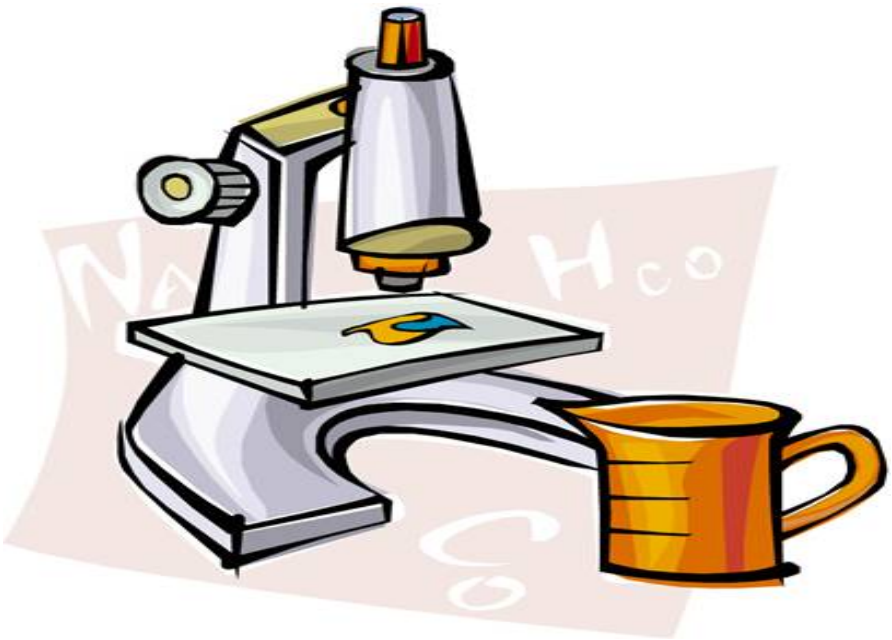
# High School Chemistry Curriculum Essentials Document



Boulder Valley School District
Department of Curriculum and Instruction
May 2009

# Boulder Valley School District
# Board of Education

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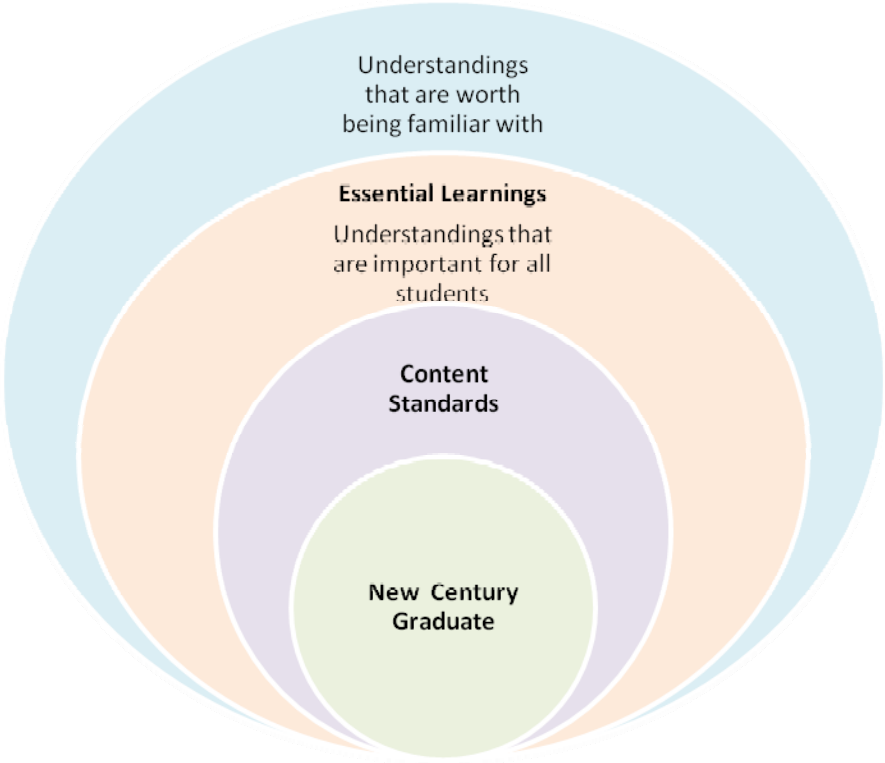
## General Introduction



## High School Chemistry Curriculum Essentials

# General Introduction

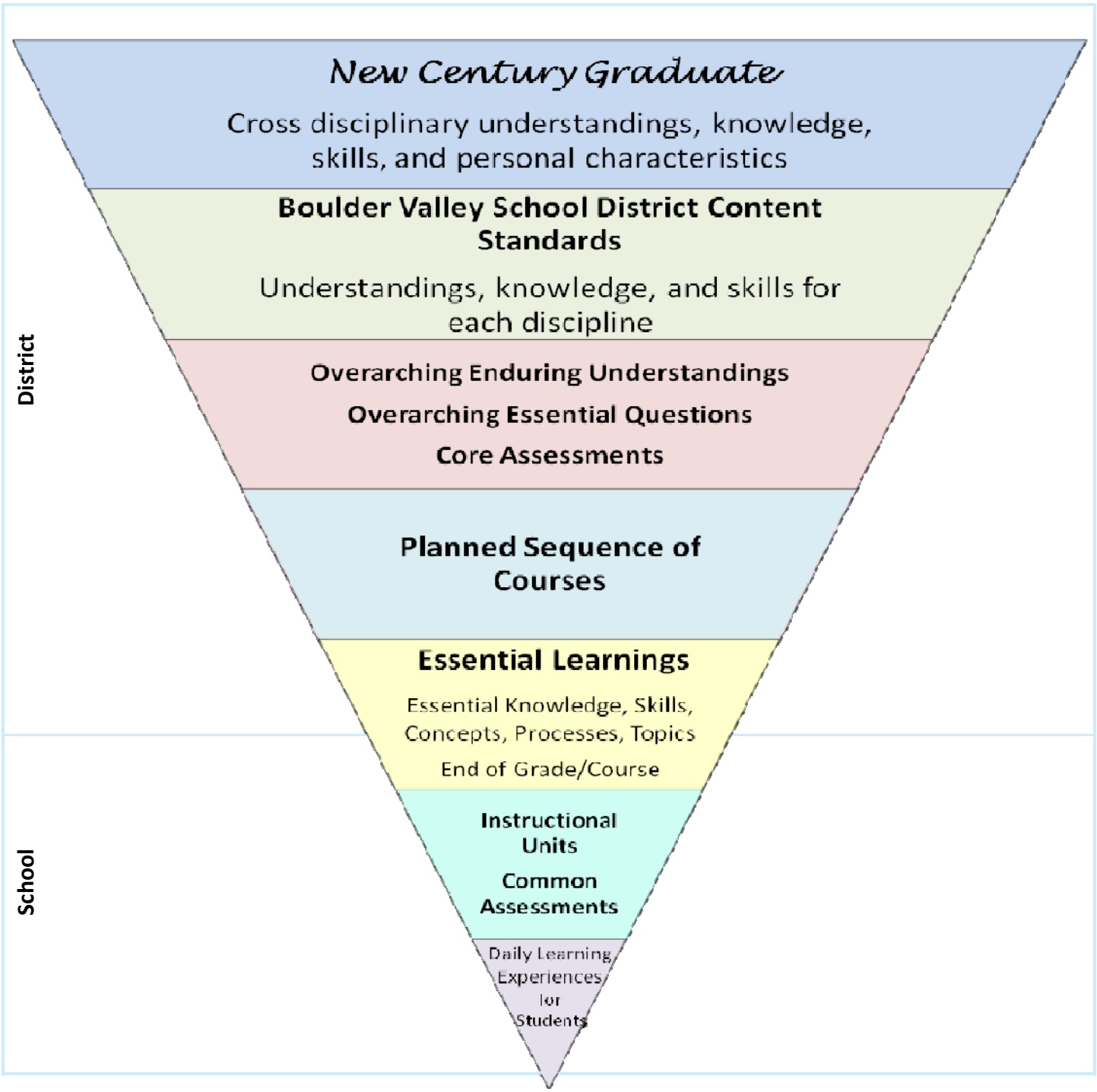
# What is a Curriculum Essentials Document? How Does it Relate to a Guaranteed and Viable Curriculum?




Because we are faced with more content than we can reasonably address, we are obligated to make choices and frame priorities. A useful framework for establishing priorities is graphically depicted using 4 nested ovals. The innermost oval, *New Century Graduate*, represents the goals of schooling that have been identified by the Boulder Valley School District community. Moving to the next oval, *Content Standards*, levels of performance for each program of study are clearly articulated. The third oval, *Essential Learnings*, represents the **viable curriculum**. A curriculum is viable when the number of learnings can be accomplished in the time provided (usually a semester, trimester, or year). Thus, an Essentials Document identifies the priorities for learning that are necessary for successful learning at a particular grade level or course and beyond. It also identifies the essential knowledge, skills, concepts, topics, and processes that support the attainment of the essential learning. Finally, the largest oval represents the field of all possible content that might be examined during a grade level or course. This includes extended learning opportunities for students who have achieved the essential learnings or attending to background knowledge and skills that students may need to review or learn to ensure achievement of grade level or course essential learnings.

# Curriculum Framework: Macro and Micro Levels

The New Century Graduate identifies the knowledge, skills and personal characteristics that our community has identified as the goals of schooling. Programs of study and curricular content are identified and addressed as a means




Adapted from Grant Wiggins and Jay McTighe (2007). *Schooling by Design.* Alexandria, VA: Association for Supervision and Curriculum

# *New Century Graduate*
## Knowledge and Skills

### ***Life Competencies***

Leads a balanced life: exhibits physical fitness, knows good nutrition rules, stays safe and drug free, knows how to have fun and relax, manages anger and stress, exhibits self-sufficiency and self confidence, and finishes tasks.

Understands money management, budgeting, balancing a checkbook, debt management, and record keeping.

Demonstrates time management skills and a broad base of knowledge in practical skills such as cooking, sewing, driving, and map reading.

Knows how to search for a job and knows where to go to find answers.

### ***Communication: Speaking and Writing***

Writes and speaks thoughtfully and articulately to inform, to express one's thinking and creativity, and to communicate to diverse audiences.

Uses correct grammar, spelling, and mechanics; organizes for effectiveness

Uses technology for effective communication

.

### ***Multicultural/Global Perspective***

Understands global customs, economics, literature, history, politics, religions, geography, and demographics.

Understands the contributions of different cultures to our society

Demonstrates proficiency in a language other than English.

### ***Literacy: Reading***

Reads critically, fluently, and with comprehension.

Reads for information research, pleasure and knowledge of literature.

### ***Mathematics***

Demonstrates basic math computational skills and understand higher-level mathematical concepts and reasoning.

Understands conservation and resource management.

### ***History***

Possesses knowledge of American and World Histories and their influence upon the present and the future.

Employs literature as a tool for learning about history across cultures.

### ***Science***

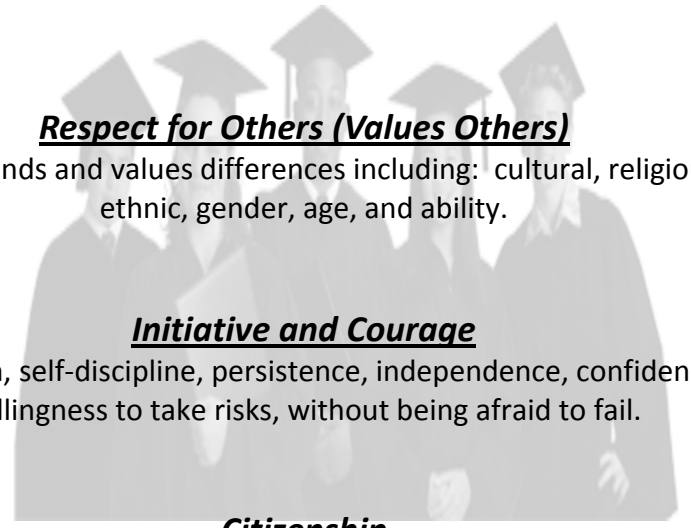
Demonstrates basic sciences knowledge and understands high-level scientific systems including environmental systems.

Knows how to apply the scientific method to real situations.

### ***Arts***

Experiences and appreciates music, visual arts, dance and theater.

# *New Century Graduate*
## Personal Characteristics



***Respect for Others (Values Others)***

Understands and values differences including: cultural, religious, ethnic, gender, age, and ability.

***Initiative and Courage***

Exhibits self-motivation, self-discipline, persistence, independence, confidence, curiosity, and willingness to take risks, without being afraid to fail.

***Citizenship***

Understands his or her role and responsibilities and contributes to the community, nation, and world.

***Responsibility***

Takes responsibility for own thoughts and actions, accepting the consequences.

***Ethical Behavior***

Exhibits personal integrity through honesty, fairness, sincerity, and a sense of justice.

***Flexibility and Open Mindedness***

Demonstrates flexibility, open-mindedness, adaptability, resiliency, and openness to change.

***Self-respect***

Possesses self-respect and confidence, while recognizing one's own limitations.

# What are Enduring Understandings and Essential Questions?

## Enduring Understandings

are the big ideas central to a content area that have lasting value beyond the classroom and are transferable to new situations. Enduring understandings describe what, specifically, students should understand about the topic. Such understandings are generally abstract in nature and are often not obvious, thus requiring uncovering of a topic through sustained inquiry.

