Wisconsin Student Assessment System

Criterion-Referenced Test Framework

For the fall Wisconsin Knowledge and Concepts Examinations Statewide Assessment

Assessment Framework for

Science

In Grades 4, 8, and 10

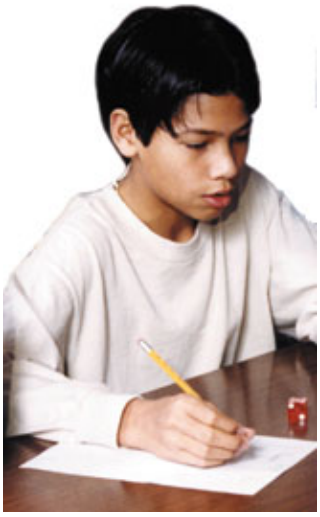
Developed from Wisconsin's K-12 Model Academic Standards for Science

Elizabeth Burmaster, State Superintendent
Wisconsin Department of Public Instruction

CTB/McGraw-Hill
Test Development Contractor

March, 2006

This document provides an indication of the range of coverage on the science portion of the Wisconsin Knowledge and Concepts Examination that will be administered statewide in Wisconsin each November beginning in 2007 in grades 4, 8, and 10. It is intended to foster discussion among educators and others across grades and across subject areas. It should be used in conjunction with the *Wisconsin's Model Academic Standards for Science* and your local curriculum.



March, 2006

Office of Educational Accountability
Wisconsin Department of Public Instruction
125 South Webster Street
P.O. Box 7841
Madison, WI 53707-7841

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Overview

The federal No Child Left Behind Act requires all states to test all students in science once in grades 3 through 5, once in grades 6 through 8, and once in high school. Under Wisconsin law s. 118.30, students are to be assessed in grades 4, 8, and 10. Thus, beginning in 2007-08 school year, both state and federal laws apply to science; the result is that students will be assessed in grades 4, 8, and 10. These tests are referred to as the Wisconsin Knowledge and Concepts Examination (WKCE) and will replace WKCE science tests beginning in fall 2007.

The Wisconsin Department of Public Instruction published a request for proposals to support the development of customized criterion-referenced reading, mathematics, and science tests. CTB/McGraw-Hill was awarded the contract. Panels of Wisconsin teachers began meeting during the 2004–2005 school year to develop a science framework that provides content information about science for the beginning of grades 4, 8, and 10. Those teachers also reviewed (accept/reject/edit) all customized items developed by the contractor.

The Wisconsin Department of Public Instruction contracted with three national experts to evaluate the work of CTB/McGraw-Hill as well as to advise the department on issues of validity and reliability of the new WKCE test design for reading, mathematics, and science. This Technical Advisory Committee (TAC) met initially in February 2004 and will meet twice annually in the future to assure the continued technical validity of the tests.

General Test Specifications

Beginning in the 2007-08 school year**,** items developed for the new WKCE tests in science will be either selected-response (multiple-choice) or constructed-response (CR) format. The test reporting categories and items assigned to measure each reporting category are aligned to the *Wisconsin's Model Academic Standards for Science* with appropriate science framework descriptors supporting learning expectations for tests administered in the fall semester. The test design draws approximately 80% of the total score points from selected-response items and 20% of the score points from student-generated constructed-response items. It is important to point out that CR items will be used for certain standards when selected-response (SR) items are not available or feasible to use.

All students in grades 4, 8, and 10 will be tested in science using these new customized WKCE tests beginning in fall 2007. Students with disabilities will be allowed accommodations during these tests unless an alternate assessment is required based on an IEP process. Students whose English language proficiency as tested on state-approved language proficiency examinations is level three or higher will take the WKCE tests with allowable accommodations. English language learners with language proficiency scores less than three will take an alternate assessment. All alternate assessments are aligned to state standards.

Students in grades 4, 8, and 10 will continue to be assessed in language arts and social studies as required by s. 118.30 Wisconsin Statutes. These assessments will be a shelf-test provided under the terms of the department's contract with CTB/McGraw-Hill.

Table 1. Science Assessment Framework Information

WKCE Science

REPORTING CATEGORIES

A. SCIENCE CONNECTIONS

B. NATURE OF SCIENCE

C. SCIENCE INQUIRY

D. PHYSICAL SCIENCE

E. EARTH AND SPACE SCIENCE

F. LIFE AND ENVIRONMENTAL SCIENCE

G. SCIENCE APPLICATIONS

H. SCIENCE IN SOCIAL AND PERSONAL PERSPECTIVES

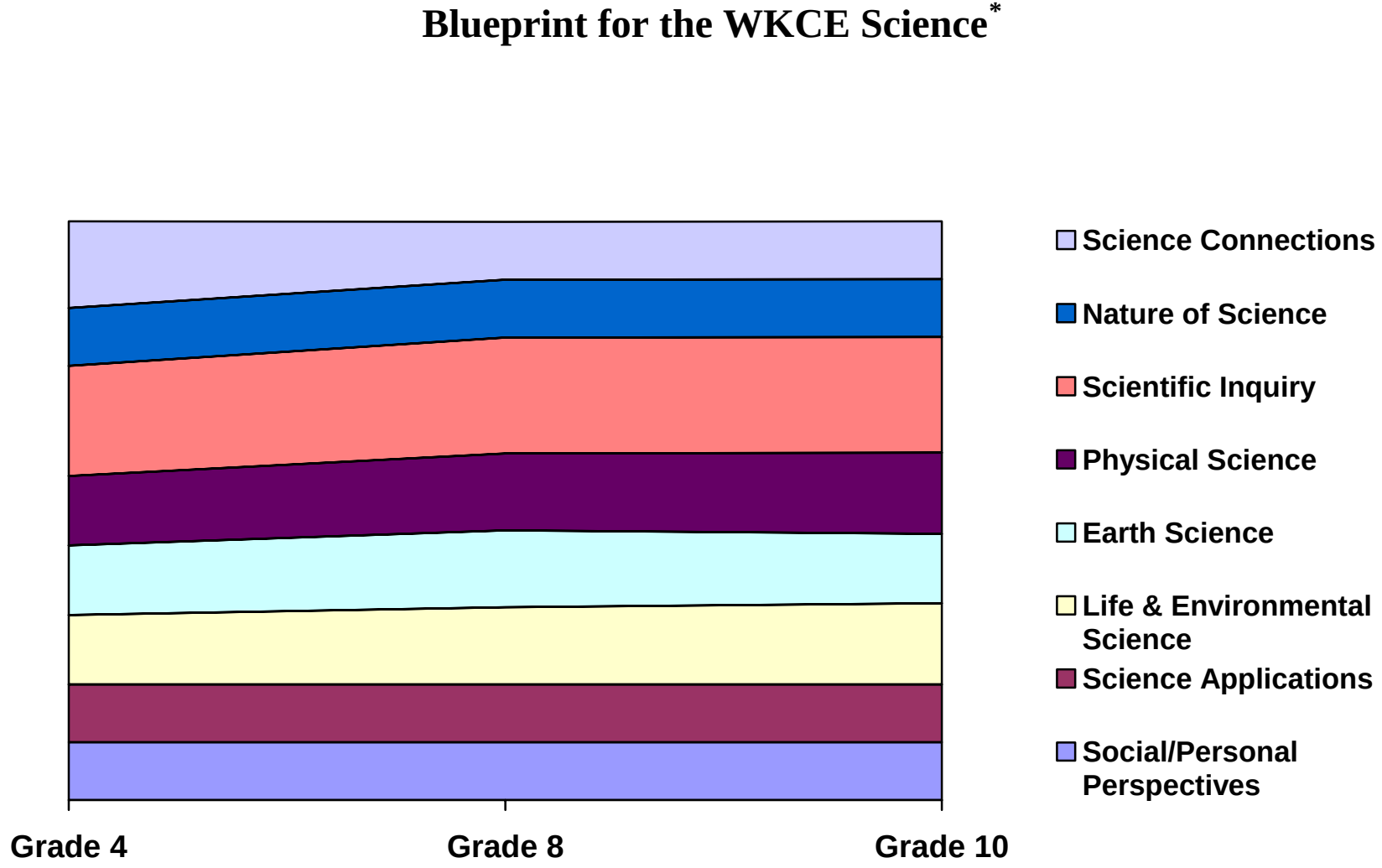
Table 2. Science Assessment Framework

WKCE Science*
REPORTING CATEGORIES, 2007-08
(80% of score points: selected response/20% constructed-response)**

Science Standard	Estimated Percentage of Score Points per Grade		
	Gr4	Gr8	Gr10
A. Science Connections	15	10	10
B. Nature of Science	10	10	10
C. Science Inquiry	18	20	20
D. Physical Science	13	14	14
E. Earth and Space Science	13	13	13
F. Life and Environmental Science	13	14	14
G. Science Applications	8	10	10
H. Science in Social and Personal Perspectives	10	10	10

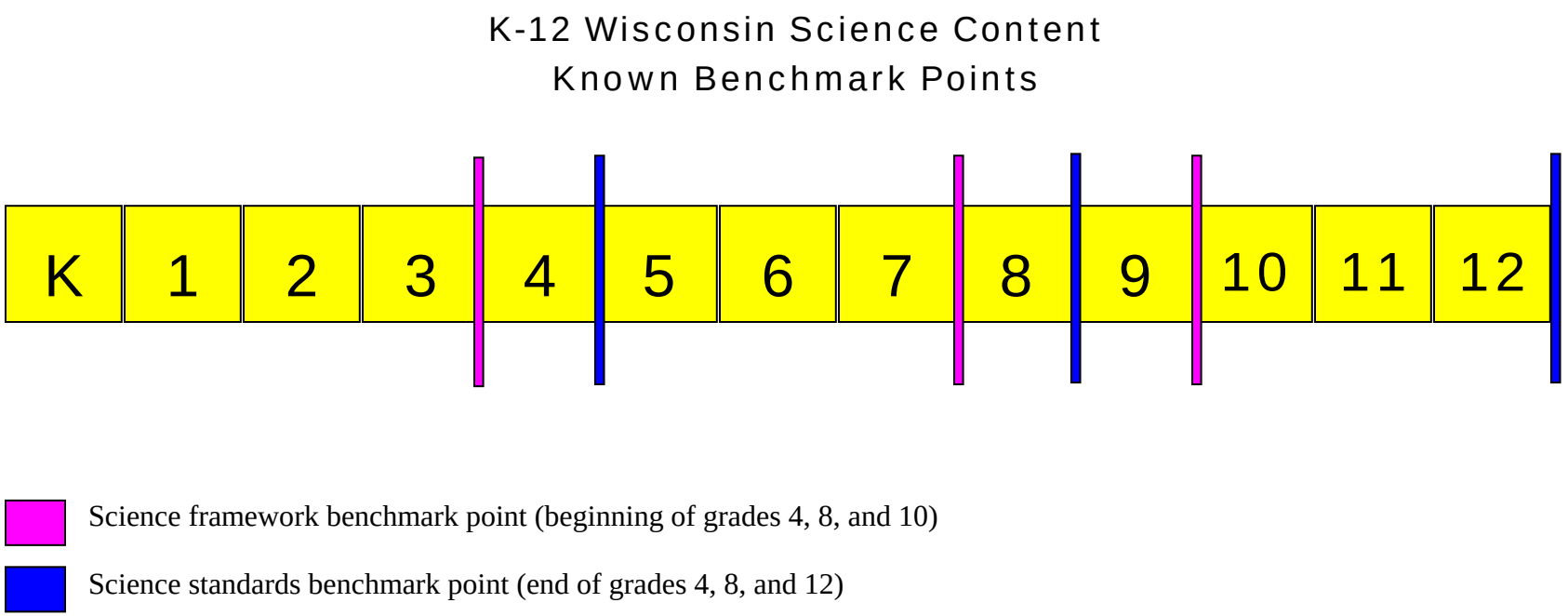
* Distribution of items across standards may vary slightly from year to year.
** CR items will be used for certain standards if SR items are not available or feasible to use.

