A QUICK GUIDE TO
career connections

Career Connection Learning Strategies help educators connect student learning to future work. Here are examples of how the model curriculum for Ohio's New Learning Standards incorporates strategies beginning in kindergarten through high school. To view the model curriculum in its entirety, visit:

http://education.ohio.gov/Topics/Academic-Content-Standards

Career Connections is a joint initiative among the Governor's Office of Workforce Transformation and Ohio Department of Education. In addition to the learning strategies embedded into the model curricula, Career Connections will align the many efforts around college and career readiness to support students' in becoming productive and engaged citizens.

Career Awareness

Elementary Grades (K-5)

Students become familiar with careers through learning that connects classroom instruction to future work. Career awareness strategies show students various types of careers and stimulate interest in future work.

Career Exploration

Middle Grades (6-8)

Students explore their career interests through embedded activities. Career exploration strategies are opportunities for students to discover work environments and understand the various aspects of the workplace.

Strategies include tools and instruments that help students understand and appreciate their strengths and interests. Students start plans for their future with career information and postsecondary education data. Plans include course selection and planning as well as career aspirations and goals.

Career Planning

High School (9-12)

Students continue career exploration while focusing on career planning. Activities provide advanced experiences that offer hands-on opportunities in a workplace. Career planning strategies focus on making clear links between career options and educational decisions. Students develop the skills to revisit previous exploration and planning strategies as they face career changes throughout life.

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Strand	Reading: Literature
Topic	Integration of Knowledge and Ideas

Standard Statements	**Content Elaborations**
7. With prompting and support, describe the relationship between illustrations and the story in which they appear (e.g., what moment in a story an illustration depicts). 8. (Not applicable to literature) 9. With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories.	The focus of the **Integration of Knowledge and Ideas** topic is making connections and comparisons, and determining themes and main topics across different texts and genre. Images or illustrations in books serve to enhance and/or explain the messages for the reader. They can be used as one of the cues for the written text while reading. Beginning readers that compare characters within and across texts develop a fuller and more appropriate conceptualization of stories. **In the next grade band, students will be expected to analyze the contributions of the visual text to the overall meaning of the story, and compare and contrast themes and topics and the ways these are treated in texts within and across genres.**

Enduring Understanding

Competent readers can synthesize information from a variety of sources including print, audio and visual. Comparing and contrasting text in a variety of forms or genres provides a full understanding of the author's message/theme as well as the ideas being explored.

Strand	Reading: Literature
Topic	Integration of Knowledge and Ideas

Instructional Strategies and Resources

Shared Reading
During shared reading (or in small group guided reading) the teacher guides students through a "picture walk." Students make predictions about the story based on the illustrations. Chart predictions so that students can compare theirs to what actually happens.

Career Connection
During shared reading, select a text (e.g., *Welcome to Kindergarten An Alphabet* by Violet Smith or *Welcome to Kindergarten* by Anne Rockwell) that focuses on the various jobs within a school (e.g., teacher, principal, custodian, IT, librarian). Students will identify jobs in the book and make comparisons among illustrations within the book (e.g., type of tools or resources used, working alone or in a group, skills involved). Guide students through a tour of the school building identifying the different settings in which staff work (e.g., school office, cafeteria, supply room).

Venn Diagrams
Students use Venn diagrams or similar graphic organizers to compare and contrast characters and events in familiar stories read in class. For example, compare the characters and adventures of the Three Little Pigs and the Three Bears.

The Castle in the Classroom: Story As a Springboard for Early Literacy by Ranu Bhattacharyya and Georgia Heard (Stenhouse, 2010) discusses ways to use the life stories and imaginations of young children as gateways to literacy.

Diverse Learners
Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Strand	Reading: Foundational Skills
Topic	Print Concepts

Standard Statements	**Content Elaborations**
1. Demonstrate understanding of the organization and basic features of print. a. Recognize the distinguishing features of a sentence (e.g., first word, capitalization, ending punctuation).	Readers show their understanding of **Print Concepts** by demonstrating their understanding that print carries meaning by incorporating the functions of print in word-play activities. They show an understanding of single words initially by using environmental print (e.g., stop signs, fast food chains). The more readers experience text, the greater their understanding is of its make up (e.g., words are made of letters, spaces between words). These skills are important foundations for reading-comprehension skills that readers will use throughout their lives.

Enduring Understanding

Understanding of print features, structures and characteristics facilitate the reader's ability to make meaning of the text.

Instructional Strategies and Resources

Shared Reading
During shared reading, the teacher can point out concepts of books (e.g., front cover, author and illustrator, top and bottom of page). Finger pointing at text during shared reading reinforces the concept of words and word boundaries as well as directionality. Encouraging students to use a pointer (a ruler will do) to point to words as they read is another way to focus attention on the concepts of print.

Career Connection
During shared reading, select a text with an alphabet theme that highlights different skills used across many careers (e.g., *My Teacher Can Teach…Anyone!* by W. Nikola-Lisa). After the read aloud, lead a discussion with students allowing them to identify how these skills relate to both the classroom and workplace.

Strand	Reading: Foundational Skills
Topic	Print Concepts

Name Games
Playing with students' names provides ample opportunities for students to begin understanding print. The difficulty of and involvement with the activity depends on the sophistication of the learner.

- Post the numbers 1 through 5 and have students place their name cards under the number that corresponds to the syllables in their name.
- Using names that have been cut apart, have learners arrange names correctly (words are made up of letters).
- If your name ends with… (noting similarities in words).
- She said/he said – chart the answers to a question by writing the student's/respondent's name with the answer (right to left). For example:
    - What did Rosie do?
        - Joe said, "She went for a walk."
        - Mary said, "Rosie went around the pond."
        - John said, "She stepped on a rock first."

Alphabet Books
Use alphabet books to support learning letter sounds. Texts can range from simplistic (one picture/one letter per page)like Ehlert's *Eating the Alphabet* to interactive (rhymes, repetition) like Martin's *Chicka Chicka Boom* to conceptually more difficult (letters taking the shape of the objects named) like Pelletier's *The Graphic Alphabet*. As children advance in confidence, they can create alphabet books in which each letter is represented by a sentence that has words beginning with that letter. For example: Aaron ate an apple; Bob burst Billy's balloon; Carla carried cotton candy, etc.

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Strand	Writing
Topic	Production and Distribution of Writing

Standard Statements	**Content Elaborations**
4. (Begins in grade 3) 5. With guidance and support from adults and peers, focus on a topic and strengthen writing as needed by revising and editing. 6. With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers.	Students at this age are writing more independently and have begun to understand that words are powerful ways to express themselves. They begin to draw their messages less as their ability to work with text increases. As students learn the craft of writing, they also must understand the pieces of the **Production and Distribution of Writing**. Peer editing can begin at this level. Student writers are capable of providing editing and revision feedback as long as this has been focused or targeted on specific writing areas. **In the next grade band, students are expected to produce texts that reflect planning, organization, and evidence of revision and editing. In addition, students are expected to use appropriate technologies to enhance their messages further.**

Enduring Understanding

Writers share information, opinions and ideas through multiple ways and texts. Knowledge of different genres supports students' understanding and writing of text and structures. This allows them to communicate in appropriate and meaningful ways to their audience to achieve their intended purpose.

Strand	Writing
Topic	Production and Distribution of Writing

Instructional Strategies

Writing and Technology
Students share their writing with their peers through the use of technology such as ELMO, SMARTBoard or PowerPoint. After the share, provide opportunities for peers to contribute constructive feedback to the author. The author uses the suggestions. The revised writing is again shared and the impact of the suggestions is noted.

Career Connection
Invite your school's technology director or another technology professional from the community to discuss how integrating technology in to a presentation strengthens and supports the speaker's message, rather than a tool used for delivering the message. Then, students will create a presentation that shares their personal strengths and interests, while demonstrating their skills for integrating technology and writing, speaking, and listening.

Constructive Feedback
Model how to provide constructive feedback to an author's work and then have students provide feedback to each other. For example, after hearing a peer's story, students offer one compliment focused on the craft used and one suggestion for next steps.

Wordle
Wordle gives students the opportunity to play graphically with words to create a word collage.

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English Language Arts Model Curriculum
Grade 3

Strand	Reading: Literature
Topic	Key Ideas and Details

Standard Statements	**In the previous grade band, students were expected to retell, answer questions and describe characters using key details.**
1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. 2. Recount stories, including fables, folktales, and myths from diverse cultures; determine the central message, lesson, or moral and explain how it is conveyed through key details in the text. 3. Describe characters in a story (e.g., their traits, motivations, or feelings) and explain how their actions contribute to the sequence of events.	**Content Elaborations** Readers use **Key Ideas and Details** to provide textual evidence, make inferences, identify theme and literary elements, and summarize text. Determining central ideas and key details gives the reader a more complete picture of a text. Retelling a story demonstrates comprehension of a text, knowledge of characterization and an initial understanding of how a story connects to the larger world. **In the next grade band, students are expected to cite evidence that reflects the theme or main idea without adding personal judgment and describe how plot events or scenes build on and impact one another.**

Enduring Understanding

Imaginative texts can provide rich and timeless insights into universal themes, dilemmas and social realities of the world in which we live. Literary text represents complex stories in which the reflective and apparent thoughts and actions of human beings are revealed. Life therefore shapes literature and literature shapes life.

Strand	Reading: Literature
Topic	Key Ideas and Details

Instructional Strategies and Resources

Comparison Matrix Organizer
Use a comparison matrix organizer like a T-Chart to compare and contrast one or more elements of two literary texts. Students should use specific details to identify or illustrate literary elements such as central messages, lessons or morals. Graphic organizing software is a useful multi-media tool for this activity (i.e., Inspiration, Kidspiration).

Understanding Character
Students select a character from an individually or group read text. They can *become* the character to provide details about how that character's actions impact the sequence of events in the selection. Becoming the character can include dressing like that character, creating character specific props and/or making character puppets. They should know the character well enough to explain character feelings, attitudes and motivations.

Career Connection
When focusing on understanding characters, students will choose an individually or group read text that includes characters that represent various careers (e.g., *Community Helpers from A to* Z by Bobbie Kalman). Students will assume the role of a chosen character. Students may choose to dress like the character, include character-specific props, or make character puppets.

Questioning the Text
Using the think-aloud strategy, model for students how to question the text while reading. The teacher might read aloud a text printed large enough for students to see. On large sticky notes, the teacher can pose questions or wonderings as the selection is read aloud. Once the reading is complete, the teacher and students can work together to determine where they might find answers to the questions that were asked. Encourage students to repeat this process while reading individually.

The El Paso Collaborative for Academic Excellence (Copyright © 2003, Literacy in Action) provides lessons for writing informational text at

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Strand	Language
Topic	Vocabulary Acquisition and Use

Standard Statements

4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on *grade 4 reading and content*, choosing flexibly from a range of strategies.
    a. Use context (e.g., definitions, examples, or restatements in text) as a clue to the meaning of a word or phrase.
    b. Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word (e.g., *telegraph, photograph, autograph)*.
    c. Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation and determine or clarify the precise meaning of key words and phrases.

5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
    a. Explain the meaning of simple similes and metaphors (e.g., *as pretty as a picture*) in context.
    b. Recognize and explain the meaning of common idioms, adages, and proverbs.
    c. Demonstrate understanding of words by relating them to their opposites (antonyms) and to words with similar but not identical meanings (synonyms).

6. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., *wildlife*, *conservation*, and *endangered* when discussing animal preservation).

In the previous grade band, students were expected to understand how word parts work together to create meaning.

Content Elaborations

Learning, as a language-based activity, is fundamentally and profoundly dependent on **Vocabulary Acquisition and Use**. Knowing vocabulary goes beyond knowing a definition. Students acquire and use vocabulary through exposure to language-rich situations and events. They use an array of strategies including language structure and origin, textual clues, word relationships, and differences between literal and figurative language to build vocabulary and enhance comprehension. Understanding the nuances of words and phrases (shades of meaning) allows students to use vocabulary purposefully and precisely.

In the next grade band, students are expected to determine the meaning of and to use words and phrases that have multiple or nonliteral meanings to enhance the quality of their written products.

Strand	Language
Topic	Vocabulary Acquisition and Use

Enduring Understanding

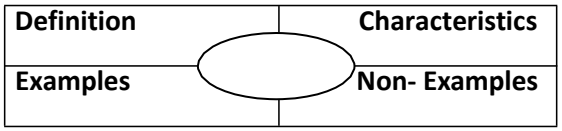
Words are powerful. Interacting with words actively engages students in investigating and celebrating language.

Instructional Strategies and Resources

Frayer Model

The Frayer Model is a graphical organizer used to define words and acquire new vocabulary. The graphic has four squares that include:

- A definition of the word/concept
- A description of its essential characteristics
- Examples of the word/concept
- Non-examples of the word/concept



Frayer, D., Frederick, W. C., and Klausmeier, H. J. (1969*). A Schema for Testing the Level of Cognitive Mastery.* Madison, WI: Wisconsin Center for Education Research.

Career Connection

Using the *Frayer Model*, students will determine and clarify the meaning of unknown terms related to career readiness and provide characteristics, examples and non-examples of each term within the organizer. Conduct a class discussion guiding students through examples of characteristics of career readiness (e.g., Career Ready Practices, and Life and Career Skills.)

Strand	Language
Topic	Vocabulary Acquisition and Use

Proverbs, Idioms and Unusual Expressions
Brainstorm the definitions of proverb and idiom. Write proverbs about natural elements on the leaves and petals of flower images. Post the images around the classroom. Ask students to pick a proverb to explain. Encourage students to listen for proverbs that can be added to their flower petals/leaves. For example:

- As right as rain..... Don't beat around the bush
- Out on a limb..... The grass is always greener

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Strand	Speaking and Listening
Topic	Presentation of Knowledge and Ideas

Standard Statements	
4. Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. 5. Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. 6. Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation.	**In the previous grade band, students were expected to tell stories or recount experiences with appropriate facts and details. They were expected to create audio recordings, adding visual displays to clarify information when appropriate. They also were expected to produce complete sentences in order to provide requested details or clarification.** **Content Elaborations** The focus of this topic, **Presentation of Knowledge and Ideas**, is the understanding that effective speakers use relevant facts and details to report, retell, recount and support their ideas. They include multimedia components when appropriate to enhance ideas and themes. Effective speakers also understand how to use speech and language in various situational contexts. They make choices regarding pacing and the use of formal and informal language. **In the next grade band, students are expected to present claims and findings using appropriate eye contact, adequate volume and clear pronunciation. They are expected to adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated.**

Enduring Understanding

Proficient speakers make deliberate choices regarding language, content and media to capture and maintain the audience in order to convey their message.

Strand	Speaking and Listening
Topic	Presentation of Knowledge and Ideas

Instructional Strategies and Resources

Presenting with Multimedia
In small groups, students view and analyze sample multimedia presentations and create a list of characteristics of the genre and of what makes a good presentation. Students then list programs and tools they could use to make their own multimedia presentations. Teachers can review copyright and plagiarism with the students at this point. Small groups plan and make a storyboard for their own multimedia presentations.

Career Connection
In small groups, students will discuss traditional and non-traditional careers (e.g., non-traditional for women would be engineer, traditional for women would be a nurse; non-traditional for men would be an early childhood educator, traditional for men would be a construction manager) within an identified career field (e.g., STEM, construction, education). For a list of non-traditional occupations for both women and men, visit http://dol.gov (search: non-traditional). Students will research these careers and create multimedia presentations supported by facts and details that either inform or present an opinion of traditional and/or non-traditional careers.

Powerful Words
This strategy helps students understand that words used in persuasive speaking are critical to the effectiveness of the outcome. Present students with a series of paired statements and have them select the sentence that is the most persuasive. An example of sentence pairs is:

- Fifth-grade students should be allowed to chew gum in school.
- Because mint increases brainpower, chewing gum should be required in the fifth grade.

Have students listen to or read excerpts of famous speeches paying attention to the power words and phrases. As they craft their own speeches, encourage students to include power words and phrases to increase the persuasive effectiveness.

Active Literacy Across the Curriculum: Strategies for Reading, Writing, Speaking and Listening by Heidi Hayes Jacobs. (Eye on Education, 2006) discusses curriculum mapping as a tool for literacy integration.

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Strand	Writing
Topic	Research to Build and Present Knowledge

Standard Statements

7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

8. Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    a. Apply *grade 6 Reading standards* to literature (e.g., "Compare and contrast texts in different forms or genres [e.g., stories and poems; historical novels and fantasy stories] in terms of their approaches to similar themes and topics").
    b. Apply *grade 6 Reading standards* to literary nonfiction (e.g., "Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not").

In the previous grade band, students were expected to conduct short research projects that use several sources, and recall and gather relevant information from experiences or print and digital sources. Students were to summarize or paraphrase information and provide a list of sources. They also were expected to draw evidence from texts to support analysis, reflection and research.

Content Elaborations

The focus of this topic, **Research to Build and Present Knowledge,** is the understanding that writers activate prior knowledge and then engage in the process of inquiry and research. Topics and research questions are developed and continually refined. As writers encounter and gather new and relevant information from multiple sources, they refocus their inquiry and research in order to create new understandings and new knowledge for specific purposes. They evaluate this information for accuracy, credibility and reliability.

In the next grade band, students are expected to draw evidence from literary or informational texts to support analysis, reflection and research. Students also are expected to delineate and evaluate the argument and specific claims assessing the reasoning and evidence in text.

Enduring Understanding

Writing is a tool for thinking and problem solving. In order to create new understandings, activating prior knowledge and engaging in the process of independent and shared inquiry are essential.

Strand	Writing
Topic	Research to Build and Present Knowledge

Instructional Strategies and Resources

Computer Search
Once students have found resources that they think will be credible, they will research a few of the authors or sponsors of their resources and ask the following questions:

- What information do they write about?
- What organizations do they belong to?

Have students determine if their sources are truly credible and usable. Students discover that all websites have an author and ultimately, bias. They need to determine those biases before accepting the website as a source.

Career Connection
Students will research a specific occupation within a selected career field. Using various resources (e.g., print, electronic, video, professional interview), students will focus on research questions identified ahead of time, such as:

- What is the future job outlook for your community and across the state? How much would you expect to be paid starting out?
- What are the education and training requirements?
- What types of classes or activities could you get involved in throughout middle and high school to prepare for this occupation?
- What types of skills are needed? What types of technology are used?
- What are the typical working conditions? What are some common tasks?
- What pathways and related occupations are available within the same career field?
- How do this career field, pathway, and occupation align with your interests, skills, abilities, and future goals?

