation of mass and energy
- Heat and thermodynamics: thermal energy, measurement, transfer and effects on matter, first and second laws of thermodynamics
- Atomic and nuclear structure: atomic and nuclear structure and related chemical properties; nuclear transformations and characteristics of radioisotopes and radiation

Physics

- Mechanics: straight-line, projectile, circular, and periodic motion; Newton's laws of motion; work, energy, and power; simple machines; torque; friction; conservation of energy and momentum; gravity; Archimedes' principle and Bernoulli's principle
- Electricity and magnetism: characteristics of static and current electricity, electrical circuits, alternating and direct current, transformers and motors, sources of EMF, magnetism
- Waves: characteristics of transverse and longitudinal waves; reflection, refraction, diffraction, and interference; Doppler effect; sound; electromagnetic radiation; color; optics

Chemistry

- Periodicity: the periodic table, trends in chemical and physical properties
- The mole and chemical bonding: the mole concept, the formulas and nomenclature of inorganic and simple organic compounds, bonding, electron dot and structural formulas, chemical composition and stoichiometry
- The kinetic theory and states of matter: kinetic molecular theory, phase characteristics and transformations, gas laws, characteristics of crystals
- Chemical reactions: types of reactions; endothermic and exothermic reactions; effects of temperature, pressure, concentration, and presence of catalysts on reactions; practical applications of electrochemistry; balance chemical equations
- Solutions and solubility: types of solutions; solvents and the dissolving process; effects of temperature and pressure on solubility; acids, bases, and salts; pH; buffers

III. The Life Sciences

- The Cell: biologically important inorganic and organic molecules, structure and function of cells, cell organelles, cellular bioenergetics, the cell cycle and cytokinesis, meiosis and mitosis, homeostasis
- Molecular basis of heredity and classical genetics: DNA replication, protein synthesis, Mendelian and non-Mendelian inheritance, mutations and transposable elements, genetic engineering, human genetic disorders, recombinant DNA, mapping the human genome, the interaction between heredity and the environment
- Evolution: evidence, theories and patterns of evolution, factors affecting evolution, speciation, hypotheses relating to the origin of life
- Diversity of life: general characteristics, biological systems of classification, viruses, bacteria, protists, fungi, plants, and animals
- Plants: structure and function of roots, stems, and leaves; nonvascular plants; transport systems; control mechanisms; sexual and asexual reproduction
- Animals: anatomy and physiology of systems, homeostasis, response to stimuli
- Ecology: population dynamics, social behavior, interspecific relationships, community structure and species diversity, succession and disturbance, ecosystems, food webs and energy flow, biomes, biogeochemical cycles

IV. The Earth/Space Sciences

- Physical geology: minerals and rocks, folding and faulting, earthquakes and volcanoes, structure of Earth, plate tectonic theory and its supporting evidence, hydrologic cycle, weathering, erosional and depositional processes
- Historical geology: uniformitarianism, time scales, fossils and stratigraphy, Earth's history
- Oceanography: waves, tides, and currents; ocean floor and margins; chemistry of seawater; shore processes; nutrient cycles of the ocean
- Meteorology: structure and properties of the atmosphere; seasonal and latitudinal variation of solar radiation; heat budget; circulation patterns and winds; humidity, clouds, and precipitation; air masses, high and low pressure systems, frontal systems, maps, and forecasting; climate and climatic change
- Astronomy: theories of the origin and structure of the universe, origins and life cycles of stars, major features and structure of the solar system, Sun-Moon-Earth relationships, artificial satellites and space exploration, Earth's seasons, time zones, large units of distance, contributions of remote sensing

V. Science, Technology, and Society

- Impact of science and technology on the environment and human affairs
- Human and nature-induced hazards
- Issues and applications: production, use, management, and disposal of energy and consumer products, management of natural resources
- Social, political, ethical, and economic issues in science and technology
- Societal issues with health awareness and medical advances

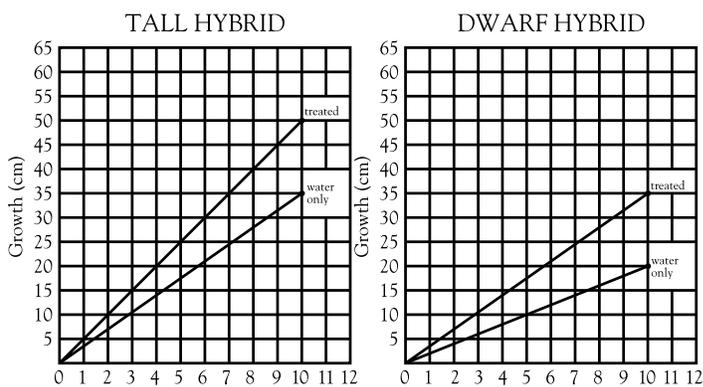
Sample Test Questions

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.

- Which of the following poses the greatest safety risk while being heated in a school laboratory?
 - A mixture of iron and sulfur
 - Mercury(II) oxide
 - Sodium chloride
 - Copper(II) sulfate hydrate
- 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?
 - Blue
 - Green
 - Red
 - Black
- What quantity of oxygen, O_2 , contains very nearly the same number of molecules as 36.0 grams of water, H_2O ?
 - 64.0 grams
 - 32.0 grams
 - 16.0 grams
 - 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.



- Which of the following is the most reasonable conclusion that can be drawn from the data above?
 - The new fertilizer influences the growth of both corn varieties tested.
 - The new fertilizer causes faster growth rate for both varieties than do other fertilizers.
 - The new fertilizer improves the root system of the tall hybrid to a greater extent than it does that of the dwarf hybrid.
 - The new fertilizer is effective in producing faster growth for both varieties for the first ten days only.
- 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?
 - 0.0
 - 0.25
 - 0.50
 - 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. One theory is that this event accounts for 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. The Earth's seasons can be attributed primarily to which of the following in conjunction with its revolution about the Sun?
- (A) The tilt of the Earth's axis of rotation relative to the ecliptic
 - (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 the Earth in the future?
- (A) Atomic warfare
 - (B) CO₂ 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) become turbulent as flow storms develop
 - (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) They 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 (2×18 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 2×32.0 grams = 64.0 grams.

4. The correct answer is A. Both graphs indicate more rapid growth for the treated samples than for the untreated samples. 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. On an acre of land there is more energy in plants than in herbivores, so 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 possess 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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