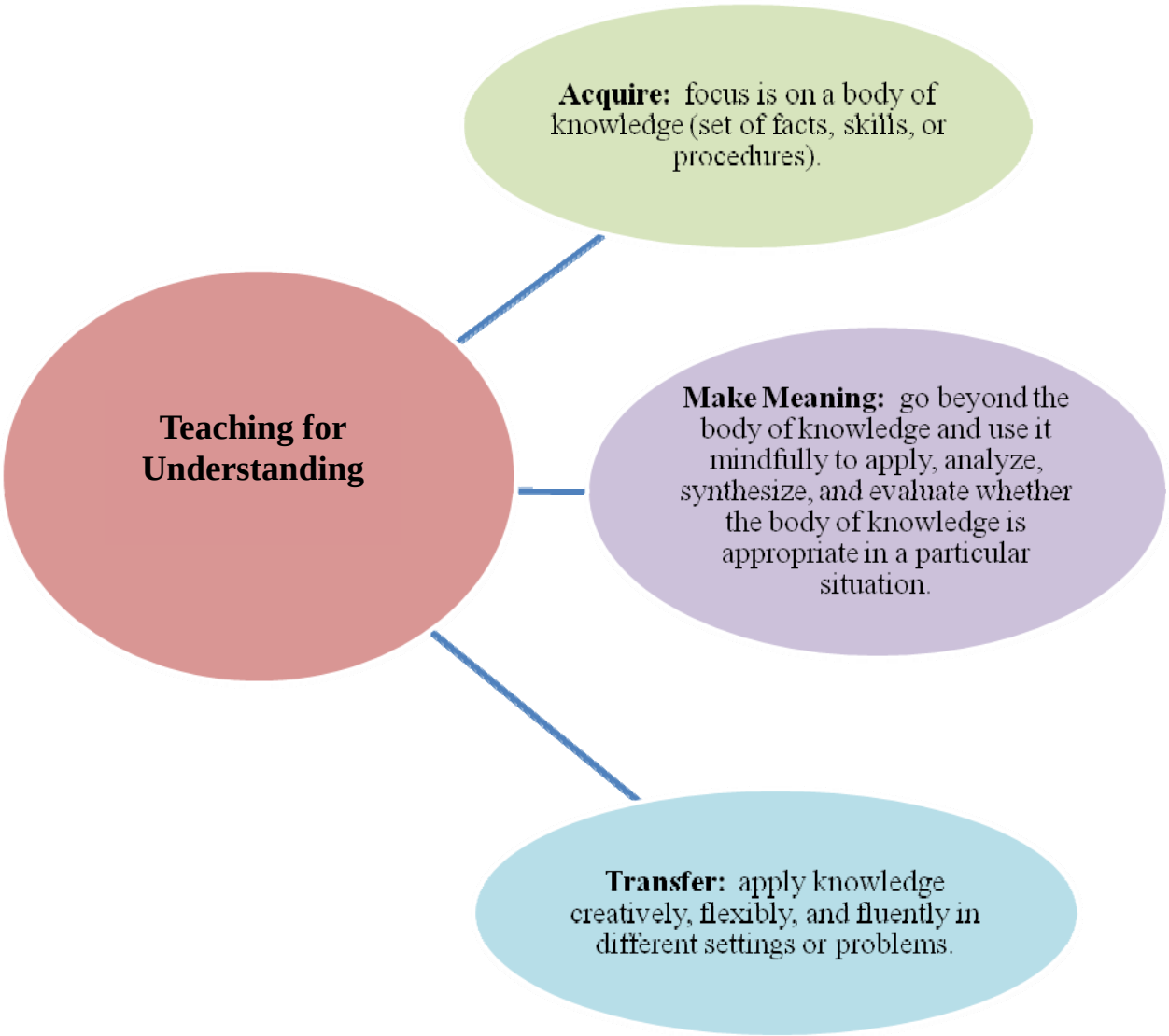
An understanding can be overarching or topical. Overarching understandings are broad (as the name implies) and offer a possible bridge to other units and courses. Overarching understandings at identified at the district-level. Topical understandings are unit specific, identified by teachers about the understandings the unit will cultivate about specific topics.

**Essential Questions** provoke deep thought, lively discussion, sustained inquiry, and new understandings culminating in meaningful performances. They require students to consider alternatives, weigh evidence, support their ideas, and justify answers. Essential questions do not yield a single straightforward answer, but produce different plausible responses, about which thoughtful and knowledgeable people may disagree. Essential questions spark meaningful connections with prior learnings and personal experiences and create opportunities for transfer to other situations and subjects.

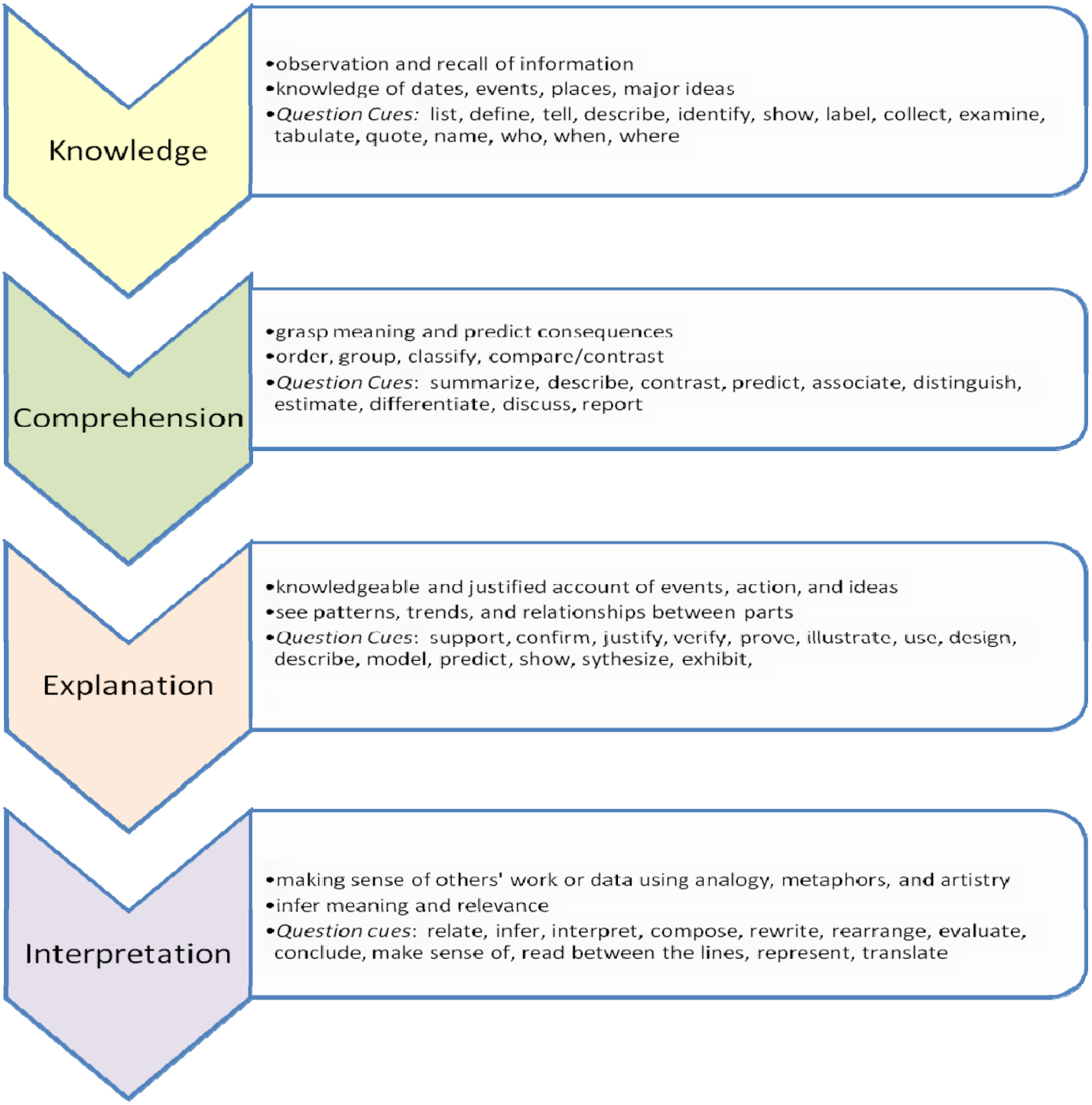
An essential questions can be either overarching or topical in scope. Overarching essential questions are general in nature, causing genuine and relevant inquiry into the big ideas and core content. They cut across units and/or courses. Topical essential questions focus on a specific topic and meant to be answered—if only provisionally—by unit's end.

# Teaching for Understanding

If learning is to endure in a flexible, adaptable way for future use, then teachers must design units that in provide opportunity for students to 1) acquire knowledge; 2) to deepen the meaning of that knowledge by using it mindfully, and 3) to transfer their learning to new situations or problems.



# What Does it Mean to Understand?

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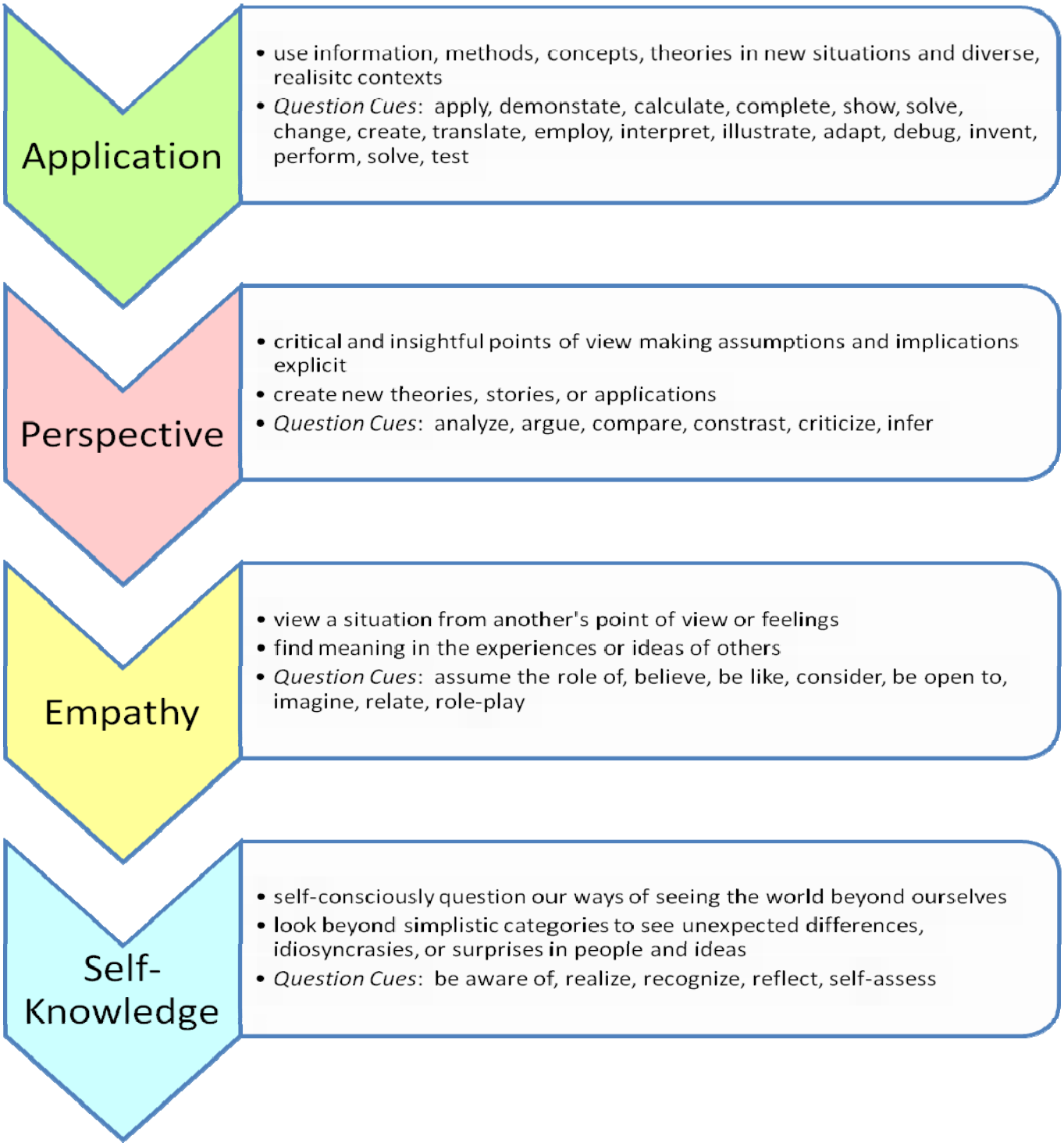
# What Does it Mean to Understand? (continued)