Students will present a summary of their research to the class while dressed according to their workplace (e.g., suit, uniform, business casual).

Historical Research
Design a series of questions for students to answer about a famous person, famous place or current or historical event. Students conduct research for answers to their questions. Crediting all helpful resources, students write a script and create a multimedia presentation to demonstrate what they have learned. Some students may self-select topics and design their own research questions.

Strand	Writing
Topic	Research to Build and Present Knowledge

Writing Instruction for Struggling Adolescent Readers: A Gradual Release Model. By Fisher, Douglas and Nancy Frey. *Journal of Adolescent and Adult Literacy.* This model can also be found electronically at INFOhio's EBSCOhost, Professional Search: Teachers and Administrators.

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Strand	Reading: Informational Text
Topic	Range of Reading and Level of Text Complexity

Standard Statements	**In the previous grade band, students were expected to read and comprehend informational texts, including history/social studies, science and technical texts, at the high end of the grades 4-5 text complexity band independently and proficiently.**
10. By the end of the year, read and comprehend literary nonfiction in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.	**Content Elaborations** The Common Core states that there is a "general, steady decline- over time, across grades, and substantiated by several sources – in the difficulty and likely also the sophistication of content of the texts students have been asked to read in school since 1962." To help teachers match complex, grade-appropriate texts to their students, the Common Core Standards document contains a model with three dimensions for measuring text complexity. To effectively establish the text complexity level, all three dimensions must be used together: (1) Qualitative dimensions of text complexity (levels of meaning or purpose, structure, language conventionality and clarity, and knowledge demands) (2) Quantitative dimensions of text complexity (word length or frequency, sentence length, text cohesion –typically measured by computer software) (3) Reader and task considerations (motivation, knowledge, experiences, purpose and complexity of task assigned)

Strand	Reading: Informational Text	
Topic	Range of Reading and Level of Text Complexity	
		The Common Core recognizes that not all students arrive at school with the tools and resources to ensure that they are exposed to challenging text away from school; it also recognizes that a "turning away from complex texts is likely to lead to a general impoverishment of knowledge…." This trend can be "turned around" when teachers match students with challenging, engaging text in the classroom, creating an atmosphere that helps to nurture curious, capable and critical readers. Students, through more exposure to informational text and the development of important reading skills and strategies that aid in reading this text, will gain knowledge as well as familiarity with various text structures and elements.
Enduring Understandings To build a foundation for college and career readiness, students must read widely and deeply from among a broad range of high-quality, increasingly challenging informational texts.		
Instructional Strategies and Resources **Instruction Manual** Have students go through instruction manuals to analyze and determine how the parts are structured. Then have students write their own instruction manuals. This will help students be aware of the importance of headings, subheadings, organization and structure. **Career Connection** Students will select an instruction manual that represents a career field of interest (selection provided by the teacher, contributed by student, or available on the Internet). Lead a class discussion where students have a chance to brainstorm which types of careers they think might be associated with the manual, answering questions like: who created it?, who designed it?, who produced it?, what is the purpose?, and who will consume it? (representing the many roles involved throughout the process). After students write their own instruction manuals, revisit the brainstorm discussion to emphasize the application of classroom content to the workplace.		

Strand	Reading: Informational Text
Topic	Range of Reading and Level of Text Complexity

Stump the Teacher
Students and teachers read a selection independently. The students ask the teacher questions for a set amount of time. Then the teacher asks students questions for a brief amount of time.

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Strand	Writing
Topic	Text Types and Purposes

Standard Statements

1. Write arguments to support claims with clear reasons and relevant evidence.
    a. Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
    b. Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
    c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
    d. Establish and maintain a formal style.
    e. Provide a concluding statement or section that follows from and supports the argument presented.

2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
    a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
    b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

In the previous grade band, students were expected to write opinion pieces supporting a point of view with reasons and information. They also were expected to write informative/explanatory texts that examined a topic and to write narrative texts that developed real or imagined experiences.

Content Elaborations

The focus of this topic, **Text Types and Purposes**, is the understanding that writers develop complete, logically sequenced text with relevant, credible evidence and detail while critically acknowledging opposing claims. This evidence can be in the form of facts, examples, details and/or statistics and should be presented logically so that writers can clarify relationships between and among ideas. In order to convey information best, writers purposefully select and use precise language and domain-specific vocabulary as well as techniques that characterize writing styles and tones, both of which are determined by topic and audience. Writers make use of figurative language (language enriched by word images and figures of speech) in order to stir the reader's emotions or convince the reader to come to the same conclusions about the topic as they have. A writer's use of language also is important in identifying his or her writing style. Whether or not a writer consistently uses short, choppy sentences or long, complex sentences speaks to the writer's writing style. The tone or attitude that a writer takes toward a subject also is important. The more convincing a writer is in the feelings and beliefs about the topic or real or imagined experience written about, the likelier it is that a reader will agree with the writer's viewpoint.

Strand	Writing
Topic	Text Types and Purposes

c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style. f. Provide a concluding statement or section that follows from and supports the information or explanation presented. 3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences. a. Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically. b. Use narrative techniques, such as dialogue, pacing, description, and reflection, to develop experiences, events, and/or characters. c. Use a variety of transition words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another, and show the relationships among experiences and events. d. Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events. e. Provide a conclusion that follows from and reflects on the narrated experiences or events.	**In the next grade band, students are expected to write arguments to support claims and to write informative/expository texts to convey complex information clearly and accurately. They are expected to write narratives that develop real or imagined experiences using narrative techniques and precise language. They also should provide a logical conclusion for the narrative.**

Strand	Writing
Topic	Text Types and Purposes

Enduring Understanding

Writers share information, opinions and ideas by using multiple techniques and text types. This knowledge allows them to communicate in appropriate and meaningful ways to achieve their intended purpose.

Instructional Strategies

Pre-Writing Activity
When writing an informational essay, have students determine/pre-write the three to five key ideas to be covered in the essay. (This can be accomplished from a teacher-directed activity or determined independently.) On horizontally aligned paper, put each key idea statement in a separate box so that the boxes are in a row. Draw an umbrella over the boxes. Model for students the thesis statement that includes aspects of the key ideas.

Career Connection
Students will brainstorm and then research the characteristics and skills of a quality employee (e.g. Career Ready Practices or Life and Career Skills. For their pre-writing activity, students will choose three to five of these ideas to focus their key idea statements, which will serve as the structure of their essay. Invite a Human Resources professional to the classroom to share their expectations of quality applicants. Students will realize the skills expected to be demonstrated during job interviews and in the workplace.

Sentence Connection
Using the SMARTBoard or sentence strips, create a series of short sentences that could be connected with transitional words. Have students reorder sentences, connect and include a transition word. Words may be provided in a box or on strips, or words could be determined by the students without assistance. Note the meaning change of the connected sentences, which are dependent on the transition word choice.

Strand	Writing
Topic	Text Types and Purposes

Traveling the Road to Freedom Through Research and Historical Fiction by O'Conner, Beth. (Readwritethink, IRA/NCTE, 2010). Students read historical fiction to gain an understanding of an important period .

"Fostering thought, talk, and inquiry: Linking literature and social studies" by Roser, Nancy L. & Susan Keehn. *The Reading Teacher*, *55*(5), 416–426, 2002).

Students read historical fiction to understand periods of American history and collaborate via a WebQuest and book discussions to analyze different historical perspectives. This information is used to create a fictional character for a piece of historical fiction.

Diverse Learners
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Strand	Writing
Topic	Text Types and Purposes

Standard Statements

1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
    a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
    b. Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.
    c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
    d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
    e. Provide a concluding statement or section that follows from and supports the argument presented.

In the previous grade band, students were expected to produce narrative and informative writing that was organized, engaging and possessed strong arguments.

Content Elaborations

Understanding **Text Types and Purposes** is essential for writing. Effective and coherent text creation requires conscious choices about purpose for text creation (e.g., to inform, explain, persuade, entertain or inspire), motives for selecting strategies to engage an audience (e.g., to communicate information, promote action or build relationships), and potential consequences of choices regarding text creation (e.g., follow-up action, position defended, appropriate tone and style). It also includes appropriate structures for particular types of texts, language, voice, style, ideology, form and genre.

In the next grade band, students are expected to produce informative and narrative writings that examine and convey complex ideas, and have well-developed arguments with valid reasoning, relevant evidence and well-chosen details.

Strand	Writing
Topic	Text Types and Purposes

2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
    a. Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
    b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
    c. Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
    d. Use precise language and domain-specific vocabulary to manage the complexity of the topic.
    e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
    f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

Strand	Writing
Topic	Text Types and Purposes

3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. a. Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events. b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters. c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole. d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters. e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.	

Enduring Understanding

Writers share information, opinions and ideas by using multiple techniques and text types. This knowledge allows them to communicate in appropriate and meaningful ways to achieve their intended purpose.

Strand	Writing
Topic	Text Types and Purposes

Instructional Strategies and Resources

Evaluating Models of Performance
Explain the criteria for a particular writing assignment. Show students models of essays representing a range of scores. Have students assess them based on the criteria discussed. Students can use this knowledge to write their own essays with the same criteria. (*See Appendix C – Samples of Student Writing* in the Common Core Standards.)

Claims T-Chart
Students use a T-chart to list claims and counterclaims that might be made in an argumentative text. They can use the chart to determine their position and develop their own persuasive essay on the subject.

Character Reflection
After completion of novel or play, students write a reflective response in the voice of a major character based on textual references. (Diary entry, blog entry, letter, journal entry, etc.)

Career Connection
After reading an argumentative text (e.g., *From Courage to Freedom: Frederick Douglass's 1845 Autobiography*) and analyzing the author's craft, students will apply those strategies to their own writing. Students will develop an argumentative piece about themselves, convincing an employer of their skills and knowledge (e.g., letter of intent, scholarship essay, résumé). The letter will form their position as to why they are the best candidate, providing supporting details pulled from their self-analysis.

Burkhard, Ross M. *Writing for Real: Strategies for Engaging Adolescent Writers.* Portland: Stenhouse, 2003. This text offers various strategies used by veteran middle school teacher Ross Burkhardt. The text can be used as a guide to create an entire academic year of curriculum for writing.

Diverse Learners
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Strand	Reading: Informational Text
Topic	Integration of Knowledge and Ideas

Standard Statements

7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., *The Federalist,* presidential addresses.

9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

In the previous grade band, students were expected to examine various text presented in different mediums, delineate and evaluate arguments, and analyze the themes and concepts of seminal U.S. documents of historical and literary significance.

Content Elaboration

The **Integration of Knowledge and Ideas** from informational text requires analysis and evaluation of critical themes and concepts from various perspectives. Critical reading of a wide variety of seminal texts, including those told from historical, literary and scientific perspectives, mirrors and challenges thinking and enhances the understanding of content.

Enduring Understanding

Integrating knowledge and ideas from informational text expands the knowledge base and the perspectives found in text, which empowers the reader to make informed choices in life.

Strand	Reading: Informational Text
Topic	Integration of Knowledge and Ideas

Instructional Strategies and Resources

Compare/Contrast

- Students read "Letter from Birmingham Jail" and then evaluate a picture, a cartoon and a video relating to civil rights.
- Students compare and contrast the message in the original text to the messages in the picture, cartoon and video. (*Frames of Mind: A Rhetorical Reader with Occasions for Writing* by Robert Dianni and Patsy Hoy)

Create Your Own Historical Document

Before reading historical documents, students create one of their own (e.g., farewell address to their classmates, a state of the union about their accomplishments and goals over the past year). Then, after discussing themes and content of their own, students read the original document. This strategy scaffolds them into understanding the genre.

Career Connection

Before reading historical documents (e.g., President Lincoln's and President Obama's Second Inaugural Address), students will develop a speech describing their accomplishments over the past year. Students will identify key events that occurred in their school and personal life (e.g., nominations, awards, extra-curricular activities, clubs, sports, academic successes, driver license, part-time job, CPR/First Aid). They will highlight the details of each accomplishment, and briefly describe a vision for their future (e.g., apply for financial aid, graduate high school, pass Algebra II, become an Insurance Broker). The format and substance of their accomplishments and vision should resemble that of the Inaugural Addresses of both Presidents Lincoln and Obama. Students will take their address and use the information to update or create a résumé.

Strand	Reading: Informational Text
Topic	Integration of Knowledge and Ideas

Suitable for Texting
Students analyze 17th-, 18th- and 19th-century foundational U.S. documents of historical and literary significance for their themes, purposes and rhetorical features.

- **Basic:** Rewrite the Mayflower Compact into a message suitable for texting. Define the audience, research the meaning of the unfamiliar words, determine to whom the text would be sent, etc.
- **Extended:** Write a four-sentence précis for the Mayflower Compact.

Summarizing a historical document into four sentences or into a modern texting format hones analytical skills to find the important details. Have students consider the audience of both the original and a new audience. Students could create a new compact using the basic argument of the Mayflower Compact.

- http://oregonstate.edu/instruct/phl201/modules/rhetorical-precis/sample/peirce_sample_precis_
- http://http://www.uhv.edu/ac/research/prewrite/pdf/sources.pdf
- http://www.jstor.org/pss/40031761

Time Period Comparison
Students compare texts from a time period on an issue with historical events resulting from those beliefs. End with a seminar letting students draw and support their own conclusions. Students need to synthesize materials and evaluate the information.

Diverse Learners
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Kindergarten

Domain	Geometry
Cluster	***Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).***
Standards	1. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as *above*, *below*, *beside*, *in front of*, *behind*, and *next to*. 2. Correctly name shapes regardless of their orientations or overall size. 3. Identify shapes as two-dimensional (lying in a plane, "flat") or three-dimensional ("solid").

Content Elaborations

Ohio has chosen to support shared interpretation of the standards by linking the work of multistate partnerships as the Mathematics Content Elaborations. Further clarification of the standards can be found through these reliable organizations and their links:

- Achieve the Core Modules, Resources
- Hunt Institute Video examples
- Institute for Mathematics and Education Learning Progressions Narratives
- Illustrative Mathematics Sample tasks
- National Council of Supervisors of Mathematics (NCSM) Resources, Lessons, Items
- National Council of Teacher of Mathematics (NCTM) Resources, Lessons, Items
- Partnership for Assessment of Readiness for College and Careers (PARCC) Resources, Items

Expectations for Learning

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- Accommodations
- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

Develop spatial sense by connecting geometric shapes to students' everyday lives. Initiate natural conversations about shapes in the environment. Have students identify and name two- and three-dimensional shapes in and outside of the classroom and describe their relative position.

Ask students to find rectangles in the classroom and describe the relative positions of the rectangles they see, e.g. *This rectangle (a poster) is over the sphere (globe)*. Teachers can use a digital camera to record these relationships. Hide shapes around the room. Have students say where they found the shape using positional words, e.g. *I found a triangle UNDER the chair*.

Have students create drawings involving shapes and positional words: *Draw a window ON the door* or *Draw an apple UNDER a tree*. Some students may be able to follow two- or three-step instructions to create their drawings.

Use a shape in different orientations and sizes along with non-examples of the shape so students can learn to focus on defining attributes of the shape.

Manipulatives used for shape identification actually have three dimensions. However, Kindergartners need to think of these shapes as two-dimensional or "flat" and typical three-dimensional shapes as "solid." Students will identify two-dimensional shapes that form surfaces on three-dimensional objects. Students need to focus on noticing two and three dimensions, not on the words *two-dimensional* and *three-dimensional.*

Career Connection

Provide students with real-work examples that demonstrate the use of shapes in various work places (e.g., circle wheels on a car, rectangle door on a house, triangle suspensions on a bridge). Students will identify the shapes within the context. Then, lead a discussion of careers related to the examples (e.g., architects, designers, engineers).

Instructional Resources/Tools

Common two- and three-dimensional items
Digital camera
Pattern blocks
Die cut shapes
Three-dimensional models
Assorted shapes
Tangrams

ORC # 4459 From the International Reading Association and the National Council of Teachers of English: Going on a Shape Hunt: Integrating Math and Literacy
In this unit, students are introduced to the idea of shapes through a read-aloud session with an appropriate book. They then use models to learn the names of shapes, work together and individually to locate shapes in their real-world environment.

ORC # 3336 From the National Council of Teachers of Mathematics: Investigating Shapes (Triangles)
Students will identify and construct triangles using multiple representations in this unit.

ORC # 423 From the National Council of Teachers of Mathematics: I've Seen That Shape Before
Students will learn the names of solid geometric shapes and explore their properties at various centers or during multiple lessons.

Common Misconceptions

Students many times use incorrect terminology when describing shapes. For example students may say a *cube* is a *square* or that a *sphere* is a *circle*. The use of the two-dimensional shape that appears to be part of a three-dimensional shape to name the three-dimensional shape is a common misconception. Work with students to help them understand that the two-dimensional shape is a part of the object but it has a different name.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the Kindergarten Critical Area of Focus #2, **Describing shapes and space**. More information about this critical area of focus can be found by clicking here.

This cluster is connected to *Analyze, compare, create and compose shape*s in Kindergarten, and to *Reason with shapes and their attributes* in Grade 1.

Grade 1

Domain	Operations and Algebraic Thinking
Cluster	***Understand and apply properties of operations and the relationship between addition and subtraction.***
Standards	3. Apply properties of operations as strategies to add and subtract. *Examples: If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known (commutative property of addition).To add 2 + 6 + 4, the second two numbers can be added to make a ten, so 2 + 6 + 4 = 2 + 10 = 12 (associative property of addition).* 4. Understand subtraction as an unknown-addend problem. *For example, subtract 10 – 8 by finding the number that makes 10 when added to 8.*

Content Elaborations

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- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

One focus in this cluster is for students to discover and apply the commutative and associative properties as strategies for solving addition problems. Students do not need to learn the names for these properties. It is important for students to share, discuss and compare their strategies as a class. The second focus is using the relationship between addition and subtraction as a strategy to solve unknown-addend problems. Students naturally connect counting on to solving subtraction problems. For the problem "15 – 7 =?" they think about the number they have to add to 7 to get to 15. First graders should be working with sums and differences less than or equal to 20 using the numbers 0 to 20.

