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ABSTRACT

Beginning in the 1995-96 school year, the science test will be added to the Ninth-grade Proficiency Tests Program. Any student graduating after September 15, 2000 will be required to pass the Ninth-grade Proficiency Test in Science, as well as the other tests in reading, writing, mathematics, and citizenship. This fact sheet provides information about the Ninth-grade Proficiency Test in science. The multiple-choice test is based on 20 learning outcomes developed by a committee consisting primarily of Ohio educators and adopted in 1994 by the State Board of Education. About 40% of the questions deal with acquiring scientific knowledge, and another 40% focus on processing scientific knowledge. The remaining 20% pertain to extending scientific knowledge, and test students' ability to apply knowledge and conceptual understanding to new situations. Student performance is assessed along the four strands of life science, physical science, earth and space science, and the nature of science. The 20 learning outcomes and the knowledge students need to demonstrate for each are listed. A field test of 10 items from the science assessment in 1994 indicated areas of high and low student performance. (SLD)

Ohio Proficiency Tests for Grade 9

Writing • Reading • Mathematics • Citizenship • Science

Fact Sheet

Ninth-Grade Proficiency Test in Science

INTRODUCTION

Beginning in the 1995-96 school year, the science test will be added to the Ninth-grade Proficiency Tests Program. In the 1995-96 and the 1996-97 school year, the science test will be administered only once a year in March. Beginning in the 1997-98 school year, the science test will be administered twice a year. At that time, students who do not pass the science test the first time will have additional opportunities to pass the test. Any student graduating after September 15, 2000, will be required to pass the Ninth-grade Proficiency Test in science, as well in the other areas of reading, writing, mathematics, and citizenship and meet curriculum requirements in order to receive a diploma.

The purpose of this material is to provide information about the Ninth-grade Proficiency Test in science. The information included in this fact sheet applies to most test questions; however, the descriptions may not cover all questions that could be used on the test. Schools may use this information as they prepare students for this important statewide testing program.

LEARNING OUTCOMES

The ninth-grade science test is based upon twenty learning outcomes developed by a committee consisting primarily of Ohio educators and adopted in 1994 by the State Board of Education. The work of this committee was based on the Ohio Model Competency-Based Science program and other related documents. The science portion of the Ninth-grade Proficiency Tests emphasizes both scientific content and process. Questions developed from the learning outcomes emphasize basic facts, understanding of concepts, and ability to analyze and apply information in a given situation. The three types of questions that can be expected are described below.

<u>Acquiring Scientific Knowledge</u> (about 40% of the questions on the test)

Questions of this type test students' ability to make observations and collect and organize data. This may include the ability to make measurements; read graphs, charts, and tables; and classify objects on the basis of their characteristics.

Processing Scientific Knowledge (about 40% of the questions on the test)

Questions of this type test students' ability to interpret and analyze information. This may include the ability to make an inference from given information; recognize patterns and trends in data; and manipulate variables.

Extending Scientific Knowledge (about 20% of the questions on the test)

Questions of this type test students' ability to apply knowledge and conceptual understanding to new situations. This may include students' ability to develop models; draw conclusions; ask and evaluate questions; and make predictions.

The learning outcomes (in bold) and related information that follow describe the content for the science portion of the Ninth-grade Proficiency Tests. The indented, italicized information that follows each learning outcome is an example that provides further clarification of the learning outcome in non-science terms. It should become obvious that student preparation for the ninth-grade test is a process that begins in Kindergarten and first grade and continues through grade eight. The material for the ninth-grade test was drawn from grades six through eight in the Ohio Science Model. In general, this proficiency test is designed to assess long-term student learning—problem solving and thinking skills—and is not limited to rote knowledge and facts.

This type of learning, according to the Ohio Science Model, is best achieved through hands on experience, the use of authentic science sources including but not limited to library references, textbooks, on-line sources, experts, and long-term activities as students ask questions, collect and analyze data, and make decisions. In this view of science, students' reasons and processes to find answers are more important than their memory of facts. The more experience a student has with collecting and analyzing data and information, and justifying their answers, the better prepared that student is for the science test.