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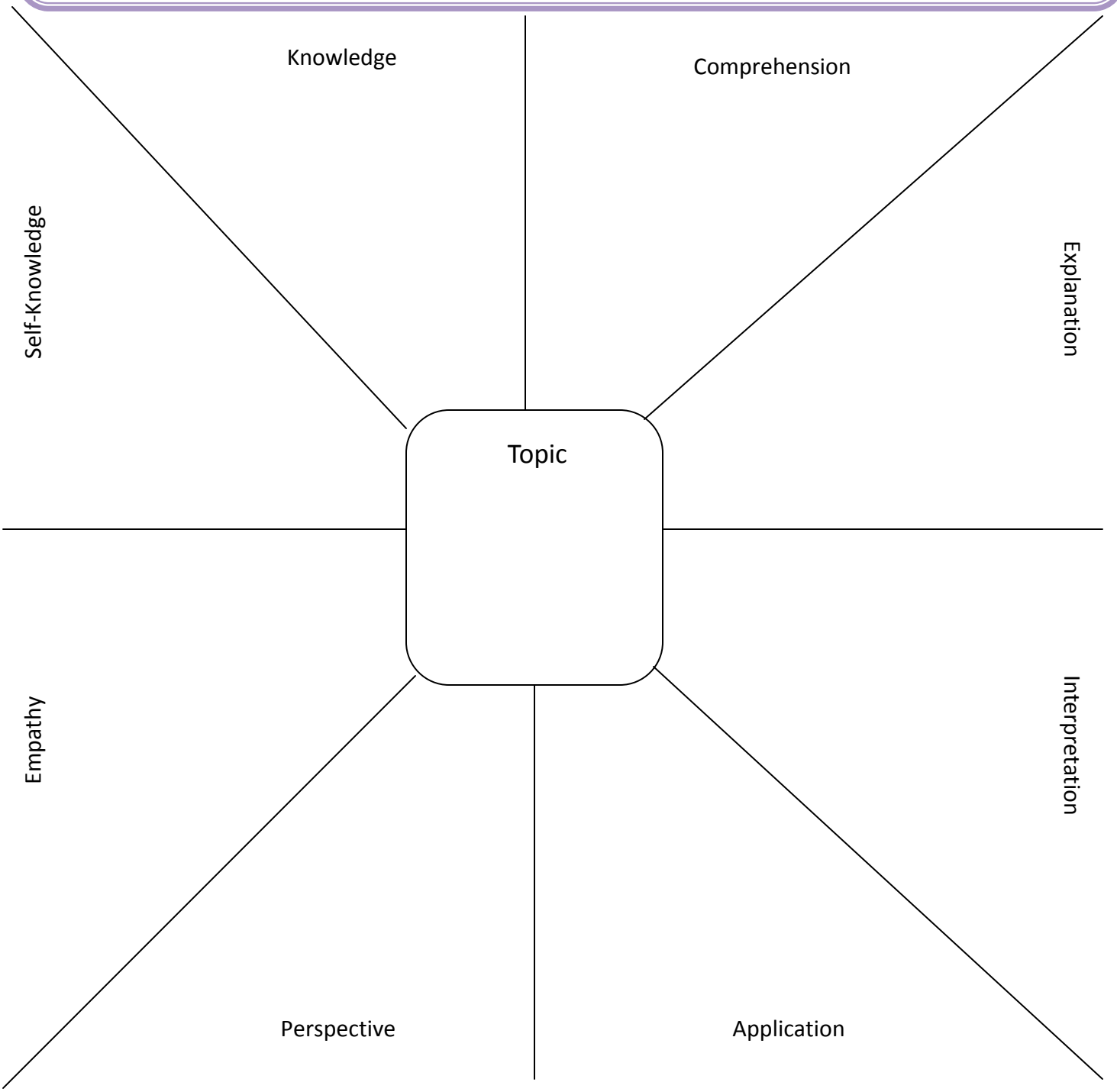
# Levels of Understanding Essential Questions

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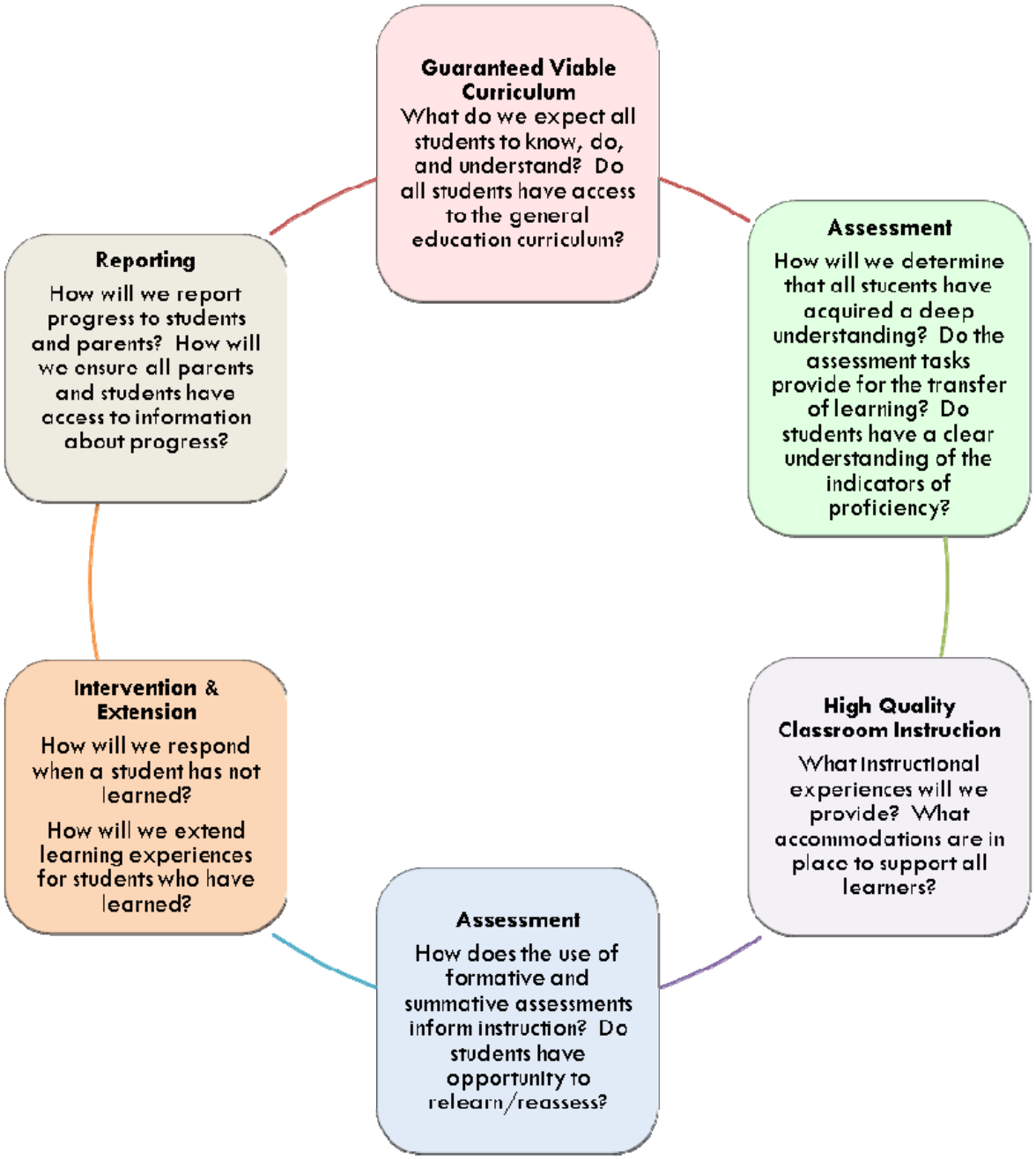
# Instructional Framework
# Making the Connections

A rigorous and challenging standards-based instructional program ensures maximum academic achievement for all students. The Boulder Valley School District Instructional Framework is a graphic representation that demonstrates how all of the components of an instructional program fit together. Teachers should use this framework and its questions to guide instructional planning and decision-making.



# Characteristics of a Boulder Valley School District Standards-based Classroom

## Curriculum

*All Students Have Access to the General Education Curriculum*

- Standards/essential learnings are clearly visible—in writing—in age appropriate student-friendly language
- Continual correlation of curriculum is made to the standards/essential learnings
- Models of high quality products (teacher generated, student generated or both) are provided by the district
- Students and parents are informed of expectations (course syllabus course, standards/essential learnings, grading policy, homework policy, and final culminating activity)
- All students are guaranteed access to the standards/essential learnings
- Lessons and units are developed using a backwards design process
- Suggested timelines are followed

## Instruction

*Quality Instruction Demands Student-Teacher Collaboration in the Learning Process*

Instruction focuses on standards/essential learnings/curriculum

- Clear and high expectation for all students
- Instruction driven by standards/curriculum, not materials or a published program
- Frequent, timely, meaningful feedback of student accomplishment

Instruction supports equity with multiple opportunities to learn through grouping, scaffolding, differentiation, and extension

- Teachers use multiple forms of representation are used (e.g., pictures, words, symbols, diagrams, tables, graphs, word walls)

Students actively engage in learning

- Participate in classroom talk (listening, elaborating, clarifying, expanding)
- Apply rigorous, strategic thinking (application, explanation, perspective, interpretation, perspective, empathy, self-knowledge)

# Characteristics of a Boulder Valley School District Standards-based Classroom

## Assessment

*Assessments are Tightly Aligned to the Standards*

- Students and parents are provided with clear descriptions of proficiency
- Classroom grading practices clearly show how students are progressing toward essential learnings/standards
- Grading is based on attainment of the standards
- Student understanding is assessed through multiple types of formative and summative assessments
- Student assessment results are used to make instructional decisions about what direction to take
- Feedback explicitly guides continuous progress toward mastery of the standard and is provided to students in a timely manner
- Opportunities to relearn, reassess, and extend learning are embedded in every classroom
- Teachers collaborate in the design and analysis of common assessments that are aligned to standards
- Students create authentic products and performances for critical audiences

## Learning Environment

*A Healthy Community of Learners Thrives on Collaborative Processes That Value the Input of All Members*

- Positive respectful relationships are evident within the classroom
- Students monitor and manage the quality of their own learning
- Student enrollment shows gender and racial/ethnic diversity
- Verbal and nonverbal cues indicate student engagement
- Teachers plan so that time is used purposefully and efficiently
- Students use time provided purposefully and efficiently
- Students and teachers negotiate and share decisions that positively impact the learning environment
- Teachers help students make connections between community, nation, world, and self
- Teachers show a connectedness with all students, respectful of student diversity and individual differences
- Students believe they are capable of success, take risks to engage in new experiences, and extend skills and habits of mind

# High School Science Essential Learnings

## High School Physical Science

- Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation
- Designs and conducts scientific investigations
- Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations
- Identifies major sources of error or uncertainly within an investigation (e.g., particular measuring devices and experimental procedures)
- Communicates and evaluates scientific thinking that leads to particular conclusions
- Using the kinetic-molecular model of matter, explains and predicts phase changes of matter relative to changes in thermal energy
- Explains that all elements have physical and chemical properties, which are determined by their atomic structure and are reflected in the element's location in the Periodic Table
- Describes how elements chemically combine to form compounds and that chemical changes can be represented in balanced chemical equations
- Explains that all substances have chemical and physical properties (density, pH, melting point, conductivity, magnetism, reactivity) that can be measured and used to compare and classify substances
- Uses quantitative measurements and calculations to demonstrate the conservation of mass and conservation of energy
- Explains that energy can be transferred or transformed through a variety of mechanisms, and that in any change, some energy is lost through transformation into heat
- Identifies the types and characteristics of waves and describes their interactions
- Explains how a variety of forces act on matter
- Describes the nature of electric charge and force and the relationship between electricity and magnetism
- Understands interrelationships among science, technology, and human activity and how they can affect the world
- Explains the difference between a hypothesis and a theory and between a theory and a law, and understands that science involves a particular way of knowing, and understanding common themes among scientific disciplines

# High School Science Essential Learnings

## High School Biology

- Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation
- Designs and conducts scientific investigations
- Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations
- Identifies major sources of error or uncertainly within an investigations (e.g., particular measuring devices and experimental procedures)
- Communicates and evaluates scientific thinking that leads to particular conclusions
- Recognizes and analyzes alternative explanations (hypotheses) and models
- Understands, describes, and demonstrates that living things are diverse, but all living things share common physical, genetic, and molecular characteristics, all of which are evidence of common ancestry.
- Describes the structure and function of cells, explain how new cells are made, and describes that cells differentiate to perform specific functions
- Explains that living systems have structures, such as molecules, organelles, cells, tissues, organs, and organ systems, which interact to maintain internal balance
- Describes and demonstrates that DNA codes for proteins and is the molecular basis for the transfer of biological characteristics from one generation to the next
- Explains that populations evolve over time through the non-random process of natural selection and other evolutionary mechanisms (both random and non-random)
- Explain that photosynthesis and cellular respiration are the biochemical processes by which most organisms obtain and use energy
- Demonstrates understanding of the complex interactions among organisms and their environments and the implications of these interactions for biodiversity
- Understands interrelationships among science, technology, and human activity and how they can affect the world
- Explains the relationship between hypotheses, theories and laws
- Understands that science involves a particular way of knowing and understand common themes among scientific disciplines

# High School Science Essential Learnings

## High School Chemistry

- Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation
- Designs and conducts scientific investigations
- Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations
- Identifies major sources of error or uncertainly within an investigation (e.g., particular measuring devices and experimental procedures)
- Communicates and evaluates scientific thinking that leads to particular conclusions
- Recognizes and analyzes alternative explanations and models
- Uses evidence to describe the structure of matter
- Uses chemical nomenclature accurately to identify and describe substances
- Explains, using models, observations of chemical and physical properties according to the nature of bonding within the substance
- Uses kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance
- Applies the concept of equilibrium to different types of chemical reactions
- Applies the principle of conservation of mass to chemical reactions
- Understands interrelationships among science, technology, and human activity and how they can affect the world
- Describes the relationships among a hypothesis, a theory, and a law
- Understands that science involves a particular way of knowing and understands common themes among scientific disciplines

# High School Science Essential Learnings

## High School Physics

- Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation
- Designs and conducts scientific investigations
- Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations
- Identifies major sources of error or uncertainty within an investigation (e.g., particular measuring devices and experimental procedures)
- Communicates and evaluates scientific thinking that leads to particular conclusions
- Recognizes and analyzes alternative explanations and models
- Uses evidence to describe the concepts of linear and two-dimensional motion, including projectile motion
- Explains the relationships among forces, motion, momentum and impulse
- Demonstrates an understanding of the concept of energy as the ability to cause change
- Analyzes and explains the nature of electric charge and force and the relationship between electricity and magnetism
- Explains the nature and characteristics of waves and analyzes their interaction
- Describes the corrections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large
- Understands interrelationships among science, technology, and human activity and how they can affect the world
- Explains the difference between a hypothesis and a theory and between a theory and a law
- Understands that science involves a particular way of knowing and understands common themes among scientific disciplines