Provide investigations that require students to identify and then apply a pattern or structure in mathematics. For example, pose a string of addition and subtraction problems involving the same three numbers chosen from the numbers 0 to 20, like 4 + 13 = 17 and 13 + 4 = 17. Students analyze number patterns and create conjectures or guesses. Have students choose other combinations of three numbers and explore to see if the patterns work for all numbers 0 to 20. Students then share and discuss their reasoning. Be sure to highlight students' uses of the commutative and associative properties and the relationship between addition and subtraction.

Expand the student work to three or more addends to provide the opportunities to change the order and/or groupings to make tens. This will allow the connections between place-value models and the properties of operations for addition to be seen. Understanding the commutative and associative properties builds flexibility for computation and estimation, a key element of number sense.

Provide multiple opportunities for students to study the relationship between addition and subtraction in a variety of ways, including games, modeling and real-world situations. Students need to understand that addition and subtraction

are related, and that subtraction can be used to solve problems where the addend is unknown.

Career Connection

Students will use manipulatives present among various workplaces (e.g., pencils, paper clips, rulers) to show the relationship between addition and subtraction. Host a career speaker in the classroom to discuss how addition and subtraction are essential to their work (e.g., logistics, accounting, health science).

Instructional Resources/Tools

A variety of objects for modeling and solving addition and subtraction problems

Dot Card and Ten Frame Activities (pp. 9-11, 21-24, 26-30, 32-37) Numeracy Project, Winnipeg School Division, 2005-2006

ORC # 3992 From the National Council of Teachers of Mathematics: Balancing equations
In this lesson, students imitate the action of a pan balance and record the modeled subtraction facts in equation form.

ORC # 3978 From the National Council of Teachers of Mathematics: How many left?
This lesson encourages the students to explore unknown-addend problems using the set model and the game *Guess How Many?*

Common Misconceptions

A common misconception is that the commutative property applies to subtraction. After students have discovered and applied the commutative property for addition, ask them to investigate whether this property works for subtraction. Have students share and discuss their reasoning and guide them to conclude that the commutative property does not apply to subtraction.

First graders might have informally encountered negative numbers in their lives, so they think they can take away more than the number of items in a given set, resulting in a negative number below zero. Provide many problems situations where students take away all objects from a set, e.g. 19 - 19 = 0 and focus on the meaning of 0 objects and 0 as a number. Ask students to discuss whether they can take away more objects than what they have.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the First Grade Critical Area of Focus #1**, Developing understanding of addition, subtraction, and strategies for addition and subtraction within 20**. More information about this critical area of focus can be found by clicking here.

This cluster is connected to *Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from* in Kindergarten, to *Add and subtract within 20* and *Use place value understanding and properties of operations to add and subtract* in Grade 1 and to *Use place value understanding and properties of operations to add and subtract* in Grade 2.

Grade 2

Domain	Measurement and Data
Cluster	***Work with time and money.***
Standards	7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m. 8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. *Example: If you have 2 dimes and 3 pennies, how many cents do you have?*

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

Second graders expand their work with telling time from analog and digital clocks to the nearest hour or half-hour in Grade 1 to telling time to the nearest five minutes using a.m. and p.m.

The topic of money begins at Grade 2 and builds on the work in other clusters in this and previous grades. Help students learn money concepts and solidify their understanding of other topics by providing activities where students make connections between them. For instance, link the value of a dollar bill as 100 cents to the concept of 100 and counting within 1000. Use play money - nickels, dimes, and dollar bills to skip count by 5s, 10s, and 100s. Reinforce place value concepts with the values of dollar bills, dimes, and pennies.

Students use the context of money to find sums and differences less than or equal to 100 using the numbers 0 to 100. They add and subtract to solve one- and two-step word problems involving money situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions. Students use drawings and equations with a symbol for the unknown number to represent the problem. The dollar sign, $, is used for labeling whole-dollar amounts without decimals, such as $29.

Students need to learn the relationships between the values of a penny, nickel, dime, quarter and dollar bill.

Career Connection

Students will use play money to solve real-work, word problems. Arrange a field trip to your local bank or credit union where students can interview professionals who count money and interact with math in their work (e.g., bank teller, loan officer, investment banker).

Instructional Resources/Tools

Play money

Coin Box

This game will help students learn how to count, collect, exchange and make change for coins.

From the National Library of Virtual Manipulatives, Utah State University: Time – Match Clocks

Students manipulate a digital clock to show the time given on an analog clock. They can also manipulate the hands on a face clock to show the time given on a digital clock. Times are given to the nearest five minutes.

ORC # 1133 From the National Council of Teachers of Mathematics: Number Cents

In this unit, students explore the relationship between pennies, nickels, dimes, and quarters. They count sets of mixed coins, write story problems that involve money, and use coins to make patterns.

Common Misconceptions

Some students might confuse the hour and minutes hands. For the time of 3:45, they say the time is 9:15. Also, some students name the numeral closest to the hands, regardless of whether this is appropriate. For instance, for the time of 3:45 they say the time is 3:09 or 9:03. Assess students' understanding of the roles of the minute and hour hands and the relationship between them. Provide opportunities for students to experience and measure times to the nearest five minutes and the nearest hour. Have them focus on the movement and features of the hands.

Students might overgeneralize the value of coins when they count them. They might count them as individual objects. Also some students think that the value of a coin is directly related to its size, so the bigger the coin, the more it is worth. Place pictures of a nickel on the top of five-frames that are filled with pictures of pennies. In like manner, attach pictures of dimes and pennies to ten-frames and pictures of quarters to 5 x 5 grids filled with pennies. Have students use these materials to determine the value of a set of coins in cents.

Diverse Learners

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Connections:

This cluster is connected to the Second Grade Critical Area of Focus #2, **Building fluency with addition and subtraction, and beyond the critical area of focus in addressing, telling time and writing time**. More information about these critical area of focus can be found by clicking here.

This cluster connects to *Tell and write time in* Grade 1, to *Represent and solve problems involving addition and subtraction* in Grade 2, and to *Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses* of objects in Grade 3.

Grade 3

Domain	Number and Operations - Fractions
Cluster	***Develop understanding of fractions as numbers.***
Standards	1. Understand a fraction 1/*b* as the quantity formed by 1 part when a whole is partitioned into *b* equal parts; understand a fraction *a*/*b* as the quantity formed by *a* parts of size 1/*b*. 2. Understand a fraction as a number on the number line; represent fractions on a number line diagram. a. Represent a fraction 1/*b* on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into *b* equal parts. Recognize that each part has size 1/*b* and that the endpoint of the part based at 0 locates the number 1/*b* on the number line. b. Represent a fraction *a*/*b* on a number line diagram by marking off *a* lengths 1/*b* from 0. Recognize that the resulting interval has size *a*/*b* and that its endpoint locates the number *a*/*b* on the number line. 3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size. a. Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line. b. Recognize and generate simple equivalent fractions, e.g., 1/2 = 2/4, 4/6 = 2/3). Explain why the fractions are equivalent, e.g., by using a visual fraction model. c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers. *Examples: Express 3 in the form 3 = 3/1; recognize that 6/1 = 6; locate 4/4 and 1 at the same point of a number line diagram.* d. Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.

Content Elaborations

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- Reference Sheets

Instructional Strategies and Resources

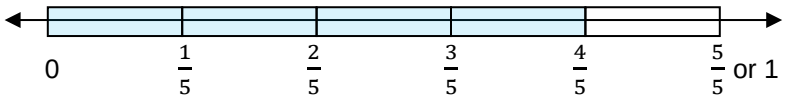
Instructional Strategies

This is the initial experience students will have with fractions and is best done over time. Students need many opportunities to discuss fractional parts using concrete models to develop familiarity and understanding of fractions. Expectations in this domain are limited to fractions with denominators 2, 3, 4, 6 and 8.

Understanding that a fraction is a quantity formed by part of a whole is essential to number sense with fractions. Fractional parts are the building blocks for all fraction concepts. Students need to relate dividing a shape into equal

parts and representing this relationship on a number line, where the equal parts are between two whole numbers. Help students plot fractions on a number line, by using the meaning of the fraction. For example, to plot $4/5$ on a number line, there are 5 equal parts with 4 copies of the 5 equal parts.

5 equal parts make the whole



4 copies of the 5 equal parts represent the fractional amount

As students counted with whole numbers, they should also count with fractions. Counting equal-sized parts helps students determine the number of parts it takes to make a whole and recognize fractions that are equivalent to whole numbers.

Students need to know how big a particular fraction is and can easily recognize which of two fractions is larger. The fractions must refer to parts of the same whole. Benchmarks such as $1/2$ and 1 are also useful in comparing fractions.

Equivalent fractions can be recognized and generated using fraction models. Students should use different models and decide when to use a particular model. Make transparencies to show how equivalent fractions measure up on the number line.

Venn diagrams are useful in helping students organize and compare fractions to determine the relative size of the fractions, such as more than $1/2$, exactly $1/2$ or less than $1/2$. Fraction bars showing the same sized whole can also be used as models to compare fractions. Students are to write the results of the comparisons with the symbols >, =, or <, and justify the conclusions with a model.

Career Connection

Select a text for a shared reading that features how fractions are used in many parts of life (e.g., *If You Were a Fraction* by Trisha Speed Shaskan). Lead a discussion that emphasizes the importance of fractions in everyday experiences and the workplace. Allow students to share their ideas reflected in the text and identify examples of how fractions are used.

Instructional Resources/Tools

Region or area models
Length or measurement models
Grid or dot paper (draw pictures to explore fraction ideas)
Set models
Geoboards
Fraction bars or strips

National Library of Virtual Manipulatives
- Fractions – Naming – Write the fraction corresponding to the highlighted portion of a shape.
- Fractions – Visualizing – Illustrate a fraction by dividing a shape and highlighting the appropriate parts.
- Fractions – Parts of a Whole – Relates parts of a whole unit to written description and fraction.

From the National Council of Teachers of Mathematics, Illuminations: Fun with Fractions: Investigating Equivalent Fractions with Relationship Rods - Students investigate the length model by working with relationship rods to find equivalent fractions. Students develop skills in reasoning and problem solving as they explain how two fractions are equivalent (the same length).

Transparencies you can make to show students how equivalent fractions measure up on the number line. http://mathforum.org/paths/fractions/seeing.equiv.html

From the National Council of Teachers of Mathematics, Illuminations: Fun with Fractions - In this unit, students explore relationships among fractions through work with the length model. This early work with fraction relationships helps students make sense of basic fraction concepts and facilitates work with comparing and ordering fractions and working with equivalency.

Learn Fractions with Cuisenaire Rods
- template to create Cuisenaire rods
- equivalent fractions

Common Misconceptions

The idea that the smaller the denominator, the smaller the piece or part of the set, or the larger the denominator, the larger the piece or part of the set, is based on the comparison that in whole numbers, the smaller a number, the less it is, or the larger a number, the more it is. The use of different models, such as fraction bars and number lines, allows students to compare unit fractions to reason about their sizes.

Students think all shapes can be divided the same way. Present shapes other than circles, squares or rectangles to prevent students from overgeneralizing that all shapes can be divided the same way. For example, have students fold a triangle into eighths. Provide oral directions for folding the triangle:

1. Fold the triangle into half by folding the left vertex (at the base of the triangle) over to meet the right vertex.
2. Fold in this manner two more times.
3. Have students label each eighth using fractional notation. Then, have students count the fractional parts in the triangle (one-eighth, two-eighths, three-eighths, and so on).

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the Third Grade Critical Area of Focus #2, Developing understanding of fractions, especially unit fractions(fractions with numerator 1). More information about this critical area of focus can be found by clicking here.

Partitioning traditional shapes into equal parts. (Grade 1 G 3)

Students will perform operations with decimals to hundredths in Grade 5 (Grade 5 NBT 5 -7).

Grade 4

Domain	Measurement and Data
Cluster	***Solve problems involving measurement and conversion of measurement from a larger unit to a smaller unit.***
Standards	1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...* 2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. 3. Apply the area and perimeter formulas for rectangles in real world and mathematical problems.

Content Elaborations

Ohio has chosen to support shared interpretation of the standards by linking the work of multistate partnerships as the Mathematics Content Elaborations. Further clarification of the standards can be found through these reliable organizations and their links:

- Achieve the Core Modules, Resources
- Hunt Institute Video examples
- Institute for Mathematics and Education Learning Progressions Narratives
- Illustrative Mathematics Sample tasks
- National Council of Supervisors of Mathematics (NCSM) Resources, Lessons, Items
- National Council of Teacher of Mathematics (NCTM) Resources, Lessons, Items
- Partnership for Assessment of Readiness for College and Careers (PARCC) Resources, Items

Expectations for Learning

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- Model Content Framework
- Item Specifications/Evidence Tables
- Sample Items
- Calculator Usage
- Accommodations
- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

In order for students to have a better understanding of the relationships between units, they need to use measuring devices in class. The number of units needs to relate to the size of the unit. They need to discover that there are 12 inches in 1 foot and 3 feet in 1 yard. Allow students to use rulers and yardsticks to discover these relationships among these units of measurements. Using 12-inch rulers and yardstick, students can see that three of the 12-inch rulers, which is the same as 3 feet since each ruler is 1 foot in length, are equivalent to one yardstick. Have students record the relationships in a two column table or t-charts. A similar strategy can be used with rulers marked with centimeters and a meter stick to discover the relationships between centimeters and meters.

Present word problems as a source of students' understanding of the relationships among inches, feet and yards.

Students are to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.

Present problems that involve multiplication of a fraction by a whole number (denominators are 2, 3, 4, 5 6, 8, 10, 12 and 100). Problems involving addition and subtraction of fractions should have the same denominators. Allow students to use strategies learned with these concepts.

Students used models to find area and perimeter in Grade 3. They need to relate discoveries from the use of models to develop an understanding of the area and perimeter formulas to solve real-world and mathematical problems.

Career Connection

Students will use yard and meter sticks and rulers with inches and centimeters to solve problems with different units. Host a career speaker in the classroom to discuss how measurement and various units are used across their career field (e.g., construction, carpentry, design). Consider inviting a speaker who works on a school-based project, at your school or nearby, to share information about their work on school campuses. Lead a discussion that allows students to reflect on their work with different units and how it applies to the careers shared in the speaker's presentation.

Instructional Resources/Tools

Yardsticks(meter sticks) and rulers (marked with customary and metric units)
Teaspoons and tablespoons
Graduated measuring cups (marked with customary and metric units)

Common Misconceptions

Students believe that larger units will give the larger measure. Students should be given multiple opportunities to measure the same object with different measuring units. For example, have the students measure the length of a room with one-inch tiles, with one-foot rulers, and with yard sticks. Students should notice that it takes fewer yard sticks to measure the room than rulers or tiles.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the Fourth Grade Critical Areas of Focus #1 , **Developing understanding and fluency with multi-digit multiplication , and developing understanding of dividing to find quotients involving multi-digit dividends**, and #2, **Developing an understanding of fractions equivalence, addition and subtraction of fractions with like denominators, and multipication of fractions by whole numbers**. More information about these critical areas of focus can be found by clicking here.

Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures (Grade 3 MD 8).

Geometric measurement; understand concepts of area and relate area to multiplication and to addition.
Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers (Grade 4 NF 3 – 4).

Grade 5

Domain	Measurement and Data
Cluster	***Convert like measurement units within a given measurement system.***
Standards	1. Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

Content Elaborations

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- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

Students should gain ease in converting units of measures in equivalent forms within the same system. To convert from one unit to another unit, the relationship between the units must be known. In order for students to have a better understanding of the relationships between units, they need to use measuring tools in class. The number of units must relate to the size of the unit. For example, students have discovered that there are 12 inches in 1 foot and 3 feet in 1 yard. This understanding is needed to convert inches to yards. Using 12-inch rulers and yardsticks, students can see that three of the 12-inch rulers are equivalent to one yardstick (3 × 12 inches = 36 inches; 36 inches = 1 yard). Using this knowledge, students can decide whether to multiply or divide when making conversions.

Once students have an understanding of the relationships between units and how to do conversions, they are ready to solve multi-step problems that require conversions within the same system. Allow students to discuss methods used in solving the problems. Begin with problems that allow for renaming the units to represent the solution before using problems that require renaming to find the solution.

Career Connection

Students will use yard sticks and rulers to make conversions among inches, feet, and yards for measurement. Provide students with real-work examples of how this skill is applied (e.g., football field as an example of how yards are used; doorway height for feet; inseam of pants for inches) and discuss related careers (e.g., agriculture, design, construction).

Instructional Resources/Tools

Yardsticks(meter sticks) and rulers (marked with customary and metric units)
Teaspoons and tablespoons
Graduated measuring cups (marked with customary and metric units)

From the National Council of Teachers of Mathematics, Illuminations: - Discovering Gallon Man. Students experiment with units of liquid measure used in the customary system of measurement. They practice making volume conversions in the customary system.

From the National Council of Teachers of Mathematics, Illuminations: – Do You Measure Up? Students learn the basics of the metric system. They identify which units of measurement are used to measure specific objects, and they learn to convert between units within the same system.

Common Misconceptions

When solving problems that require renaming units, students use their knowledge of renaming the numbers as with whole numbers. Students need to pay attention to the unit of measurement which dictates the renaming and the number to use. The same procedures used in renaming whole numbers should not be taught when solving problems involving measurement conversions. For example, when subtracting 5 inches from 2 feet, students may take one foot from the 2 feet and use it as 10 inches. Since there were no inches with the 2 feet, they put 1 with 0 inches and make it 10 inches.

	2 feet	is thought of as	2 feet	0 inches	becomes	1 foot	10 inches
-	5 inches		-	5 inches		-	5 inches
						1 foot	5 inches

Diverse Learners

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Connections:

This cluster is connected to the Grade 5 Critical Area of Focus #2, **Extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations.** More information about this critical area of focus can be found by clicking here.

Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit (Grade 4 MD 1).

Grade 6

Domain	Geometry
Cluster	***Solve real-world and mathematical problems involving area, surface area, and volume.***
Standards	1. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems. 2. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = l w h and V = b h to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems. 3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems. 4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

Content Elaborations

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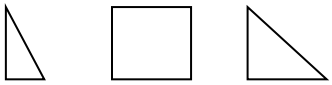
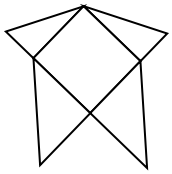
Instructional Strategies and Resources

Instructional Strategies

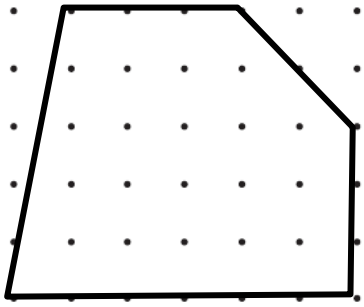
It is very important for students to continue to physically manipulate materials and make connections to the symbolic and more abstract aspects of geometry. Exploring possible nets should be done by taking apart (unfolding) three-dimensional objects. This process is also foundational for the study of surface area of prisms. Building upon the understanding that a net is the two-dimensional representation of the object, students can apply the concept of area to find surface area. The surface area of a prism is the sum of the areas for each face.