Figure 1. Distribution of WKCE science score points by benchmark grades of 4, 8, and 10. Bands indicate percent of score points at grade elvel related to each standard.



* Distribution of items across standards may vary slightly from year to year.

Figure 2. Represents content benchmark points for science from both the Science Framework and *Wisconsin's Model Academic Standards for Science.*

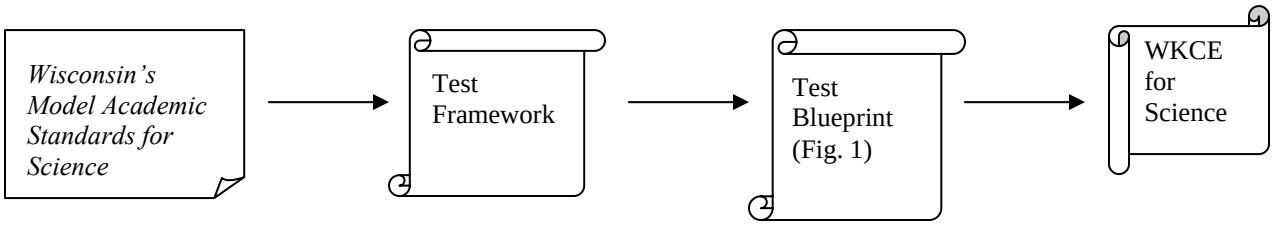


Frequently Asked Questions

What is the framework?

The framework was derived from *Wisconsin's Model Academic Standards for Science* and designed to provide clarity and specificity to the standards and to provide greater details about what will be assessed on the WKCE for science. The blueprint (Figure 1) provides information about the range and coverage for each content standard in science for the three grades being assessed.

Relationships among the Wisconsin Model Academic Standards, test blueprint, test, and framework.

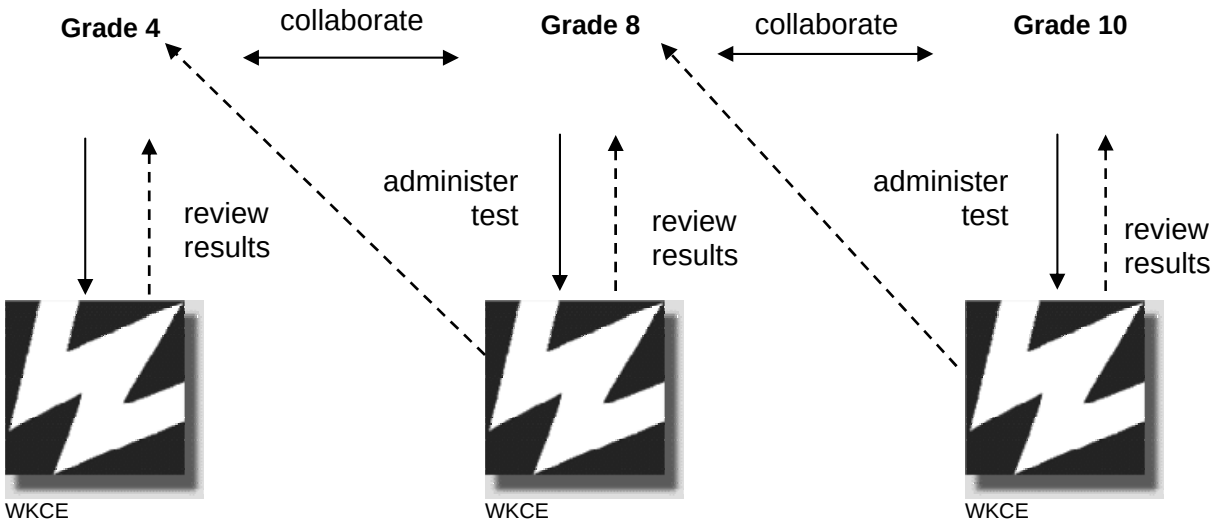


How can I use the framework?

You can use the framework to ensure that your local curriculum includes the knowledge and skills described in the framework. However, since the science assessment framework is only an indication of the knowledge and skills that will be assessed on the November WKCE, *this information does not replace your local curriculum*.

Another way to use the framework is as a basis for teachers to engage in multi-grade-level discussions. Since the test is administered in the fall, students should have an opportunity to acquire the knowledge and skills that will be assessed prior to the tested grade. Similarly, teachers will want to examine test results for feedback on what is happening at their own grade level, as illustrated in the example in Figure 3. Finally, the science framework (and standards) is not grade specific, discussions can take place about what portion or aspects of the framework should be learned at each grade leading to the tested grades.

Figure 3. Knowledge and skills assessed at one grade must be part of the curriculum prior to that grade, including grades K through 3.



Do I need to teach something if it isn't assessed at my grade level?

Yes. You may want to ensure that you introduce students to the knowledge and skills that will be assessed at least one year (or more) before they are assessed. On the other hand, even if something is no longer assessed, you may need to teach it if students haven't mastered it because it is assumed to be known and because it may be a prerequisite for something that is assessed.

Does the science assessment framework replace our local curriculum or *Wisconsin's Model Academic Standards for Science*?

The science assessment framework is an indication of the knowledge and skills that will be assessed on the November WKCE. *This information does not replace your local curriculum or the science standards*. You may wish to ensure that your local curriculum includes – *but is not limited to* – the knowledge and skills described in the framework.

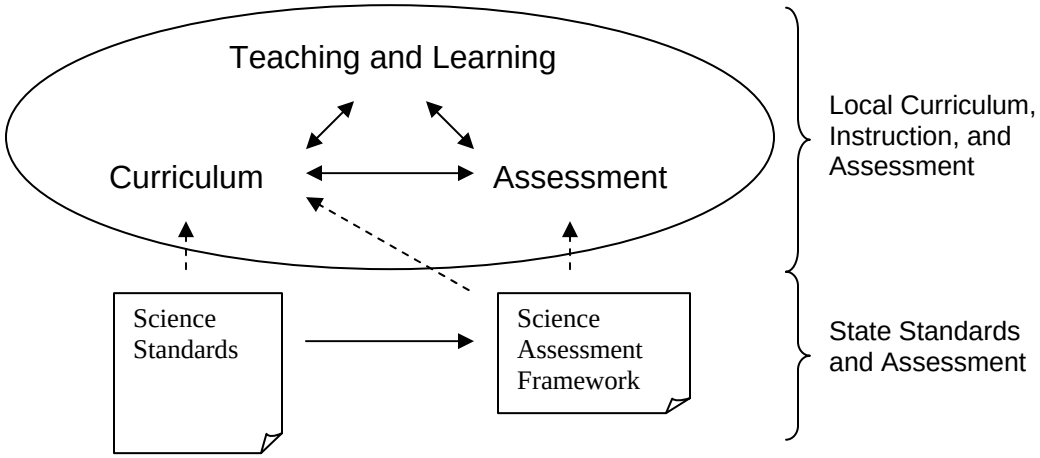
Table 4 on the following page is intended to help foster discussion among educators about local curriculum, state standards, and the framework.

To assist in curriculum planning, the Wisconsin Department of Public Instruction has prepared a comprehensive guide "*Planning Curriculum in Science*."

How does the framework relate to our local curriculum?

If your local curriculum is linked to Wisconsin's Model Academic Standards, then it is also linked to the framework because the science framework is based on the Wisconsin's Model Academic Standards. However, since the framework provides additional information about what may be assessed at grade intervals, you may wish to ensure that your local curriculum includes the knowledge and skills described in the framework. *Note, however, that the framework does not replace your local curriculum*. Figure 4 shows the relationships among the framework, local curriculum, and state standards.

Figure 4. Suggested relationships among the *Wisconsin's Model Academic Standards for Science*, science assessment framework, and local curriculum, instruction, and assessment. Solid arrows indicate direct influence, and dotted arrows indicate indirect or recommended influence.



What is a criterion-referenced test?

This term refers to the way test results are interpreted. A criterion-referenced interpretation of an assessment relates a student's performance to specific performance criteria, rather than to the performance of other students (which would be a norm-referenced interpretation). Wisconsin has defined five proficiency categories: pre-requisite skill, minimal performance, basic, proficient, and advanced. A combination of professional judgment (involving educators from around Wisconsin) and statistical analysis is used to link assessment scores with proficiency levels.

What kinds of questions are on the test?

There are both selected-response (multiple-choice) and constructed-response (short answer) items on the WKCE. Approximately 80% of a student's score points will come from selected-response items and 20% from constructed-response (CR) items. (CR items will be used for certain standards if selected response items are not available or feasible to use.)

How can I help my students prepare for the test?

The best test preparation involves a rich, engaging curriculum coupled with ongoing assessment that is integrated into instruction. Students should be familiar with the kinds of items they will see on the test and with general test-taking strategies, but this should not be a major focus of instruction.

Whom can I contact with questions or suggestions?