# High School Science Essential Learnings

## Earth, Space, and Geophysical Science

- Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation
- Designs and conducts scientific investigations
- Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations
- Identifies major sources of error or uncertainty within an investigation (e.g., particular measuring devices and experimental procedures)
- Recognizes and analyzes alternative explanations and models
- Describes and interprets Earth's surface features and explains changes in the Earth's surface due to geologic processes
- Describes rocks and minerals on a macroscopic and microscopic scale and explains the chemical and physical process through which they are formed
- Explains how scientific dating methods of fossils and rock sequences are used to construct a chronology of Earth's history expressed in a geologic time scale
- Describes both the structure of the Earth's interior and the evidence that supports this model
- Explains that plate tectonics is the global mechanism for major geologic processes and that heat transfer, governed by the principles of thermodynamics, is the driving force
- Describes how the use of Earth's resources impacts Earth's subsystems
- Describes how the hydrosphere and atmosphere subsystems interact on various time scales
- Explains how the Earth's global ocean, powered by the Sun, affects weather and climate through complex atmospheric interactions
- Explains how Earth interacts within a larger complex system and is unique in our solar system
- Analyzes interrelationships among science, technology, and human activity and how they affect the world
- Differentiates between a hypothesis and a theory and between a theory and a law
- Explains that science involves a particular way of knowing and understands common themes among scientific disciplines

# *Design Templates*

# Unit Design Template

| Desired Results | |
|---|---|
| **BVSD Standard(s)/Essential Learnings** | |
| **Unit Enduring Understandings** | **Unit Essential Questions** |
| **Students will know……** | **Students will be able to……** |
| **Assessment Evidence** | |
| **Performance/Transfer Tasks** | **Other Evidence** |
| **Rubric** | **Student Self-Assessment and Reflection** |

# Unit Design Template (continued)

## Learning Plans

**Learning Activities**

**Materials**

**Accommodations**

**Technology Integration**

# Unit Design Template

Essential Learning:

Assessment:

## Teaching for Understanding

| | Acquire Knowledge | Make Meaning | Transfer |
|---|---|---|---|
| Essential Questions | | | |
| Learning Activities | | | |
| Materials | | | |
| Accommodations | | | |

# Curriculum Map

| Month | Standards/Essential Learnings | Assessment | Knowledge Skills | Learning Activities | Accommodations | Materials |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# Curriculum Map

| | August | September | October | November | December |
|---|---|---|---|---|---|
| **Standards/ Essential Learnings** | | | | | |
| **Assessment** | | | | | |
| **Knowledge** | | | | | |
| **Skills** | | | | | |
| **Learning Activities** | | | | | |
| **Accommodations** | | | | | |
| **Materials** | | | | | |

# Curriculum Map

| | January | February | March | April | May |
|---|---|---|---|---|---|
| **Standards/ Essential Learnings** | | | | | |
| **Assessment** | | | | | |
| **Knowledge** | | | | | |
| **Skills** | | | | | |
| **Learning Activities** | | | | | |
| **Accommodations** | | | | | |
| **Materials** | | | | | |

# Curriculum Map

Month
Theme:
Unit Guiding Question(s):

| Standards | Assessment | Knowledge and Skills | Learning Activities | Accommodations | Materials |
|---|---|---|---|---|---|
| **Science** | | | | | |
| **Math** | | | | | |
| **Reading** | | | | | |
| **Writing** | | | | | |
| **Speaking** | | | | | |
| **Listening** | | | | | |
| **Social Studies** | | | | | |
| **Health** | | | | | |

# Curriculum Map

| Year At A Glance | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Reading** | **Writing** | **Math** | **Science** | **Social Studies** | **Health** | **Speaking/ Listening** |
| **August** | | | | | | | |
| **September** | | | | | | | |
| **October** | | | | | | | |
| **November** | | | | | | | |
| **December** | | | | | | | |
| **January** | | | | | | | |
| **February** | | | | | | | |
| **March** | | | | | | | |
| **April** | | | | | | | |
| **May** | | | | | | | |

# Curriculum Map

Unit: Timing:

| **Essential Questions** | | | | | |
|---|---|---|---|---|---|
| **Standards/Essential Learnings** | | | | | |
| **Notes** | **Assessments** | **Knowledge and Skills** | **Learning Activities** | **Accommodations** | **Materials** |
| | | | | | |
| | | | | | |
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| | | | | | |

# Curriculum Map

Unit: Timing:

| Standards/Essential Learnings | |
|---|---|
| **Enduring Understandings** | **Assessment** |
| | **Knowledge and Skills** |
| **Essential Questions** | **Learning Activities** |
| | **Accommodations** |
| | **Materials** |

# Curriculum Glossary of Terms

| | |
|---|---|
| **Anchor** | An anchor is a sample of work or performance used to set the specific performance standard for each level of proficiency. Anchors contribute to scoring reliability and support students by providing tangible models of quality work. |
| **Assessment** | Assessment refers to the act of determining a value or degree. |
| **Authentic assessment** | An authentic assessment is one composed of tasks and activities design to simulate or replicate important, real-world challenges. It asks a student to use knowledge in real-world ways, with genuine purposes, audiences, and situational variables. Authentic assessments are meant to do more than "test;" they should teach students what the "doing" of a subject looks like and what kinds of performance challenges are actually considered most important in a field or profession. |
| **Backward Design** | An approach to designing a curriculum or unit that begins with the end in mind and designs toward that end. This term is used by Grant Wiggins and Jay McTighe in *Understanding by Design*. |
| **Benchmark** | Clearly demarcated progress points that serve as concrete indicators for a standard. |
| **Big Idea** | In *Understanding by Design* (Wiggins and McTighe, 2005), the core concepts, principles, theories, and processes that should serve as the focal point of the curriculum, instruction, and assessment. Big ideas are enduring and important and transferable beyond the scope of a particular unit. |
| **Concept** | A concept is a mental construct or category represented by a word or phrase. Concepts include both tangible objects (chair, telephone) and abstract ideas (bravery, anarchy). |
| **Content Standard** | A content standard answers the question, "What *a student should know, do or understand*?" |
| **Curriculum** | The curriculum represents what should be taught. It is an explicit and comprehensive plan that is based on content and process standards. |
| **Curriculum Implementation** | Curriculum implementation is putting the curriculum into place. |
| **Curriculum Mapping** | Curriculum mapping and webbing are approaches that require teachers to align the curriculum, standards, and learning activities across grade levels, within a grade level to ensure a continuum of learning that makes sense for all students. |
| **Enduring Understanding** | Enduring understandings are specific inferences, based on big ideas that have lasting value beyond the classroom. They are full-sentence statements that describe specifically what students will understand about the topic. |

# Curriculum Glossary of Terms (continued)

| | |
|---|---|
| **Essential Learnings** | Essential Learnings are the backbone of a guaranteed viable curriculum. Essential Learnings are aligned with standards and articulate the skills, content, and concepts determined to be non-negotiable areas of proficiency attainment by all students so that they are prepared for the next year/level of education. The Essential Learnings are the mandated curriculum of the Boulder Valley School District and form the basis upon which summative assessments are created. |
| **Essential Question** | An Essential Question lies at the heart of a subject or a curriculum (as opposed to being either trivial or leading) and promotes inquiry and uncoverage of a subject. Essential questions do not yield a single answer, but produce different plausible responses, about which thoughtful and knowledgeable people may disagree. An essential question can be overarching, grade level specific, or unit specific in scope. |
| **Essential Topics, Skills, Processes, Concepts** | The topics, skills, processes, and concepts clarify the Essential Learnings, describe indicators of achievement, and inform the selection of formative and summative assessments. |
| **Formative assessment** | An assessment is considered formative when the feedback from learning activities is actually used to adapt the teaching to meet the learner's needs. |
| **Guaranteed Viable Curriculum** | In researching what works in schools, Robert Marzano (2003), found five school-level factors that promote student achievement. Using the process of statistical effect size analysis, Marzano concluded that a guaranteed and viable curriculum is the most powerful school-level factor in determining overall student achievement. Marzano defines a guaranteed and viable curriculum as a combination of opportunity to learn (guaranteed) and time to learn (viable). According to Marzano, students have the opportunity to learn when they study a curriculum that clearly articulates required standards to be addressed at specific grade levels and in specific courses. A curriculum is viable when the number of required standards is manageable for a student to learn to a level of mastery in the time provided (usually a semester, trimester, or year). |
| **Learning Activities** | These represent the experiences and instruction that will enable students to achieve the desired results such as materials, projects, lectures, videos, homework, assignments, presentations, accommodations, and vocabulary. |
| **Performance Task** | A performance task uses one's knowledge to effectively act or bring to fruition a complex product that reveals one's knowledge and expertise. |
| **Prerequisite knowledge and skill** | The knowledge and skill required to successfully perform a culminating tasks or achieve an understanding. These typically identify discrete knowledge and know-how required to put everything together in a meaningful, final performance. |

# Curriculum Glossary of Terms (continued)

| | |
|---|---|
| **Processes** | Processes include all the strategies, decisions, and sub-skills a student uses in meeting the content standard. |
| **Product** | The tangible and stable result of a performance and the processes that led to it. The product is valid for assessing the student's knowledge to the extent that success or failure in producing the product reflects the knowledge taught and being assessed. |
| **Rubric** | A scoring tool that rates performance according to clearly stated levels of criteria and enables students to self-assess. A rubric answers the question, *What does understanding or proficiency for an identified result look like?* The scales can be numeric or descriptive. |
| **Scope and Sequence** | Scope refers to the breadth and depth of content to be covered in a curriculum at any one time (e.g. week, term, year, over a student's school life). Sequence refers to the order in which content is presented to learners over time. The order in which you do it. Together a scope and sequence of learning bring order to the delivery of content, supporting the maximizing of student learning and offering sustained opportunities for learning. Without a considered scope and sequence there is the risk of ad hoc content delivery and the missing of significant learning. |
| **Strategies** | Strategies are procedures, methods, or techniques to accomplish an essential learning. |
| **Summative assessment** | An assessment is considered summative when the feedback is used as a summary of the learning up to a given point in time. |

# High School Chemistry Curriculum Essentials

# Boulder Valley School District Science Background

## Content and Goals

Since the publications of the *National Science Education Standards* by the National Research Council in 1996, the teaching of science in grades K-12 has undergone a gradual revolution. Instead of presenting science as a collection of isolated facts, teachers strive to help each student develop the ability to conduct scientific inquiry, a strong understanding of scientific concepts and how they are connected, and an understanding of the nature and history of science. In 2007, the Colorado Department of Education published the most recent version of the Colorado Model Content Standards for Science and Colorado Assessment Frameworks for Science.

This revision of the Boulder Valley School District Science Curriculum had three key goals:

- Clearly articulate what every student should know, understand, and be able to do with regards to science at every grade level
- Align with the revised Colorado Standards and Frameworks
- Reduce the breadth of science content at each grade level so that concepts can be explored in greater depth.

## Scientific Inquiry

A central focus of the revised BVSD science curriculum is scientific inquiry. The following definition from the *National Science Education Standards* serves as the basis for our common understanding of how scientific inquiry is defined.

> **Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work.**
>
> **Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.**

The following points serve to clarify the vision of what inquiry means in BVSD.

- Inquiry involves five essential features. Students engaged in scientific inquiry should ask or respond to scientifically oriented questions, give priority to evidence, formulate explanations based on evidence, connect explanations to scientific knowledge, and communicate and justify explanations *(Inquiry and the National Science Education Standards).*
- Inquiry-based science instruction involves a continuum of learning experiences from teacher-led to learner self-directed activities, including but not limited to hands-on labs. Hence, both a structured assignment involving reading and written reflection and an open-ended, hands-on investigation could be considered inquiry as long as they involve the five essential features identified above.
- The ultimate goals of inquiry-based instruction are to engage learners, develop their conceptual understanding of the natural world around them, and to overcome misconceptions in science.
- Inquiry-based activities should balance students' application of content knowledge, creativity, and critical thinking in order to analyze data, solve a problem, or address a unique question.

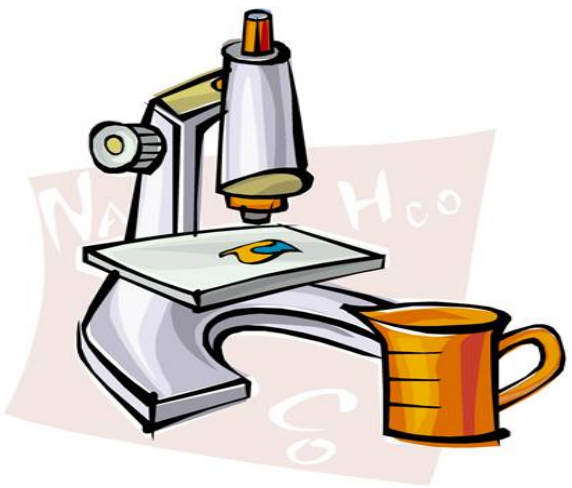
**Literature Cited**

National Research Council. 1996. *National Science Education Standards.* Washington, DC: National Academy Press.
National Research Council. 2000. *Inquiry and the National Science Education Standards*. Washington, DC: National Academy Press.

# Boulder Valley School District Science Content Standards

## Science Standard 1

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*



## Science Standard 2

*Students know and understand common properties, forms, and changes in matter and energy.*

## Science Standard 3

*Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.*

## Science Standard 4

*Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.*

## Science Standard 5

*Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

# Science Overarching Enduring Understandings and Essential Questions

| Overarching Enduring Understanding | Overarching Essential Questions |
|---|---|
| • Science involves a particular way of knowing that includes relying on empirical evidence, logical arguments, skepticism, and peer review. Scientific ideas are revised over time as new evidence becomes available. | • How is science different from other disciplines in the way it approaches questions? |
| • Benefits and costs of scientific research and technological innovation include consequences that are long-term as well as short-term, and indirect as well as direct. | • How have science and technology affected the quality of life? |
| • Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations. | • How do people use the process of science to investigate questions about the natural world? |
| • Matter has properties related to its structure that can be measured and used to identify, classify and describe substances or objects. | • What is matter? |
| • Energy occurs in different forms and is necessary to do work or to cause change. | • What is energy?<br>• How does energy interact with matter to cause change and do work? |
| • All organisms share similar characteristics and basic needs, but they also have differences that allow people to identify, describe and classify them. | • How are all living things the same, and how are they different? |
| • The Earth System is composed of and part of a multitude of systems, which cycle and interact resulting in dynamic equilibrium. | • How do Earth's systems interact? |

# Boulder Valley School District Content Standards and High School Chemistry Essential Learnings

**Science Standard 1:** *Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

***To meet this standard, a High School Chemistry student:***

- √ Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation.
- √ Designs and conducts scientific investigations.
- √ Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations.
- √ Identifies major sources of error or uncertainly within an investigation (e.g., particular measuring devices and experimental procedures).
- √ Communicates and evaluates scientific thinking that leads to particular conclusions.
- √ Recognizes and analyzes alternative explanations and models.