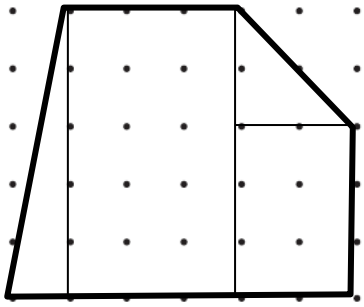
Multiple strategies can be used to aid in the skill of determining the area of simple two-dimensional composite shapes. A beginning strategy should be to use rectangles and triangles, building upon shapes for which they can already determine area to create composite shapes. This process will reinforce the concept that composite shapes are created by joining together other shapes, and that the total area of the two-dimensional composite shape is the sum of the areas of all the parts.





A follow-up strategy is to place a composite shape on grid or dot paper. This aids in the decomposition of a shape into its foundational parts. Once the composite shape is decomposed, the area of each part can be determined and the sum of the area of each part is the total area.





Fill prisms with cubes of different edge lengths (including fractional lengths) to explore the relationship between the length of the repeated measure and the number of units needed. An essential understanding to this strategy is the volume of a rectangular prism does not change when the units used to measure the volume changes. Since focus in Grade 6 is to use fractional lengths to measure, if the same object is measured using one centimeter cubes and then measured using half centimeter cubes, the volume will appear to be eight times greater with the smaller unit. However, students need to understand that the value or the number of cubes is greater but the volume is the same.

Career Connection
Students will role-play as a small business owner, where they sell items by posting them on a website. They need to ship a "mystery item" (e.g., egg, single potato chip, shoes). Provide students with characteristics (e.g., perishable, breakable, sharp edges, liquid, flammable, approximate dimensions) of the "mystery item" for which you need to package and ship. Students will design a package to accommodate the "mystery item", identifying the area, surface area, and volume. Lead a discussion, or host a career speaker, to relate this skill to various career fields that require critical thinking, problem solving, and mathematic calculations (e.g., logistics, transportation, health).

Instructional Resources/Tools

Cubes of fractional edge length

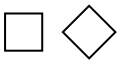
Squares that can be joined together used to develop possible nets for a cube.

Use floor plans as a real world situation for finding the area of composite shapes.

Online dot paper

Illuminations lessons on area

Common Misconceptions

Students may believe that the orientation of a figure changes the figure. In Grade 6, some students still struggle with recognizing common figures in different orientations. For example, a square rotated 45° is no longer seen as a square and instead is called a diamond. 
This impacts students' ability to decompose composite figures and to appropriately apply formulas for area. Providing multiple orientations of objects within classroom examples and work is essential for students to overcome this misconception.

Diverse Learners

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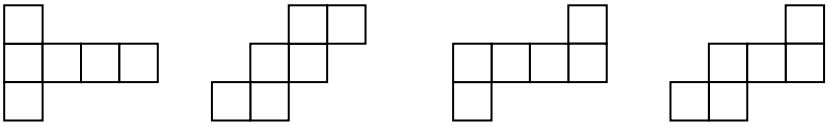
Specific strategies for mathematics may include:

Understanding that there are multiple nets for the same object may be difficult for some to visualize, provide concrete examples of nets for the object. Both the composition and decomposition of rectangular prisms should be explored. The understanding that there may be multiple nets that create a cube may be challenging. For example the following are a few of the possible nets that will create a cube.



Connections

This cluster does not direct relate to one of the Grade 6 Critical Areas of Focus. This cluster focuses on additional content for development. Students in Grade 6 build on their work with area in elementary school by reasoning about relationships among shapes to determine area, surface area, and volume.

An understanding of how to find the area, surface area and volume of an object is developed in Grade 5 and should be built upon in Grade 6 to facilitate understanding of the formulas found in Measurement and Data and when to use the appropriate formula.

The use of floor plans and composite shapes on dot paper is a foundational concept for scale drawing and determining the actual area based on a scale drawing Grade 7 (Geometry and Ratio and Proportional Relationships).

Domain	Statistics and Probability
Cluster	***Use random sampling to draw inferences about a population***
Standards	7. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences. 8. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. *For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.*

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

In Grade 6, students used measures of center and variability to describe data. Students continue to use this knowledge in Grade 7 as they use random samples to make predictions about an entire population and judge the possible discrepancies of the predictions. Providing opportunities for students to use real-life situations from science and social studies shows the purpose for using random sampling to make inferences about a population.

Make available to students the tools needed to develop the skills and understandings required to produce a representative sample of the general population. One key element of a representative sample is understanding that a random sampling guarantees that each element of the population has an equal opportunity to be selected in the sample. Have students compare the random sample to population, asking questions like “Are all the elements of the entire population represented in the sample?” and “Are the elements represented proportionally?” Students can then continue the process of analysis by determining the measures of center and variability to make inferences about the general population based on the analysis.

Provide students with random samples from a population, including the statistical measures. Ask students guiding questions to help them make inferences from the sample.

Career Connection

Students will use data available from: http://www.amstat.org/censusatschool to draw inferences about the population of

students in Ohio from the sample provided. Students will use the data to determine measurements for a long-sleeve shirt, identifying the arm span for a small, medium, large and extra-large (box plotting, where each quartile is a size). To see how this skill is applied across various workplaces, students will choose a career to research (e.g., marketing, logistics, finance) and identify where drawing inferences is part of the typical duties.

Instructional Resources/Tools

Guidelines for Assessment and instruction in Statistics Education (GAISE) Report, American Statistical Association

Ohio Resource Center
Mathline Something Fishy #257: Students estimate the size of a large population by applying the concepts of ratio and proportion through the capture-recapture statistical procedure.

Random Sampling and Estimation # 8347: In this session, students estimate population quantities from a random sample.

Bias in Sampling #11062: This content resource addresses statistics topics that teachers may be uncomfortable teaching due to limited exposure to statistical content and vocabulary. This resource focuses a four-component statistical problem-solving process and the meaning of variation and bias in statistics and to investigate how data vary.

From the National Council of Teachers of Mathematics, Illuminations - Capture Recapture: In this lesson, students experience an application of proportion that scientists use to solve real-life problems. Students estimate the size of a total population by taking samples and using proportions.

Common Misconceptions

Students may believe:
One random sample is not representative of the entire population. Many samples must be taken in order to make an inference that is valid. By comparing the results of one random sample with the results of multiple random samples, students can correct this misconception.

Diverse Learners
Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the Grade 7 Critical Area of Focus #4, **Drawing inferences about populations based on samples**. More information about this critical area of focus can be found by clicking here.

Initial understanding of statistics, specifically variability and the measures of center and spread begins in Grade 6.

Grade 8

Domain	Geometry
Cluster	***Understand and apply the Pythagorean Theorem.***
Standards	6. Explain a proof of the Pythagorean Theorem and its converse. 7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. 8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

Previous understanding of triangles, such as the sum of two side measures is greater than the third side measure, angles sum, and area of squares, is furthered by the introduction of unique qualities of right triangles. Students should be given the opportunity to explore right triangles to determine the relationships between the measures of the legs and the measure of the hypotenuse. Experiences should involve using grid paper to draw right triangles from given measures and representing and computing the areas of the squares on each side. Data should be recorded in a chart such as the one below, allowing for students to conjecture about the relationship among the areas within each triangle.

Triangle	Measure of Leg 1	Measure of Leg 2	Area of Square on Leg 1	Area of Square on Leg 2	Area of Square on Hypotenuse
1					

Students should then test out their conjectures, then explain and discuss their findings. Finally, the Pythagorean Theorem should be introduced and explained as the pattern they have explored. Time should be spent analyzing several proofs of the Pythagorean Theorem to develop a beginning sense of the process of deductive reasoning, the significance of a theorem, and the purpose of a proof. Students should be able to justify a simple proof of the Pythagorean Theorem or its converse.

Previously, students have discovered that not every combination of side lengths will create a triangle. Now they need situations that explore using the Pythagorean Theorem to test whether or not side lengths represent right triangles. (Recording could include Side length *a*, Side length *b*, Sum of $a^2 + b^2$, c^2, $a^2 + b^2 = c^2$, Right triangle? Through these opportunities, students should realize that there are Pythagorean (triangular) triples such as (3, 4, 5), (5, 12, 13), (7, 24, 25), (9, 40, 41) that always create right triangles, and that their multiples also form right triangles. Students should see how similar triangles can be used to find additional triples. Students should be able to explain why a triangle is or is not a right triangle using the Pythagorean Theorem.

The Pythagorean Thereom should be applied to finding the lengths of segments on a coordinate grid, especially those segments that do not follow the vertical or horizontal lines, as a means of discussing the determination of distances between points. Contextual situations, created by both the students and the teacher, that apply the Pythagorean theorem and its converse should be provided. For example, apply the concept of similarity to determine the height of a tree using the ratio between the student's height and the length of the student's shadow. From that, determine the distance from the tip of the tree to the end of its shadow and verify by comparing to the computed distance from the top of the student's head to the end of the student's shadow, using the ratio calculated previously. Challenge students to identify additional ways that the Pythagorean Theorem is or can be used in real world situations or mathematical problems, such as finding the height of something that is difficult to physically measure, or the diagonal of a prism.

Career Connection

Students will use the Pythagorean Theorem for constructing a design and proving the measurements. They will construct a real-work design (e.g., landscaping or garden, building floor plan, scaled map) and then use the 3-4-5 concept to prove their measurements and plan their project. Coordinate a hands-on project (e.g., community garden, school map, classroom model) where students will apply this skill and identify the application among careers (e.g., agriculture, engineering, design).

Instructional Resources/Tools

From the National Library of Virtual Manipulatives

Pythagorean Theorem – Solve two puzzles that illustrate the proof of the Pythagorean Theorem.
Right Triangle Solver – Practice using the Pythagorean theorem and the definitions of the trigonometric functions to solve for unknown sides and angles of a right triangle.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

This cluster is connected to the Grade 8 Critical Area of Focus #3, **Analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.** More information about this critical area of focus can be found by clicking here.

High School Conceptual Category: Number and Quantity

Domain	Quantities
Cluster	***Reason quantitatively and use units to solve problems***
Standards	1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. 2. Define appropriate quantities for the purpose of descriptive modeling. 3. Choose a level of accuracy appropriate to limitations on measurement reporting quantities

Content Elaborations

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- Achieve the Core Modules, Resources
- Hunt Institute Video examples
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Expectations for Learning

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- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

In real-world situations, answers are usually represented by numbers associated with units. Units involve measurement and often require a conversion. Measurement involves both precision and accuracy. Estimation and approximation often precede more exact computations.

Students need to develop sound mathematical reasoning skills and forms of argument to make reasonable judgments about their solutions. They should be able to decide whether a problem calls for an estimate, for an approximation, or for an exact answer. To accomplish this goal, teachers should provide students with a broad range of contextual problems that offer opportunities for performing operations with quantities involving units. These problems should be connected to science, engineering, economics, finance, medicine, etc.

Some contextual problems may require an understanding of derived measurements and capability in unit analysis. Keeping track of derived units during computations and making reasonable estimates and rational conclusions about accuracy and the precision of the answers help in the problem-solving process.

For example, while driving in the United Kingdom (UK), a U.S. tourist puts 60 liters of gasoline in his car. The gasoline cost is £1.28 per liter The exchange rate is £ 0.62978 for each $1.00. The price for a gallon of a gasoline in the United States is $3.05. The driver wants to compare the costs for the same amount and the same type of gasoline when he/she pays in UK pounds. Making reasonable estimates should be encouraged prior to solving this problem. Since the current exchange rate has inflated the UK pound at almost twice the U.S. dollar, the driver will pay more for less gasoline.

By dividing $3.05 by 3.79L (the number of liters in one gallon), students can see that 80.47 cents per liter of gasoline in US is less expensive than £1.28 or $ 2.03 per liter of the same type of gasoline in the UK when paid in U.S. dollars. The

cost of 60 liters of gasoline in UK is £76.8 ($\frac{£1.28}{1\,L} \times 60L = UK\,£76.8$).

In order to compute the cost of the same quantity of gasoline in the United States in UK currency, it is necessary to convert between both monetary systems and units of volume. Based on UK pounds, the cost of 60 liters of gasoline in the U.S. is £30.41 ($\frac{US\$3.05}{1\ gal} \times \frac{1\ gal}{3.79\,L} \times 60L \times \frac{UK\,£0.62978}{US\ \$1.00} = UK\,£30.41$).

The computation shows that the gasoline is less expensive in the United States and how an analysis can be helpful in keeping track of unit conversations. Students should be able to correctly identify the degree of precision of the answers which should not be far greater than the actual accuracy of the measurements.

Graphical representations serve as visual models for understanding phenomena that take place in our daily surroundings. The use of different kinds of graphical representations along with their units, labels and titles demonstrate the level of students' understanding and foster the ability to reason, prove, self-check, examine relationships and establish the validity of arguments. Students need to be able to identify misleading graphs by choosing correct units and scales to create a correct representation of a situation or to make a correct conclusion from it.

Career Connection
Students will compare the cost of gasoline across two countries with different monetary systems and units of measure. Host a career speaker in the classroom, who students can ask questions of related to the work-based applications of these concepts (e.g., economics, engineering, finance, health). Additional work-based examples.

Instructional Resources/Tools
NCTM. *Focus in High School Mathematics (Reasoning and Sense Making)*
Mathematical Sciences Education Board. *High School Mathematics at Work*
NCTM. *Principles and Standards for School Mathematics*
Joint Committee of the MAA and NCTM. *A Sourcebook of Applications of School Mathematics*

Common Misconceptions
Students may not realize the importance of the units' conversions in conjunction with the computation when solving problems involving measurements.

Since today's calculating devices often display 8 to 10 decimal places, students frequently express answers to a much greater degree of precision than the required.

Diverse Learners
Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections
Measuring commonly used object and choosing proper units for the measurements is part of the mathematics curriculum prior to high school. In high school, students experience a broader variety of units through real-world situations and modeling along with the exploration of the different levels of accuracy and precision of the answers.

High School Conceptual Category: Algebra

Domain	**Seeing Structure in Expressions**
Cluster	***Interpret the structure of expressions***
Standards	1. Interpret expressions that represent a quantity in terms of its context. (a) Interpret parts of an expression, such as terms, factors, and coefficients. (b) Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1 + r)^n$ *as the product of P and a factor not depending on P.* 2. Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$*.*

Content Elaborations

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Expectations for Learning

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- Reference Sheets

Instructional Strategies and Resources

Instructional Strategies

Extending beyond simplifying an expression, this cluster addresses interpretation of the components in an algebraic expression. A student should recognize that in the expression $2x + 1$, "2" is the coefficient, "2" and "x" are factors, and "1" is a constant, as well as "$2x$" and "1" being *terms* of the binomial expression**.** Development and proper use of mathematical language is an important building block for future content.

Using real-world context examples, the nature of algebraic expressions can be explored**.** For example, suppose the cost of cell phone service for a month is represented by the expression $0.40s + 12.95$**.** Students can analyze how the coefficient of 0.40 represents the cost of one minute (40¢), while the constant of 12.95 represents a fixed, monthly fee, and s stands for the number of cell phone minutes used in the month. Similar real-world examples, such as tax rates, can also be used to explore the meaning of expressions.

Factoring by grouping is another example of how students might analyze the structure of an expression**.** To factor $3x(x - 5) + 2(x - 5)$, students should recognize that the "$x - 5$" is common to both expressions being added, so it simplifies to $(3x + 2)(x - 5)$**.** Students should become comfortable with rewriting expressions in a variety of ways until a structure emerges.

Have students create their own expressions that meet specific criteria (e.g., number of terms factorable, difference of two squares, etc.) and verbalize how they can be written and rewritten in different forms. Additionally, pair/group students to share their expressions and rewrite one another's expressions.

Career Connection

Students will evaluate cell phone plans across multiple providers to identify one that is the most cost effective for their expected use. They will consider the fixed and variable costs to support their decision (e.g., unlimited plans, cost per unit, insurance protection, activation and cancellation fees). In collecting data related to the cost of service, students will research the employment opportunities available across the telecommunication companies via website, phone, and email.

Resources/Tools

Hands-on materials, such as algebra tiles, can be used to establish a visual understanding of algebraic expressions and the meaning of terms, factors and coefficients.
From the National Library of Virtual Manipulatives - Algebra Tiles – Visualize multiplying and factoring algebraic expressions using tiles.

Common Misconceptions

Students may believe that the use of algebraic expressions is merely the abstract manipulation of symbols. Use of real-world context examples to demonstrate the meaning of the parts of algebraic expressions is needed to counter this misconception.

Students may also believe that an expression cannot be factored because it does not fit into a form they recognize. They need help with reorganizing the terms until structures become evident.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Specific strategies for mathematics may include:

Technology may be useful to help a student recognize that two different expressions represent the same relationship. For example, since $(x – y)(x + y)$ can be rewritten as $x^2 – y^2$, they can put both expressions into a graphing calculator (or spreadsheet) and have it generate two tables (or two columns of one table), displaying the same output values for each expression.

Connections:

An introduction to the use of variable expressions and their meaning, as well as the use of variables and expressions in real-life situations is included in the Expressions and Equations Domain of Grade 7.

High School Conceptual Category: Functions

Domain	Building Functions
Cluster	***Build a function that models a relationship between two quantities***
Standards	1. Write a function that describes a relationship between two quantities. (a) Determine an explicit expression, a recursive process, or steps for calculation from a context. (b) Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential and relate these functions to the model*. (c) (+) Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time*. 2. Write arithmetic and geometric sequences both recursively and with an explicit formula; use them to model situations, and translate between the two forms.

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

Provide a real-world example (e.g., a table showing how far a car has driven after a given number of minutes, traveling at a uniform speed), and examine the table by looking “down” the table to describe a recursive relationship, as well as “across” the table to determine an explicit formula to find the distance traveled if the number of minutes is known.