We welcome your questions and suggestions! Please contact:

Mailing address:
Wisconsin Department of Public Instruction
P.O. Box 7841
Madison, WI 53707-7841

A. SCIENCE CONNECTIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
A.4.1 When conducting science investigations ask and answer questions that will help decide the general areas of science being addressed.	A.4.1 a. Describe the connections between and among the general domains of science; which are, physical, earth, and life science. b. Recognize and use information from the domains of science (physical, earth, and life science) to ask and answer testable questions during investigations.
A.4.2 When faced with a science-related problem, decide what evidence, models, or explanations previously studied can be used to better understand what is happening now.	A.4.2 a. Compare previously studied evidence, models, or explanations with current observations to show that things change, stay the same, or follow a pattern. *Examples: plant growth that occurred a month ago and current plant growth; weather observations in the spring and fall…*
A.4.3 When investigating a science-related problem, decide what data can be collected to determine the most useful explanations.	A.4.3 a. Identify and collect data which provides the best evidence that things change, stay the same, or follow a pattern.
A.4.4 When studying science-related problems, decide which of the science themes are important.	A.4.4 a. Identify change or lack of changes (constancy) and/or patterns that can be observed with data. *Examples of themes: change, constancy, patterns, evidence…*
A.4.5 When studying a science-related problem, decide what changes over time are occurring or have occurred.	A.4.5 a. Identify change or lack of changes (constancy) over an extended period of time. *Examples: temperature changes during the seasons, amount of daylight during different seasons, life cycle, growth, erosion, and changes in state between solid and liquid…*

B. NATURE OF SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
B.4.1 Use encyclopedias, source books, texts, computers, teachers, parents, other adults, journals, popular press, and various other resources, to help answer science-related questions and plan investigations.	B.4.1 a. Recognize that a variety of resources can be used to answer questions and plan investigations. b. Determine which resources are the most appropriate resources to use when asking testable questions and planning investigations. *Example, given a science-related question, list the resources necessary and appropriate to answer questions and plan investigations…*
B.4.2: Acquire information about people who have contributed to the development of major ideas in the sciences and learn about the cultures in which these people lived and worked.	B.4.2 a. Identify commonly known careers in science (e.g., doctor, astronaut, veterinarian, nurse). b. Recognize that men and women from many cultures have contributed to science throughout history.
B.4.3 Show how the major developments of scientific knowledge in the earth and space, life and environmental, and physical sciences have changed over time.	B.4.3 a. Know that much has been learned about objects, events, and phenomena in nature through scientific inquiry, but much more remains to be learned and understood. b. Communicate understandings about science *using timelines or simple diagrams as possible tools* to show how scientific knowledge has changed over time. *Examples: human understandings about the earth's shape has changed, or human understandings about the changes in the composition and configuration of the solar system…*

C. SCIENCE INQUIRY	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
C.4.1 Use the vocabulary of the unifying themes to ask questions about objects, organisms, and events being studied.	C.4.1 a. Ask testable questions about the natural world being studied. b. Ask testable questions that can be answered using scientific vocabulary/themes. *Examples: change, pattern, measurement…*
C.4.2 Use the science content being learned to ask questions, plan investigations, make observations, make predictions, and offer explanations.	C.4.2 a. Plan a simple investigation, using science content from physical, earth/space, or life/environmental science. b. Decide what observations are needed to explain the results. c. Predict the results of the investigations. d. Conduct simple investigations. e. Use evidence collected to explain results.
C.4.3 Select multiple sources of information to help answer questions selected for classroom investigations.	C.4.3 a. Select a variety of resources that best answer questions and plan investigations. *Scientific resource examples: textbooks, internet, on-line and electronic resources, science speakers, reference books, peers, field trips...* b. Recognize that there are multiple sources of information available to answer investigative questions. *Scientific resource examples: textbooks, internet, on-line and electronic resources, science speakers, reference books, peers, field trips…* c. Decide which of the resources are appropriate/credible to the investigation at hand. *Example: Using a comic book is probably not an excellent resource for a science investigation…* d. Develop a list of issues that citizens must make decisions about and describe a strategy for becoming informed about the science behind these issues.

C.4.4 Use simple science equipment including rulers, balances, graduated cylinders, hand lenses, thermometers, and computers safely and effectively to collect data relevant to questions and investigations.	C.4.4 *a.* Select and safely use equipment relevant to a science investigation. *Examples: rulers, balances, graduated cylinders, hand lenses, thermometers, and computers…* *b.* Collect data relevant to questions and investigations
C.4.5 Use data they have collected to develop explanations and answer questions generated by investigations.	C.4.5 a. Interpret data (use the results of their data) to answer questions developed during their investigations.
C.4.6 Communicate the results of their investigations in ways their audiences will understand by using charts, graphs, drawings, written descriptions, and various other means.	C.4.6 a. Report the results of science investigations to different audiences (friends, teachers, and younger students) by using graphs, tables, and illustrations.
C.4.7 Support their conclusions with logical arguments.	C.4.7 a. State evidence from data collected to justify/explain conclusions from investigations.
C.4.8 Ask additional questions that might help focus or further an investigation.	C.4.8 a. After completing an investigation, develop additional questions that support new investigations about the original topic of study. *Example: "I wonder what would happen if…"*

D. PHYSICAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
Properties of Earth Materials	
D.4.1 Understand that objects are made of more than one substance, by observing, describing, and measuring the properties of earth materials, including properties of size, weight, shape, color, temperature, and the ability to react with other substances.	D.4.1 *a.* Describe the properties of earth materials. *Examples: rocks, minerals, soils, air, water, and wood…* b. Describe objects by the materials they are made of and by their physical properties. c. Observe that earth materials physically react with other substances in different ways based on their properties.
D.4.2 Group and/or classify objects and substances based on the properties of earth materials.	D.4.2 a. Classify objects based on their observable physical properties; such as, texture, color, hardness, shape, and composition.
D.4.3 Understand that substances can exist in different states - solid, liquid, gas.	D.4.3 *a.* Know that there are three states of matter: solid, liquid, or gas. *Examples*: *Recognize that water can exist as liquid water, ice, and water vapor. Recognize that air takes up space…* b. Communicate that common substances exists either as a solid, liquid or gas.
D.4.4 Observe and describe changes in form, temperature, color, speed, and direction of objects and construct explanations for the changes.	D.4.4 *a.* Observe and describe physical changes in matter. *Example: change in size, shape, color, temperature, speed, or direction…*

D.4.5 Construct simple models of what is happening to materials and substances undergoing change, using simple instruments or tools to aid observations and collect data.	D.4.5 a. Illustrate/show/model what is happening to something as it is physically changing. *Example: Use a simple model such as a ball rolling down a ramp as an illustration of acceleration of a car, or an ice cube melting as a model for snow melting or changing state of matter…* b. Use appropriate simple science instruments to aid in making observations and collect data.
Position and Motion of Objects	
D.4.6 Observe and describe physical event in objects at rest or in motion.	D. 4.6 *a.* Compare, contrast, and explain what happens to an object at rest and an object in motion: *Examples: Motion does not happen if the forces are balanced. Motion occurs because of unbalanced forces (push or pull)…*
D.4.7 Observe and describe physical events involving objects and develop record-keeping systems to follow these events by measuring and describing changes in their properties, including position relative to another object, motion over time, and position due to forces.	D.4.7 a. Describe and explain the position of an object by its position relative to another object, its motion (over time) relative to another object, and the forces acting upon it. b. Devise simple record-keeping systems. *Examples: Use charts, graphs, or diagrams, to track physical events by measuring and describing changes in their properties, including position relative to another object, motion over time, and position due to forces…*
Light, Heat, Electricity, and Magnetism	
D.4.8 Ask questions and make observations to discover the differences between substances that can be touched (matter) and substances that cannot be touched (forms of energy, light, heat, electricity, sound, and magnetism).	D.4.8 a. Ask questions about the differences between matter (substances that can be touched) and energy. b. Describe and record observational differences between matter (substances that can be touched) and energy. (*Examples: Light, heat, sound, electricity, and magnetism…)*

E. EARTH AND SPACE SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
Properties of Earth Materials	
E.4.1 Investigate that earth materials are composed of rocks and soils and correctly use the vocabulary for rocks, minerals, and soils during these investigations.	E.4.1 *a.* Describe the properties of earth materials. *Examples: Earth materials consist of rocks and soils. Rocks are made up of a combination of two or more minerals. Soil is a mixture of earth materials and can vary from place to place (e.g., clay vs. sand)…*
E.4.2 Show that Earth materials have different physical and chemical properties, including the properties of soils found in Wisconsin.	E.4.2 a. Compare and contrast properties of soil including color, texture, and capacity to hold water. b. Compare and contrast properties of rocks and minerals; such as, hardness, color, texture, and appearance.
E.4.3 Develop descriptions of the land and water masses of the earth and of Wisconsin's rocks and minerals, using the common vocabulary of earth and space science.	E.4.3 *a.* Describe land and water masses, including land masses in Wisconsin. *Examples: Recognize that continents are made up of rocks, minerals, and soils. Recognize that oceans are large bodies of water. Recognize that Wisconsin has a specific topography and unique bodies of water. Explain the impact of glaciation on Wisconsin's topography…*
Objects in the Sky	
E.4.4 Identify celestial objects (stars, sun, moon, planets) in the sky, noting changes in patterns of those objects over time.	E.4.4 a. Identify the sun, moon, and stars in the sky, and recognize that they appear to change position in the sky over time. *Examples*: *Recognize the sun as a star. Identify that the appearance of the moon changes throughout the month. Understand that earth is a planet in our solar system…*

Changes in the Earth and Sky	
E.4.5 Describe the weather commonly found in Wisconsin in terms of clouds, temperature, humidity, and forms of precipitation, and the changes that occur over time, including seasonal changes.	E.4.5 a. Identify both daily and seasonal weather changes in Wisconsin, noting changes in temperature, wind, precipitation, cloud cover, and sunshine.
E.4.6 Using the science themes, find patterns and cycles in the earth's daily, yearly, and long-term changes.	E.4.6 a. Describe changes, patterns, and cycles that are observable during night/day and seasonal events on earth. b. Recognize that there are patterns in the earth's motion activities.
E.4.7 Using the science themes, describe resources used in the home, community, and nature as a whole.	E.4.7 a. Using the themes of form and function, models, organization, systems; identify resources (i.e., soils, rocks, minerals, and plants) that are used by humans. *Examples: How wood is used for building materials, how soils and plants are used for producing food and other manufactured materials, or how fossil fuels are used in the manufacturing of plastics…*
E.4.8 Illustrate resources humans use in mining, forestry, farming, and manufacturing in Wisconsin and elsewhere in the world.	E.4.8 a. Distinguish between natural and manufactured materials. b. Identify that natural resources such as soils, rocks, minerals, fossil fuels, and plants are used to make manufactured goods that people use in their daily lives.

F. LIFE AND ENVIRONMENTAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
The Characteristics of Organisms	
F.4.1 Discover how each organism meets its basic needs for water, nutrients, protection, and energy in order to survive.	F.4.1 a. Describe the basic needs of an organism. *Examples: energy, food, water, air, and protectio*n… b. Communicate (understand) that plants and animals have certain structures with specific functions that help them grow, reproduce, and survive.
F.4.2 Investigate how organisms, especially plants, respond to both internal cues (the need for water) and external cues (changes in the environment).	F.4.2 a. Describe how plants respond to changes in their environment. b. Observe and describe how an organism's behavior helps it to survive in a changing environment. c. Identify that animals have senses that help them to detect internal and external cues. *Examples: Recognize that when an animal is hungry, it eats; when it is thirsty, it drinks; when it is tired, it sleeps. Hibernation activities, the need to conserve water, or personal protection such as hiding from a predator…*
Life Cycles of Organisms	
F.4.3 Illustrate the different ways that organisms grow through life stages and survive to produce new members of their type.	F.4.3 a. Identify that plants and animals have life cycles, which are different for each organism. b. Explain to others that offspring look very much, but not exactly, like their parents or one another. c. Explain that organisms have structures and behaviors that help them survive during each stage of their life cycle. d. Communicate to others that life stages occur in a specific order.

