Physical Science 6-12 Standards

FINAL

Approved on October 6, 2000

SCIENCE STANDARDS

Standard I. The science teacher manages classroom, field, and laboratory activities to ensure the safety of all students and the ethical care and treatment of organisms and specimens.

Standard II. The science teacher understands the correct use of tools, materials, equipment, and technologies.

Standard III. The science teacher understands the process of scientific inquiry and its role in science instruction.

Standard IV. The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.

Standard V. The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.

Standard VI. The science teacher understands the history and nature of science.

Standard VII. The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.

Standard VIII. The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.

Standard IX. *Teachers of physical science are not responsible for this standard.*

Standard X. *Teachers of physical science are not responsible for this standard.*

Standard XI. The science teacher knows unifying concepts and processes that are common to all sciences.

Standard I. **The science teacher manages classroom, field, and laboratory activities to ensure the safety of all students and the ethical care and treatment of organisms and specimens.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

1.1k safety regulations and guidelines for science facilities;

1.2k safety regulations and guidelines for science instruction;

1.3k procedures for the appropriate storage, handling, use, disposal, care, and maintenance of chemicals, materials, specimens, and equipment;

1.4k sources of information about laboratory safety;

1.5k procedures for the safe handling and ethical care and treatment of organisms and specimens;

1.6k procedures for responding to an accident in the laboratory, including first aid;

1.7k legal issues associated with accidents and injuries that occur in the classroom, field, or laboratory;

1.8k potential safety hazards in the field (e.g., insect bites, poisonous plants); and

1.9k the importance of providing laboratory space and equipment for all students, including those with special needs.

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

1.1s employ safe practices in designing, planning, and implementing all instructional activities (e.g., laboratory, field, demonstrations);

1.2s determine sufficient space and classroom arrangement for carrying out laboratory activities;

1.3s provide students with continuous instruction and training in safe techniques and procedures for all laboratory and field activities, student demonstrations, and independent projects;

1.4s read and interpret safety information about chemicals on a Materials Safety Data Sheet (MSDS) and on other chemical labels, including household products;

1.5s check equipment for safety (e.g., cracks in glassware, proper grounding of electrical equipment) prior to use;

1.6s create, implement, and enforce rules and safety procedures to promote and maintain a safe learning environment during laboratory and field activities;

1.7s implement regular procedures to inventory and maintain appropriate safety equipment; and

1.8s optimize quick and safe access to all safety equipment (e.g., eyewash station, sink, safety shower, fire blanket, and extinguisher).

Standard II. **The science teacher understands the correct use of tools, materials, equipment, and technologies.**

Teacher Knowledge: What Teachers Know	**Application: What Teachers Can Do**
Teachers of Students in Grades 6–12	***Teachers of Students in Grades 6–12***
The beginning teacher knows and understands:	The beginning teacher is able to:
2.1k procedures for the storing, securing, and routine maintenance of scientific equipment used in instructional activities;	2.1s select and use appropriate tools, technology, materials, and equipment needed for instructional activities;
2.2k correct and safe operating procedures for scientific equipment used in instructional activities;	2.2s instruct and monitor students' use of materials, tools, and instruments;
2.3k concepts of precision, accuracy, and error with regard to reading and recording numerical data from a scientific instrument;	2.3s make science resources accessible to all students;
2.4k the international system of measurement (i.e., metric system);	2.4s recycle, reuse, and conserve laboratory resources as appropriate;
2.5k the use of grade-appropriate equipment and technology for gathering, analyzing, and reporting data; and	2.5s use the appropriate number of significant figures to record and report numerical data;
2.6k the use of technology to acquire, assess, analyze, interpret, and communicate information.	2.6s perform unit conversions within the international system of measurement (i.e., metric system);
	2.7s perform conversions within and across measurement systems;
	2.8s use techniques to calibrate measuring devices as appropriate;
	2.9s organize, display, and communicate data in a variety of ways (e.g., charts, tables, graphs, diagrams, written reports, oral presentations);
	2.10s gather, organize, display, and communicate data using appropriate technology (e.g., Internet, graphing calculators, spreadsheets); and
	2.11s evaluate the validity of data and data sources.

