

# 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. 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.

## 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

## General Science: Content Knowledge (0435)

### 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

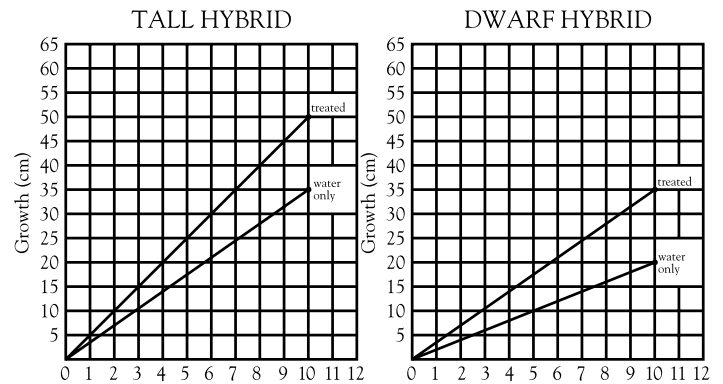
- Impact of science and technology on the environment and human affairs
- Human and nature-induced hazards
- Issues and applications: production, use, management, and disposal of energy and consumer products, management of natural resources
- Social, political, ethical, and economic issues in science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

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

Go on to the next page.

**Answers**

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) CO<sub>2</sub> from fossil fuels
  - (C) Dust clouds from volcanoes
  - (D) Depletion of the Earth's ozone layer

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 ( $2 \times 18$  grams). A 2-mole sample of O<sub>2</sub> contains the same number of molecules as does 2 moles of any other substance. A 2-mole sample of O<sub>2</sub> would have a mass of  $2 \times 32.0$  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 be 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.