Organisms and Their Environment	
F.4.4 Using the science themes, develop explanations for the connections among living and nonliving things in various environments.	F.4.4 a. Using the themes, including systems, models, explanations, form and function, evolution, and order, to identify something as living or nonliving. *b.* Explain to others that some animals eat plants for food. Other animals eat animals for food. *Examples*: *food webs/food chains…* c. Explain to others that plants and animals both depend on nonliving things in the environment (habitat). *Examples: water, air, and soil….*
G. SCIENCE APPLICATIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
G.4.1 Identify the technology used by someone employed in a job or position in Wisconsin and explain how the technology helps.	G.4.1 *a.* Identify how technology helps people do their jobs in Wisconsin. *Examples may include robots, machines, transportation, computers, and telecommunication devices…*
G.4.2 Discover what changes in technology have occurred in a career chosen by a parent, grandparent, or an adult friend over a long period of time.	G.4.2 a. Describe how careers have changed as technology has changed over time.
G.4.3 Determine what science discoveries have led to changes in technologies that are being used in the workplace by someone employed locally.	G.4.3 a. Determine which science discoveries have led to changes in technologies that are being used in the workplace by someone employed locally. *Example: Understandings about tooth decay has led to sealants…*

G.4.4 Identify the combinations of simple machines in a device used in the home, the workplace, or elsewhere in the community.	G.4.4 a. Identify that a simple machine is something that makes work easier for humans. b. Identify common tools in the home, workplace, and community; identify the simple machines within the tool.
G.4.5 Ask questions to find answers about how devices and machines were invented and produced.	G.4.5 a. Identify that technology is the result of people asking questions and finding answers through science inquiry.
H. SCIENCE IN SOCIAL AND PERSONAL PERSPECTIVES	
Performance Standards	**Assessment Frameworks**
By the end of Grade 4 students will:	***By the beginning of Grade 4 students will:***
H.4.1 Describe how science and technology have helped, and in some cases hindered, progress in providing better food, more rapid information, quicker and safer transportation, and more effective health care.	H.4.1 a. List examples of how science and technology have had an impact on food quality and quantity, transportation, health, sanitation, and communication.
H.4.2 Using the science themes, identify local and state issues that are helped by science and technology and explain how science and technology can also cause a problem.	H.4.2 a. Using the themes of change, evolution, and systems, describe the impact of science and technology on societal issues. *Examples: air and water pollution, and recycling...*
H.4.3 Show how science has contributed to meeting personal needs, including hygiene, nutrition, exercise, safety, and health care.	H.4.3 a. Show how science has contributed to the quality of personal health and safety.
H.4.4 Develop a list of issues that citizens must make decisions about and describe a strategy for becoming informed about the science behind these issues.	H.4.4 a. Develop a list of issues that citizens must make decisions about and describe a strategy for becoming informed about the science behind these issues. *Examples: invasive species, recycling, exercise, nutrition, safety, and hygiene…*

A. SCIENCE CONNECTIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
A.8.1 Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems.	A. 8.1 a. Through investigations routinely become involved in activities that improve the ability to use questioning and reasoning skills when investigating science-related issues and problems.
A.8.2 Describe limitations of science systems and give reasons why specific science themes are included in or excluded from those systems.	A.8.2 a. Apply science themes while making connections among the earth and space, life and environmental, and physical sciences.
A.8.3 Defend explanations and models by collecting and organizing evidence that supports them and critique explanations and models by collecting and organizing evidence that conflicts with them.	A.8.3 a. Examine and evaluate data sets from multiple perspectives which can lead to several possible conclusions by emphasizing the themes of evidence (data), explanation, and models.
A.8.4 Collect evidence to show that models developed as explanations for events were (and are) based on the evidence available to scientists at the time.	A.8.4 a. Based on historical and/or current scientific data and evidence, design a model to explain an event. *Examples: geocentric theory, flat earth, medical techniques, simulations; such as, wind tunnels, stream tables…*
A.8.5 Show how models and explanations, based on systems, were changed as new evidence accumulated (the effects of constancy, evolution, change, and measurement should all be part of these explanations).	A.8.5 a. Emphasize the themes of change, constancy, models, explanation, evolution, change, and measurement to examine historical and current scientific thought and the nature of science using models and explanations. *Examples geocentric theory, flat earth, medical techniques, scientific tools…*

A.8.6 Use models and explanations to predict actions and events in the natural world.	A.8.6 a. Emphasize the themes of change, models, explanation, and systems to employ conceptual and/or physical models and explanations to predict actions and events in the natural world. *Examples: Plate tectonics, succession, weather data/maps and weather events…*
A.8.7 Design real or thought investigations to test the usefulness and limitations of a model.	A.8.7 a. Design, assess, and evaluate scientific models through group discussions.
A.8.8 Use the themes of evolution, equilibrium, and energy to predict future events or changes in the natural world.	A.8.8 a. Make connections among earth and space, life and environmental, and physical sciences through the unifying themes of change, evolution, equilibrium, and energy in the natural world in order to predict future events. *Examples: Investigate and predict what evolutionary changes might occur if our sun completed its life cycle; examine smaller systems such as unbalanced forces on a see-saw or coiled spring; study the elimination of one component in a food chain or web and examine its impacts…*
B. NATURE OF SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
B.8.1 Describe how scientific knowledge and concepts have changed over time in the earth and space, life and environmental, and physical sciences.	B.8.1 a. Relate historical perspectives to one or more major science concepts. *Examples: Models of solar system, evolution, cell theory, germ theory and disease, genetics…* b. Show how the work of scientists has changed throughout history. *Examples: alchemy - modern chemistry; Galileo's telescope - Hubble telescope, space travel…*

B.8.2 Identify and describe major changes that have occurred over time in conceptual models and explanations in the earth and space, life and environmental, and physical sciences and identify the people, cultures, and conditions that led to these developments.	B.8.2 a. Routinely incorporate multicultural historical events that have contributed to the development of science over time.
B.8.3 Explain how the general rules of science apply to the development and use of evidence in science investigations, model-making, and applications.	B.8.3 a. Distinguish between common and scientific use of the word theory. b. Study how evidence and peer review are hallmarks of scientific thought. c. Discuss the development of a scientific theory as an explanation that has been robustly tested and supported through several lines of evidence. d. Explain the use of evidence and peer review in establishing scientific thought. e. Recognize that a hypothesis is a prediction based on previous information. f. Explain ways to make a scientific investigation valid. *Examples: the use of multiple trials, control, one independent variable, dependent variable, and constants…*
B.8.4 Describe types of reasoning and evidence used outside of science to draw conclusions about the natural world.	B.8.4 *a.* Show how non-scientific evidence can lead to non-scientific conclusions about the natural world. *Examples: fad diets, television advertisements, information read in a newspaper ad...* b. Demonstrate how science and scientific evidence can assist with making a decision. *Examples: whether to recycle, selecting a location for a house…*
B.8.5 Explain ways in which science knowledge is shared, checked, and extended, and show how these processes change over time.	B.8.5 a. Demonstrate how science knowledge is shared, replicated, and extended by scientists through peer review, journals, databases, and student presentations.

B.8.6 Explain the ways in which scientific knowledge is useful and also limited when applied to social issues.	B.8.6 a. Demonstrate and communicate how science and scientific evidence can assist with making an informed decision. b. Know the limitations that are associated with using science or scientific knowledge to solve a real world problem or issue. c. Understand the impact on society when making a decision.
C. SCIENCE INQUIRY	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
C.8.1 Identify questions they can investigate using resources and equipment they have available.	C.8.1 a. Identify questions that can be answered with available equipment, resources, scientific tools, logical reasoning, and/or dichotomous keys. b. Determine which is the most logical equipment to use when answering a question in science. c. Determine if the questions asked are testable.
C.8.2 Identify data and locate sources of information including their own records to answer the questions being investigated.	C.8.2 a. Identify sources of data. b. Determine and explain which is the most logical data needed to answer a scientific question.
C.8.3 Design and safely conduct investigations that provide reliable quantitative or qualitative data, as appropriate, to answer their questions.	C.8.3 a. Design an investigation that will answer a scientifically testable question. b. Conduct experiments that will generate both qualitative and quantitative data. c. Emphasize appropriate safety measures in all scientific investigations.

C.8.4 Use inferences to help decide possible results of their investigations, use observations to check their inferences.	C.8.4 a. Decide what are the most logical results for an investigation. b. Verify (either accept or reject) the decided results through experimentation.
C.8.5 Use accepted scientific knowledge, models, and theories to explain their results and to raise further questions about their investigations.	C.8.5 a. Compare the results to known science concepts, models, or theories to determine the accuracy of their results. b. Raise further questions after making comparisons of experimental results to known science understandings.
C.8.6 State what they have learned from their investigations, relating their inferences to scientific knowledge and to data they have collected.	C.8.6 a. Explain the results of an investigation to others using multiple forms of communication such as oral presentation or written report. b. Use collected data to support and explain scientific inferences. c. Explain their results by using the scienctific concepts being learned.
C.8.7 Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation and the answers they have developed.	C.8.7 *a.* Communicate the results to others, and communicate the results in ways others can understand. *Examples: understandable data, quantitative summary, clear presentation, use of visual aids…* b. Routinely incorporate and discuss the use of appropriate graphical representations of data.
C.8.8 Use computer software and other technologies to organize, process, and present their data.	C.8.8 a. Use equipment and/or computer software for their data that allows the students to present logical and reasoned results to others; equipment may include computers, probe ware, microscope, or telescope.
C.8.9: Evaluate, explain, and defend the validity of questions, hypotheses, and conclusions to their investigations.	C.8.9 a. Using collected data, defend the validity of the experimental design and results.

C.8.10 Discuss the importance of their results and implications of their work with peers, teachers, and other adults.	C.8.10 a. Regularly discuss the results and implications of an investigation within the classroom with peers, teachers, and other adults. b. Verify the accuracy of the science concepts being presented.
C.8.11 Raise further questions which still need to be answered.	C.8.11 a. Generate new questions about existing experiments that reflect upon new science understandings.
D. PHYSICAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
Properties and Changes of Properties in Matter	
D.8.1 Observe, describe, and measure physical and chemical properties of elements and other substances to identify and group them according to properties such as density, melting points, boiling points, conductivity, magnetic attraction, solubility, and reactions to common physical and chemical tests.	D.8.1 a. Observe chemical and physical properties of a substance. b. Measure chemical and physical properties of a substance. *c.* Classify substances using chemical and physical properties. *Examples: density, melting points, boiling points, conductivity, magnetic attraction, and solubility…* d. Differentiate between chemical and physical properties based on observation of physical and chemical changes.
D.8.2 Use the major idea of atomic theory and molecular theory to describe physical and chemical interactions among substances, including solids, liquids, and gases.	D.8.2 a. Explain that all matter is composed of atoms. b. Describe that matter is in constant motion. c. Explain that changes of state are related to energy changes.
D.8.3 Understand how chemical interactions and behaviors lead to new substances with different properties.	D.8.3 a. Investigate common chemical reactions emphasizing the differing properties of reactants and products. *Examples of reactions: acid/base, oxidation, or combustion…*

D.8.4 While conducting investigations, use the science themes to develop explanations of physical and chemical interactions and energy changes.	D.8.4 a. Conduct investigations and apply science themes to explain physical and chemical changes. *Examples: rusting – change, balancing reactions – constancy…*
Motions and Forces	
D.8.5 While conducting investigations, explain the motion of objects by describing the forces acting on them.	D.8.5 a. Conduct investigations which study how balanced and unbalanced forces act on objects either in motion or at rest.
D.8.6 While conducting investigations, explain the motion of objects using the concepts of speed, velocity, acceleration, friction, momentum, and changes over time, among others, and apply these concepts and explanations to real-life situations outside the classroom.	D.8.6 a. Demonstrate a conceptual understanding of motion by conducting investigations of speed, velocity, acceleration, friction, and momentum. b. Investigate speed and velocity through their graphical representations and mathematical relationships. c. Apply these concepts to real-life situations.
D.8.7 While conducting investigations of common physical and chemical interactions occurring in the laboratory and the outside world, use commonly accepted definitions of energy and the idea of energy conservation.	D.8.7 a. Describe kinetic and potential energy. b. Explain what happens to an object as the object's energy changes from potential and kinetic energy and vice versa. c. Understand that energy can neither be created nor destroyed; it is transformed among heat, light, sound, mechanical, chemical, nuclear, and electrical energy.
Transfer of Energy	
D.8.8 Describe and investigate the properties of light, heat, gravity, radio waves, magnetic fields, electrical fields, and sound waves as they interact with material objects in common situations.	D.8.8 a. Describe and explain the properties of light (reflection, absorption, refraction), sound (wave behavior and motion through various media), heat transfer (conduction, convection, radiation), electricity (transfer through circuits) magnetism (magnetic fields) and gravity.