Standard III. **The science teacher understands the process of scientific inquiry and its role in science instruction.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

3.1k how scientists use different types of investigation, depending on the questions they are trying to answer;

3.2k principles and procedures for designing and conducting an inquiry-based scientific investigation (such as making observations; asking questions; researching and reviewing current knowledge in light of experimental evidence; using tools to gather and analyze evidence; proposing answers, explanations, and predictions; and communicating results);

3.3k the characteristics of various types of scientific investigations (e.g., descriptive studies, controlled experiments, comparative data analysis);

3.4k how current knowledge and theories guide scientific investigations;

3.5k the use of technology in scientific research; and

3.6k appropriate methods of statistical analysis and measures (e.g., mean, median, mode, correlation).

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

3.1s design and conduct inquiry-based scientific investigations, including nonexperimental and experimental designs;

3.2s plan and implement instruction that provides opportunities for all students to engage in scientific inquiry by using various appropriate combinations of the following processes:

- ask a scientific question;
- formulate a testable hypothesis;
- select appropriate equipment and technology for gathering information related to the hypothesis;
- make observations and collect data taking accurate and precise measurements;
- organize, analyze, and evaluate data to find data trends and patterns and make inferences; and
- communicate and defend a valid conclusion about the hypothesis under investigation;

3.3s link inquiry investigations to students' prior knowledge and experience;

3.4s focus inquiry-based instruction on questions and issues that are relevant to students;

3.5s use strategies to assist students in identifying, refining, and focusing scientific ideas and questions guiding an inquiry activity (i.e., an inquiry-based scientific investigation);

3.6s guide students in making systematic observations and measurements;

3.7s use a variety of tools and techniques to access, gather, store, retrieve, organize, and analyze data;

Application: What Teachers Can Do

Teachers of Students in Grades EC–12 (continued)

Standard III. **The science teacher understands the process of scientific inquiry and its role in science instruction.**

	Application: What Teachers Can Do ***Teachers of Students in Grades 6–12 (continued)*** 3.8s provide opportunities for students to use higher-order thinking skills, logical reasoning, and scientific problem solving to reach conclusions based on evidence; 3.9s develop, analyze, and evaluate different explanations for a given scientific result; 3.10s identify potential sources of error in a given inquiry-based investigation; and 3.12s develop criteria for assessing student participation in and understanding of the inquiry process.

***Standard IV*. The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

4.1k theories about how students develop scientific understanding;

4.2k how the developmental characteristics of students influence science learning;

4.3k the statewide curriculum as defined in the Texas Essential Knowledge and Skills (TEKS);

4.4k methods of planning and implementing an inquiry-based science program;

4.5k how students' prior knowledge and attitudes about science may affect their learning;

4.6k common student misconceptions in science and effective ways to address these misconceptions;

4.7k how to establish a collaborative scientific community among students that supports actively engaged learning;

4.8k the importance of planning activities that are inclusive and accommodate the needs of all students;

4.9k strategies that students with diverse strengths and needs can use to determine word meaning in content-related texts;

4.10k strategies that students with diverse strengths and needs can use to develop content-area vocabulary;

4.11k strategies that students with diverse strengths and needs can use to facilitate comprehension before, during, and after reading content-related texts;

4.12k the design and management of learning environments that provide the time, space, and resources needed for learning science;

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

4.1s use lab and field investigations to enable students to develop an understanding of science;

4.2s sequence learning activities in a way that allows students to build upon their prior knowledge and challenges them to expand their understanding of science;

4.3s model active learning and inquiry processes for students;

4.4s encourage students' self-motivation in their own learning;

4.5s display and model scientific attributes, such as curiosity, openness to new ideas, and skepticism;

4.6s design and adapt curricula and select content to meet the interests, knowledge, understanding, abilities, experiences, and needs of students;

4.7s use a variety of instructional strategies to ensure all students' reading comprehension of content-related texts, including helping students link the content of texts to their lives and connect related ideas across different texts;

4.8s teach students how to locate, retrieve, and retain content-related information from a range of texts and technologies;

4.9s teach students how to locate the meanings and pronunciations of unfamiliar content-related words using appropriate sources, such as dictionaries, thesauruses, and glossaries;

4.10s use questioning strategies to move students from concrete to more abstract understanding;