Write out terms in a table in an expanded form to help students see what is happening. For example, if the *y*-values are 2, 4, 8, 16, they could be written as 2, 2(2), 2(2)(2), 2(2)(2)(2), etc., so that students recognize that 2 is being used multiple times as a factor.

Focus on one representation and its related language – recursive or explicit – at a time so that students are not confusing the formats.

Provide examples of when functions can be combined, such as determining a function describing the monthly cost for owning two vehicles when a function for the cost of each (given the number of miles driven) is known.

Using visual approaches (e.g., folding a piece of paper in half multiple times), use the visual models to generate sequences of numbers that can be explored and described with both recursive and explicit formulas. Emphasize that there are times when one form to describe the function is preferred over the other.

Career Connection

Students will research and evaluate several options when purchasing a vehicle (e.g., new versus used, lease versus own, down payment, and interest rate). They will examine the differences in gas mileage consumption by selecting two vehicles to evaluate (e.g., SUV versus compact hybrid). Once they choose a vehicle, they will use their evaluations to show why they chose the vehicle. Their research will include interviewing automotive professionals, visiting dealerships, and navigating company websites.

Instructional Resources/Tools

Hands-on materials (e.g., paper folding, building progressively larger shapes using pattern blocks, etc.) can be used as a visual source to build numerical tables for examination.

Visuals available to assist students in seeing relationships are featured at the National Library of Virtual Manipulatives as well as The National Council of Teachers of Mathematics, Illuminations.

Common Misconceptions

Students may believe that the best (or only) way to generalize a table of data is by using a recursive formula. Students naturally tend to look "down" a table to find the pattern but need to realize that finding the 100^{th} term requires knowing the 99^{th} term unless an explicit formula is developed.

Students may also believe that arithmetic and geometric sequences are the same. Students need experiences with both types of sequences to be able to recognize the difference and more readily develop formulas to describe them.

Additionally, advanced students who study composition of functions may misunderstand function notation to represent multiplication (e.g., $f(g(x))$ means to multiply the f and g function values).

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections: In Grade 8, students compare functions by looking at equations, tables and graphs, and focus primarily on linear relationships. In high school, examination of functions is extended to include recursive and explicit representations and sequences of numbers that may not have a linear relationship.

Domain	Congruence
Cluster	***Make geometric constructions***
Standards	12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.* 13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

Students should analyze each listed construction in terms of what simpler constructions are involved (e.g., constructing parallel lines can be done with two different constructions of perpendicular lines).

Using congruence theorems, ask students to prove that the constructions are correct.

Provide meaningful problems (e.g. constructing the centroid or the incenter of a triangle) to offer students practice in executing basic constructions.

Challenge students to perform the same construction using a compass and string. Use paper folding to produce a reflection; use bisections to produce reflections.

Ask students to write “how-to” manuals, giving verbal instructions for a particular construction.
Offer opportunities for hands-on practice using various construction tools and methods.

Compare dynamic geometry commands to sequences of compass-and-straightedge steps.

Prove, using congruence theorems, that the constructions are correct.

Career Connection

Students will construct perpendicular bisectors while designing a delivery route for a local pizza shop, as described in: Dividing a Town into Pizza Delivery Regions. Lead a class discussion where students will identify application of

these skills across various career fields (e.g., landscaping, agriculture, construction, architecture, logistics). Students will apply the information to their plan for education and training through high school and beyond.

Instructional Resources/Tools

Compass
Straightedge
String
Origami paper
Reflection tool (e.g. Mira®).
Dynamic geometry software (e.g. Geometer's Sketchpad®, Cabri®, or Geogebra®).

Pythagorean Puzzle - In this self-guided investigation, students use Geometer's Sketchpad to construct a right triangle and discover a geometric proof of the Pythagorean Theorem. Students test the geometric proof with acute and obtuse triangles.

Concurrent Events - This lesson enhances student knowledge of how to use Geometer's Sketchpad to explore geometric concepts (e.g. the points of concurrency in a triangle). It includes the construction of line segments, triangles, circles, perpendicular bisectors of line segments, angle bisectors, altitudes of triangles, and medians of triangles.

Designs With Circles - Students will construct a number of compass-and-straightedge designs using ideas from this site.

Common Misconceptions

Some students may believe that a construction is the same as a sketch or drawing. Emphasize the need for precision and accuracy when doing constructions. Stress the idea that a compass and straightedge are identical to a protractor and ruler. Explain the difference between measurement and construction.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

Drawing geometric shapes with rulers, protractors and technology is developed in Grade 7. In high school, students perform formal geometry constructions using a variety of tools. Students will utilize proofs to justify validity of their constructions.

High School Conceptual Category: Statistics and Probability

Domain	**Making Inferences and Justifying Conclusions**
Cluster	***Understand and evaluate random processes underlying statistical experiments***
Standards	1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. 2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. *For example, a model says a spinning coin falls heads up with probability 0.5. would a result of 5 tails in a row cause you to question the model?*

Content Elaborations

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Instructional Strategies and Resources

Instructional Strategies

Inferential statistics based on Normal probability models is a topic for Advanced Placement Statistics (e.g., t-tests). The idea here is that all students understand that statistical decisions are made about populations (parameters in particular) based on a random sample taken from the population and the observed value of a sample statistic (note that both words start with the letter “s”). A population parameter (note that both words start with the letter “p”) is a measure of some characteristic in the population such as the population proportion of American voters who are in favor of some issue, or the population mean time it takes an Alka Seltzer tablet to dissolve.

As the statistical process is being mastered by students, it is instructive for them to investigate questions such as “If a coin spun five times produces five tails in a row, could one conclude that the coin is biased toward tails?” One way a student might answer this is by building a model of 100 trials by experimentation or simulation of the number of times a truly fair coin produces five tails in a row in five spins. If a truly fair coin produces five tails in five tosses 15 times out of 100 trials, then there is no reason to doubt the fairness of the coin. If, however, getting five tails in five spins occurred only once in 100 trials, then one could conclude that the coin is biased toward tails (if the coin in question actually landed five tails in five spins).

A powerful tool for developing statistical models is the use of simulations. This allows the students to visualize the model and apply their understanding of the statistical process.

Provide opportunities for students to clearly distinguish between a population parameter which is a constant, and a sample statistic which is a variable.

Career Connection

Students will explore the concepts of direct marketing, a marketing database, and a sales promotion as described in the High School Operations Research Modules. Use the provided case studies to lead a discussion on how this content is critical to tasks performed across various career fields (e.g., business, marketing, finance). Students will use the discussion to guide their research of related careers for developing future career goals.

Instructional Resources/Tools

TI-83/84 and TI emulator
Quantitative Literacy The Art and Techniques of Simulation module
Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report
Software such as TinkerPlots and Fathom

Common Misconceptions

Students may believe:

That population parameters and sample statistics are one in the same, e.g., that there is no difference between the population mean which is a constant and the sample mean which is a variable.

Making decisions is simply comparing the value of one observation of a sample statistic to the value of a population parameter, not realizing that a distribution of the sample statistic needs to be created.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Connections:

The four-step statistical process was introduced in Grade 6, with the recognition of statistical questions. At the high school level, students need to become proficient in all the steps of the statistical process.

Using simulation to estimate probabilities is a part of the Grade 7 curriculum as is initial understanding of using random sampling to draw inferences about a population.

Model Curriculum
Kindergarten
Earth and Space Science (ESS)

Topic: Daily and Seasonal Changes
This topic focuses on observing, exploring, describing and comparing weather changes, patterns in the sky and changing seasons.

Content Statement
Weather changes are long-term and short-term.

Weather changes occur throughout the day and from day to day.

Air is a nonliving substance that surrounds Earth and wind is air that is moving.

Wind, temperature and precipitation can be used to document short-term weather changes that are observable.

Yearly weather changes (seasons) are observable patterns in the daily weather changes.

Note: The focus is on observing the weather patterns of seasons. The reason for changing seasons is not appropriate for this grade level; this is found in grade 5.

Content Elaboration
Kindergarten Concepts
Wind, temperature and precipitation are components of the weather that can be observed and measured for Kindergarten. The measurements collected and tools used can be nonstandard and must be age-appropriate. For example, the temperature may be above or below a given point (warmer or colder) or the amount of snow is marked on a dowel rod to check the depth.

Weather measurements must be collected on a regular basis throughout the school year and then compared, explained and discussed each week and each month. At the end of the school year, a comparison can be made and seasons can be identified by the patterns that were measured throughout the year. Consistent review and questioning to deepen understanding are essential.

Use technology to compare classroom data to local data, study weather events, communicate and share data with other classrooms, and record classroom data.

Future Application of Concepts
Grades 1-2: The properties of water and air are explored as they relate to the weather observations and measurement from Kindergarten.
Grades 3-5: Different states of water are defined in Physical Sciences. Wind and water are recognized as processes that can change the surface of Earth through weathering and erosion. The observed seasons from Kindergarten are related to the sun and the tilt and orbit of Earth in grade 5.

Expectations for Learning: Cognitive Demands
This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
As a class, make a portable weather station that can measure wind, temperature and precipitation amounts. Test and select the best location for the weather station (so that accurate readings can be collected). 	Experiment with different methods or make/use tools to collect precipitation amounts (rain, snow or ice) and measure the speed (faster or slower) and direction of wind (*which way is the wind blowing?*). Ask questions about what happens next, such as: *When the wind increases, what happens to the temperature?*  **Note:** Nonstandard measurements can be used to meet this objective.	Make a weather chart or graphic that documents observed weather on a regular basis throughout the year. As a class, compare changes in temperature, precipitation and wind and include the changes that are observed each day, each week and month to month. 	Identify the four different seasons. Recognize that temperature, wind and precipitation are different ways to measure weather. 

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Children need to be encouraged to experiment with ways to measure weather and how to measure weather accurately. Asking effective questions as children are trying different methods is an important part of understanding what the child knows pertaining to measuring weather. Allow children to make their own tools to measure weather using everyday materials. Weather tools, such as windmills, windsocks or rain gauges, can be very creative and artistic products that can actually measure the weather.

Career Connection

Students will maintain a class weather chart where they will record each day's weather. As a class, students will discuss types of jobs that are related to weather or seasons (e.g., meteorologist, landscaper, construction worker, truck driver). Discuss examples such as, Which jobs are done outdoors? Which jobs are done in the summer? Which jobs are done in the winter?.

Common Misconceptions

- Misconceptions about weather and weather observations at this age often stem from children's literature and expressions (Old Man winter, raining cats and dogs, raining buckets, fog like pea soup). Reading stories that include accurate representation of weather events can be a good start to addressing misconceptions. Collecting and discussing weather data on a regular basis will help to clarify weather at this age. For examples of age-appropriate, scientifically accurate storybooks about rain and wind, visit http://www.magnet.fsu.edu/education/community/scienceinliterature/picturebooks.html.
- NASA lists common misconceptions for all ages about the sun and the Earth, including weather and seasons, at http://www-istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

A series of case studies of K-8 science classrooms by the Smithsonian and Harvard University can be found at http://www.learner.org/resources/series21.html. Teachers need to sign up to use this free site. The case studies *Jennie–K* and *Elsa–K* are examples of how to design age-appropriate science investigations using activities and games to interest students in science.

The Annenberg Foundation offers training modules that support Earth and Space Sciences for K-4 teachers. There are numerous resources and video clips of actual classroom practices that can be useful training tools at http://www.learner.org/resources/series195.html.

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Model Curriculum
Grade 1
Life Science (LS)

Topic: Basic Needs of Living Things

This topic focuses on the physical needs of living things in Ohio. Energy from the sun or food, nutrients, water, shelter and air are some of the physical needs of living things.

Content Statement

Living things have basic needs, which are met by obtaining materials from the physical environment.

Living things require energy, water and a particular range of temperatures in their environments.

Plants get energy from sunlight. Animals get energy from plants and other animals.

Living things acquire resources from the living and nonliving components of the environment.

Content Elaboration

Prior Concepts Related to Interactions within Habitats

PreK-K: Use macroscopic ways to identify living things. Living things have physical traits, which enable them to live in different environments.

Grade 1 Concepts

Earth has many different environmental conditions that support living things. The emphasis of this content statement is that living things meet their basic needs for survival by obtaining necessary materials from the environment. This includes, but is not limited to, temperature range, amount of water, amount of sunlight and available food sources. The environment includes both living (plants and animals) and nonliving (e.g., water, air, sunlight, nutrients) things.

Living things get the energy they require to respond, grow and reproduce from the environment. Observing energy being used in everyday situations can help promote understanding that living things get resources from the physical environment. A detailed discussion of energy is not appropriate at this grade level (see section heading E). Energy is not scientifically explained until grade 3.

When studying living things, ethical treatment of animals and safety must be employed. Respect for and proper treatment of living things must be modeled. For example, shaking a container, rapping on insect bottles, unclean cages or aquariums, leaving living things in the hot sun or exposure to extreme temperatures (hot or cold) must be avoided. The National Science Teachers Association (NSTA) has a position paper to provide guidance in the ethical use and treatment of animals in the classroom at http://www.nsta.org/about/positions/animals.aspx.

Investigations about the types of living things that live in specific environments can be done virtually or in nature.

Future Application of Concepts

Grade 2: How living things impact the environment and how the environment impacts living things will be examined.
Grade 3-5: Life cycles of plants and animals will be explored.
Grades 6-8: Changes in environmental conditions can affect how beneficial a trait will be for survival and reproductive success of an individual or an entire species.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Using data from the Demonstrating Science Knowledge investigation, design a bird feeder and blend of birdseed that will attract the most birds of one kind or the greatest variety of birds. Share designs, results and recommendations with an authentic audience. 	Plan and implement a classroom investigation that answers the question: *Does the type of food influence what type of birds will come to a bird feeder?* **Note:** For a simple pinecone bird feeder, cover pinecones with vegetable shortening and coat with one type of food (e.g., black or striped sunflower seeds, millet, cracked corn, thistle). 	Based on observations of birds in the field, compare the food choices of birds in the study and create a chart to communicate findings. 	Identify the basic survival needs of plants and animals (classroom pets, plants used in classroom experiments). At this grade level, students will not be assessed on common or scientific names of living things. 

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The Toledo Zoo offers distance learning Life Science opportunities for animal adaptations. Children can begin to explore how animal traits play a role in survival.
- The Annenberg Media series *Essential Science for Teachers: Life Science: Session 1: What is Life* provides background information about the basic needs of living things and provides classroom strategies for instruction.
- Observe a variety of living things in the wild or the classroom and ask questions about how they survive. *How do they get food? Where do they live? What do they use for shelter?* The Ohio Department of Natural Resources website also provides information about observing animals in the wild and promotes safety for children and wildlife. The Guide to Using Animals in the Classroom explains legally which organisms may be collected.
- Explore various plant life in the local environment. Document the conditions that support the plant. Ask: *Is the area moist? Is it dry? Does it get lots of sun or shade? What other types of plants are in the area?* The physical characteristics and habitat requirements for native trees in Ohio can be found on the Ohio State Extension website.
- ODNR-Division of Wildlife's A to Z Species Guide has photos, information, tracks and sounds of Ohio's wild animals
- *Project Wild* was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the ODNR Website. In the activity *Surprise Terrarium*, students use a classroom terrarium to observe animal behavior and interactions. In *Beautiful Basics*, students list and organize needs of people, pets and wildlife.

Career Connection

Students will design a zoo map that incorporates the climate and environmental characteristics of native habitats for each zoo animal. Lead a discussion to assist students by asking them probing questions such as, What would a zoologist think about your design? Would an architect agree with your design?. Identify careers that play a role in the process, such as:

- Zoologist: studying and understanding animals and their behavior.
- Animal Care Worker: managing animals, knowing animal dietary needs, understanding animal behavior.
- Veterinarian: managing the health and wellness of all animals, prescribing and administering medications, and performing surgeries as needed.
- Zoo Maintenance Workers: maintaining the zoo grounds.
- Botanist: work with plants.
- Landscape Architect or Designer: designing animal habitats that are reflective of the animal's natural environment with plants and materials found in different biomes.

Common Misconceptions

- *Benchmarks for Science Literacy* contains a detailed discussion of energy. Scroll to section heading E for detailed information of grade-appropriate exposure to energy.
- Students may think that food must come from outside an organism. They may also think that fertilizers are actually plant food. They fail to understand that plants make sugars and starches through the process of photosynthesis and that light is essential for plant survival. *Beyond Penguins and Polar Bears* is an online magazine for K-5 teachers that provides information for misconceptions about plants.
- The Annenberg Media series *Essential Science for Teachers* can be used to provide greater insight to misconceptions children hold about living things

and energy. Classroom videos and lessons are provided to help students avoid these misconceptions.

- The Annenberg Media series, *Essential Science for Teachers*, offers *Life Science: Sessions 1 and 2*, which provide greater insight to misconceptions children hold about living, dead and nonliving things and strategies to address those misconceptions.
- AAAS' Benchmarks 2061 Online, Chapter 15, 5e, *Flow of Matter and Energy*, highlights that children think plants get their food from the environment rather than making it internally from water and air. Students often have difficulty in identifying the source of energy for plants and animals.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

- Many *Project Wild* activities feature Universal Design for Learning principals by providing multiple means of concept representation; means of physically interacting with materials; and multiple means of engagement, including collaboration and communication. In *Surprise Terrarium* students use a classroom terrarium to observe animal behavior and interactions. Information about upcoming *Project Wild* workshops is available on the ODNR Website.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

A series of case studies of K-8 science classrooms by the Smithsonian and Harvard University can be found at http://www.learner.org/resources/series21.html. Teachers need to sign up to use this free site. The case study *Jeanie–K* is an example of how to teach young children about observations of the living environment.

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Topic: Changes in Motion

This topic focuses on observing the relationship between forces and motion.

Content Statement

Forces change the motion of an object.

Motion can increase, change direction or stop depending on the force applied.

The change in motion of an object is related to the size of the force.

Some forces act without touching, such as using a magnet to move an object or objects falling to the ground.

Note: At this grade level, gravitational and magnetic forces should be introduced through observation and experimentation only. The definitions of these forces should not be the focus of the content statements.

Content Elaboration

Prior Concepts Related to Forces and Motion

PreK-1: Vibrating objects are observed producing sound. Motion is described as a change in an object's position. Forces are pushes and pulls that can change the motion of objects.