D.8.9 Explain the behaviors of various forms of energy by using the models of energy transmission, both in the laboratory and in real-life situations.	D.8.9 a. Identify the various forms of energy using models of energy transmission. b. Investigate energy transformations. *Examples: home energy diagrams, combustion cycle in a car…*
D.8.10 Explain how models of the atomic structure of matter have changed over time, including historical models and modern atomic theory.	D.8.10 a. Compare historical atomic models to current atomic models. b. Explain how increased scientific knowledge led to changes in historical models of the atom. c. Explain how increased understandings about the atom have led to the development of current atomic models. d. Explain the limitations of current atomic models.
E. EARTH AND SPACE SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
Structure of Earth System	
E.8.1 Using the science themes, explain and predict changes in major features of land, water, and atmospheric systems.	E.8.1 a. Use the themes of systems, change, and organization to describe and explain how land forms are a result of a combination of constructive and destructive forces and how these factors contribute to the forming and changing of earth and its atmosphere. (Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.)
E.8.2 Describe underlying structures of earth that cause changes in the earth's surface.	E.8.2 a. Describe the layers of earth. *Examples: crust, mantle, core…* b. Describe how movement of plates within the earth result in major geological events. *Examples: volcanoes, earthquakes, mountain building…*

E.8.3 Using the science themes during investigations, describe climate, weather, ocean currents, soil movements and changes in the forces acting on the earth.	E.8.3 a. Emphasize the themes of change, systems, and models to investigate how uneven distribution of solar energy causes convection (of water and air) which influences climate, weather, and ocean currents. b. Explore and investigate patterns of soil movement.
E.8.4 Using the science themes, analyze the influence living organisms have had on the earth's systems, including their impact on the composition of the atmosphere and the weathering of rocks.	E.8.4 a. Study the effects of living organisms, including humans, on the composition of earth's atmosphere and earth's systems. *Examples: global warming, acid rain, and ozone layer depletion…*
Earth's History	
E.8.5 Analyze the geologic and life history of the earth, including change over time, using various forms of scientific evidence.	E.8.5 a. Use geologic evidence to establish the history of earth. *Examples: Atmospheric composition, changes in earth's surface, fossil evidence, relative age and type of rocks…*
E.8.6 Describe through investigations the use of the earth's resources by humans in both past and current cultures, particularly how changes in the resources used for the past 100 years are the basis for the efforts to conserve and recycle renewable and nonrenewable resources.	E.8.6 *a.* Investigate how humans have used renewable and non-renewable natural resources through history. *Examples: Water, rocks and minerals, fossil fuels, and solar energy…* b. Recognize relationships and patterns in human resource use through data collection and analysis. *Example: long-term consequences of overuse…* c. Develop strategies for the conservation of resources.

Earth in the Solar System	
E.8.7 Describe the general structure of the solar system, galaxies, and the universe, explaining the nature of the evidence used to develop current models of the universe.	E.8.7 a. Recognize that the sun is a star in our solar system. b. Recognize that there are many different stars, and they have different properties. c. Research gravity's role in holding together the solar system. d. Study and analyze data from various sources to support or further understand current models of our solar system. *Examples: optical and radio-telescopes, computer models, space probes….* e. Use models competently to represent solar system, galaxies, and universe.
E.8.8 Using past and current models of the structure of the solar system, explain the daily, monthly, yearly, and long-term cycles of the earth, citing evidence gained from personal observation as well as evidence used by scientists.	E.8.8 a. Research, using models, how objects in the solar system have regular and predictable orbits and motion. b. Recognize that the tilt of the earth on its axis as it revolves around the sun causes seasons. c. Explain that rotation of the earth on its axis causes day and night. d. Explore historical models of the solar system *Example: geocentric model…*

F. LIFE AND ENVIRONMENTAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
Structure and Function in Living Things	
F.8.1 Understand the structure and function of cells, organs, tissues, organ systems, and whole organisms.	F.8.1 a. Understand that organisms are composed of cells and that cells are the basic unit of life. b. Explore cell components, including different components of plant and animal cells. c. Apply cell specialization to the organization of tissues, organs, systems, and organisms in both plants and animals (photosynthesis and respiration on a conceptual level). d. Explain how major systems within organidms interact.
F.8.2 Show how organisms have adapted structures to match their functions, providing means of encouraging individual and group survival within specific environments.	F.8.2 a. Compare form and function of various organisms' adaptations as related to their environments. b. Investigate natural selection.
F.8.3 Differentiate between single-celled and multiple-celled organisms (including humans) through investigation, comparing the cell functions of specialized cells for each type of organism.	F.8.3 *a.* Investigate a variety of cells using microscopes and illustrations. *Examples: single-celled, multi-celled organisms, plant and animal cells…* b. Present conceptual understandings of differences between single-celled and multiple-celled organisms. c. Compare and contrast structure and function of specialized cells. *Examples: muscle, nerve, blood cells in animals, photosynthetic cells in plants…*

Reproduction and Heredity	
F.8.4 Investigate and explain that heredity is comprised of the characteristic traits found in genes within the cells of an organism.	F.8.4 a. Investigate basic genetics including Mendel's theories, Punnett squares, and predictions of possible offspring. b. Understand that genes determine traits.
F.8.5 Show how different structures both reproduce and pass on characteristics of their group.	F.8.5 a. Study sexual and asexual reproduction with emphasis on the advantages and disadvantages of each.
Regulation and Behavior	
F.8.6 Understand that an organism is regulated both internally and externally.	F. 8.6 a. Investigate external/internal stimuli on organisms using themes of equilibrium and constancy. Examples: Stimulus/response, feedback loop, diffusion/osmosis within cells, body temperature regulation…
F.8.7 Understand that an organism's behavior evolves through adaptation to its environment.	F.8.7 a. Study an organism's behavioral modifications to their environment. *Examples: hibernation, fluffing feathers, migration, nesting, shivering, huddling, herding, caring for young…*
Populations and Ecosystems	
F.8.8 Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet.	F.8.8 a. Investigate interactions within various ecosystems and their components (including non-living). b. Analyze population fluctuations and energy flow in ecosystems.
Diversity and Adaptations of Organisms	
F.8.9 Explain how some of the changes on the earth are contributing to changes in the balance of life and affecting the survival or population growth of certain species.	F.8.9 a. Investigate environmental problems. *Examples: invasive species, extinction, overpopulation, degradation of habitat, exceeding carrying capacity, drought…*

F.8.10 Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends.	F.8.10 a. Study current policies and their impact on our environment.
G. SCIENCE APPLICATIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
G.8.1 Identify and investigate the skills people need for a career in science or technology and identify the academic courses that a person pursuing such a career would need.	G.8.1 a. Explore careers in science and technology.
G.8.2 Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers.	G.8.2 a. Explore and connect technology with changing trends in career options.
G.8.3 Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life.	G.8.3 a. Highlight the impacts science and technology have had on our culture both positive and negative. *Example: simple risk-benefit analysis...*
G.8.4 Propose a design (or re-design) of an applied science model or a machine that will have an impact in the community or elsewhere in the world and show how the design (or re-design) might work, including potential side-effects.	G.8.4 a. Design, test, and revise a model, machine, or device. b. Discuss a model's potential impact in the community or elsewhere in the world and show how the design (or re-design) might work, including potential side-effects.

G.8.5 Investigate a specific local problem to which there has been a scientific or technological solution, including proposals for alternative choices of action, the choices that were made, reasons for the choices, any new problems created, and subsequent community satisfaction.	G.8.5 a. Investigate a specific local problem or issue where the issue was solved through science or technology. b. Examine the issue or problem to determine why the solution was chosen. *Examples: alternative solutions, reasons for the choices, new problems created by the solution, subsequent community satisfaction…*
G.8.6 Use current texts, encyclopedias, source books, computers, experts, the popular press, or other relevant sources to identify examples of how scientific discoveries have resulted in new technology.	G.8.6 a. Research (using multiple science sources) how a scientific discovery resulted in new technology.
G.8.7 Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations.	G.8.7 a. Show relationships between science and technology over time. *Examples: changes in cell theory, medical advancements, space exploration, commercial applications, communications…*
H. SCIENCE IN SOCIAL AND PERSONAL PERSPECTIVES	
Performance Standards	**Assessment Frameworks**
By the end of Grade 8 students will:	***By the beginning of Grade 8 students will:***
H.8.1 Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of source.	H.8.1 a. Evaluate various sources of information about a social issue with emphasis on scientific quality (scientific accuracy, credibility, and bias). *Example: Compare tabloid versus scientific journal…*
H.8.2 Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision.	H.8.2 a. Engage in consenus-building discussions about important current situations. b. Determine a solution to a problem based on scientific evidence.

H.8.3 Understand the consequences of decisions affecting personal health and safety.	H.8.3 a. Using scientific evidence, investigate and critique decision-making in personal health and safety issues. *Examples: nutrition, seat belt safety, helmet use, limitations of antibiotics, personal hygiene, spread of viruses, tobacco, and alcohol use…*

A. SCIENCE CONNECTIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
A.12.1 Apply the underlying themes of science to develop defensible visions of the future.	A.10.1 *a.* Given an an event, issue, or problem in the natural or designed world, apply the science theme(s) associated with it. *Examples: pollution- apply the themes: interactions, change, and evidence; new technologies such as hybrid cars or hydrogen fuel cells - apply the themes: form and function, models, and systems…* b. Explain how science ideas have changed as new knowledge becomes available. *Examples: Alchemy led to chemistry which will lead to new understandings in chemistry. earth's history can predict what Earth will look like in 100 million years…*
A.12.2 Show how conflicting assumptions about science themes lead to different opinions and decisions about evolution, health, population, longevity, education, and use of resources, and show how these opinions and decisions have diverse effects on an individual, a community, and a country, both now and in the future.	A.10.2 *a.* Explain how scientists have developed different ideas to explain phenomenon, based on differences in the data that they collected and different prior knowledge about the natural world. *b.* Give an example of how science is changing as new evidence is found *Example: Dalton's Atomic Theory…* c. Demonstrate that science is replicated and reliable.
A.12.3 Give examples that show how partial systems, models, and explanations are used to give quick and reasonable solutions that are accurate enough for basic needs.	A.10.3 *a.* Give examples of partial models either physical or conceptual, that adequately explain the science concept. *Examples: cell diagram, Bohr model of the atom, the Big Bang Theory, common cold, medical diagnosis, diagrams of a model…*
A.12.4 Construct arguments that show how conflicting models and explanations of events can start with similar evidence.	Beyond 10th Grade.