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades EC–12 (continued)

Application: What Teachers Can Do

Teachers of Students in Grades EC–12 (continued)

***Standard IV*. The science teacher has theoretical and practical knowledge about teaching science and about how students learn science.**

Standard V. **The science teacher knows the varied and appropriate assessments and assessment practices to monitor science learning.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

5.1k the relationships among curriculum, assessment, and instruction;

5.2k characteristics of various assessments, such as reliability, validity, and the absence of bias;

5.3k the purposes, characteristics, and uses of various types of assessments in science, including formative and summative assessments;

5.4k the importance of carefully selecting or designing formative and summative assessments for the specific decisions they are intended to inform;

5.5k the importance of monitoring and assessing students' science understanding and skills on a regular, ongoing basis;

5.6k ways in which assessment results inform instructional practice;

5.7k strategies for assessing students' prior knowledge and misconceptions about science;

5.8k questioning strategies designed to elicit higher-level thinking;

5.9k the importance of sharing evaluation criteria with students;

5.10k the role of assessments as learning experiences; and

5.11k strategies for engaging students in meaningful self-assessment.

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

5.1s use formal and informal assessments of science performance and products (e.g., rubrics, portfolios, student profiles, checklists) to evaluate student participation in and understanding of the inquiry process (i.e., of inquiry-based scientific investigations);

5.2s select or design a variety of appropriate assessment instruments and/or methods (e.g., formal/informal, formative/summative) to monitor student understanding and progress;

5.3s design assessments that match each learning objective;

5.4s base decisions regarding instructional content, methods, and practice on information about students' strengths and needs gathered through assessment;

5.5s select assessment instruments and methods that provide students with adequate opportunities to demonstrate their achievements;

5.6s evaluate assessment materials and procedures for reliability, validity, absence of bias, and clarity of language;

5.7s encourage use of self-assessment strategies in science;

5.8s use a variety of strategies (e.g., pre-testing, reviewing student journals, monitoring discussions, asking questions) to gain insight about students' prior knowledge and misconceptions about science;

5.9s state evaluation criteria clearly so that students can understand and derive meaning from them; and

5.10s evaluate the quality of data obtained from an assessment and determine what decisions can appropriately be made based on the data.

Standard VI. **The science teacher understands the history and nature of science.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

6.1k the limitations of the scope of science and the use and limitations of physical, mathematical, and conceptual models to describe and analyze scientific ideas about the natural world;

6.2k that science is a human endeavor influenced by societal, cultural, and personal views of the world;

6.3k that scientific ideas and explanations must be consistent with observational and experimental evidence;

6.4k how logical reasoning is used in the process of developing, evaluating, and validating scientific hypotheses and theories;

6.5k the roles that publishing and peer review play in developing and validating scientific knowledge;

6.6k principles of scientific ethics in reporting data and in experimenting with living organisms, including human subjects;

6.7k that scientific theories have predictive power;

6.8k that scientific theories are constantly being modified to conform more closely to new observational and experimental evidence about the natural world;

6.9k the historical development of science and the contributions that diverse cultures and individuals of both genders have made to scientific knowledge; and

6.10k the relationship between science and technology.

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

6.1s provide students with opportunities to examine the types of questions that science can and cannot answer;

6.2s design and conduct scientific investigations to answer questions;

6.3s analyze, review, and critique the strengths and weaknesses of scientific explanations, hypotheses, and theories using scientific evidence and information;

6.4s analyze ways in which personal or societal bias can affect the direction, support, and use of scientific research;

6.5s use key events and knowledge of individuals from throughout the history of science to illustrate scientific concepts;

6.6s design instruction that accounts for the contributions to science of individuals from a variety of cultures; and

6.7s use examples from the history of science to demonstrate the changing nature of scientific theories and knowledge (i.e., that scientific theories and knowledge are always subject to revision in light of new evidence).