**Science Standard 2:** *Students know and understand common properties, forms, and changes in matter and energy.*

***To meet this standard, a High School Chemistry student:***

- √ Uses evidence to describe the structure of matter.
- √ Uses chemical nomenclature accurately to identify and describe substances.
- √ Explains, using models, observations of chemical and physical properties according to the nature of bonding within the substance.
- √ Uses kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.
- √ Applies the concept of equilibrium to different types of chemical reactions.
- √ Applies the principle of conservation of mass to chemical reactions.

**Science Standard 3:** *Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.*

**No essential learning in High School Chemistry.**

**Science Standard 4:** *Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.*

**No essential learning in High School Chemistry.**

**Science Standard 5:** *Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

***To meet this standard, a High School Chemistry student:***

- √ Understands interrelationships among science, technology, and human activity and how they can affect the world.
- √ Describes the relationships among a hypothesis, a theory, and a law.
- √ Understands that science involves a particular way of knowing and understands common themes among scientific disciplines.

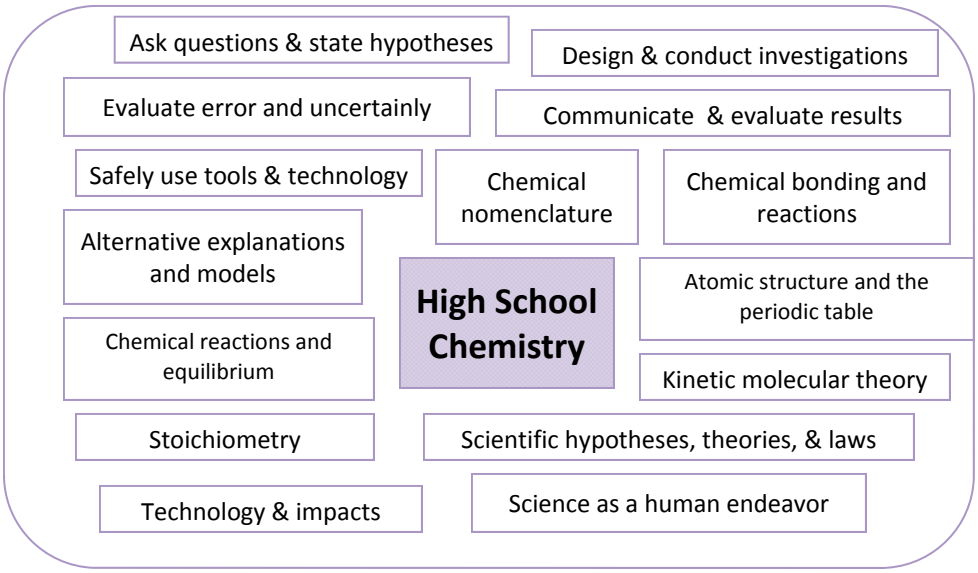
# BVSD HS Chemistry Overview

## Course Description

This course provides the opportunity to develop knowledge and understanding about the relationships between the structure and properties of matter and the interaction of matter and energy. Units of study include: matter and its changes, atomic structure, chemical composition, nomenclature, reactions, stoichiometry, gas laws, periodicity, bonding, molecular geometry, and thermo chemistry. Laboratory activities reinforce concepts and principles presented in the course.

## Effective Components of a HS Chemistry Program

- Maintains an inquiry-based learning environment
- Addresses a limited number of concepts, but does so in depth
- Provides students with multiple opportunities to learn and timely feedback to help students know what they need to improve upon
- Explains concepts and problems in multiple ways
- Uses assessment to guide instruction
- Differentiates instruction to meet student needs
- Draws out and actively engages the preexisting understandings about the natural world that students bring with them
- Assists students in developing metacognitive skills within the context of learning about science
- Provides opportunities and support to apply writing, reading, and mathematics skills in the context of investigating scientific concepts, including hand-graphing data
- Provides a safe, equitable and engaging learning environment for all students




## Essential Questions

- What types of questions and hypotheses can be answered by science?
- What elements of design are critical in conducting a scientific investigation?
- How can we ensure that scientific investigations are both safe and consistent with standard scientific practice?
- How do we identify sources of error and quantify their impact on data?
- How do we know whether the conclusions of a scientific investigation are valid?
- Is there only one explanation for how things behave in nature?
- What is stuff, and how do we know?
- How do people identify and name substances?
- How does chemical bonding relate to the properties of a substance?
- What is heat, and how does it affect the way molecules interact?
- How do people use the equilibrium model of chemical interactions to represent, analyze, and communicate structure and relationships in chemical systems and chemical interactions?
- How do we know how much of something we have, and how do we demonstrate that the amount of something is conserved?
- How have science and technology affected the quality of life?
- What are the relationships among scientific hypotheses, theories, and laws?
- What makes science different from other disciplines?

## Assessment

- √ Science ACT
- √ Teacher-created assessments

## Technology Integration & Information Literacy

- ⓘ Uses technology responsibly for communication and transfer of ideas
- ⓘ Uses technology to gather, organize, analyze and communicate about data
- ⓘ Collaborates with others to identify information problems and to seek their solutions
- ⓘ Organizes and reports information in a variety of complex ways including tables, graphs, charts, reports, labeled diagrams
- ⓘ Evaluates the accuracy and objectivity of various information sources (text, audio, video, etc.)
- ⓘ Presents information in a variety of formats including text, audio, pictures, video

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Question**

What types of questions and hypotheses can be answered by science?

## Essential Learnings

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem1 | Asks questions and states hypotheses using prior scientific knowledge to help design and guide development and implementation of a scientific investigation | |
|---|---|---|---|
| | | a | Develops scientific questions based on observed phenomena |
| | | b | Formulates testable hypotheses |
| | | c | Describes different methods used to investigate scientific questions (e.g., controlled experiments, constructing models, researching scientific literature, etc.) |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1 (continued)**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Question**

What elements of design are critical in conducting a scientific investigation?

## Essential Learnings (continued)

Essential Knowledge, Skills, Topics, Processes, and Concepts

| HS Chem2 | Designs and conducts scientific investigations | |
|---|---|---|
| | a | Creates and defends a written plan of action for a controlled experiment |
| | b | Identifies the independent and dependent variables in a scientific investigation |
| | c | Keeps all conditions other than the independent variable constant, while monitoring variables that cannot be held constant |
| | d | Selects and uses the appropriate observation or measurement technique |
| | e | Selects and uses appropriate technologies to gather, process, and analyze data |
| | f | Records qualitative and quantitative observations |
| | g | Describes how different types of technologies are used in scientific investigations |

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# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1 (continued)**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Questions**

How can we ensure that scientific investigations are both safe and consistent with standard scientific practice?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem3 | Appropriately selects and safely uses tools (including laboratory materials, equipment, technology, and electronic resources) to conduct scientific investigations | |
|---|---|---|---|
| | | a | Demonstrates how to conduct laboratory investigations safely (e.g., knowing the hazards and precautions needed when working with chemicals and hazardous materials and disposal of hazardous materials) |
| | | b | Uses personal protection equipment, such as safety goggles, when appropriate |
| | | c | Knows the location and procedure for using safety equipment such as fire extinguishers, eyewashes, safety showers, etc. |
| | | d | Measures accurately using common SI units and non-SI units common to chemistry (meters, grams, milliliters, Celsius, atmospheres) |
| | | e | Reads and records measurements made on a piece of standard, calibrated scientific equipment with the correct degree of certainty/significant digits |
| | | f | Uses dimensional analysis to appropriately solve problems |
| | | g | Calculates quantities (such as density and specific heat) using the correct significant digits |
| | | h | Demonstrates the proper care of science equipment and laboratory facilities |

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# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1 (continued)**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Question**

How do we identify sources of error and quantify their impact on data?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem4 | Identifies major sources of error or uncertainty within an investigation (e.g., particular measuring devices and experimental procedures) | |
|---|---|---|---|
| | | a | Identifies when error has been introduced into a scientific investigation because certain variables are not controlled or more than one variable is changed |
| | | b | Describes ways of minimizing experimental errors in a scientific investigation, such as changing only one variable while holding all other conditions constant or having the same person take measurements each time |
| | | c | Distinguishes between error, uncertainty, and mistakes |
| | | d | Calculates percent error |
| | | e | Calculates values and preserves their uncertainty using significant digits |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1 (continued)**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Question**

How do we know whether the conclusions of a scientific investigation are valid?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem5 | Communicates and evaluates scientific thinking that leads to particular conclusions | |
|---|---|---|---|
| | | a | Summarizes data effectively using graphs and tables |
| | | b | Identifies and uses evidence to support a particular conclusion |
| | | c | Writes a conclusion that links the question being investigated to the evidence collected during the investigation |
| | | d | Identifies and explains whether or not a conclusion is aligned with the testable question and the scientific investigation that was conducted |
| | | e | Explains how conclusions and models from previous scientific investigations need to be revised based on new evidence |

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# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 1 (continued)**

*Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.*

**Enduring Understanding**

Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

**Essential Questions**

Is there only one explanation for how things behave in nature?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem6 | Recognizes and analyzes alternative explanations (hypotheses) and models | |
|---|---|---|---|
| | | a | Describes and explains that alternative models can be used to investigate the same testable question |
| | | b | Describes and analyzes other reasonable explanations , using the same independent and dependent variable, for the resulting data or observations from an investigation |

**Key Academic Vocabulary:** calibrate, dimensional analysis, error, hypothesis, qualitative, quantitative, significant digits, uncertainty, variable

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding**

Matter has properties related to its structure that can be measured and used to identify, classify and describe substances or objects.

**Essential Questions**

What is stuff made of, and how do we know?

## Essential Learnings

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem7 | Uses evidence to describe the structure of matter | |
|---|---|---|---|
| | | a | Compares and contrasts physical and chemical changes |
| | | b | Demonstrates physical and chemical methods used to separate mixtures that are based on the properties of the substances |
| | | c | Describes atomic theory and atomic structure (including electron energy levels, atomic orbitals, and electron configurations) using evidence for the modern view of atomic theory |
| | | d | Determines the atomic number and mass number of isotopes |
| | | e | Calculates the average atomic mass of an element |
| | | f | Describes the periodic relationships of elements based on the following properties: atomic radii, ionization energies, electronegativity, and oxidation states |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding (continued)**

Matter has properties related to its structure that can be measured and used to identify, classify and describe substances or objects.

**Essential Questions**

How do people identify and name substances?

## Essential Learnings (continued)

| | | | |
|---|---|---|---|
| Essential Knowledge, Skills, Topics, Processes, and Concepts | **HS Chem8** | **Uses chemical nomenclature accurately to identify and describe substances** | |
| | | a | Determines chemical formulas and names of ionic compounds and covalent molecules |
| | | b | Names substances given IUPAC formulas |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding (continued)**

Matter has properties related to its structure that can be measured and used to identify, classify and describe substances or objects.

**Essential Questions**

How does chemical bonding relate to the properties of a substance?

## Essential Learnings (continued)

Essential Knowledge, Skills, Topics, Processes, and Concepts

| HS Chem9 | Explains, using models, observations of chemical and physical properties according to the nature of bonding within the substance | |
|---|---|---|
| | a | Discriminates between ionic compounds and covalently bonded molecules based on the electronegativity differences between the atoms in the compound |
| | b | Describes bonding in metals |
| | c | Understands the continuum between purely non-polar covalent, polar covalent and ionic substances |
| | d | Describes the nature of intermolecular attractive forces: dispersion forces, hydrogen bonding, dipole-dipole interactions and Van der Waals interactions |
| | e | Distinguishes between a chemical bond and an intermolecular attractive force |
| | f | Explains observations of chemical and physical properties according to the nature of bonding within the substance |
| | g | Uses models to represent relationships of atoms in substances and represent positions of electrons in compounds using Lewis structures, including the concept of resonance structures |
| | h | Uses VSEPR (Valence Shell Electron Pair Repulsion) Theory to represent the three-dimensional geometry of atoms in covalently bonded substances |
| | i | Compares and contrasts characteristics of organic compounds with other substances |
| | j | Describes types of solutions and factors affecting solubility of solutes in solvents |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding**

Energy occurs in different forms and is necessary to do work or to cause change.

**Essential Questions**

What is heat, and how does it affect the way molecules interact?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem10 | Uses kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance | |
|---|---|---|---|
| | | a | Explains the concept of "Rate of Reaction" |
| | | b | Observes the effect of temperature change on the rate of reaction and explains using kinetic-molecular theory |
| | | c | Defines the Energy of Activation and uses it to explain the role of catalysts in a chemical reaction |
| | | d | Uses gas laws, including the ideal gas law, to calculate the volume, pressure, temperature, or the molar mass of a gas |
| | | e | Uses calorimetry to calculate the specific heat of a substance and the amount of heat change in a chemical reaction |
| | | f | Describes different forms of energy and their transformations |
| | | g | Calculates enthalpy change in a chemical reaction |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding**

Chemical reactions occur all around us and may either release or consume energy. A large number of reactions involve the transfer of either electrons or hydrogen ions.