A.12.5 Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources.	A.10.5 a. Apply the themes of science to human endeavors. *Examples: systems - human body systems (impact of smoking;, order - lifestyle, workplace, and resource use, changes related to season;, organization - apply the idea of organization to levels of classification found in the school; interactions - laws of motion applied to student driving; evidence - collection of data about the workplace before applying for a position, fad diets; change - career changes students will face in the future, lifestyle changes resulting from seasonal activities…*
A.12.6 Identify and replace inaccurate personal models and explanations of science-related phenomena using evidence learned or discovered.	A.10.6 a. Research and gather evidence to challenge inaccuracies and/or misconceptions and replace these with accurate models and explanations. *Example: Use data about heredity to explain that organisms are born with adaptations that help an organism to survive, rather than the misconception that the organism develops an adaptation in response to an environmental change, additional examples …*
A.12.7 Re-examine the evidence and reasoning that led to conclusions drawn from investigations, using the science themes.	A.10.7 a. Re-examine or re-evaluate results or conclusions (and the evidence that led to those results) and relate those results to the themes. *Examples: systems - results from a simple erosion experiment and how it relates to the Grand Canyon; evidence - given the results of friction experiments, relate those results to general friction concepts; organization - relate one classification scheme to another…*

B. NATURE OF SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
B.12.1 Show how cultures and individuals have contributed to the development of major ideas in the earth and space, life and environmental, and physical sciences.	B.10.1 a. Show how cultures and individuals have contributed to the development of major ideas in the earth and space, life and environmental, and physical sciences. (Note: the following should NOT be taught as just recall of name and discovery.) *Examples: Aldo Leopold: ecology, Rachel Carson: ecology, John Muir: ecology, Watson & Crick: DNA, Rosalind Franklin: DNA, Clark, Lovell, Deke Slayton: shuttle, Pasteur: vaccinations, Drew: blood bank, Mendeleev: periodic table, Chinese: acupuncture, Russian space: Sputnik, Greeks and Romans: astronomy, Barbara McClintock: transposons, Jonas Salk: polio vaccine, Sir Isaac Newton: Laws of Motion, Albert Einstein: relativity, Germ theory/diseases, Europe: industrialization, Marie Curie: radium…*
B.12.2 Identify the cultural conditions that are usually present during great periods of discovery, scientific development, and invention.	B.10.2 a. Identify the cultural conditions that are usually present during great periods of discovery, scientific development, and invention such as: war, prosperity, competition between countries, government support, political philosophies. *Examples: space race of the 1960's, Manhattan Project…*

B.12.3 Relate the major themes of science to human progress in understanding science and the world.	B.10.3 a. Relate the major themes of science to scientific endeavors. *Examples: change - Copernican revolution; evidence - observing cells for the first time (Robert Hooke, Anton van Leeuvenhoek; explanation - Gregor Mendel's work on basic genetic research; measurement - Kelvin's temperature scale; model - Bohr's model of the atom; order - Mendeleev and the order of the periodic table; organization - Linnaeus and the development of binomian nomenclature; systems - Alfred Wegener, continental drift theory…*
B.12.4 Show how basic research and applied research contribute to new discoveries, inventions, and applications.	B.10.4 a. Show how basic research and applied research contribute to new discoveries, inventions, and other applications of science. *Examples: milestones in scientific research contribute to new areas of research (Human Genome Project), scientific breakthroughs provide new areas of research (DNA sequencing), scientific research results in contributions to society (antibiotics, predisposition to diseases, prenatal testing), available technology contributes to new areas of discovery (electron microscopes)…*

B.12.5	B.10.5
Explain how science is based on assumptions about the natural world and themes that describe the natural world.	*a.* Explain how science is based on assumptions about the natural world and the science themes that describe the natural world. *Example: "Scientists can never be sure that a given explanation is complete and final. Yet, many scientific explanations have been so thoroughly tested and confirmed that they are held with great confidence," the nature of science…* b. Understand that multiple lines of evidence support each other and give more credibility to a scientific idea. *Example: evolution…* c. Differentiate between facts, hypotheses, theories, and laws. d. Understand that the results of scientific investigations are replicable. e. Understand causality, comprehensibility, reproducibility, tentativeness, and contingency. *Examples: Natural causes have natural effects (causality). The human mind is capable of pulling many ideas together to explain occurrences through logical reasoning (comprehensibility). There is always some degree of error in experiments and results may be tentative. Data and explanations that come from data are contingent on the validity of prior assumptions (contingency)…* f. Understand that science distinguishes itself from other ways of knowing and from other bodies of knowledge through the use of empirical standards, logical arguments, skepticism, creativity, intuition, imagination, and perseverance.

C. SCIENCE INQUIRY	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
C.12.1 When studying science content, ask questions suggested by current social issues, scientific literature, and observations of phenomena; build hypotheses that might answer some of these questions; design possible investigations; and describe results that might emerge from such investigations.	C.10.1 When studying science content: a. Ask testable questions suggested by current social issues, scientific literature, or observations of phenomena. b. Choose appropriate resources that could be used to research the question or questions. c. Develop alternative hypotheses for the question or questions.
C.12.2 Identify issues from an area of science study, write questions that could be investigated, review previous research on these questions, and design and conduct responsible and safe investigations to help answer the questions.	C.10.2 a. Develop testable questions that could be investigated. b. Review previous research available for the question or questions. c. Design and conduct responsible and safe investigations to help answer the question or questions. d. Demonstrate knowledge of basic safe laboratory procedures. *Examples: understand warning labels, use of appropriate laboratory equipment and appropriate attire such as goggles, apron, etc., importance of washing hands and keeping work surface clear of clutter…*
C.12.3 Evaluate the data collected during an investigation, critique the data-collection procedures and results, and suggest ways to make any needed improvements.	C.10.3 a. Evaluate the data collected during an investigation. b. Critique the data-collection procedures and results. c. Suggest ways to make any needed improvements. d. Distinguish qualitative and quantitative data and represent the data appropriately. *Example: graphing techniques, mean, median, mode…* e. Use the metric system (SI: System International units).

C.12.4 During investigations, choose the best data-collection procedures and materials, use them competently, and calculate the degree of precision of the resulting data.	C.10.4 a. During investigations choose the best-data collection procedures. b. Select appropriate materials and tools for the investigation. c. Use the procedures and materials competently
C.12.5 Use the explanations and models found in earth and space, life and environmental, and physical sciences to develop likely explanations for the results of their investigations.	C.10.5 a. Use the explanations and models found in the earth and space, life and environmental, and physical sciences to develop likely explanations for the results of their investigations. *Example: writing a conclusion…* b. Use the results of an experiment to develop a valid explanation. *c.* Explain concepts in science using appropriate models. *Examples: plate tectonics, erosion patterns, cell models, magnetic fields, light, heat, and forces of nature…* d. Evaluate models, physical or conceptual, for accuracy and completeness. e. Develop and defend ideas or conclusions based on data. f. Generalize the results to the natural world.
C.12.6 Present the results of investigations to groups concerned with the issues, explaining the meaning and implications of the results, and answering questions in terms the audience can understand.	C.10.6 When presenting conclusions to others: a. Present clear and logical arguments for the results. b. Be able to answer questions about the results. c. Defend the results. d. Communicate the results and their implications in ways that others will understand.

C.12.7 Evaluate articles and reports in the popular press, in scientific journals, on television, and on the Internet, using criteria related to accuracy, degree of error, sampling, treatment of data, and other standards of experimental design.	C.10.7 a. Evaluate the scientific accuracy of articles found in popular press, journals, television, and Internet. b. Determine the scientific accuracy of the article using the criteria of evidential quality, type of evidence, kind of evidence, source of the evidence, potential bias, and degree of accuracy. c. Determine if research is sufficient to support the claims made in the article.

D. PHYSICAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
Structures of Atoms and Matter	
D.12.1 Describe atomic structure and the properties of atoms, molecules, and matter during physical and chemical interactions.	D.10.1 a. Identify and compare three basic particles of the atom (proton, neutron, and electron). *b.* Describe physical and chemical properties of matter. *Examples: density, melting point, boiling point, solubility, conductivity, and magnetic attraction…* c. Identify and compare the three states of matter based on motion and distance between particles. d. Identify how matter changes during physical and chemical interactions. e. Indicate that atoms combine to form molecules. f. Illustrate that bonds within a molecule are created when electrons are transferred or shared. g. Describe that energy is required to change the state of matter.
D.12.2 Explain the forces that hold the atom together and illustrate how nuclear interactions change the atom.	D.10.2 a. Explain how the attractive force that hold an atom together is an electrostatic force. b. Explain how the nuclear forces hold an atom's nucleus together.
D.12.3 Explain exchanges of energy in chemical interactions and exchange of mass and energy in atomic/nuclear reactions.	D.10.3 a. Recognize that during chemical reactions, energy is absorbed or released and that the energy can be in the form of light, heat, or electrical energy.

Chemical Reactions	
D.12.4 Explain how substances, both simple and complex, interact with one another to produce new substances.	D.10.4 a. Indicate that the formation of new substances can be represented by chemical equations. b. Explain how substances interact to form new substances through the transfer or sharing of electrons. c. Describe that matter is conserved in physical and chemical changes. d. Identify factors that affect the rate of a chemical reaction.
D.12.5 Identify patterns in chemical and physical properties and use them to predict likely chemical and physical changes and interactions.	D.10.5 a. Identify patterns in the periodic table such as number of protons, atomic mass, and number of valence electrons. b. Illustrate that elements on the periodic table can be grouped according to their properties, such as metals vs. non-metals, metalloids (semi-metals), and noble gases. c. State how a given material acquires a net charge (atom only).
D.12.6 Through investigations, identify the types of chemical interactions, including endothermic, exothermic, oxidation, photosynthesis, and acid/base reactions.	D.10.6 a. As a result of investigation, identify various types of chemical interactions. *Examples: endothermic/exothermic, photosynthesis, cellular respiration, and simple acid/base reactions…*
Motions and Forces	
D.12.7 Qualitatively and quantitatively analyze changes in the motion of objects and the forces that act on them and represent analytical data both algebraically and graphically.	D.10.7 a. Describe and apply Newton's three laws of motion. b. Interpret motion graphs including position, acceleration, and velocity. c. Identify and evaluate forces acting on objects. d. Describe motion of an object from a single frame of reference, for example, a person observing a ball rolling down a ramp. e. Describe and differentiate between kinetic and potential energy.