Grade 2 Concepts:

Forces are needed to change the movement (speed up, slow down, change direction or stop) of an object. Some forces may act when an object is in contact with another object (e.g., pushing or pulling). Other forces may act when objects are not in contact with each other (e.g., magnetic or gravitational).

Earth's gravity pulls any object toward it, without touching the object. Static electricity also can pull or push objects without touching the object. Magnets can pull some objects to them (attraction) or push objects away from them (repulsion). Gravity, static electricity and magnets must be explored through experimentation, testing and investigation at this grade level.

For a particular object, larger forces can cause larger changes in motion. A strong kick to a rock is able to cause more change in motion than a weak kick to the same rock. Real-world experiences and investigations must be used for this concept.

Note 1: Introducing fields, protons, electrons or mathematical manipulations of positive and negative to explain observed phenomena are not appropriate at this grade level.

Note 2: There often is confusion between the concepts of force and energy. Force can be thought of as a push or pull between two objects and energy as the property of an object that can cause change. A force acting on an object can sometimes result in a change in energy. The differences between force and energy will be developed over time and is not appropriate at this grade level.

Note 3: Charges and poles are often confused. It is important to emphasize they are different.

Future Application of Concepts

Grades 3-5: The amount of change in movement of an object depends on the mass* of the object and the amount of force exerted.

Grades 6-8: Speed is defined and calculated. The field concept for forces at a distance is introduced.

*While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Investigate how noncontact forces can affect motion.			
Design and construct a device to move a matchbox car from one position to another without touching it. Test the device and evaluate the design. 	Plan and implement a scientific experiment to explore the effects some objects have on others even when the two objects might not touch (e.g., magnets). 	Pictorially represent the design. Compare the designs and their effectiveness from the different groups in the class. 	Identify a noncontact force that can affect the motion of an object.
Investigate ways to change the motion of objects.			
	Plan and implement a scientific experiment to explore how to change how something is moving (e.g., push, pull, speeding up, slowing down, changing direction, stopping). 	Represent the observations from the experiment orally and in writing. Explain the relationship between forces and motion.	Give two examples of how a force can be applied to an object.
	Predict the changes in motion that a moving object or an object at rest experiences when acted on by a force (e.g., push, pull, gravity). 	Compare what is needed to get stationary objects moving and what is needed to get moving objects to stop.	Identify contact/noncontact forces that affect motion of an object (e.g., gravity, magnetic force, contact). Recognize that greater changes in the motion of an object require larger forces.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- *Making Objects Move* from NetLinks provides a strategy that emphasizes an inquiry approach to teaching and learning about different motions of objects.
- *Science in Focus: Forces and Energy* produced by Annenberg, is part of a series of videos on demand to help teachers improve their content knowledge about forces and energy. This particular segment focuses on forces and how they are related to, yet different from, work and energy. While children do not study work and energy until later, knowledge of these concepts can help teachers avoid perpetuating misconceptions.
- *Magnets and Springs* is an interactive simulation from BBC Schools that demonstrates two important concepts: change in motion depends on the amount of force, and some objects are attracted by magnets and others are not. The size of the magnet, the rotation of the magnet and the types of objects exposed to the magnet and the force that puts the magnet in motion can all be changed.
- *Pushes and Pulls* is an interactive simulation from BBC Schools in which children can investigate the effects of pushes and pulls on motion. The subsequent quiz is not aligned to the content statement.
- Observe attractions and repulsions involved with electrical (e.g., static electricity on a balloon or sweater) and magnetic forces (e.g., compass or bar magnet).

Career Connection

Lead a discussion around the types of careers that design vehicles or devices that respond to or are impacted by force (e.g. airplanes, boats, trucks). Students will explore a career related to various types of transportation, including those connected to the military, through available resources in the school or classroom library. Then, they will depict their findings in a drawing.

Common Misconceptions

- The only natural motion is for an object to be at rest.
- If an object is at rest, no forces are acting on the object.
- Only animate objects can exert a force. Thus, if an object is at rest on a table, no forces are acting on it.
- Force is a property of an object.
- An object has force and when it runs out of force, it stops moving.
- A force is needed to keep an object moving with a constant speed.
- Gravity only acts on things when they are falling.
- Only animate things (people, animals) exert forces; passive ones (tables, floors) do not exert forces.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

Starting at a time of about 8:50, children study magnetic forces on this video on demand produced by Annenberg. First, children gain experiential knowledge by sorting objects into things that can be picked up by magnets and those that cannot. Then, they explore whether the force of magnets can go through paper, water, wood and cloth. While content shown during other segments of the video does not apply to this content statement, watching the entire sequence demonstrates how Elsa learns to incorporate appropriate science experiences with lessons that teach social, motor and communication skills in her bilingual classroom. These instructional strategies can be applied to any content area.

Richard and Jo-Ann are second-grade teachers who are integrating math and science in this video on demand produced by Annenberg. Although not all of the content is directly aligned to this content statement, the strategies could be applied to any content. Especially interesting segments start at times of about 13:50 and 23:50 where children are asked to invent formulas for paste and cola. These segments are examples of how inquiry and design can be infused in an elementary classroom.

Linda is featured on this video on demand produced by Annenberg. She is a resource teacher who models inquiry-based science lessons for Grades 2-4 teachers in her large urban district. Although not all of the content is directly aligned to this content statement, the strategies could be applied to any content.

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Model Curriculum
Grade 3
Earth and Space Science (ESS)

Topic: Earth's Resources

This topic focuses on Earth's resources. While resources can be living and nonliving, within this strand, the emphasis is on Earth's nonliving resources, such as water, air, rock, soil and the energy resources they represent.

Content Statement

Earth's resources can be used for energy.

Many of Earth's resources can be used for the energy they contain. Renewable energy is an energy resource, such as wind, water or solar energy, that is replenished within a short amount of time by natural processes. Nonrenewable energy is an energy resource, such as coal or oil, that is a finite energy source that cannot be replenished in a short amount of time.

Content Elaboration

Prior Concepts Related to Energy from Earth's Resources

PreK-2: Wind is moving air, water and wind have measurable properties, and sunlight warms the air and water

Grade 3 Concepts

Distinguishing between renewable and nonrenewable resources through observation and investigation is the emphasis for this content statement. This can be connected to learning about the different forms of energy (PS grade 3). Electrical circuit or solar panel models can be used to demonstrate different forms of energy and the source of the energy. The conservation of energy is explored within the content statement *Some of Earth's resources are limited*.

Specific energy sources in Ohio are introduced, such as fossil fuels found in Ohio, new energy technologies, and the development of renewable energy sources within Ohio. Ohio must be compared to other states regarding energy sources.

Future Application of Concepts

Grades 4-5: Energy is explored through electrical energy, magnetic energy, heat, light and sound.
Grades 6-8: The formation of coal, oil and gas, kinetic and potential energy, thermal energy, energy conservation, energy transfer (includes renewable energy systems) and additional examination of nonrenewable resources are studied.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Research, design and/or construct a model of a simple energy collection system for a specific location (use locations in Ohio or areas near water/prairies/rivers/mountains). Provide a selection of everyday materials for the model (rather than a preplanned kit), such as PVC piping and Mylar to make a windmill or water wheel to allow student-led investigation and design. 	Develop a plan to determine the most effective method of collecting renewable energy (e.g., shapes/number/materials used in wind or water turbines, locations that allow solar panels to collect the most energy from the sun). 	Research the efficiency and cost of different types of energy resources (renewable and/or nonrenewable). Compare and contrast the findings. Present or discuss findings with the class. 	Recognize the differences between renewable and nonrenewable energy. Be able to provide examples of each. 

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- To understand the relationship between energy and wind, the Texas Energy Conservation Office developed fact sheets and other resources for elementary students and teachers. There also are ideas for activities and projects, all related to renewable energy.
- The National Renewable Energy Laboratory provides links to elementary wind programs (like KidWind and Wind for Schools) and resources and support for teaching about wind and wind turbines. There is information about national challenges for building wind turbine models at different grade levels and links to learn about solar energy and the relationship of solar and wind energy.
- The National Energy Education Development Project provides online information about energy sources at the primary grades, offers free downloads of primary books, and supports the teaching of a variety of energy resources, inquiry-based labs and experiments.
- Hydrologic power basics (at the teacher level) can be found at the USGS website. This basic information can be adapted to an observational level for students in grade 3. Building simple water turbines can be a good way to explore this renewable energy resource.
- Combine/integrate energy resources with PS grade 3 to learn about different forms of energy.

Career Connection
Students will explore the concept of "green jobs", by identifying careers, organizations, and policies that reflect the conservation of energy or utilization of alternative energy sources. They may focus on aspects of green jobs such as wind, solar, and wave, energy, renewable materials, transportation, and buildings and structures that conserve energy. Additional information about green jobs is available at: http://www.bls.gov/green/.

Common Misconceptions

- Misconceptions about fossil fuels and energy resources are common. Use effective questioning to help understand preconceptions that elementary students may have about energy resources and address the misconceptions.
- Students may have difficulty differentiating between renewable and nonrenewable resources. Providing investigations and local (Ohio) examples can help students make the connections needed for this understanding. For a teacher fact sheet with important examples to support this content statement and to ensure that misconceptions are addressed, see http://www.epa.gov/osw/education/quest/pdfs/unit1/chap1/u1_natresources.pdf.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

A series of case studies of K-8 science classrooms by the Smithsonian and Harvard University can be found at http://www.learner.org/resources/series21.html. Teachers need to sign up to use this free site. The case study *Erien, Year One–Grade 5* is an example of how to conduct soil profiling in an elementary class setting. Of particular interest are the questioning techniques that Erien uses with her students to generate interest.

The Annenberg Foundation offers training modules that support Earth and Space Sciences for K-4 teachers. There are numerous resources and video clips of actual classroom practices that can be useful training tools at http://www.learner.org/resources/series195.html.

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Model Curriculum
Grade 4
Life Science (LS)

Topic: Earth's Living History
This topic focuses on using fossil evidence and living organisms to observe that suitable habitats depend upon a combination of biotic and abiotic factors.

Content Statement
Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful.

Ecosystems can change gradually or dramatically. When the environment changes, some plants and animals survive and reproduce and others die or move to new locations. An animal's patterns of behavior are related to the environment. This includes the kinds and numbers of other organisms present, the availability of food and resources, and the physical attributes of the environment.

Content Elaboration
Prior Concepts Related to Behavior, Growth and Changes
PreK-2: Plants and animals have variations in their physical traits that enable them to survive in a particular environment. Living things that once lived on Earth no longer exist, as their needs were not met. Living things have basic needs, which are met by obtaining materials from the physical environment.
Grade 3: Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.

Grade 4 Concepts
Ecosystems are based on interrelationships among and between biotic and abiotic factors. Ohio has experienced various weather patterns. Some parts of Ohio hosted glaciers and other parts of Ohio were submerged with water. Ecosystems can change rapidly (e.g., volcanoes, earthquakes, or fire) or very slowly (e.g., climate change). Major changes over a short period of time can have a significant impact on the ecosystem and the populations of plants and animals living there. The changes that occur in the plant and animal populations can impact access to resources for the remaining organisms, which may result in migration or death. The fossil record provides evidence for changes in populations of species.

Researching and investigating specific areas in Ohio (e.g., Cedar Bog, Lake Erie, Hocking Hills, Ceasar Creek, Kellys Island) via field studies, virtual field trips or other references must be used to explore the relationships between previous environments, changes that have occurred in the environments and the species that lived there.

Note: Grade 4 ES focuses on changes to Earth's surface due to erosion, deposition of soil, rock sediment, flooding, volcanoes and earthquakes that can be taught along with this content.

Future Application of Concepts
Grades 6-8: Organisms that survive pass on their traits to future generations. Climate, rock record and geologic periods are explored in Earth and Space Science.
High School: The concepts of evolution are explored.

Expectations for Learning: Cognitive Demands
This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Critique plans (written or oral) from different organizations to reintroduce a species into an Ohio environment. Write a newspaper article in support or against the reintroduction of the species based upon scientific facts. Find more information at http://www.clemetzoo.com/rttw/swan/allabt.htm. 	Conduct an investigation to determine if removing or adding plants to an area increases or decreases erosion. Ask: *How does this impact other organisms in that environment?* 	Read a firsthand description, view drawings of Ohio ecosystems as first observed by explorers and compare the historical environmental descriptions to the current environment. Explain the changes that occurred in the biotic and abiotic components of the ecosystem. 	Describe the immediate consequences of rapid ecosystem change for organisms within an ecosystem and describe the consequences this change will have on an ecosystem a decade or more later (e.g., flooding, wind storms, snowfall, volcanic eruptions). 
		Research a major geologic event (e.g., Mt. St. Helens volcanic eruption, tsunami). Develop a timeline depicting the environment before the event, immediately after the event and in designated time intervals until a stable community is established (e.g., 30 or more years). Find information at http://www.fs.fed.us/gpnf/mshnvm/education/teachers-corner/library/life-returns01.shtml#01. 	Describe major changes in Ohio's environments over time and the organisms supported in each (e.g., oceanic, glacial, wetlands, forests). 

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Investigate various species that have been endangered due to environmental changes and examine efforts to reestablish and support their populations. One example is the trumpeter swan. The Ohio History Central and Cleveland Metropolitan Zoo provide details of this bird's story.
- The Virtual Nature Trail at Penn State New Kensington is an opportunity to observe photos of various species of plants interacting with one another and the environment and examine what changes result due to those interactions.
- Citizen Science is program promoted by the National Wildlife Federation to have the public volunteer time to assist scientists in their wildlife research by collecting data, sharing experiences and spreading valuable information. Wildlife can be monitored and the changes that occur in the ecosystem can be monitored and analyzed.
- The ODNR-Division of Wildlife's Research and Survey website has information on current research projects on Ohio wildlife, including migration tracking, distribution and reintroduction and monitoring programs.
- The ODNR-Division of Wildlife has a poster with an activity called *Ohio's Wildlife History*. The poster can be ordered by mail through the Education Materials Brochure found online at www.wildohio.com.
- *Project Wild* was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the ODNR Website. In the activity *Oh Deer*, students portray deer and habitat components in a physical activity that illustrates the factors that cause fluctuations in wildlife populations over time. In *Here Today, Gone Tomorrow,* students identify and describe causes of extinction within animal species and identify locally endangered and threatened species.

Career Connection

Students will choose a recent disaster to explore (e.g., hurricane, earthquake, oil spill, tsunami) and identify the immediate and long-term consequences including the interactions and relationships among the Earth's surface, ecosystem, and plant and animal populations. Through exploring the impact, students will address the types of careers involved in addressing the issues. This may include performing tasks, such as relocating organisms, rebuilding habitats, rescuing or rehabilitating organisms.

Common Misconceptions

- Students may think that people provide the materials (water, nutrients, light) needed for plants to survive. *Beyond Penguins and Polar Bears* is an online magazine for K-5 teachers that provides information for misconceptions about plants.
- A list of common ecological misconceptions about adaptation is provided with strategies for implementing the 5E model of instruction to overcome misconception.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

- Many *Project Wild* activities feature Universal Design for Learning principals by providing multiple means of concept representation; means of physically interacting with materials; and multiple means of engagement, including collaboration and communication. In the activity *Oh Deer*, students portray deer and habitat components in a physical activity that illustrates the factors that cause fluctuations in wildlife populations over time. In *Here Today, Gone*

Tomorrow, students identify and describe causes of extinction within animal species and identify locally endangered and threatened species.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

Session 5 of the Annenberg Media series *Essential Science for Teachers: Life Science* provides information about how children can learn about the variations of living things and offers with classroom footage to illustrate implementation at http://www.learner.org/resources/series179.html.

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Topic: Interconnections within Ecosystems

This topic focuses on foundational knowledge of the structures and functions of ecosystems.

Content Statement

Organisms perform a variety of roles in an ecosystem.

Populations of organisms can be categorized by how they acquire energy.

Food webs can be used to identify the relationships among producers, consumers and decomposers in an ecosystem.

Content Elaboration

Prior Concepts Related to Behavior, Growth and Changes

PreK-2: Plants get energy from sunlight. Animals get energy from plants and other animals. Living things cause changes on Earth.

Grade 5 Concepts

The content statements for fifth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories: dynamic relationships within ecosystems. It is recommended that the content statements be combined and taught as a whole. For example, it is important that the ecological role of organisms is interwoven with a clear understanding that all living things require energy.

Plants and some microorganisms are producers. They are the foundation of the food web. Producers transform energy from the sun and make food through a process called photosynthesis. Animals get their energy by eating plants and other animals that eat plants. Animals are consumers and many form predator-prey relationships. Decomposers (primarily bacteria and fungi) are consumers that use waste materials and dead organisms for food. Decomposers also return nutrients to the ecosystem.

One way ecosystem populations interact is centered on relationships for obtaining energy. Food webs are defined in many ways, including as a scheme of feeding relationships, which resemble a web. This web serves as a model for feeding relationships of member species within a biological community. Members of a species may occupy different positions during their lives. Food chains and webs are schematic representations of real-world interactions. For this grade level, it is enough to recognize that food webs represent an intertwining of food chains within the same biological community. See the next content statement for details on grade-appropriate food webs.

Organisms have symbiotic relationships in which individuals of one species are dependent upon individuals of another species for survival. Symbiotic relationships can be categorized as mutualism where both species benefit, commensalism where one species benefits and the other is unaffected, and parasitism where one species benefits and the other is harmed.

Investigations of locally threatened or endangered species must be conducted and include considerations of the effects of remediation programs, species loss and the introduction of new species on the local environment.

	Note: At this grade, species can be defined by using Ernst Mayer's definition "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups." Assessments will not include the definition of species. **Future Application of Concepts** **Grades 6-8:** The importance of biodiversity within an ecosystem is explored. **High School:** The concepts of evolution and biodiversity are explored.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Design and build a self-sustaining ecosystem (e.g., terrarium, bottle biology). Considerations for the ecosystem include the size of the container, the location to create the proper temperature, light and humidity, and organisms that will support one another. 	Investigate change in an established model of an ecosystem over time (e.g., terrarium, aquarium). Answer: *What would happen with removal or introduction of one kind of living thing* (e.g., one species of producers not all producers)? Design experiments to observe what actually happens when one species is changed.  **Note:** At this grade, species can be defined by using Ernst Mayer's definition of "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups." Students will not be assessed on the definition of species at this grade level.	Compare the roles of producers, consumers and decomposers and explain how they work together within an ecosystem. 	Given a list of organisms and a description of their interactions within an environment, classify them as producers, consumers, decomposers or by type of symbiotic relationships (mutualism, commensalism and parasitism). 