**Essential Question**

How do people use the equilibrium model of chemical interactions to represent, analyze, and communicate structure and relationships in chemical systems and chemical interactions?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem11 | Applies the concept of equilibrium to different types of chemical reactions | |
|---|---|---|---|
| | | a | Describes, gives examples of, and predicts products for different types of reactions: syntheses, decomposition, single replacement, double replacement, and combustion |
| | | b | Defines and compares concepts of acids and bases according to Arrhenius and Bronsted-Lowry |
| | | c | Performs a neutralization reaction between an acid and a basic substance |
| | | d | Represents ionic and molecular species present in chemical systems using a chemical equation |
| | | e | Observes and explains the concept of dynamic equilibrium in both physical and chemical systems |
| | | f | Observes and explains Le Chatelier's Principle as it applies to a chemical system and uses this to predict shifts in the concentrations of substances in equilibrium |
| | | g | Writes the equilibrium expression for a given reaction and is able to solve for concentrations of substances and/or the equilibrium constant |
| | | h | Describes qualitatively the effect of buffers on the pH of solutions |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Enduring Understanding**

Energy and matter can neither be created nor destroyed.

**Essential Questions**

How do we know how much of something we have, and how do we demonstrate that the amount of something is conserved?

## Essential Learnings (continued)

Essential Knowledge, Skills, Topics, Processes, and Concepts

| HS Chem12 | Applies the principle of conservation of mass to chemical reactions | |
|---|---|---|
| | a | Explains Avogadro's hypothesis and the mole concept |
| | b | Uses mole ratios in a balanced chemical equation to determine stoichiometric relationships of reactants and products including titration calculations |
| | c | Balances chemical equations to illustrate mole ratios and conservation of mass in a chemical reaction |
| | d | Calculates the mass and volume relationships of substances with emphasis on the mole concept, including percent composition, empirical formulas, limiting reactants and percent yield |
| | e | Calculates the concentration of solutions using molarity and percent by mass |
| | f | Calculates the empirical formula and molecular formula of a substance from experimental data |
| | g | Recognizes and applies a variety of empirical methods for determining molar mass |

Continued on next page

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 2 (continued)**

*Students know and understand common properties, forms, and changes in matter and energy.*

**Key Academic Vocabulary:** acid, atom, atomic mass, atomic number, atomic radius, base, calorimetry, catalyst, chemical bond, chemical change, chemical property, chemical reaction, combustion, compound, covalent, decomposition, double displacement, dipole, dispersion force, displacement, dynamic equilibrium, electromagnetic spectrum, electron, electronegativity, element, energy, energy of activation, enthalpy, equilibrium, heat, ideal gas law, inorganic, ionic, ionization energy, hydrogen bond, kinetic energy, kinetic molecular theory, Lewis structure, linear, molar mass, mole, molecule, neutron, neutralization, orbital, organic, oxidation state, physical change, physical property, proton, rate of reaction, resonance structure, single displacement, solubility, solute, solution, solvent, stoichiometry, synthesis, titration

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 5**

*Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

**Enduring Understanding**

Benefits and costs of scientific research and technological innovation include consequences that are long-term as well as short-term, and indirect as well as direct.

**Essential Questions**

How have science and technology affected the quality of life?

## Essential Learnings

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem13 | Understands interrelationships among science, technology, and human activity and how they can affect the world | |
|---|---|---|---|
| | | a | Analyzes the effects of technology and human activity on the natural world |
| | | b | Analyzes benefits, limitations, costs, and consequences involved in using technology or resources (eg., X-rays, agricultural chemicals, natural gas reserves) |
| | | c | Analyzes how the introduction of a new technology has affected or could affect human activity (eg., X-rays, agricultural chemicals, natural gas reserves) |
| | | d | Gives an example of the interrelationships between science and technology |

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# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 5 (continued)**

*Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

**Enduring Understanding**

Science involves a particular way of knowing that includes relying on empirical evidence, logical arguments, skepticism, and peer review. Scientific ideas are revised over time as new evidence becomes available.

**Essential Questions**

What is the difference between a scientific hypothesis, theory, and law?

## Essential Learnings (continued)

| Essential Knowledge, Skills, Topics, Processes, and Concepts | HS Chem14 | Explains the relationship between hypotheses, theories, and laws | |
|---|---|---|---|
| | | a | Identifies examples of scientific hypotheses, scientific theories, and scientific laws |
| | | b | Describes what distinguishes a scientific theory from a scientific law |
| | | c | Describes what distinguishes a scientific hypothesis from a scientific theory |
| | | d | Explains how scientific theories and laws inform new hypotheses |

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# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 5 (continued)**

*Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

**Enduring Understanding (continued)**

Science involves a particular way of knowing that includes relying on empirical evidence, logical arguments, skepticism, and peer review. Scientific ideas are revised over time as new evidence becomes available.

**Essential Questions**

What makes science different from other disciplines?

## Essential Learnings (continued)

Essential Knowledge, Skills, Topics, Processes, and Concepts

| HS Chem15 | Understands that science involves a particular way of knowing and understands common themes among scientific disciplines | |
|---|---|---|
| | a | Identifies the key factors that distinguish science from other disciplines, such as the use of empirical evidence, controlled experiments, logical arguments, peer review, and skepticism |
| | b | Identifies the strengths in published or presented scientific information (e.g., Are the results logical and supported by evidence? Was bias introduced? Were data shared and reviewed by peers? Were previous investigations on the same subject reviewed? Were there flaws in the research study?, etc.) |
| | c | Identifies and describes cause and effect relationships |
| | d | Explains reasons why scientific knowledge changes over time |
| | e | Identifies examples of when new scientific evidence has dramatically changed previously accepted views in certain scientific fields |
| | f | Evaluates the credibility of various sources of scientific information |
| | g | Identifies that peer review is critical to the scientific process because it exposes a scientist's ideas to criticism by others, who may identify flaws in experimental design or logic |

# Essential Learnings

## Essential Knowledge, Skills, Topics, Processes, and Concepts

**Science Standard 5 (continued)**

*Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.*

**Key Academic Vocabulary:** empirical evidence, peer review, scientific hypothesis, scientific law, scientific theory, skepticism

# Suggested Timelines

| Topic (can be done in any order) | Suggested Timeframe (can be done in any order) |
|---|---|
| Scientific Investigation Skills and Concepts<br>Ask questions and state hypotheses<br>Design and conduct investigations<br>Safely use tools and technology<br>Evaluate error and uncertainty<br>Communicate and evaluate results<br>Alternative explanations and models | Embedded throughout |
| Key Science Concepts<br>Atomic structure and the periodic table<br>Chemical nomenclature<br>Chemical bonding and reactions<br>Kinetic molecular theory<br>Chemical reactions and equilibrium<br>Stoichiometry | <br>4 weeks<br>4 weeks<br>6weeks<br>4 weeks<br>6 weeks<br>6 weeks |
| Nature of science<br>Technology and impacts<br>Scientific hypotheses, theories and laws<br>Science as a human endeavor | Embedded throughout |

# Science Scope & Sequence K-5

| Standard | K | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| **Scientific Investigations** | Observation, simple questions and predictions, safety | Observation, simple questions and predictions, recording data, safety | Observation, simple questions and predictions, recording data, explanations, and safety | Designing investigations, measurement, explanations, safety | Designing investigations, organizing and representing data, measurement, explanations, safety | Fair test, identifying and controlling variables, organizing and representing data, explanations, safety |
| **Physical Science** | Properties of objects | Balance and motion | States of matter | Matter and Energy | Magnetism and electricity | Changes in matter, Force and motion |
| **Life Science** | Characteristics of living things | Structures and life cycles of plants | Structures and life cycles of insects | Human body systems | Structure, function, and energy in organisms | Ecosystems |
| **Earth and Space Science** | Seasons | Sorting and comparing Earth's materials | Air and weather | Fossils | Water<br>Solar system | Landforms |
| **Nature of Science** | N/A | N/A | N/A | Repeating investigations and models | Repeating investigations and models | Repeating investigations and models |

# Science Scope & Sequence 6-12

| Standard | 6 | 7 | 8 | Physical Science | Biology |
|---|---|---|---|---|---|
| **Scientific Investigations** | Design and conduct investigations<br>Use tools and technology<br>Organize and use data<br>Communicate results<br>Safety | Design and conduct investigations<br>Use tools and technology<br>Organize and use data<br>Communicate results<br>Safety | Design and conduct investigations<br>Use tools and technology<br>Organize and use data<br>Communicate results<br>Safety | Ask questions and state hypotheses<br>Design and conduct investigations<br>Safely use tools and technology<br>Evaluate error and uncertainty<br>Communicate and evaluate results | Ask questions and state hypotheses<br>Design and conduct investigations<br>Safely use tools and technology<br>Evaluate error and uncertainty<br>Communicate and evaluate results<br>Alternative explanations and models |
| **Standards 2-4**<br>• **Physical Science**<br>• **Life Science**<br>• **Earth and Space Science** | **Physical Science**<br>Particulate model of matter<br>Atoms<br>Mixtures and solutions<br>Compounds and molecules<br>Conservation of matter<br>Mass and weight<br>Energy sources<br>Energy transformations<br>Force and motion<br>Electrical circuits<br>Light waves | **Life Science**<br>Characteristics of organisms<br>Human body<br>Transport within multi-cellular organisms<br>Photosynthesis and respiration<br>Interactions within ecosystems<br>Matter and energy in ecosystems<br>Cells<br>Evolution<br>Genetics | **Earth and Space Science**<br>Water cycle<br>Bodies of water<br>Processes that shape Earth's surface<br>Atmosphere structure and function<br>Fossils<br>Atmosphere circulation<br>Minerals, rocks, and soils<br>Weather and climate<br>Plate tectonics<br>Solar System<br>Sun, Earth, Moon<br>Galaxies and space exploration | **Physical Science**<br>Kinetic-molecular model of matter<br>Atomic structure and the periodic table<br>Chemical bonding and reactions<br>Separating complex mixtures<br>Conservation of matter and energy<br>Energy transformations<br>Waves<br>Force and motion<br>Electricity and magnetism | **Life Science**<br>Physical and biochemical characteristics of living things<br>Cell structure, function and differentiation<br>Homeostasis and cellular transport<br>Molecular basis of heredity<br>Evolution<br>Photosynthesis and cellular respiration<br>Interactions within ecosystems |
| **Nature of Science** | Repeatability<br>Models<br>Technology and impacts<br>Science as a human endeavor | Repeatability<br>Models<br>Technology and impacts<br>Science as a human endeavor | Repeatability<br>Models<br>Technology and impacts<br>Science as a human endeavor | Technology and impacts<br>Scientific hypotheses, theories and laws | Technology and impacts<br>Scientific hypotheses, theories and laws<br>Science as a human endeavor |