D.12.8 Understand the forces of gravitation, the electromagnetic force, and the intermolecular force, and explain their impact on the universal system.	D.10.8 a. Identify gravity as an attractive force between two or more objects that have mass (mass vs. weight). b. Identify the electrostatic force as the force that exists between two or more charged objects. c. Identify the magnetic force as the attraction and repulsion between poles. d. Compare and contrast mass and weight.
D.12.9 Describe models of light, heat, and sound and through investigations describe similarities and differences in the way these energy forms behave.	D.10.9 a. Identify that vibrations in materials create waves that transfer energy away from the source. b. Identify the wave characteristics of frequency, wavelength, velocity, and amplitude. c. Compare and contrast light and sound waves. d. Identify regions of the electromagnetic spectrum. e. Describe that heat energy can be transferred by conduction, convection, and radiation.
Conservation of Energy and the Increase in Disorder	
D.12.10 Using the science themes, illustrate the law of conservation of energy during chemical and nuclear reactions.	D.10.10 *a.* Illustrate the law of conservation of energy by using the themes of explanation, constancy, and change in chemical reactions. *Example:; explanation –photosynthesis, the light energy absorbed by the plant is converted to chemical energy; constancy - light energy in equals chemical energy out; change - light energy converted to chemical energy…*

Interactions of Matter and Energy	
D.12.11 Using the science themes, explain common occurrences in the physical world.	D.10.11 *a.* Apply the themes of change, constancy, equilibrium, measurement, order, or model to explain common occurrences in the physical world. *Example: Sample topic: the common occurrence of a falling object; use the following themes: change - position varies; constancy - objects fall at the same rate; equilibrium - conservation of energy (potential energy changes to kinetic energy); measurement - distance or rate of fall over time; model - gravity; order - all objects fall toward the earth (free fall)…*
D.12.12 Using the science themes and knowledge of chemical, physical, atomic and nuclear interactions, explain changes in materials, living things, the earth's features, and stars.	D.10.12 a. Using the science concepts of chemical and physical interactions, explain changes in materials, living things, the earth's features, and stars. *Example: Sample topic: changes in materials; using the following themes: change – iron rusts over time; constancy – all types of iron rust; equilibrium – conservation of mass as the iron rusts (adding oxygen, model – chemical equation iron + oxygen → iron oxide…*

E. EARTH AND SPACE SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
Energy in the Earth System	
E.12.1 Using the science themes, distinguish between internal energies (decay of radioactive isotopes, gravity) and external energies (sun) in the earth's systems and show how these sources of energy have an impact on those systems.	E.10.1 a. Distinguish between internal energy like gravity and external energies (solar) that influence the earth's system. b. Predict and explain phenomena resulting from internal and external energies in the earth system. *Examples: earthquakes, volcanoes, landforms, weather, and climate....* c. Use the following themes to explain energies in the earth system: change, equilibrium, evidence, evolution, measurement, models, order, and systems. *Examples: sample topic, plate tectonics, using the themes of change - relative position, and shape of continent; equilibrium - rock cycle; evidence - fossil location; evolution - change in landforms over geologic time (glaciers); measurement - age of fossils; model - convection in mantle, earth/moon/sun dynamics (tides); order - predictable movement of continents; systems - interacting plates are predictors of earthquakes and volcanic eruptions, sun's energy affecting earth systems…*
Geochemical Cycles	
E.12.2 Analyze the geochemical and physical cycles of the earth and use them to describe movements of matter.	E.10.2: a. Describe the rock and water cycles and how they are related to the conservation of matter.

The Origin and Evolution of the Earth System	
E.12.3: Using the science themes, describe theories of the origins and evolution of the universe and solar system, including the Earth system as a part of the solar system, and relate these theories and their implications to geologic time on earth.	E.10.3 a. Describe the theories of the origins of the universe and solar system. b. Use rock, fossil, and satellite evidence to determine the history of the earth which supports the theories of continental drift and plate tectonics. c. Use the following themes to explain the origin and evolution of the universe and solar system: change, evidence, evolution, measurement, models, order, organization, and systems. E*xamples: sample topic, Origin of the Universe, using the themes of change – supernova; evolution - star life cycle, formation of planets over time; evidence - background radiation measurement: motion of the stars (red shift); models - Copernican theory of solar system; order - revolutions of planets; organization: galaxies; systems - star systems…*
E.12.4 Analyze the benefits, costs, and limitations of past, present, and projected use of resources and technology and explain the consequences to the environment.	E.10.4 *a.* Conduct an analysis that includes costs, benefits and risks, limitations of the resource, impact on the environment of human resource use. *Examples: petroleum exploration, use of wetlands, location of local well…*
The Origin and Evolution of the Universe	
E.12.5 Using the science themes, understand that the origin of the universe is not completely understood, but that there are current ideas in science that attempt to explain its origin.	E.10.5 a. Understand that as new evidence is discovered, questions still exist about the origin of the universe and the current evidence that supports the Big Bang Theory. *b.* Use the following themes to describe the theoretical origin of the universe: evidence and models. *Examples: Sample topic, Big Bang Theory.; using the themes, evidence - the expanding universe based on measurements; models - solar system, star formation…*

F. LIFE AND ENVIRONMENTAL SCIENCE	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
The Cell	
F.12.1 Evaluate the normal structures and the general and special functions of cells in single-celled and multiple-celled organisms.	F.10.1 a. Compare and contrast the cell structures and functions of cells for both single-celled and multiple-celled organisms. b. Identify cell organelles and describe their basic life functions. c. Recognize that most cell functions involve chemical reactions. d. Compare and contrast examples of prokaryotic and eukaryotic cells.
F.12.2 Understand how cells differentiate and how cells are regulated.	Beyond 10th grade.
The Molecular Basis of Heredity	
F.12.3: Explain current scientific ideas and information about the molecular and genetic basis of heredity.	F.10.3 a. Understand that DNA determines the genetic component of our characteristics. b. Understand that most human characteristics, including behavior, are determined by two or more genes and environmental factors. c. Understand the current scientific explanations for basic patterns of inheritance. d. Compare and contrast the end result of mitosis and meiosis. e. Understand that the combination of the DNA carried by the sperm and egg cells determines the offspring's genetic characteristics. f. Compare and contrast asexual and sexual reproduction.

F.12.4: State the relationships between functions of the cell and functions of the organism as related to genetics and heredity.	Beyond 10th grade.
Biological Evolution	
F.12.5: Understand the theory of evolution, natural selection, and biological classification.	F.10.5 a. Understand that multiple lines of evidence (fossil records, homologous structures, DNA sequences, vestigial structures, embryological development, and bacterial resistance) support the theory of evolution - that populations of organisms change over time. b. Understand that there are evidence-based mechanisms for evolution, such as natural selection which has been observed and tested in the laboratory and in the natural world. c. Understand that classification is based on an analysis of the presence and modification of features inherited from common ancestors. d. Understand that populations, not individuals, evolve.
F.12.6 Using concepts of evolution and heredity, account for changes in species and the diversity of species, including the influence of these changes on science, e.g., breeding of plants or animals.	F.10.6 a. Understand that genetic variation arises from random events, but natural selection which acts on genetic variation, is not random. b. Understand that natural selection is the process by which advantageous variations increase the chance for survival and reproduction of the organisms that possess them. c. Understand that genetic variation arises from sexual reproduction, genetic recombination (meiosis and crossing over) and mutation. d. Understand that natural selection acts on populations, not individual organisms. e. Evolution is a change in species over time through the process of natural selection.

The Interdependence of Organisms	
F.12.7 Investigate how organisms both cooperate and compete in ecosystems.	F.10.7 a. Understand that organisms both cooperate and compete in ecosystems. b. Recognize examples of mutualism and parasitism.
F.12.8 Using the science themes, infer changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water, or earth pollution.	F.10.8 a. Understand that ecosystems change. *Examples: Introduction of a new species, environmental changes, pollution, habitat destruction…* b. Describe ecosystems using the following science themes: change, constancy, equilibrium, evolution, order, organization, systems. *Examples: Change – seasons; constancy - energy input from the sun; equilibrium - photosynthesis/respiration; evolution – succession; order - producers/consumers, or energy pyramid; organization - food web; systems - community interdependence…*

Mattery, Energy, and Organization in Living Systems	
F.12.9 Using the science themes, investigate energy systems (related to food chains) to show how energy is stored in food (plants and animals) and how energy is released by digestion and metabolism.	F.10.9 a. Understand food chains, food webs, and ecosystems. b. Understand the sun is one of the primary energy sources for all life on earth. c. Understand that there are processes (*examples: photosynthesis, cellular respiration, digestion and metabolism*) that store and release energy. d. Understand food provides molecules that serve as fuel and building material for all organisms. e. Explain how energy is stored in food and how energy is released by using the themes of sicence. *Examples: change - energy conversions in photosynthesis and respiration; equilibrium - photosynthesis/respiration; models - energy pyramid, order - ten percent energy transfer rule...*
F.12.10 Understand the impact of energy on organisms in living systems.	F.10.10 a. Understand that the atoms of organisms pass through food webs and are combined and recombined in different ways. b. Understand that at each link in the food web, some energy is stored, but much is released into the environment as heat, thus continuous input of energy is required. c. Understand that the availability of matter and energy limits the distribution and abundance of organisms and populations.

F.12.11 Investigate how the complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain an organism.	F.10.11 a. Understand how the complexity and organization of organisms accommodate the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain an organism. b. Understand that different organisms have different mechanisms for performing the above functions. c. Understand that within an individual organism, different systems perform different functions.
The Behavior of Organisms	
F.12.12 Trace how the sensory and nervous systems of various organisms to react to the internal and external environment and transmit survival or learning stimuli to cause changes in behavior or responses.	F.10.12 a. Understand how the sensory and nervous systems of various organisms react to the internal and external environment and transmit survival or learning stimuli to cause changes in behavior or responses. b. Understand that some animal species are more limited to genetically determined behaviors while others with complex brains can more easily learn and modify their behavior.
G. SCIENCE APPLICATIONS	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
G.12.1 Identify personal interests in science and technology; account for implications that these interests might have for future education, and options to be considered.	G.10.1 a. Identify personal interests in science and technology. b. Identify future education needs, and determine what decisions are important. *Example: career choices…*

G.12.2 Design, build, evaluate, and revise models and explanations related to the earth and space, life and environmental, and physical sciences.	G.10.2 a. Design, build, evaluate, and revise models and explanations related to the earth and space, life and environmental, and physical sciences. *Example: Plan and build a physical model (based on a conceptual model) of an ecosystem that contains both aquatic and terrestrial components. Be able to evaluate and explain consequences of various changes to the ecosystem…*
G.12.3 Analyze the costs, benefits, or problems resulting from a scientific or technological innovation, including implications for the individual and the community.	G.10.3 a. Analyze the costs, benefits, or problems resulting from a scientific or technological innovation, including implications for the individual and community. *Examples: cloning, forensic science, biotechnology, genome sequencing, using natural predators or chemicals to fight invasive species, Mars Rover, tsunami early warning systems, biosensors, nanotechnology, mining…*
G.12.4: Show how a major scientific or technological change has had an impact on work, leisure, or the home.	G.10.4 *a.* Show how a major scientific or technological change has had an impact on work, leisure, or home. *Examples: DVR's, computers, PDA's, cell phones, MP3 players, Internet; historical examples, telephone, television…* b. Recognize that scientific inquiry is driven by the desire to understand the natural world and can result in technological discoveries that impact work, leisure, or home.
G.12.5 Choose a specific problem in our society, identify alternative scientific or technological solutions to that problem and argue its merits.	G.10.5 a. Choose a specific problem in our society, identify alternative scientific or technological solutions to that problem, and argue their merits. *Examples: allergies, obesity, stem cell research, bioterrorism, invasive species, global warming, deforestation, acid deposition, society's demand on energy…*