Two references that teachers should consider using when deciding how to teach science concepts at the right level for their students are the *Ohio Model Competency-Based Science Program* available from the ODE and *Benchmarks for Scientific Literacy* (Oxford University Press), available at your local bookstore. There are many additional resources available for this purpose. It should be noted, however, that many conceptual errors and misconceptions exist in science books including science textbooks. Using good research methods such as checking several sources is not only a good idea, it is excellent modeling for students.

The outcomes of the ninth-grade science proficiency test are designed to assess student performance along four strands of science:

- **Life Science**—Though life sciences are often the most familiar to us, these outcomes strike a balance between the life science concepts that are extremely complicated and laden with terminology with those that can be directly observed and explored by students. In these outcomes (13, 14, 15, 16 and 20), students' abilities to explain their choices and decisions are more important than their knowledge of terminology.

- **Physical Science**—Commonly thought of as physics and chemistry, physical science for this level includes the physical principles that can be observed and explored and the inferences that can be made based on concrete experiences in the classroom or witnessed by other means without complicated instrumentation or theories. Five outcomes (8, 9, 10, 11, and 12) are focused on this strand.

- **Earth and Space Science**—Many of the phenomena of earth science are either too slow or too large to witness directly in action. Instruction for these outcomes (5, 6, 7, and 18) generally involves events that students can witness either directly or indirectly through television or film. Using someone else's observations and inferences made based on evidence collected is also useful.

- **Nature of Science**—Built into this science test is an assessment of students' abilities and thinking habits in investigating science ideas. Six outcomes (1, 2, 3, 4, 17, and 19) in this strand overlap traditional science units and each other and should, therefore, be reinforced throughout the science curriculum—i.e., taught in context—at every grade level, in nearly every unit.

1. Devise a classification system for a set of objects or a group of organisms.

Use common characteristics to group items

Students should be familiar with methods of categorizing groups of objects and organisms based on their characteristics, such as simple dichotomous keys and the periodic table. Students should be able to evaluate classification schemes and identify the bases on which such schemes are developed. Students should practice following written directions, reading keys, and making simple keys in groups. Students should be able to improve and extend classification schemes given to them. The construction of simple keys and charts and students' use of keys in field guides and data in reference materials should be emphasized as students explore the natural world.

2. Distinguish between observation and inference given a representation of a scientific situation.

Tell the difference between facts and assumptions

Students should understand the difference between something that is directly observable using their own senses and something that may be inferred based on observed or given information. Students should also be able to look at other people's statements and decide whether or not they are inference or observations. For example, students should be able to distinguish between an observation (e.g., rocks sink in water) and an inference (e.g., rocks are more dense than water). By the ninth grade, students should be making inferences about the meaning of observations they have made, use these inferences to design questions and simple tests to verify their inferences, and analyze a series of observations to judge the validity of inferences made in a scientific situation.

3. Identify and apply science safety procedures.

Identify the safety precautions needed when doing an experiment

A discussion of needed safety precautions and modeling by the teacher should be a part of any science activity. Students should be able to anticipate the need for and be familiar with the use of common laboratory safety equipment, such as safety goggles, and safety procedures as they relate to personal and group safety. Students should be able to identify, and if necessary practice, the safety precautions needed in given classroom situations and school field studies. There are many safety guides and resources, including the science model, to help teachers think through these issues.

4. Demonstrate an understanding of the use of measuring devices and report data in appropriate units.

Choose an instrument to make a certain measurement

Students should be familiar with using common laboratory equipment in and out of the class, such as scales, thermometers, balances, graduated cylinders, and rulers. Experience using the SI or metric system of measurement is critical preparation for this outcome. The conversion of units between systems is not necessary. Student's ability to use units of measure depends on the ability to think in those units, not in the ability to convert them.