# Science Glossary of Terms

| | |
|---|---|
| **Abiotic** | not associated with or derived from living organisms; abiotic factors in an environment include such items as sunlight, temperature, wind patterns, and precipitation |
| **Adaptation** | a change by which an organism becomes better suited to its environment |
| **Air** | the invisible gaseous substance surrounding the earth, a mixture mainly of oxygen and nitrogen |
| **Air mass** | a body of air extending hundreds or thousands of miles horizontally and sometimes as high as the stratosphere and maintaining as it travels nearly uniform conditions |
| **Air pressure** | the pressure exerted by the atmosphere |
| **Amino Acid** | of a class of about twenty organic compounds which form the basic constituents of proteins and contain both acid and amine groups |
| **Amplitude** | the maximum extent of a vibration or oscillation from the point of equilibrium. |
| **Anatomy** | the science of the shape and structure of organisms and their parts |
| **Asexual reproduction** | reproduction without the fusion of gametes |
| **Astronomy** | the science of celestial objects, space, and the physical universe |
| **Atmosphere** | the envelope of gases surrounding the earth or another planet |
| **Atom** | the smallest particle of a chemical element, consisting of a positively charged nucleus surrounded by negatively charged electrons |
| **Attract** | to cause to draw near or adhere by physical force |
| **Axis** | an imaginary line through a body, about which it rotates |
| **Bar graph** | a graph consisting of parallel, usually vertical bars or rectangles with lengths proportional to the frequency with which specified quantities occur in a set of data |
| **Bias** | statistical sampling or testing error caused by systematically favoring some outcomes over others |
| **Binary fission** | a method of asexual reproduction, involves the splitting of a parent cell into two approximately equal parts |
| **Biodiversity** | the variability among living organisms on the earth, including the variability within and between species and within and between ecosystems |
| **Biology** | the scientific study of living organisms |
| **Biosphere** | the part of the earth and its atmosphere in which living organisms exist or that is capable of supporting life |
| **Body system** | a group of organs or structures within the body that work together to perform one or more specific functions |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Boiling point** | the temperature at which a liquid boils at a fixed pressure, especially under standard atmospheric conditions |
| **Botany** | the scientific study of plants |
| **Brain** | the portion of the vertebrate central nervous system that is enclosed within the cranium, continuous with the spinal cord, and composed of gray matter and white matter. It is the primary center for the regulation and control of bodily activities, receiving and interpreting sensory impulses, and transmitting information to the muscles and body organs. It is also the seat of consciousness, thought, memory, and emotion |
| **Capacity** | the maximum amount that can be contained |
| **Carbohydrate** | any of a group of organic compounds that includes sugars, starches, celluloses, and gums and serves as a major energy source in the diet of animals. These compounds are produced by photosynthetic plants and contain only carbon, hydrogen, and oxygen, usually in the ratio 1:2:1 |
| **Carcinogen** | a cancer-causing substance or agent |
| **Cell** | the smallest structural and functional unit of an organism |
| **Cell division** | the process in reproduction and growth by which a cell divides to form daughter cells |
| **Cellular respiration** | the series of metabolic processes by which living cells produce energy through the oxidation of organic substances |
| **Celsius** | of or relating to a temperature scale that registers the freezing point of water as 0° and the boiling point as 100° under normal atmospheric pressure |
| **Centimeter** | metric unit of length equal to 1/100 of a meter |
| **Characteristic** | a feature that helps to identify, tell apart, or describe recognizably; a distinguishing trait |
| **Chemical change** | a change in which the substances present at the beginning of the change are not present at the end; new substances are formed. The change cannot be “undone” |
| **Chemical formula** | A representation of a substance using symbols to represent constituent elements |
| **Chemistry** | the branch of science concerned with the properties and interactions of the substances of which matter is composed |
| **Chloroplast** | a structure in algal and green plant cells which contains chlorophyll and in which photosynthesis takes place |
| **Chromosome** | a thread-like structure found in the nuclei of most living cells, carrying genetic information in the form of genes |
| **Circuit** | a path followed or capable of being followed by an electric current |
| **Circulation** | movement in a circle or circuit |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Circulatory system** | the body system that circulates blood through the body, consisting of the heart and blood vessels |
| **Classification** | the systematic grouping of organisms into categories on the basis of evolutionary or structural relationships between them; taxonomy |
| **Climate** | meteorological conditions including temperature, precipitation, and wind, which characteristically prevail in a particular region |
| **Cloud** | a visible body of very fine water droplets or ice particles suspended in the atmosphere at altitudes ranging up to several miles above sea level |
| **Cohesion** | the intermolecular attraction by which the elements of a body are held together |
| **Communicable disease** | a disease that can be communicated from one person to another |
| **Community** | a group of interdependent plants or animals growing or living together or occupying a specified habitat |
| **Component** | a single part of a larger system |
| **Composition** | the combining of distinct parts or elements to form a whole |
| **Compound** | a pure, macroscopically homogeneous substance consisting of atoms or ions of two or more different elements in definite proportions that cannot be separated by physical means. A compound usually has properties unlike those of its constituent elements |
| **Conclusion** | a judgment or decision reached by reasoning |
| **Condensation** | the process by which a gas or vapor changes to a liquid |
| **Condensation, heat of** | heat liberated by a unit mass of gas at its boiling point as it condenses into a liquid |
| **Conduction** | the transmission or conveying of something through a medium or passage, especially the transmission of electric charge or heat through a conducting medium without perceptible motion of the medium itself |
| **Conductivity** | the ability or power to conduct or transmit heat, electricity, or sound |
| **Conductor** | a substance or medium that conducts an electric charge |
| **Conservation of energy** | a principle stating that the total energy of an isolated system remains constant regardless of changes within the system |
| **Conservation of mass** | a principle in classical physics stating that the total mass of an isolated system is unchanged by interaction of its parts |
| **Conservation of matter** | a fundamental principle of classical physics that matter cannot be created or destroyed in an isolated system |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Constant** | an experimental or theoretical condition, factor, or quantity that does not vary or that is regarded as invariant in specified circumstances |
| **Consumer** | an organism that cannot make its own food and must eat in order to survive |
| **Controlled experiment** | an experiment that isolates the effect of one variable on a system by holding constant all variables but the one under observation |
| **Convection** | heat transfer in a gas or liquid by the circulation of currents from one region to another |
| **Coriolis effect** | result of an apparent force that as a result of the earth's rotation deflects moving objects (as projectiles or air currents) to the right in the northern hemisphere and to the left in the southern hemisphere |
| **Crust** | solid, outermost layer of the Earth, lying above the mantle |
| **Data** | factual information (as measurements or statistics) used as a basis for reasoning, discussion, or calculation |
| **Decomposer** | an organism that breaks down organic materials in the environment |
| **Decomposition** | breakdown or decay of organic materials |
| **Density** | the mass of a substance per unit volume |
| **Dependent variable** | the observed or measured variable in an experiment or study whose changes are determined by the presence of one or more independent variables |
| **Deposition** | the laying down of matter by a natural process |
| **Development** | the process of an individual organism growing organically; a purely biological unfolding of events involved in an organism changing gradually from a simple to a more complex level |
| **Digestive system** | body system consisting of the alimentary canal and digestive glands and responsible for the ingestion, digestion, and absorption of food |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **DNA (Deoxyribonucleic Acid)** | a substance which is present in the cell nuclei of nearly all living organisms and is the carrier of genetic information |
| **Dominant** | an allele that produces the same phenotypic effect whether inherited with a homozygous or heterozygous allele |
| **Earth** | the third planet from the sun |
| **Earthquake** | a sudden movement of the Earth's crust caused by the release of stress accumulated within the Earth's crust |
| **Earth's material** | any substance occurring naturally on Earth, such as water, soil, rocks, etc |
| **Eclipse** | the partial or complete obscuring, relative to a designated observer, of one celestial body by another |
| **Ecosystem** | a biological community of interacting organisms and their physical environment |
| **Electricity** | a form of energy resulting from the existence of charged particles (such as electrons or protons), either statically as an accumulation of charge or dynamically as a current |
| **Electromagnetic radiation** | a kind of radiation including visible light, radio waves, gamma rays, and X-rays, in which electric and magnetic fields vary simultaneously |
| **Electron** | an elementary particle in all atoms that has a negative charge |
| **Element** | a substance composed of atoms having an identical number of protons in each nucleus; elements cannot be reduced to simpler substances by normal chemical means |
| **Elevation** | height above a given level, especially sea level |
| **Embryo** | an organism in its early stages of development, especially before it has reached a distinctively recognizable form |
| **Energy** | the capacity of a physical system to do work |
| **Environment** | the complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival |
| **Equator** | the imaginary great circle around the Earth's surface, equidistant from the poles and perpendicular to the Earth's axis of rotation; it divides the Earth into the Northern Hemisphere and the Southern Hemisphere |
| **Equilibrium** | the state of a chemical reaction in which its forward and reverse reactions occur at equal rates so that the concentration of the reactants and products does not change with time |
| **Erosion** | the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Error** | difference between a computed or measured value and a true or theoretically correct value |
| **Evaporation** | to convert or change into a vapor |
| **Evidence** | information acquired through objective experience |
| **Evolution** | a gradual process in which something changes into a different form |
| **Experiment** | a test under controlled conditions that is made to examine the validity of a hypothesis or determine the efficacy of something previously untried |
| **Explanation** | a statement based on scientific evidence and logical argument about causes and effects or relationships between variables |
| **Food chain** | a succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another as each usually consumes a lower member and in turn is preyed upon by a higher member |
| **Food pyramid** | a graphic representation of the structure of a food chain, depicted as a pyramid having a broad base formed by producers and tapering to a point formed by end consumers. Between successive levels, total biomass decreases as energy is lost from the system. |
| **Food web** | a complex of interrelated food chains in an ecological community |
| **Force** | an influence tending to change the motion of a body or produce motion or stress in a stationary body; a push or a pull |
| **Fossil** | a remnant or trace of an organism of a past geologic age, such as a skeleton or leaf imprint, embedded and preserved in the Earth's crust |
| **Fossil fuel** | a hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from living matter of a previous geologic time and used for fuel |
| **Frequency** | the number of complete cycles of a periodic process occurring per unit time |
| **Friction** | a force that resists the relative motion or tendency to such motion of two bodies in contact |
| **Front** | the interface between air masses of different temperatures or densities |
| **Fruit** | the ripened ovary or ovaries of a seed-bearing plant |
| **Function** | the role or purpose of a structure |
| **Galaxy** | any of numerous large-scale aggregates of stars, gas, and dust that constitute the universe |
| **Gas** | the state of matter distinguished from the solid and liquid states by relatively low density and viscosity, relatively great expansion and contraction with changes in pressure and temperature, the ability to diffuse readily, and the spontaneous tendency to become distributed uniformly throughout any container |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Gene** | hereditary unit consisting of a sequence of DNA that occupies a specific location on a chromosome and determines a particular characteristic in an organism |
| **Genetics** | the branch of biology that deals with heredity, especially the mechanisms of hereditary transmission and the variation of inherited characteristics among similar or related organisms |
| **Geologic time** | the period of time covering the physical formation and development of Earth, especially the period prior to human history |
| **Geology** | the scientific study of the origin, history, and structure of the earth |
| **Geosphere** | the solid part of the earth consisting of the crust and outer mantle |
| **Germination** | the beginning of development of a seed after a period of dormancy or rest |
| **Glacier** | a huge mass of ice slowly flowing over a land mass, formed from compacted snow in an area where snow accumulation exceeds melting and sublimation |
| **Gram** | the basic unit of mass in the metric system |
| **Gravity** | the force that attracts a body towards the center of the Earth, or towards any other physical body having mass |
| **Greenhouse effect** | the phenomenon whereby the Earth's atmosphere traps solar radiation, caused by the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but absorb heat radiated back from the Earth's surface |
| **Greenhouse gas** | a gas, such as carbon dioxide, that contributes to the greenhouse effect by absorbing infrared radiation |
| **Groundwater** | water beneath the Earth's surface, often between saturated soil and rock, which supplies wells and springs |
| **Habitat** | the area or environment where an organism or ecological community normally lives or occurs |
| **Heart** | the chambered muscular organ in vertebrates that pumps blood received from the veins into the arteries, thereby maintaining the flow of blood through the entire circulatory system |
| **Heat** | a form of energy associated with the motion of atoms or molecules and capable of being transmitted through solid and fluid media by conduction, through fluid media by convection, and through empty space by radiation |
| **Heredity** | genetic transmission of characteristics from parent to offspring |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Homeostasis** | the ability or tendency of an organism or cell to maintain internal equilibrium by adjusting its physiological processes |
| **Humidity** | the amount of water suspended in the air in tiny droplets |
| **Hydrologic cycle** | the cycle of evaporation and condensation that controls the distribution of the Earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water |
| **Hydrosphere** | the watery layer of the Earth's surface; includes water vapor |
| **Hypothesis** | a tentative explanation for an observation |
| **Igneous** | rocks or minerals formed by the cooling and hardening of magma or molten lava |
| **Implication** | a probable consequence |
| **Independent variable** | a manipulated variable in an experiment or study whose presence or degree determines the change in the dependent variable |
| **Infrared** | electromagnetic radiation having a wavelength just greater than that of red light but less than that of microwaves, emitted particularly by heated objects |
| **Inheritance** | genetic transmission of characteristics from parent to offspring |
| **Insulator** | a material that prevents the flow of electricity |
| **Internal balance** | balance within an organism of its internal environment |
| **Intestines** | the portion of the alimentary canal extending from the stomach to the anus and, in humans and other mammals, consisting of two segments, the small intestine and the large intestine |
| **Invertebrate** | an animal, such as an insect or mollusk, which lacks a backbone or spinal column |
| **Investigation** | a detailed inquiry or systematic examination |
| **Kidneys** | pair of organs in the dorsal region of the vertebrate abdominal cavity, functioning to maintain proper water and electrolyte balance, regulate acid-base concentration, and filter the blood of metabolic wastes, which are then excreted as urine |
| **Kilogram** | metric unit equaling 1000 grams |
| **Kinetic energy** | energy which a body possesses by virtue of being in motion |
| **Landform** | a recognizable, naturally formed feature on the Earth's surface. Landforms have a characteristic shape and can include such large features as plains, plateaus, mountains, and valleys, as well as smaller features such as hills, eskers, and canyons |
| **Length** | the distance of something from end to end, usually the longest dimension |
| **Life cycle** | the course of developmental changes in an organism from fertilized zygote to maturity when another zygote can be produced |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Life stage** | the stages or forms that an insect goes through as it is developing; egg, larva, pupa, adult |
| **Light** | electromagnetic radiation that can produce a visual sensation |
| **Line graph** | a diagram that exhibits a relationship, often functional, between two sets of numbers as a set of points having coordinates determined by the relationship |
| **Liquid** | the state of matter in which a substance exhibits a characteristic readiness to flow, little or no tendency to disperse, and relatively high incompressibility |
| **Liter** | basic unit of fluid volume in the metric system |
| **Lithosphere** | the rigid outer part of the earth, consisting of the crust and upper mantle |
| **Liver** | a large, reddish-brown, glandular vertebrate organ located in the upper right portion of the abdominal cavity that secretes bile and is active in the formation of certain blood proteins and in the metabolism of carbohydrates, fats, and proteins |
| **Living** | alive, having life, not dead |
| **Locomotion** | movement |
| **Lungs** | the two spongy, saclike respiratory organs in most vertebrates, occupying the chest cavity together with the heart and functioning to remove carbon dioxide from the blood and provide it with oxygen |
| **Macromolecule** | a very large molecule, such as a polymer or protein, consisting of many smaller structural units linked together |
| **Macroscopic** | large enough to be perceived or examined by the unaided eye |
| **Magnet** | an object that sticks to iron |
| **Magnetism** | the property displayed by magnets and produced by the motion of electric charges, which results in attraction or repulsion between objects |
| **Magnitude** | relative size or extent |
| **Mass** | the quantity of matter which a body contains, as measured by its acceleration under a given force or by the force exerted on it by a gravitational field |
| **Matter** | physical substance or material in general; that which occupies space and possesses mass |
| **Measure** | to ascertain the dimensions, quantity, or capacity of |
| **Mechanical** | relating to the action of forces on material objects |
| **Meiosis** | the process of cell division in sexually reproducing organisms that reduces the number of chromosomes in reproductive cells from diploid to haploid, leading to the production of gametes in animals and spores in plants |
| **Melting point** | the temperature at which a solid becomes a liquid at standard atmospheric pressure |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Metamorphic** | rocks altered considerably from the original structure and composition by pressure and heat |
| **Metamorphosis** | a change from larva to adult |
| **Meteorology** | the science that deals with the phenomena of the atmosphere, especially weather and weather conditions |
| **Meter** | metric unit of length |
| **Metric** | system of weights and measures based on multiples of ten |
| **Microscopic** | too small to be seen by the unaided eye but large enough to be studied under a microscope |
| **Milliliter** | one one-thousandth of a liter; 1000 milliliters equal 1 liter |
| **Millimeter** | one one-thousandth of a meter; 1000 millimeters equal 1 meter |
| **Mineral** | a naturally occurring, homogeneous inorganic solid substance having a definite chemical composition and characteristic crystalline structure, color, and hardness |
| **Mitosis** | a type of cell division in which daughter cells have the same number and kind of chromosomes as the parent nucleus |
| **Mixture** | a composition of two or more substances that are not chemically combined with each other and are capable of being separated |
| **Model** | an explanation or representation of an object, system, or process that cannot be easily studied |
| **Molecule** | the simplest unit of a chemical compound that can exist, consisting of two or more atoms held together by chemical bonds |
| **Moon** | the natural satellite of the earth, orbiting it every 28 days and shining by reflected light from the sun |
| **Moon (lunar) phases** | one of the cyclically recurring apparent forms of the moon |
| **Motion** | a natural event that involves a change in the position or location of something |
| **Multicellular** | describes organisms consisting of more than one cell |
| **Muscular system** | the body system that is composed of skeletal, smooth, and cardiac muscle tissue and functions in movement of the body or of materials through the body, maintenance of posture, and heat production |
| **Mutation** | a change in genetic structure which results in a variant form and may be transmitted to subsequent generations |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Natural resources** | a material source of wealth, such as timber, fresh water, or a mineral deposit, that occurs in a natural state and has economic value |
| **Natural selection** | adapted to their environment tend to survive and transmit their genetic characteristics in increasing numbers to succeeding generations while those less adapted tend to be eliminated |
| **Nervous system** | the system of cells, tissues, and organs that regulates the body's responses to internal and external stimuli. In vertebrates it consists of the brain, spinal cord and nerves |
| **Neutron** | a neutral elementary particle of about the same mass as a proton |
| **Niche** | the function or position of an organism or population within an ecological community |
| **Nonliving** | not alive; referring to something that has never been alive |
| **Nonrenewable resource** | of or relating to an energy source, such as oil or natural gas, or a natural resource, such as a metallic ore, that is not replaceable after it has been used |
| **Nuclear** | relating to atomic nuclei; derived from the energy of atomic nuclei |
| **Nutrient** | any substance that can be metabolized by an organism to give energy and build tissue |
| **Observation** | the act of making and recording a measurement |
| **Oceanography** | the branch of science concerned with the physical and biological properties and phenomena of the sea |
| **Opinion** | a belief or conclusion held with confidence but not substantiated by positive knowledge or evidence |
| **Orbit** | the path of a celestial body or an artificial satellite as it revolves around another body |
| **Organism** | a living thing that has (or can develop) the ability to act or function independently |
| **Organ** | structure of the body that performs a particular function |
| **Pangaea** | (plate tectonics) a hypothetical super-continent that included all the landmasses of the earth before the Triassic Period. When continental drift began, Pangaea broke up into Laurasia and Gondwanaland |
| **Parallel circuit** | a closed circuit in which the current divides into two or more paths before recombining to complete the circuit |
| **Parasite** | an organism that grows, feeds, and is sheltered on or in a different organism while contributing nothing to the survival of its host |
| **Particle** | a very small piece of matter |
| **Particulate model** | model of matter describing all matter as composed of particles with space in between them; the relative distance between particles and the motion of the particles can be used to explain the phases of matter (gas, liquid, solid) |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Particulate model** | model of matter describing all matter as composed of particles with space in between them; the relative distance between particles and the motion of the particles can be used to explain the phases of matter (gas, liquid, solid) |
| **Periodic table** | a table of the chemical elements arranged in order of atomic number, usually in rows, with elements having similar atomic structure appearing in vertical columns |
| **pH** | p(otential of) H(ydrogen); a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14 |
| **Phase change** | a change from one state (solid or liquid or gas) to another without a change in chemical composition |
| **Photosynthesis** | biochemical process of transforming light energy into stored chemical energy in the form of glucose; chemical formula $6CO_2 + 6H_20 +$ light energy $\rightarrow 6O_2 + C_6H_{12}O_6$ |
| **Physical change** | a change from one state (solid or liquid or gas) to another without a change in chemical composition |
| **Physical property** | property of a substance that can be measured without altering the identity of the substance |
| **Physics** | the science of matter and energy and of interactions between the two |
| **Physiology** | the branch of biology concerned with the normal functions of living organisms and their parts |
| **Planet** | a non-luminous celestial body larger than an asteroid or comet |
| **Plasma** | an electrically neutral, highly ionized gas composed of ions, electrons, and neutral particles. It is a phase of matter distinct from solids, liquids, and normal gases. |
| **Plate tectonics** | a theory that explains the global distribution of geological phenomena such as seismicity, volcanism, continental drift, and mountain building in terms of the formation, destruction, movement, and interaction of the earth's lithospheric plates |
| **Plateau** | an elevated, comparatively level expanse of land |
| **Polarity** | the state of having poles or opposites |
| **Pole** | either extremity of an axis through a sphere |
| **Pollination** | transfer of pollen from the anther to the stigma of a plant |
| **Population** | all the organisms that constitute a specific group or occur in a specified habitat |
| **Position** | place or location |
| **Potential energy** | the energy possessed by a body by virtue of its position or state |
| **Precipitation** | any form of water, such as rain, snow, sleet, or hail, which falls to the Earth's surface |