H. SCIENCE IN SOCIAL AND PERSONAL PERSPECTIVES	
Performance Standards	**Assessment Frameworks**
By the end of Grade 12 students will:	***By the beginning of Grade 10 students will:***
H.12.1 Using the science themes and knowledge of the earth and space, life and environmental, and physical sciences, analyze the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region.	H.10.1 *a.* Analyze the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region by using the following themes: change, constancy, equilibrium, evidence, explanation, form and function, measurement, models, order, organization, and systems. *Examples: Restoration of natural shoreline development to improve quality of lake ecosystems, mining, orbiting space debris, forestry. Sample topic: forestry; using the themes of evolution – succession; change - forest fire; constancy - seasonal changes; evidence - satellite imagery, or tree rings; explanation: forest conservation publications; form and function - needles v. deciduous leaves; measurement - population density; models - forest management models; order - tree canopy/forest floor coverage; organization - different types of forests (pine, deciduous); system - forest ecosystem…*
H.12.2 Evaluate proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning, and implications, both short and long term.	H.10.2 a. Evaluate proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning, and implications, both short and long term. *Examples: stem cell research, recycling policies for Wisconsin, use of national parks, land use, waste treatment issues, air pollution, transport and storage of nuclear waste, water conservation, ground water, mining in Wisconsin, natural hazards, and population growth (human and animal)…*

H.12.3 Show how policy decisions in science depend on many factors, including social values, ethics, beliefs, and time-frames, and considerations of science and technology.	Beyond 10th grade.
H.12.4 Advocate a solution or combination of solutions to a problem in science or technology.	Beyond 10th grade.
H.12.5 Investigate how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology, and quality of life in a community or region.	Beyond 10th grade.
H.12.6: Evaluate data and sources of information when using scientific information to make decisions.	H.10.6: a. Evaluate data and sources of information when using scientific information to make decisions (decide which are reliable, credible, scientific). *Examples: newspapers, tabloids, talk shows, websites, interviews, media, scientific journal articles.*
H.12.7: When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning.	Beyond 10th grade.

Glossary of Terms Used in the Wisconsin Assessment Framework

A

Analyze. The skill of recognizing the underlying details of important facts or patterns that are not always readily visible.

Apply. The skill of selecting and using information in other situations or problems.

Attribute (measurable). An identifiable property of an object, set, or event that is subject to being measured. For example, some of the measurable attributes of a box are its length, weight, and capacity (how much it holds).

B

Bias. A preference or attitude that may prevent impartial judgment.

Box plot. A graphic method that shows the distribution of a set of data by using the median, quartiles, and the extremes of the data set. The box shows the middle 50% of the data; the longer the box, the greater the spread of the data.

C

Cause and effect. A way of organizing text that emphasizes the causal relationships between two or more events or situations.

Central tendencies. A number which in some way conveys the "center" or "middle" of a set of data. The most frequently used measures are the mean and the median.

Change. A variance in the rate, scale, and pattern, including trends and cycles.

Congruence. The relationship between two objects that have exactly the same size and shape.

Constancy. The stability of a property, such as the speed of light.

Construct. The skill of developing or creating.

Constructed response. On the WKCE reading test, a type of item that requires a brief written response from a student.

Correlation. The amount of positive or negative relationship existing between two measures. For example, if the height and weight of a set of individuals were measured, it could be said that there is a positive correlation between height and weight if the data showed that larger weights tended to be paired with larger heights and smaller weights tended to be paired with smaller heights. The stronger those tendencies, the larger the measure of correlation.

Criterion-referenced. An interpretation of a test score relative to specified performance criteria.

D

Describe. The skill of developing a detailed picture or image.

Descriptor. In the WKCE assessment framework, an example of a specific knowledge or skill that may be assessed on the test.

Direct measurement. A process of obtaining the measurement of some entity by reading a measuring tool, such as a ruler for length, a scale for weight, or a protractor for angle size.

Discover. The skill of learning through study or investigation.

Dispersion. The scattering of the values of a frequency distribution (of data) from an average.

E

Energy. The work that a physical system is capable of completing or doing.

Equilibrium. The physical state in which forces and changes occur in opposite and off-setting directions.

Evaluate. The skill of collecting and examining data to make judgments and appraisals.

Evidence. Data and documentation that support inferences or conclusions.

Evolution. A series of changes, some gradual and some sporadic, that accounts for the present form and function* of objects.

Explanation. The skill of communication in which an interpretation of information is given and stated to others.

Extend. To draw conclusions or make predictions that go beyond what is stated.

F

Form and Function. Complimentary aspects of objects, organisms, and systems in the natural world.

Framework. For the WKCE, a document developed by the Department of Public Instruction to help educators understand the range of coverage of the test.

Frequency distribution. An organized display of a set of data that shows how often each different piece of data occurs. member of the second set. Functions can be used to understand how one quantity varies in relation to (is a function of) changes in the second quantity. For example, there is a functional relationship between the price per pound of a particular type of meat and the total amount paid for ten pounds of that type of meat.

G – I

Group. The skill of identifying objects according to characteristics.

Identify. The skill of recognizing patterns, facts, or details.

Illustrate. The skill of giving examples to describe something.

Indirect measurement. A process where the measurement of some entity is not obtained by the direct reading of a measuring tool, or by counting of units superimposed alongside or on that entity. For example if the length and width of a rectangle are multiplied to find the area of that rectangle, then the area is an indirect measurement.

Inference. The skill of using the results of an investigation based on a premise.

Interaction. The influence of objects, materials, or events on one another

Investigate. Scientific methodology that systematically employs many inquiry skills.

J – L

Line of best fit. A straight line used as a best approximation of a summary of all the points in a scatter-plot* (see definition below). The position and slope of the line are determined by the amount of correlation* (see definition above) between the two paired variables involved in generating the scatter-plot. This line can be used to make predictions about the value of one of the paired variables if only the other value in the pair is known.

Line plot. A graphical display of a set of data where each separate piece of data is shown as a dot or mark above a number line.

M

Matrix (pl.: matrices). A rectangular array of numbers, letters, or other entities arranged in rows and columns.

Maximum/minimum (of a graph). The highest/lowest point on a graph. A relative maximum/minimum is higher/lower than any other point in its immediate vicinity.

Mean. The arithmetic average of a set of numerical data.

Measurement. The quantification of changes in systems, including mathematics.

Median. The middle value of an ordered set of numerical data. For example, the median value of the set {5, 8, 9, 10, 11, 11,13} is 10.

Mode. The most frequently occurring value in a set of data. For example, the mode of the set {13, 5, 9, 11, 11, 8, 10} is 11.

Model (mathematical). A [verb] and a noun. [Generate] a mathematical representation (e.g., number, graph, matrix, equation(s), geometric figure) for real world or mathematical objects, properties, actions, or relationships.

Models. Tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power.

N

National Science Standards. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

(Non)-Linear functional relationship. (See definition of Function above.) Many functions can be represented by pairs of numbers. When the graph of those pairs results in points lying on a straight line, a function is said to be linear. When not on a line, the function is nonlinear.

Norm-referenced. An interpretation of a test score relative to the scores of other test-takers.

O

Observation. The skill of describing scientific events.

Order. The behavior of units of matter, objects, organisms, or events in the universe.

Organization. Descriptions of systems based on complexity and/or order.

P

Patterns. Recognizable regularities in situations such as in nature, shapes, events, sets of numbers. For example, spirals on a pineapple, snowflakes, geometric designs on quilts or wallpaper, the number sequence {0, 4, 8, 12, 16 . . . .).

Percentile. A value on a scale that indicates the percent of a distribution that is equal to it or below it. For example, a score at the 95th percentile is equal to or better than 95 percent of the scores.

Permutations. Possible arrangements of a set of objects in which the order of the arrangement makes a difference. For example, determining all the different ways five books can be arranged in order on a shelf.

Predict. The skill of explaining new events based on observations or information.

Q-R

Range (of a set of data). The numerical difference between the largest and smallest values in a set of data.

Real-world problems. Quantitative and spatial problems that arise from a wide variety of human experiences, applications to careers. These do not have to be highly complex ones and can include such things as making change, figuring sale prices, or comparing payment plans.

Relate. The skill of association.

Rubric. A scoring guide used to evaluate a student's performance.

S

Scaling (Scale drawing). The process of drawing a figure either enlarged or reduced in size from its original size. Usually the scale is given, as on a map 1 inch equals 10 miles.

Scatter plot. Also known as scattergram or scatter diagram. A two-dimensional graph representing a set of bi-variate data. That is, for each element being graphed, there are two separate pieces of data. For example, the height and weight of a group of 10 teenagers would result in a scatter plot of 10 separate points on the graph.

Selected-response. A kind of test item in which a student must choose the best response from among several choices. Also known as multiple-choice.

Show. The skill of illustration.

Similarity. The relationship between two objects that have exactly the same shape but not necessarily the same size.

Simulation. Carrying out extensive data collection with a simple, safe, inexpensive, easy-to-duplicate event that has essentially the same characteristics as another event which is of actual interest to an investigator. For example, suppose one wanted to gather data about the actual order of birth of boys and girls in families with five children (e.g., BBGBG is one possibility). Rather than wait for five children to be born to a single family, or identifying families that already have five children, one could simulate births by repeatedly tossing a coin five times. Heads vs. tails has about the same chance of happening as a boy vs. a girl being born.

Summary statistics. A single number representation of the characteristics of a set of data. Usually given by measures of central tendency and measures of dispersion (spread).

Symmetry. A figure has symmetry if it has parts that correspond with each other in terms of size, form, and arrangement. For example, a figure with line (or mirror) symmetry has two halves which match each other perfectly if the figure is folded along its line of symmetry.

Systems. An organized group of related objects or components that form a whole.

T

Technical Advisory Committee. For the Wisconsin Student Assessment System, a group of nationally-recognized experts that meets twice a year to advise the state on technical issues related to the assessments.

Transformation. A change in the size, shape, location, or orientation of a figure.

Tree diagram. A schematic way of showing the number of ways a compound event may occur. For example, the tree diagram at the right shows the eight possible ways the tossing of three coins could happen.

U-V

Understand. The skill of having and applying well-organized bodies of knowledge.

Variable. A quantity that may assume any one of a set of values. Usually represented in algebraic notation by the use of a letter. In the equation $y = 2x + 7$, both x and y are variables.

Variance. The value of the standard deviation squared.

W- Z