5. **Describe the results of earth-changing processes.**

Describe changes taking place in the Earth's surface

Students should be familiar with the theory and processes of weathering, erosion, glaciation, rock formation, and plate tectonics (vulcanism, earthquakes, rifting, mountain building, etc.). Students should understand how earth-changing processes are reflected in the land forms of the Earth's surface as presented in common situations or on maps and diagrams. By this level, students can begin to make and test inferences about earth changes observed in person or using photographic methods in real time or time lapse. Students can begin to make inferences about effects over time.

6. **Apply concepts of the Earth's rotation, tilt and revolution to an understanding of time and season.**

Explain how seasons change

Students should be familiar with the concepts of the tilt of Earth's axis, time of rotation and revolution, and orbital shape. Students should be able to relate these concepts to an understanding of seasons and how these factors influence our definition of time. Sun, Earth, and moon phenomena and arrangements can be simulated using models. Students should discuss the limitations and effectiveness of these models as a tool for accurately explaining and reinforcing their experiences with these arrangements and phenomena.

7. **Describe interactions of matter and energy throughout the lithosphere, hydrosphere, and atmosphere.**

Explain materials cycles (water, carbon, nitrogen), currents,
and weather on the land, in the water, and in the air

Students should be familiar with the concepts of weather and climate; the water, carbon, nitrogen and rock cycles; currents, including ocean currents and convection currents; and tides in relevant contexts from written passages, diagrams, pictures, charts, maps, graphs, and tables. Cycling of resources is best thought of as accounting for matter as it changes form and character. Student experience should include providing interpretations and justifications that account for observed changes in matter, de-emphasizing terminology that is not experiential in nature. Instruction for this outcome relies on a student's ability to interpret observations made over a long period of time by themselves or others.

8. Apply the use of simple machines to practical situations.

Describe how a lever or pulley can make a task easier

Students should have a basic understanding of how simple machines, such as levers, pulley systems, and inclined planes, change the effort and distance through which work is done. The simple principle that "You don't get something for nothing" is important here. Students should be able to apply the use of these machines to simple, practical situations as shown in pictures, diagrams, and charts. Students should discuss the advantages and disadvantages of many simple technological devices as they explore the functions of those devices in relevant contexts. It is much less important that students name devices or know terms than they be able to use these terms to justify decisions they make and ideas they propose.

9. Apply the concept of force and mass to predict the motion of objects.

Describe the motion of a thrown ball

Students should be familiar with the relationship between the change in motion of an object, the force applied to the object, and the mass of the object. This includes how Newton's three laws of motion relate to the motion of familiar objects. Those students best prepared for this outcome are those who have observed many moving things, controlled and explained why they moved, why changes occur in the way they move, and why they have stopped.

10. Apply the concepts of energy transformations in electrical and mechanical systems.

Describe how the energy in a flashlight battery is transformed into heat and light

Students should be familiar with the concept of energy transformation. Students should be able to distinguish between different forms of energy, such as chemical, electrical, and heat; potential and kinetic. Students will be familiar with the conservation of energy, the major sources of energy, and the major losses of energy from different systems. Students should practice observing, controlling, and explaining how energy has changed in many systems and events they can sense in their surroundings. The specific names for the types of energy will be learned as students use them in these explanations.

11. Apply concepts of sound and light waves to everyday situations.

Describe how light and sound travel through different materials

Students should be familiar with models of sound and light waves. This includes experientially grounded understanding of the concepts of frequency, wavelength, speed, energy, refraction, and reflection. Students should be able to compare and contrast how different forms of wave energy are produced, transferred, and detected. For example, explorations of light and sound contribute to explanations of why we are able to see and hear. Contrasted with how other living things see and hear can be an engaging way in which to explore this concept. Additional effective investigations and analyses of relevant applications would include, but are not limited to, simple optical devices and acoustical systems, waves in/on water, music, and noise.