Standard VII. **The science teacher understands how science affects the daily lives of students and how science interacts with and influences personal and societal decisions.**

Teacher Knowledge: What Teachers Know	**Application: What Teachers Can Do**
Teachers of Students in Grades 6–12	***Teachers of Students in Grades 6–12***
The beginning teacher knows and understands:	The beginning teacher is able to:
7.1k that human decisions about the use of science and technology are based on factors such as ethical standards, economics, and societal and personal needs;	7.1s use situations from students' daily lives to develop instructional materials that investigate how science can be used to make informed decisions;
7.2k scientific concepts and principles relating to personal and societal health, including the physiological and psychological effects and risks associated with the use of substances and substance abuse;	7.2s apply scientific principles and processes to analyze factors (e.g., diet, exercise, personal behavior) that influence personal choices concerning fitness and health;
7.3k concepts related to changes in populations and to characteristics of human population growth;	7.3s analyze factors that affect the severity of disease and methods for preventing, controlling, or curing diseases and ailments;
7.4k types and uses of natural resources and the effects of human consumption on the renewal and depletion of resources;	7.4s analyze how factors such as population growth, resource use, population distribution, overconsumption, technological capacity, poverty, and societal views can influence changes in environments;
7.5k the properties of natural ecosystems and how natural and human processes can influence changes in environments;	7.5s apply scientific principles and the theory of probability to analyze the advantages, disadvantages, or alternatives to a given decision or course of action; and
7.6k the principles of risk and benefit analysis and how it is used in the process of personal and societal decision making; and	7.6s demonstrate how science can be used to help make informed decisions about societal and global issues.
7.7k the role science can play in helping resolve personal, societal, and global challenges.	

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades EC–4*

Physical Science

The beginning teacher knows and understands:

8.1k properties of objects and materials;

8.2k concepts of force and motion;

8.3k concepts of heat, light, electricity, and magnetism; and

8.4k conservation of energy and energy transformations.

*See 8.5k below.

Application: What Teachers Can Do

Teachers of Students in Grades EC–4*

Physical Science

The beginning teacher is able to:

8.1s select appropriate techniques, procedures, and tools to observe and record properties of materials (e.g., size, shape, temperature, magnetism, hardness, mass, conduction, density);

8.2s analyze changes in the position and motion of an object subject to an unbalanced force;

8.3s apply properties of fundamental forces (e.g., push or pull, friction, gravity, electric force, magnetic force) to analyze common objects (e.g., toys, playground equipment), experiences, and situations;

8.4s describe and analyze changes in the states of matter caused by the addition or removal of heat energy; and

8.5s describe the properties of various forms of energy (e.g., mechanical, sound, heat, light) and analyze how energy is transformed from one form to another in a variety of everyday situations.

*See 8.6s below.

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Teacher Knowledge: What Teachers Know	**Application: What Teachers Can Do**
Teachers of Students in Grades 4–8**	***Teachers of Students in Grades 4–8*****
Physical Science	**Physical Science**
The beginning teacher knows and understands: 8.5k all content specified for teachers in grades EC–4; 8.6k the relationship between force and motion; 8.7k physical and chemical properties and changes in matter; 8.8k energy and energy transformations; and 8.9k the conservation of matter and energy. **See italicized text below.	The beginning teacher is able to: 8.6s apply all skills specified for teachers in grades EC–4, using content and contexts appropriate for grades 4–8; 8.7s measure, graph, and describe changes in motion and analyze the relationship between force and motion in a variety of situations including simple machines, the flow of blood through the human body, and geologic processes; 8.8s investigate physical properties of solids, liquids, and gases; 8.9s analyze physical and chemical changes in matter; 8.10s apply properties and characteristics of waves to analyze sound, light, and other wave phenomena; 8.11s interpret the periodic table and chemical formulas and equations; 8.12s apply the law of conservation of energy to analyze a variety of phenomena (e.g., specific heat, chemical and nuclear reactions, efficiency of simple machines); 8.13s apply the law of conservation of matter to analyze a variety of phenomena (e.g., water cycle, decomposition); and 8.14s analyze the transfer of energy in a variety of situations (e.g., the production of heat, light, sound, and magnetic effects by electrical energy; the process of photosynthesis; weather processes). **See 8.15s and 8.38s below.

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

Teachers of science in grades 6–12 will have a broad knowledge of all science disciplines (i.e., physical science, life science, Earth and space science) required of teachers of grades EC–8 and a deep understanding of the concepts in the science discipline(s) they teach.