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Conduct a field study involving a hands-on investigation of a rotting log in a temperate forest. Examine the relationships among organisms (e.g., decomposers, green plants, insects, worms) found in the soil.
- Based on observations of the local environment, build a food web describing each organism's role and impact within the food web.
- NSTA offers a content-rich segment for ecosystem study. Coral Reef Ecosystems: Interdependence develops understanding of the interactions and energy flow between organisms in a food web.
- ODNR-Division of Wildlife's A to Z Species Guide has photos, information, tracks and sounds of Ohio's wild animals. The guide also includes the diet of organisms.
- *Project Wild* was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the ODNR Website. The following activites are helpful in teaching this content. *Quick Frozen Critters*—Through a game of freeze tag, students will become part of a predator/prey interaction. *What's for Dinner*—Students list and analyze sources of food to illustrate that all animals, including people, depend on plants as a food source. *Surprise Terrarium*—students create a classroom terrarium to illustrate animal behavior. *Good Buddies*—students research pairs of animals, play a card game, and classify the pairs of animals according to the three major forms of symbiotic relationships. *Designing a Habitat* (Aquatic WILD)—Students design a habitat suitable for aquatic wildlife to survive.

Career Connection

When examining factors that impact white-tailed deer population in Ohio, students will determine the implications for a community when the population decreases or increases. After students determine the implications for a community, students will identify careers directly or indirectly impacted in addressing the issues. This conversation will offer an opportunity to discuss how ecosystems can impact an economy. Environmental circumstances dictate demands and influence the necessity of certain careers.

Common Misconceptions

- The Annenberg Media series *Essential Science for Teachers* can be used to provide greater insight to misconceptions children hold about living things and energy. Classroom videos and lessons are provided to help students avoid these misconceptions.
- AAAS' Benchmarks 2061 Online, Chapter 15, 5e, *Flow of Matter and Energy, Plant and Animal Nutrition*, outlines children's misconceptions about energy in relationship to producers and consumers.

Diverse Learners

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- Many *Project Wild* activities feature Universal Design for Learning principals by providing multiple means of concept representation; means of physically interacting with materials; and multiple means of engagement, including collaboration and communication. *Quick Frozen Critters*—Through a game of freeze tag, students will become part of a predator/prey interaction. *What's for Dinner*—Students list and analyze sources of food to illustrate that all animals, including people, depend on plants as a food source. *Surprise Terrarium*—students create a classroom terrarium to illustrate animal behavior. *Good Buddies*—students research pairs of animals, play a card game, and classify the pairs of animals according to the three major forms of symbiotic

relationships. *Designing a Habitat* (Aquatic WILD)—Students design a habitat suitable for aquatic wildlife to survive.

Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

A series of case studies of K-8 science classrooms by the Smithsonian and Harvard University can be found at http://www.learner.org/resources/series21.html. Teachers need to sign up to use this free site. The case studies *Sarah–Grade 5, Tom–Grade 5,* and *Erien, Year One–Grade 5* provide examples of developing meaningful science assessments, learning core science concepts and using effective questioning techniques for scientific inquiry.

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Model Curriculum
Grade 6
Earth and Space Science (ESS)

Topic: Rocks, Minerals and Soil

This topic focuses on the study of rocks, minerals and soil, which make up the lithosphere. Classifying and identifying different types of rocks, minerals and soil can decode the past environment in which they formed.

Content Statement

Minerals have specific, quantifiable properties.

Minerals are naturally occurring, inorganic solids that have a defined chemical composition. Minerals have properties that can be observed and measured. Minerals form in specific environments.

Content Elaboration

Prior Concepts Related to Mineral Properties

PreK-2: Objects have physical properties, properties of objects can change, and Earth's nonliving resources have specific properties.

Grades 3-5: Rocks and soil have characteristics, soil contains pieces of rocks, and objects are composed of matter and may exhibit electrical conductivity and magnetism.

Grade 6 Concepts

Most rocks are composed of one or more minerals. Minerals have specific properties that can be used for identification. The properties that can be used for testing minerals include luster, hardness, cleavage, streak, magnetism, fluorescence and/or crystal shape. The emphasis is on learning how to identify the mineral by conducting tests (not through memorization). Common minerals (including those on Mohs' hardness scale) must be used in the identification process. A representative sample of minerals can be used so that different testing methods can be applied and demonstrated. Appropriate tools and safety procedures must be used to test mineral properties. Technology can provide identification information and research materials to assist in mineral investigations.

Minerals present in rocks can help identify the rocks correctly. Minerals can indicate the type of environment in which the rock and/or mineral formed. Some minerals (e.g., halite, varieties of gypsum) form through evaporation and some (e.g., calcite) form through a variety of chemical processes. Other minerals (e.g., feldspar varieties, magnetite, varieties of quartz) form in an igneous environment and some minerals (e.g., epidote) form in a metamorphic environment.

Future Application of Concepts

Grades 7-8: Biogeochemical cycles, igneous environments and the history of Earth (including the changing environments) from the interpretation of the rock record are studied.

High School: The formation of elements, chemical bonding and crystal structure are found in the Physical Sciences. In grades 11-12 Physical Geology, mineralogy is explored at depth.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Determine, using scientific investigation, the best mineral to use to solve a problem or serve a specific function. Ask: *What is the best mineral or rock to use to neutralize acidic soil? What is the best rock to use to make a statue? What is the best mineral to use for sandpaper?* Evaluate the results and use the data to draw a conclusion. Share findings with an authentic audience. 	Simulate the formation of halite or gypsum in the Lake Erie area through a scientific experiment. Using data from the evaporate simulation; predict how long it took to form the existing formations. 	Research and document the environmental conditions (select Silurian Period) that existed when halite and gypsum formed in the Lake Erie area of Ohio. 	Identify the common rock-forming minerals (e.g., calcite, halite, dolomite, gypsum, quartzes, feldspars, micas, talc, kaolinite, chalk, topaz, corundum).
		Make a dichotomous key, using mineral properties, to use in testing and identifying minerals.	Identify the different processes and/or environments in which minerals can form (e.g., evaporation, chemical processes, sedimentary, igneous or metamorphic). 
		Compare and contrast rocks and minerals.	Recognize that minerals have measurable properties that can be used for identification and/or classification.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Allowing student investigation in the testing of different mineral properties is a key part of really understanding minerals. The properties of the mineral define its value and uses. The USGS provides mineral resources and information that can support the teaching of minerals. Specific mineral data is available using the website's search engine.
- Understanding how to test minerals accurately is essential in identifying minerals correctly. Identification should not be based upon visuals, but rather testing and analyzing the results. Many minerals can look or feel the same, so it is important to encourage students to run tests before identifying an unknown mineral. The Mineralogical Society of America offers training, workshops, data and resources to support learning about minerals and geology.
- NASA/CSU Partners in Education provides mineral information and mineral identification support for middle school teachers and students. Basic mineral information is provided regarding mineral properties, mineral formation and specific tests that can be conducted to identify minerals.
- Connecting mineral uses with mineral identification is an important part of teaching about minerals with connections to the real world. Geology.com provides information on each major mineral type or group with details on mineral properties and uses.

Career Connection

Explore the uses of mineral ***properties*** across various careers (e.g., construction and sand paper; acidic soil and landscaping or agriculture). Lead a discussion where you will assist students with identifying the careers and roles involved in such a process, such as:

- Geologist: people who study rocks, minerals, and composition
- Machine Operator: the person who operates equipment
- Site Manager: oversees each role and responsibility on the job site
- Environmentalists: concerned with the environmental impact of projects
- Engineer: understand and design the process, which includes the types of materials used

Host a career speaker who represents one of the roles involved in the process. The speaker can share their responsibilities and how they interact with others to complete a project.

Common Misconceptions

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html.
- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at http://science.nasa.gov/big-questions/.

Diverse Learners

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Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

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higher-level, problem-solving and minds-on inquiry and investigation techniques.

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Model Curriculum
Grade 7
Earth and Space Science (ESS)

Topic: Cycles and Patterns of Earth and the Moon

This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.

Content Statement

The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere.

Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock.

Note: Contamination can occur within any step of the hydrologic cycle. Ground water is easily contaminated as pollution present in the soil or spilled on the ground surface moves into the ground water and impacts numerous water sources.

Content Elaboration

Prior Concepts Related to Hydrologic Cycle

PreK-2: Water is observed through weather. Water is in the atmosphere. Water can be a solid, a gas and a liquid.

Grades 3-5: Water is present in soil. Water is a non-living resource. Properties of the different states of water, how water can change the surface of Earth, and how water is a factor in some weather-related events (e.g., flooding, droughts) are discussed.

Grade 6: The changes in the state of water are related to motion of atoms (changes in energy). Water flows through rock and soil (porosity and permeability).

Grade 7 Concepts

The different pieces of the hydrologic cycle (e.g., properties of water, changes of state, relationships of water to weather, effects of water on Earth's surface) from the elementary grades are formally combined in grade 7 and applied to the components of the hydrologic cycle.

The movement of water through the spheres of Earth is known as the hydrologic cycle. As water changes state and energy is transferred, it cycles from one sphere into another (e.g., water transfers from the hydrosphere to the atmosphere when evaporation occurs). Ground water and surface water quality are important components of the hydrologic cycle. The porosity and permeability of the rock and/or soil (grade 6) can affect the rate at which the water flows. The pattern of the cycling illustrates the relationship between water, energy and weather.

The movement of water in the cycle also can move contamination through each of the spheres. Relating water flow to geographic and topographic landforms and/or features leads to an understanding of where water flows and how it moves through the different spheres. Topographic and aerial maps (can be virtual) can be used to identify drainage patterns and watersheds that contribute to the cycling of water. Lab investigations or technology can be used to simulate different segments of the hydrologic cycle.

Future Application of Concepts

Grade 8: The relationship between the hydrosphere, atmosphere and lithosphere are studied as they relate to weathering and erosion.

High School: The hydrologic cycle is a component of biology as it relates to ecosystems and the diversity of life.

Expectations for Learning: Cognitive Demands

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Visions into Practice: Classroom Examples

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Produce and test solutions for reducing acid rain, erosion and/or surface run-off rates in specific regions (e.g., urban, agricultural, construction). Present findings/plan to school administrators or local government. 	Design and conduct a scientific investigation to measure and analyze surface-water discharge rates. 	Using GPS/GIS programs, topographic maps and/or aerial maps, identify regions where surface water run-off and/or acid rain could impact ground or surface water quality. Illustrate the results graphically. 	Describe the movement of water through all four spheres of Earth (lithosphere, hydrosphere, atmosphere, biosphere). 
Develop, test and evaluate plans outlining a specific method to reduce storm water flow at a specific site in the local community (e.g., a housing construction project, the school parking lot). Present findings/plans to school administrators or local government. 	Build a model to represent a cross-section of Earth's surface (soil, rock, surface, ground water) that can enable investigation of multiple water pathways. Explain and demonstrate to the class. 	Research and investigate an area in Ohio that exhibits a unique water contamination problem (e.g., acid mine drainage in southeastern Ohio, mercury contamination in Lake Erie). Document recent discoveries, case studies, clean-up technologies or field investigations that are occurring. Present findings to the class. 	Identify the changes in thermal energy as water changes state in the hydrologic cycle. 
	Investigate and use different methods and tools that measure water flow and water quality, and evaluate which methods and tools are most effective for the desired outcome. 	Research and evaluate the effectiveness of different tools, models and methods to collect ground water and surface water data (e.g., rate of flow, direction of movement, types of contamination). Present recommendations orally, graphically or in writing. 	Recognize that the sun is the source of energy that drives the hydrologic cycle. 

Instructional Strategies and Resources

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- Ground water is often overlooked or minimalized in the teaching of the hydrologic cycle. It is important to discuss and demonstrate the distribution of Earth's water to show that there is more ground water than surface water. The National Ground Water Association offers information, data and resources to support teachers in teaching all aspects of ground water.
- The USGS provides resources, data, information, books and maps that relate to Earth's resources and the hydrologic cycle.
- Contamination can be introduced at all steps of the hydrologic cycle. This relationship is important to begin to show how contamination migrates and travels between Earth's spheres. The Ohio EPA provides background and resource information related to water and water contamination issues related to the hydrologic cycle. It also includes helpful environmental education resources. Other related programs include Project Wet and ODNR's Division of Soil and Water Resources.
- iTunes provides free *Science Quest* video clip downloads that address current discoveries pertaining to water, research and events. These can generate topics of interest, research ideas and discussion points for the class.
- Using recent discoveries and technology are ways to interest and engage students by connecting to real events that are directly related to water contamination and water shortage problems. Satellite imagery can show specific contamination issues that are relevant to Ohio (e.g., algae contamination within drinking water supplies) and can be used for research and comparative studies in the classroom.
- Healthy Water, Healthy People offers ideas and resources for teaching all aspects of water and water contamination issues. Ideas for field monitoring and research projects, as well as investigative projects for students, are found within the program. Teacher training is included.
- Connecting the hydrologic cycle (and other biogeochemical cycles) with everyday life and experiences is essential since many resources and references regarding cycles within Earth systems are very abstract and difficult to apply to the real world. Choosing local issues that involve water and conducting field studies and research about the movement of water and/or contamination can lead to deeper understanding of how the cycles work (e.g., researching acid mine drainage problems in southeastern Ohio. The Monday Creek website provides research and data for southeastern Ohio and acid mine drainage cleanup efforts. There are other resources listed on the site to assist in student research.

Career Connection

Students will research or investigate an actual environmental event (e.g., a specific release of a toxin or contaminant) and determine how it impacted each of Earth's spheres. Students will identify a body of water that has been flagged as an environmental hazard. They will identify careers needed to assist in analyzing the problem, developing a solution, and acting to resolve the issue. Students will identify which organizations and agencies to consult, how they will mobilize the necessary resources, and their specific role in the project.

Common Misconceptions

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Classroom Portals

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Teachers need to sign up to use this free site. The case studies *Dotty–Grade 7* and *Erien, Year Two–Grade 7* provide examples of how to use technology in the science classroom and develop higher-level thinking for science students.

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Model Curriculum
Grade 8
Life Science (LS)

Topic: Species and Reproduction
This topic focuses on continuation of the species.

Content Statement
The characteristics of an organism are a result of inherited traits received from parent(s).

Expression of all traits is determined by genes and environmental factors to varying degrees. Many genes influence more than one trait, and many traits are influenced by more than one gene.

During reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction, the lone parent contributes DNA to the offspring. In sexual reproduction, both parents contribute DNA to the offspring.

Note 1: The focus should be the link between DNA and traits without being explicit about the mechanisms involved.

Note 2: The ways in which bacteria reproduce is beyond the scope of this content statement.

Note 3: The molecular structure of DNA is not appropriate at this grade level.

Content Elaboration
Prior Concepts Related to Species and Reproduction
PreK-2: Offspring tend to look their parents.
Grades 3-5: Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.
Grades 6-7: Modern Cell Theory states cells come from pre-existing cells.

Grade 8 Concepts
The traits of one or two parents are passed on to the next generation through reproduction. Traits are determined by instructions encoded in deoxyribonucleic acid (DNA), which forms genes. Genes have different forms called alleles. Introduce the principles of Mendelian genetics by reviewing Mendel's work. Mendel's two laws provide the theoretical base for future study of modern genetics. Mendel's first law, the Law of Segregation, and his second law, the Law of Independent Assortment, should be demonstrated and illustrated in a variety of organisms. The concepts of dominant and recessive genes are appropriate at this grade level. Codominant traits such as roan color in horses and cows may be useful to provide further validation of the theory and to help dispel some misconceptions. Pedigree analysis is appropriate for this grade level when limited to dominant, recessive or codominance of one trait. The Law of Independent Assortment should only be explored in simple cases of dominance and recessive traits. Chi-square and dihybrid crosses are reserved for high school.

Conduct a long-term investigation to analyze and compare characteristics passed on from parent to offspring through sexual and asexual reproduction. Ask questions about the phenotypes that appear in the resulting generations and what they infer about genotypes of the offspring.

Note: Incomplete dominance is not suggested for this grade level to help avoid the misconception of "blending of traits." Codominance is encouraged because both traits are expressed in the resulting offspring.

Future Application of Concepts
High School: The details and importance of gamete formation, the structure of DNA and modern genetics are studied.

Expectations for Learning: Cognitive Demands

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Designing Technological/ Engineering Solutions using Science Concepts	Demonstrating Science Knowledge	Interpreting and Communicating Science Concepts	Recalling Accurate Science
Designer dogs are developed to meet human needs. Investigate a number of breeds and explain the benefits and drawbacks of mixing the breeds. Make sure to examine several generations of dogs to determine the stability of the resulting hybrid. 	Design and implement an investigation to predict the genotype and phenotypes of offspring between plants of known heritage (e.g., Wisconsin Fast Plants™) 	Compare the exchange of genetic information during sexual and asexual reproduction. 	Describe how genes, chromosomes and inherited traits are connected. 
		Given the genetic characteristics of the parents, use a Punnett square to predict the genetic outcome of the offspring produced. 	Describe the characteristics and transfer of dominant and recessive traits. 

Instructional Strategies and Resources

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- DNA from the Beginning explores aspects of Mendel's genetic experiments with animations. The Law of Segregation, the Law of Independent Assortment and the Law of Dominance are explained.
- The University of Utah's Genetic Learning Center offers *Tour of the Basics*, a tutorial that contains animations to explain heredity and its components. For this content area, focus on *What is Heredity?* and *What is a Trait?* Some areas of this site go beyond the scope of this grade-level content.
- The Canadian Museum of Nature's section called The GEEE! in Genome offers foundational information for heredity. Click on *The Basics* and then *Heredity and Reproduction* for activities to support the understanding of genetics.
- Teachers' Domain: Reproduction and Genetics is a two-session course that explores the cellular processes that organisms use to develop, reproduce and pass traits from one generation to the next.

Career Connection

Students will research the roles of careers related to genetics, such as:

- Geneticists: expertise in the study of genetics.
- Veterinarian and Vet Techs: managing the health and wellness of animals, understanding animal reproductive behaviors and patterns.
- Biologists: study plants and animals and their environments.
- Medical and Animal Scientists: develop and improve products by conducting research and experiments.

Students will conduct career interviews, through a workplace visit or by telephone, to gather information that describes the real-work context of this classroom content.