12. Describe chemical and/or physical interactions of matter.

Describe how a cube of sugar dissolves in water, how metals rust, and how things burn

Students should be familiar with the concept of matter. Students should understand basic physical and chemical properties of matter, including phases, and be able to distinguish between a physical change and a chemical change. Students should be familiar with models of atomic and molecular structure, and understand how these models can be used to explain the structure and interactions of matter. Simple physical changes, in general, do not result in irreversible changes in the properties of matter. Students learn this concept by using the term "physical change" in their observations and analyses of things and events. Making note of changes in things such as size, phase, and mass in explanations of witnessed events will provide reinforcement for the concept of physical change. Simple chemical changes are very difficult to reverse, and usually result in a change in the properties of the material. Often chemical changes give off or absorb heat on their own. Common devices such as chemical cold or heat packs are in the range of student experience for this outcome. It is important that students look at the characteristics of something before and after an event and that they use this analysis to decide whether a change is chemical or physical.

13. Trace the flow of energy and/or interrelationships of organisms in an ecosystem.

Identify the food chain in a lake

Students should be familiar with the concept of ecosystems. Through multiple investigations of energy flow in living system processes, students will become experienced accounting for energy, illustrating that it is always conserved. This includes food pyramids, food webs and chains; the different types of interactions between organisms; and how energy and matter are transferred through an ecosystem. For example, students should be able to illustrate energy gain directly or indirectly from the sun; energy stored in chemical bonds in food; energy transformed as organisms consume food; and energy diminishing in usefulness when lost as heat.

14. Compare and contrast the characteristics of plants and animals.

Tell how plants and animals are alike and different

Students should be familiar with the similarities and differences between plants and animals at various levels of organization. At the cellular level, the emphasis will be on those characteristics that may be seen with the light microscope. At the organism level, students can explore how plants and animals use distinctly different strategies for survival. Instruction for this outcome should focus on this contrast, including but not limited to the many ways different organisms adapt for changing seasons and different environments to meet basic biological needs. Based on experiences at home or in the classroom for example, students should be able to discuss how to grow something or to keep something alive.

15. Explain biological diversity in terms of the transmission of genetic characteristics.

Explain why there are different breeds of dogs or kinds of plants

Students should be familiar with concepts related to population biology, including adaptation and offspring variability, and how different modes of reproduction affect genetic variability within a population or generation. Beyond the contrast of differences, many strategies for passing along genetic traits can be found among living things. Similarities and differences within and between species can be explored, using simulations and models. Concepts covered include Mendelian genetics and natural selection.

16. Describe how organisms accomplish basic life functions at various levels of organization and structure.

Describe a life function like digestion complete with the appropriate anatomy

Students should be familiar with how plants and animals accomplish basic life functions, such as respiration, reproduction, growth and development, energy use, circulation, digestion, excretion, and photosynthesis at various levels of organization. The association or lack of association between anatomy and life activity is included in this concept. Students should be investigating the principles that describe and predict behavior and functions of organisms, using models and analogies to draw comparisons and illustrate similarities. For example, populations of organisms may exhibit group behavior to accomplish life functions that can be explored (e.g., herding, migration); and for a single organism, cells, tissues, organs, and systems (e.g., circulatory, nervous) contribute individually and collectively to life functions for that organism.

17. Describe the ways scientific ideas have changed using historical contexts.

Describe how explanations of eclipses have changed over time

Students should have an understanding of the tentative nature of science knowledge, including how and why scientific theories and methods have changed over time. For example, these may include, but are not limited to, models of the solar system, germ theory, models of the atom, heat, elements, and genetics. The study of the history of science helps students to connect significant examples of how the weight of accumulated evidence, technology, and creative thinking have overcome some of the constraints that have affected scientific thinking throughout the years. The focus of this outcome is on the dynamic nature of the scientific endeavor to constantly refine and extend scientific knowledge, not on historical facts such as names and dates.