Physics

The beginning teacher knows and understands:

8.10k motion and forces: motion occurs when a net force is applied, and gravitation, electricity, and magnetism are universal forces;

8.11k conservation of energy and increase in disorder: energy is kinetic or potential, and everything becomes less orderly over time; and

8.12k interactions of energy and matter: waves and particles can transfer energy, and energy occurs in discrete quantities.

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

Physics

The beginning teacher is able to:

8.15s apply all skills specified for teachers in grades EC–4, using content and contexts appropriate for grades 6–12;

8.16s create, analyze, and interpret graphs describing the motion of a particle;

8.17s analyze examples of uniform and accelerated motion, including linear, projectile, and circular motion;

8.18s create and analyze free-body diagrams;

8.19s apply Newton's laws to solve a variety of practical problems (e.g., properties of frictional forces, the inclined plane, motion of a pendulum);

8.20s apply the law of universal gravitation to solve a variety of problems (e.g., gravitational fields of the planets, properties of circular orbits);

8.21s apply the inverse square law to calculate electrostatic forces, fields, and potentials;

8.22s describe the source of the magnetic force and analyze the magnetic field for various current distributions;

8.23s describe the relationship between electricity and magnetism;

8.24s design and analyze series and parallel DC circuits in terms of current, resistance, voltage, and power, and describe the components and characteristics of AC circuits (e.g., impedance, resonance, r.m.s. voltage and current);

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Application: What Teachers Can Do

Teachers of Students in Grades 6–12 (continued)

Physics (continued)

8.25s analyze the operation of electromagnets, motors, and generators;

8.26s apply the work-energy theorem to analyze and solve a variety of practical problems (e.g., finding the speed of an object given its potential energy function, determining the work done by frictional forces);

8.27s solve problems using the conservation of energy in a physical system (e.g., determining potential energy for conservative forces, investigating the mechanical equivalence of thermal energy);

8.28s apply the first law of thermodynamics to investigate energy transformations in a variety of everyday situations;

8.29s describe the concept of entropy and its relationship to the second law of thermodynamics;

8.30s compare and contrast transverse and longitudinal waves;

8.31s relate concepts of amplitude, frequency, velocity, and wavelength to the properties of sound and light waves (e.g., pitch, color);

8.32s apply the properties of wave reflection, refraction, and interference to analyze and explain acoustical and optical phenomena;

8.33s describe the electromagnetic spectrum and explain how electromagnetic waves are produced;

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

	Application: What Teachers Can Do ***Teachers of Students in Grades 6–12 (continued)*** **Physics (continued)** 8.34s interpret wave particle duality; 8.35s describe examples and consequences of the uncertainty principle; 8.36s describe and analyze the photoelectric effect; and 8.37s use the quantum model of the atom to describe the line spectra from gas-discharge tubes. **Chemistry** The beginning teacher is able to: 8.38s apply all skills specified for teachers in grades EC–4, using content and contexts appropriate for grades 6–12; 8.39s differentiate between physical and chemical properties of matter; 8.40s describe and create models to explain the molecular structure of solids, liquids, and gases; 8.41s use the periodic table to predict and explain the physical (e.g., metallic, nonmetallic) and chemical (e.g., electron valence) properties of an element; 8.42s apply the gas laws (e.g., Charles law, Boyle's law, ideal gas law) to predict gas behavior in a variety of situations;

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

	8.43s describe the properties of the bonds and the arrangement of atoms in molecules, ionic crystals, polymers, and metallic substances; 8.44s compare and contrast the chemical properties of ionic and covalent compounds; 8.45s describe the physical and chemical properties of covalent compounds in terms of intermolecular forces in the bonds; 8.46s use the physical properties of a substance (e.g., boiling point, crystal structure) to predict the kind of interaction between molecules of a given substance; 8.47s solve problems involving moles and stoichiometry; 8.48s analyze factors that affect solubility; 8.49s determine the molarity, molality, and percent composition of aqueous solutions; 8.50s analyze and describe models to explain the structural properties of water; 8.51s describe the importance of water as a solvent in living organisms and the environment; 8.52s describe the atom in terms of protons, neutrons, and electron clouds; 8.53s analyze relationships among electron energy levels, photons, and atomic spectra; 8.54s relate electronic configuration to physical and chemical properties and reactivity; 8.55s describe the relationship between the kinetic theory and the universal gas law; 8.56s analyze and describe the effects of energy transformations that occur in phase changes;