# Science Glossary of Terms (continued)

| | |
|---|---|
| **Prediction** | a statement about what one thinks will happen in an investigation |
| **Pressure** | force applied uniformly over a surface, measured as force per unit of area |
| **Prevailing wind** | a wind from the predominant or most usual direction |
| **Producer** | an organism, such as a green plant, that produces its own food |
| **Product** | a substance resulting from a chemical reaction |
| **Property** | something that can be known by looking at or feeling an object; something one can observe |
| **Proton** | an elementary particle in all atoms that has a positive charge |
| **Qualitative** | involving distinctions, descriptions, or comparisons based on qualities that can be observed without measurement (*e.g.* color, shape, appearance) |
| **Quantitative** | involving distinctions, descriptions, or comparisons that can be quantified or measured |
| **Radiation** | emission and propagation of energy in the form of rays or waves |
| **Radiometric dating** | a method of determining the age of objects or material using the decay rates of radioactive components such as potassium-argon |
| **Ratio** | the relationship between two quantities expressed as the quotient of one divided by the other |
| **Recessive** | an allele that does not produce a characteristic effect when present with a dominant allele; a trait that is expressed only when the determining allele is present in the homozygous condition |
| **Renewable resource** | any natural resource (as wood or solar energy) that can be replenished naturally with the passage of time |
| **Repel** | push away, as similar poles of two magnets push away from one another |
| **Replication** | the process whereby DNA makes a copy of itself before cell division |
| **Reproduction** | the sexual or asexual process by which organisms generate new individuals of the same kind; procreation |
| **Respiratory system** | the organs that are involved in breathing; these include the nose, throat, larynx, trachea, bronchi, and lungs. Also called the respiratory tract |
| **Resource** | available supply of something that can be drawn upon when needed |

# Science Glossary of Terms (continued)

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| **RNA** | (Ribonucleic Acid) – a substance in living cells which carries instructions from DNA for controlling the synthesis of proteins and in some viruses carries genetic information instead of DNA |
| **Rock** | any natural material with a distinctive composition of minerals |
| **Rock cycle** | the process by which rocks are recycled and changed from one form of rock to another |
| **Rotation** | the act or process of turning around a center or an axis |
| **Salinity** | the relative proportion of salt in a solution |
| **Satellite** | any celestial body orbiting around a planet or star |
| **Science** | the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment |
| **Scientific Law** | a phenomenon of nature that has been shown to invariably occur whenever certain conditions exist or are met |
| **Scientific Theory** | a well-substantiated explanation of some aspect of the natural world; an organized system of accepted knowledge that applies in a variety of circumstances to explain a specific set of phenomena; "scientific theories must be falsifiable" |
| **Season** | one of the natural periods into which the year is divided by the equinoxes and solstices or atmospheric conditions |
| **Sediment** | material that has been deposited by water, ice or wind |
| **Sedimentary** | rocks formed when sediment is deposited and becomes tightly compacted |
| **Series circuit** | an electric circuit connected so that current passes through each circuit element in turn without branching |
| **Sexual reproduction** | reproduction by the union or fusion of two differing gametes |
| **Shelter** | something that provides cover or protection |
| **Skeleton** | hard inner framework of bones inside an animal that provides shape, support, and protection |
| **Skin** | flexible organ that covers the body and protects it |
| **Soil** | the top layer of the Earth's surface, consisting of rock and mineral particles mixed with organic matter |
| **Solar system** | a system of planets or other bodies orbiting a star |

# Science Glossary of Terms (continued)

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| **Solid** | the state in which a substance has no tendency to flow under moderate stress; resists forces (such as compression) that tend to deform it; and retains a definite size and shape |
| **Solubility** | the quality or condition of being soluble |
| **Soluble** | that can be dissolved, especially easily dissolved |
| **Solution** | homogeneous mixture of two or more substances, which may be solids, liquids, gases, or a combination of these |
| **Sort** | to arrange according to class, kind, or size; classify |
| **Sound** | vibrations transmitted through an elastic solid or a liquid or gas, capable of being detected by human organs of hearing |
| **Source** | the point or device from which electricity flows |
| **Space** | an empty area (usually bounded in some way between things); the expanse in which the solar system, stars, and galaxies exist; the universe |
| **Species** | a fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding |
| **Specific heat** | the ratio of the amount of heat required to raise the temperature of a unit mass of a substance by one unit of temperature to the amount of heat required to raise the temperature of a similar mass of a reference material, usually water, by the same amount |
| **Spectroscope** | an instrument for producing and observing spectra, the entire range of wavelengths of electromagnetic radiation |
| **Speed** | the rate or a measure of the rate of motion |
| **Star** | a celestial body of hot gases that radiates energy derived from thermonuclear reactions in the interior |
| **State of matter** | the physical state that matter exists in; solid, liquid or gas |
| **Static electricity** | electricity that is generated when one object rubs against another object; positive and negative electric charges that are separated from each other and are not moving |
| **Stem** | any stalk supporting leaves, flowers, or fruit |
| **Stomach** | the enlarged, saclike portion of the alimentary canal, one of the principal organs of digestion, located in vertebrates between the esophagus and the small intestine |
| **Stratosphere** | the atmospheric layer between the troposphere and the mesosphere |
| **Structure** | any identifiable part of an organism |
| **Substance** | a particular kind of matter with uniform properties |
| **Sun** | the star round which the earth orbits |

# Science Glossary of Terms (continued)

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| **Support** | to bear the weight of; to hold in position so as to keep from falling, sinking, or slipping |
| **Switch** | device used to open and close circuits |
| **Surface** | the outer or the topmost boundary of an object |
| **Symbiotic** | a close, prolonged association between two organisms in which both benefit |
| **Synthesis** | formation of a compound from simpler compounds or elements |
| **System** | a group of interacting, interrelated, or interdependent elements forming a complex whole |
| **T-chart** | a graphic organizer with two columns in which the entry in one column is paired with the entry in the other |
| **Table** | an orderly arrangement of data, especially one in which the data are arranged in columns and rows in an essentially rectangular form |
| **Telescope** | a scientific instrument designed to collect and record electromagnetic radiation from cosmic sources |
| **Temperature** | a measure of the average kinetic energy of the particles in a sample of matter, expressed in terms of units or degrees designated on a standard scale |
| **Testable** | able to be tested or investigated by a scientific investigation |
| **Thermometer** | a tool used to measure temperature |
| **Tide** | the alternate rising and falling of the sea due to the attraction of the moon and sun |
| **Tissue** | aggregation of morphologically similar cells and associated intercellular matter acting together to perform one or more specific functions in the body |
| **Transfer** | to convey or cause to pass from one place or thing to another |
| **Transform** | to convert from one form to another |
| **Troposphere** | the lowest region of the atmosphere between the Earth's surface and the tropo pause, characterized by decreasing temperature with increasing altitude |
| **Ultraviolet** | electromagnetic radiation having a wavelength just shorter than that of violet light but longer than that of X-rays |
| **Unicellular** | consisting of a single cell |

# Science Glossary of Terms (continued)

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| **Unit** | a standard amount of a physical quantity, such as length or energy, used to express magnitudes of that quantity |
| **Universe** | all matter and energy, including the Earth, the galaxies, and the contents of intergalactic space, regarded as a whole |
| **Uplift** | upheaval; raising something to a higher level |
| **Variable** | a factor or condition that can change and might affect the outcome of an experiment |
| **Velocity** | a vector quantity whose magnitude is a body's speed and whose direction is the body's direction of motion |
| **Verify** | to determine or test the accuracy of, as by comparison, investigation, or reference |
| **Visible light** | electromagnetic radiation that can produce a visual sensation |
| **Volcanic eruption** | the sudden occurrence of a violent discharge of steam and volcanic material |
| **Volcano** | an opening in the Earth's crust through which molten lava, ash, and gases are ejected |
| **Volume** | the amount of 3-dimensional space occupied by an object |
| **Water cycle** | the circulation of the Earth's water, in which water from the sea evaporates, forms clouds, falls as rain or snow, and returns to the sea by rivers |
| **Wavelength** | the distance between one peak or crest of a wave of light, heat, or other energy and the next corresponding peak or crest |
| **Weather** | the state of the atmosphere at a given time and place, with respect to variables such as temperature, moisture, wind velocity, and barometric pressure |
| **Weathering** | any of the chemical or mechanical processes by which rocks exposed to the weather undergo changes in character and break down |
| **Weight** | the force with which a body is attracted to Earth or another celestial body, equal to the product of the object's mass and the acceleration of gravity |
| **White light** | apparently colorless light containing all the wavelengths of the visible spectrum at equal intensity (such as ordinary daylight) |
| **Work** | the transfer of energy from one physical system to another, especially the transfer of energy to a body by the application of a force that moves the body in the direction of the force |
| **Year** | the time taken by the Earth to make one revolution around the sun |