18. Compare renewable and nonrenewable resources and strategies for managing them.

Compare oil and sunlight as sources of energy

Students should be familiar with and be able to identify renewable and nonrenewable resources (includes energy sources). Students should be able to relate resource use to existing supplies and be able to apply appropriate management strategies, such as conservation and recycling. Students should be able to recognize and discuss the trade-offs (including risks and benefits) represented as humans act to consume and/or conserve natural resources, while differentiating this analysis from how social pressure and advertising may impact actions. The conservation or accounting of energy in a system is the focus of this outcome.

19. Describe the relationship between technology and science.

How do science and inventions affect each other?

Students should understand the interactions between science and technology in society. They should be able to recognize advantages, disadvantages, and limitations of human actions intended to research, reshape, and control nature and the environment. For example, students should understand how electrical devices and energy sources may affect human health. Over time, students who are actively engaged and/or conducting research in numerous applications of science and technology in society should be expected to discuss and illustrate trade-offs and risks and benefits inherent in their explorations from a personal, local, and global perspective.

20. Describe how a given environmental change affects an ecosystem.

Describe how a flood or drought affects plant and animal life

Students should understand how environmental changes, both living and non-living, may affect an ecosystem. This may include species introductions, extinction, pollution, biological magnification, and changes in abiotic factors, such as rainfall, temperature, and light availability. Simulations and case studies offer opportunities to obtain and study data related to understanding this outcome. Both long-term and short-term changes and effects may be discussed. Examples may be taken from natural influences such as weather catastrophes on the local or global scale, or human influences such as pollution over a period of years.

ITEM DISTRIBUTION

The test questions will be distributed over four strands as follows:

Strand	Learning Outcomes
Life Science	13, 14, 15, 16, and 20
Physical Science	8, 9, 10, 11, and 12
Earth Science	5, 6, 7, and 18
Nature of Science	1, 2, 3, 4, 17, and 19

Each operational form of the science test will consist of 45 multiple-choice questions (5 of which are embedded field test questions and will not be counted in the student's score). Most learning outcomes will be assessed on each form of the test. The following table shows the possible numbers of questions in each area.

Strands	Acquiring Scientific Knowledge	Processing Scientific Knowledge	Extending Scientific Knowledge	Totals	Approximate % of Test
Life Science	3 - 5	3 - 5	1 - 3	9 - 11	25%
Physical Science	3 - 5	3 - 5	1 - 3	9 - 11	25%
Earth/Space Science	3 - 5	3 - 5	1 - 3	9 - 11	25%
Nature of Science	3 - 5	3 - 5	1 - 3	9 - 11	25%
Totals	14 - 18	14 - 18	7 - 9	40	100%
Approximate % of Test	40%	40%	20%	100%	

FACTS FROM THE NINTH-GRADE PROFICIENCY *FIELD TEST*

Test questions based on the science learning outcomes were field tested in the fall of 1994. While the number of students responding to each test item was limited, some general observations regarding student achievement can be made.

- Student performance was highest on questions measuring outcomes 3, 4, and 7.
- Student performance was lowest on questions measuring outcomes 2, 10, and 20.

ADDITIONAL INFORMATION

- The questions will be grouped into two types:

  1) a reading selection (passage) that may contain tables, charts, or figures followed by a series of related questions. This type of question will comprise 80% of the test questions.

  2) questions that can be answered without referring to a reading selection. The stand-alone questions will comprise 20% of the test questions.

- Each test question will have four answer choices, but only one answer will be correct. There will not be a penalty for choosing an incorrect answer.

- While most questions will require students to interpret/analyze and apply information given to them, some questions may require students to recall specific information.

- Students will not be permitted to use references or tools other than pencils on this test.

- Students will have a maximum of two and one-half hours to finish the test. Most students will be able to complete the test within an hour.

- Charts, maps, and other materials in the classroom that could assist students with the test questions will need to be covered or removed during test administration.

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