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Application: What Teachers Can Do
Teachers of Students in Grades 6–12 (continued)

Chemistry (continued)

8.57s identify and analyze the effects of energy transformations that occur in chemical reactions to enable students to make predictions about other reactions;

8.58s analyze and describe models to explain the process(es) of radioactivity and radioactive decay;

8.59s compare fission and fusion reactions in terms of the mass of the reactants and products and the amount of energy released in the reactions;

8.60s use the half-life of radioactive elements to solve real-world problems (e.g., carbon dating, radioactive traces);

8.61s evaluate the risks and benefits of the commercial uses of nuclear energy and the medical uses of radioisotopes;

8.62s evaluate environmental issues associated with the storage, containment, and disposal of nuclear wastes;

8.63s interpret and balance chemical and nuclear equations using number of atoms, mass, and charge;

8.64s analyze processes occurring during redox reactions using applications from everyday life;

8.65s determine oxidation numbers and balance redox equations in order to determine if the reaction will occur;

8.66s describe the operating principles of an electrochemical cell and the process of electroplating metals;

Standard VIII. **The science teacher knows and understands the science content appropriate to teach the statewide curriculum (Texas Essential Knowledge and Skills [TEKS]) in physical science.**

Application: What Teachers Can Do
Teachers of Students in Grades 6–12 (continued)

Chemistry (continued)

8.67s describe the effect of solution concentration on the properties and chemical reactivity of a variety of aqueous solutions;

8.68s analyze and interpret relationships among ionic and covalent compounds, electrical conductivity, and colligative properties of water;

8.69s illustrate the relationship between the hydronium ion concentration and the pH for various acids and bases;

8.70s apply the principles of solution concentration and stoichiometry to analyze characteristics of a neutralization reaction;

8.71s analyze and apply the principles of acid-base titration;

8.72s analyze examples from the real world that illustrate the effects of acids and bases on an ecological system;

8.73s apply the law of conservation of energy to evaluate the energy exchange that occurs during a chemical reaction;

8.74s analyze factors (e.g., temperature, concentration) that affect the rate of a chemical reaction; and

8.75s analyze and describe the chemical properties of a variety of household chemicals in order to predict potential for chemical reactivity.

Standard IX. *Teachers of physical science are not responsible for this standard.*

Standard X. *Teachers of physical science are not responsible for this standard.*

Standard XI. **The science teacher knows unifying concepts and processes that are common to all sciences.**

Teacher Knowledge: What Teachers Know

Teachers of Students in Grades 6–12

The beginning teacher knows and understands:

11.1k how systems and subsystems can be used as a conceptual framework to organize and unify the common themes of science and technology;

11.2k how patterns in observations and data which explain natural phenomena allow predictions to be made;

11.3k how the concepts and processes listed below provide a unifying framework across the science disciplines:

- systems, order, and organization;
- evidence, models, and explanation;
- change, constancy, and measurements;
- evolution and equilibrium; and
- form and function;

11.4k properties and patterns of systems can be described in terms of space, time, energy, and matter;

11.5k how change and constancy occur in systems (e.g., conservation laws, symmetry, stability, cyclic variation, rates of change);

11.6k the complementary nature of form and function in a given system; and

11.7k how models are used to represent the natural world and how to evaluate the strengths and limitations of a variety of scientific models (e.g., physical, conceptual, mathematical).

Application: What Teachers Can Do

Teachers of Students in Grades 6–12

The beginning teacher is able to:

11.1s apply the systems model (e.g., interacting parts, boundaries, input, output, feedback, subsystems) to identify and analyze common themes that occur in physical science, life science, and Earth and space science;

11.2s analyze a system (e.g., a cell, the ocean, an ideal gas) in terms of cycles, structure, and processes;

11.3s analyze the general features of systems (e.g., input, process, output, feedback);

11.4s analyze the interactions that occur between the components of a given system or subsystem;

11.5s analyze the interactions and interrelationships between various systems and subsystems; and

11.6s use the systems model to analyze the concepts of constancy (e.g., conservation of mass, energy, and momentum) and change (e.g., evolution).