Common Misconceptions

- Weber State University provides a list for misconceptions in biology. Scroll down to Standard IV to address misconceptions about patterns of inheritance.
- AAAS' Benchmarks 2061 Online, Chapter 15, 5b, *Heredity*, highlights that students think sexual reproduction results in traits being inherited from only one parent (e.g., the mother or same-sex parent). They also may believe that there is a "blending of characteristics" in offspring.

Diverse Learners

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Classroom Portals

These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.

A Harvard case study on improving the teaching of science in real classrooms is available at http://www.learner.org/resources/series21.html?pop=yes&pid=1050. Nancy, an eighth-grade teacher, encourages students to work and think more on their own in her science class. This encourages true scientific inquiry and investigation at the student level.

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Content Elaboration: Cells

Building on knowledge from middle school (cell theory), this topic focuses on the cell as a system itself (single-celled organism) and as part of larger systems (multicellular organism), sometimes as part of a multicellular organism, always as part of an ecosystem. The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation are studied at this grade level. Additionally, cellular organelles studied are cytoskeleton, Golgi complex and endoplasmic reticulum.

From about 4 billion years ago to about 2 billion years ago, only simple, single-celled microorganisms are found in the fossil record. Once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.

Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape. Within the cell are specialized parts for the transport of materials, energy transformation, protein building, waste disposal, information feedback and movement. In addition to these basic cellular functions, most cells in multicellular organisms perform some specific functions that others do not.

A living cell is composed of a small number of elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorous and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules. The essential functions of cells involve chemical reactions that involve water and carbohydrates, proteins, lipids and nucleic acids. A special group of proteins, enzymes, enables chemical reactions to occur within living systems.

Cell functions are regulated. Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Most cells function within a narrow range of temperature and pH. At very low temperatures, reaction rates are slow. High temperatures and/or extremes of pH can irreversibly change the structure of most protein molecules. Even small changes in pH can alter how molecules interact.

The sequence of DNA bases on a chromosome determines the sequence of amino acids in a protein. Proteins catalyze most chemical reactions in cells. Protein molecules are long, usually folded chains made from combinations of the 20 typical amino-acid sub-units found in the cell. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes as a result of that sequence.

Note 1: The idea that protein molecules assembled by cells conduct the work that goes on inside and outside the cells in an organism can be learned without going into the biochemical details. It is sufficient for students to know that the molecules involved are different configurations of a few amino acids and that the different shapes of the molecules influence what they do.

Note 2: The concept of the cell and its parts as a functioning system is more important than memorizing parts of the cell.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

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Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Investigate the effect of different chemicals on the growth of algal colonies. Use mathematics to explain why even under ideal situations the colonies cannot continue exponential growth.
- Plan and design an investigation to determine the factors that affect the activity of enzymes on their substrates.
- Research and provide a written explanation of how unicellular organisms are used for industrial purposes.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Optical enhancements can be used to alter the image produced by a light microscope to show greater detail. Compare cells using unaltered Compound Light Microscopes with the same cells using Darkfield, Rheinberg and Polarization techniques.
- Examine the role of bacteria in food production. Determine what types of bacteria are used and how it impacts (pH levels, gases produced, impact on proteins) the production of the product (yogurt, cheese).
- Determine the limitations of and uses of DNA in a criminal investigation.

Career Connection

Students will research careers in the field of food production relative to the role of bacteria across quality control, the U.S. Food and Drug Administration, agriculture, and research and development of food production (e.g., biologists; chemists; agricultural scientists; science technician; food processors, inspectors, and preparers). Through their research, they will identify applications of this classroom content to the workplace. Students will conduct career interviews, workplace visits, and navigate company or agency websites.

Common Misconceptions

- The Annenberg Media series *Minds of Our Own* offers *Lessons From Thin Air*, which illustrates the misconceptions that students have about photosynthesis and plant growth, at http://www.learner.org/resources/series26.html.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

The Annenberg Media series "Teaching High School Science" is a six-video program that highlights a variety of classroom activities that foster inquiry-based learning.

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- Phases of matter
- Intermolecular chemical bonding
  - Types and strengths
  - Implications for properties of substances
    - Melting and boiling point
    - Solubility
    - Vapor pressure

Interactions of Matter

- Chemical reactions
  - Types of reactions
  - Kinetics
  - Energy
  - Equilibrium
  - Acids/bases
- Gas laws
  - Pressure, volume and temperature
  - Ideal gas law
- Stoichiometry
  - Molar calculations
  - Solutions
  - Limiting reagents
- Nuclear Reactions
  - Radioisotopes
  - Nuclear energy

Content Elaboration

Structure and Properties of Matter

- ***Atomic structure***

  The physical science syllabus included properties and locations of protons, neutrons and electrons, atomic number, mass number, cations and anions, isotopes and the strong nuclear force that hold the nucleus together. In this course, the historical development of the atom and the positions of electrons are explored in more detail.

  Atomic models are constructed to explain experimental evidence and make predictions. The changes in the atomic model over time exemplify how scientific knowledge changes as new evidence emerges and how technological advancements like electricity extend the boundaries of scientific knowledge. Thompson's study of electrical discharges in cathode-ray tubes led to the discovery of the electron and the development of the plum pudding model of the atom. Rutherford's experiment, in which he bombarded gold foil with α-particles, led to the discovery that most of the atom consists of empty space with a relatively small, positively charged nucleus. Bohr used data from atomic spectra to propose a planetary model of the atom in which electrons orbit the nucleus, like planets around the sun. Later, Schrödinger used the idea that electrons travel in waves to develop a model in which electrons travel randomly in regions of space called orbitals (quantum mechanical model).

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Based on the quantum mechanical model, it is not possible to predict exactly where electrons are located but there is a region of space surrounding the nucleus in which there is a high probability of finding an electron (electron cloud or orbital). Data from atomic spectra (emission and absorption) gives evidence that electrons can only exist at certain discrete energy levels and not at energies between these levels. Atoms are usually in the ground state where the electrons occupy orbitals with the lowest available energy. However, the atom can become excited when the electrons absorb a photon with the precise amount of energy (indicated by the frequency of the photon) to move to an orbital with higher energy. Any photon without this precise amount of energy will be ignored by the electron. The atom exists in the excited state for a very short amount of time. When an electron drops back down to the lower energy level, it emits a photon that has energy equal to the energy difference between the levels. The amount of energy is indicated by the frequency of the light that is given off and can be measured. Each element has a unique emission and absorption spectrum due to its unique electron configuration and specific electron energy jumps that are possible for that element. Being aware of the quantum mechanical model as the currently accepted model for the atom is important for science literacy as it explains and predicts subatomic interactions, but details should be reserved for more advanced study.

Electron energy levels consist of sublevels (s, p, d and f), each with a characteristic number and shape of orbitals. The shapes of d and f orbitals will not be assessed in high school. Orbital diagrams and electron configurations can be constructed to show the location of the electrons in an atom using established rules. However, the names of these rules will not be assessed. Valence electrons are responsible for most of the chemical properties of elements. In this course, electron configurations (extended and noble gas notation) and orbital diagrams can be shown for any element in the first three periods.

Although the quantum mechanical model of the atom explains the most experimental evidence, other models can still be helpful. Thinking of atoms as indivisible spheres is useful in explaining many physical properties of substances, such as the state (solid, liquid or gas) of a substance at room temperature. Bohr's planetary model is useful to explain and predict periodic trends in the properties of elements.

Note: Quantum numbers and equations of de Broglie, Schrödinger and Plank are beyond the scope of this course.

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- ***Periodic Table***

  In the physical science syllabus, elements are placed in order of increasing atomic number in the periodic table such that elements with similar properties are placed in the same column. How the periodic table is divided into groups, families, periods, metals, nonmetals and metalloids also was in the physical science syllabus. In chemistry, with more information about the electron configuration of elements, similarities in the configuration of the valence electrons for a particular group can be observed. The electron configuration of an atom can be written from the position on the periodic table. The repeating pattern in the electron configurations for elements on the periodic table explain many of the trends in the properties observed. Atomic theory and bonding must be used to explain trends in properties across periods or down columns including atomic radii, ionic radii, first ionization energies, electronegativities and whether the element is a solid or gas at room temperature. Additional ionization energies, electron affinities and periodic properties of the transition elements, lanthanide and actinide series is reserved for more advanced study**.**

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- ***Intramolecular Chemical Bonding***
  In the physical science syllabus, atoms with unpaired electrons tend to form ionic and covalent bonds with other atoms forming molecules, ionic lattices or network covalent structures. In this course, electron configurations, electronegativity values and energy considerations will be applied to bonding and the properties of materials with different types of bonding.

  Atoms of many elements are more stable as they are bonded to other atoms. In such cases, as atoms bond, energy is released to the surroundings resulting in a system with lower energy. An atom's electron configuration, particularly the valence elections, determines how an atom interacts with other atoms. Molecules, ionic lattices and network covalent structures have different, yet predictable, properties that depend on the identity of the elements and the types of bonds formed.

  Differences in electronegativity values can be used to predict where a bond fits on the continuum between ionic and covalent bonds. The polarity of a bond depends on the electronegativity difference and the distance between the atoms (bond length). Polar covalent bonds are introduced as an intermediary between ionic and pure covalent bonds. The concept of metallic bonding also is introduced to explain many of the properties of metals (e.g., conductivity). Since most compounds contain multiple bonds, a substance may contain more than one type of bond. Compounds containing carbon are an important example of bonding, since carbon atoms can bond together and with other atoms, especially hydrogen, oxygen, nitrogen and sulfur, to form chains, rings and branching networks that are present in a variety of compounds, including synthetic polymers, fossil fuels and the large molecules essential to life. Detailed study of the structure of molecules responsible for life is reserved for more advanced courses.

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- ***Representing Compounds***
  Using the periodic table, formulas of ionic compounds containing specific elements can be predicted. This can include ionic compounds made up of elements from groups 1, 2, 17, hydrogen and oxygen and polyatomic ions if given the formula and charge of the polyatomic ion. Given the formula, a compound can be named using conventional systems that include Greek prefixes and Roman numerals where appropriate. Given the name of an ionic or covalent substance, formulas can be written.

  Many different models can be used to represent compounds including chemical formulas, Lewis structures, and ball and stick models. These models can be used to visualize atoms and molecules and to predict the properties of substances. Each type of representation provides unique information about the compound. Different representations are better suited for particular substances. Lewis structures can be drawn to represent covalent compounds using a simple set of rules and can be combined with valence shell electron pair repulsion (VSEPR) theory to predict the three-dimensional electron pair and molecular geometry of compounds. Lewis structures and molecular geometries will only be constructed for the following combination of elements: hydrogen, carbon, nitrogen, oxygen, phosphorus, sulfur and the halogens. Organic nomenclature is reserved for more advanced courses.

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- ***Quantifying matter***
  In earlier grades, properties of materials were quantified with measurements that were always associated with some error. In this course, scientific protocols for quantifying the properties of matter accurately and precisely are studied. Using metric measuring systems, significant digits or figures, scientific notation, error analysis and dimensional analysis are vital to scientific communication.

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There are three domains of magnitude in size and time: the macroscopic (human) domain, the cosmic domain and the submicroscopic (atomic and subatomic) domain. Measurements in the cosmic domain and submicroscopic domains require complex instruments and/or procedures.

Matter can be quantified in a way that macroscopic properties such as mass can reflect the number of particles present. Elemental samples are a mixture of several isotopes with different masses. The atomic mass of an element is calculated given the mass and relative abundance of each isotope of the element as it exists in nature. Because the mass of an atom is very small, the mole is used to translate between the atomic and macroscopic levels. A mole is used as a counting number, like a dozen. It is equal to the number of particles in exactly 12 grams of carbon – 12 atoms. The mass of one mole of a substance is equal to its formula mass in grams. The formula mass for a substance can be used in conjunction with Avogadro's number and the density of a substance to convert between mass, moles, volume and number of particles of a sample.

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- ***Phases of Matter***

  In middle school, solids, liquids and gases were explored in relation to the spacing of the particles, motion of the particles and strength of attraction between the particles that make up the substance. In this course, plasmas and Bose-Einstein condensates also are included. Plasmas occur when gases have so much energy that the electrons are stripped away; therefore, they are electrically charged. In Bose-Einstein condensation the atoms, when subjected to temperatures a few billionths of a degree above absolute zero, all coalesce to lose individual identity and become a "super atom." Just as plasmas are super-hot atoms, Bose-Einstein condensates are the opposite – super-cold atoms (see **Note**). The forces of attraction between particles that determine whether a substance is a solid, liquid or gas at room temperature are addressed in greater detail with intermolecular chemical bonding later in the course.

  Note: The advancement of technology makes it possible to extend the boundaries of current knowledge and understanding. Consequently, Bose-Einstein condensates were only recently created in the laboratory (1995), although predicted more than 80 years ago. Detailed instruction of Bose-Einstein condensates or plasmas is not required at this grade level. This information is strictly for recognition that new discoveries are continually occurring, extending the realm of current understanding in science.

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- ***Intermolecular Chemical Bonding***

  In middle school, the concept of attractions between separate particles that hold molecules together in liquids and solids was introduced. These forces, called intermolecular attractions, are addressed in more detail in chemistry. Intermolecular attractions are generally weak when compared to intramolecular bonds, but span a wide range of strengths. The composition of a substance and the shape and polarity of a molecule are particularly important in determining the type and strength of bonding and intermolecular interactions. Types of intermolecular attractions include London dispersion forces (present between all molecules), dipole-dipole forces (present between polar molecules) and hydrogen bonding (a special case of dipole-dipole where hydrogen is bonded to a highly electronegative atom such as fluorine, oxygen or nitrogen), each with its own characteristic relative strengths.

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The configuration of atoms in a molecule determines the strength of the forces (bonds or intermolecular forces) between the particles and therefore the physical properties (e.g., melting point, boiling point, solubility, vapor pressure) of a material. For a given substance, the average kinetic energy (and therefore the temperature) needed for a change of state to occur depends upon the strength of the intermolecular forces between the particles. Therefore, the melting point and boiling point depend upon the amount of energy that is needed to overcome the attractions between the particles. Substances that have strong intermolecular forces or are made up of three-dimensional networks of ionic or covalent bonds tend to be solids at room temperature and have high melting and boiling points. Nonpolar organic molecules are held together by weak London dispersion forces. However, substances with longer chains provide more opportunities for these attractions and tend to have higher melting and boiling points. Increased branching of organic molecules interferes with the intermolecular attractions that lead to lower melting and boiling points.

Substances will have a greater solubility when dissolving in a solvent with similar intermolecular forces. If the substances have different intermolecular forces, they are more likely to interact with themselves than the other substance and remain separated from each other. Water is a polar molecule and it is often used as a solvent since most ionic and polar covalent substances will dissolve in it. In order for an ionic substance to dissolve in water, the attractive forces between the ions must be overcome by the dipole-dipole interactions with the water. Dissolving of a solute in water is an example of a process that is difficult to classify as a chemical or physical change and it is not appropriate to have students classify it one way or another.

Evaporation occurs when the particles with enough kinetic energy to overcome the attractive forces separate from the rest of the sample to become a gas. The pressure of these particles is called vapor pressure. Vapor pressure increases with temperature. Particles with larger intermolecular forces have lower vapor pressures at a given temperature since the particles require more energy to overcome the attractive forces between them. Molecular substances often evaporate more due to the weak attractions between the particles and can often be detected by their odor. Ionic or network covalent substances have stronger forces and are not as likely to volatilize. These substances often have little if any odor. Liquids boil when their vapor pressure is equal to atmospheric pressure.

In solid water, there is a network of hydrogen bonds between the particles that gives it an open structure. This is why water expands as it freezes and why solid water has a lower density than liquid water. This has important implications for life (e.g., ice floating on water acts as an insulator in bodies of water to keep the temperature of the rest of the water above freezing.)

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Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Design an investigation to show that the volume of any liquid sample is constant when divided by its mass (ref. ACS resource below).
- Devise an investigation to show that the addition of a solute affects the density of a liquid (ref. ACS resource below).

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- Investigate the volume of one drop of liquid from a Beral-type pipet. Devise a method. Defend the method with data and present it to a wider audience using multiple formats (ref. ACS resource below).
- Investigate the variations and similarities between regular table sugar, high fructose corn syrup, Stevia, Aspartame (Equal®), saccharin (Sweet n' Low®), sucralose (Splenda®) and Agave. Draw a conclusion, based on data analysis regarding which compound is the most damaging for human consumption. Present your findings in multiple formats. Variation for this project could be made with oils (e.g., canola, coconut, olive, vegetable).
- Determine the percent by mass of water content in popcorn. Correlate its effect on the amount of popcorn produced (or time it takes to start the batch popping). Compare three brands, isolate other variables (e.g., popping method, use of different types of oil) and present findings in multiple formats (http://faculty.coloradomtn.edu/jeschofnig/popcorn.htm).
- Design an investigation to substantiate or negate the claims of a commercial product (e.g., ionic-tourmaline, a mineral that is said to emit quick-drying ions; a hair dryer; a shake weight dumbbell; a type of strong-bond glue). Determine function of, intent of and any potential bias with the product. Present findings in multiple formats.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Chem4Kids, University of Colorado at Boulder, and Scientific American have articles and websites devoted to providing more information about Bose-Einstein condensates.
- "Ultra Cold Atoms" is an interview with a scientist who studies Bose-Einstein condensates. He describes the process needed to form Bose-Einstein condensates and the unusual properties of super-cooled matter.
- "How Low Can You Go" is an interactive simulation of the process by which substances can be cooled to absolute zero.
- ACS Small-Scale Laboratory Assessment Activities were prepared by Robert G. Silberman and Lucy T. Eubanks in association with the American Chemical Society Division of Chemical Education Examinations Institute in 1996 and provide excellent inquiry laboratory assessments. The Visions into Practice examples referenced above have been adapted from activities presented in this book.
- "Alkali metals" Discover the explosive results when water and alkali metals come together - and the science behind the reaction. Video.
- The Periodic Table of Data is an interactive periodic table. Students can select the properties they wish to view.
- Atoms and Molecules is a program produced by Annenberg that deals with teaching the very first steps of chemistry. It introduces the basic building blocks – the atoms – which, through their properties, periodicity and binding, form molecules.
- Masterminding Molecules seeks to develop logic and reinforce the principles of fair testing. It introduces the importance of concepts such as size, polarity and drug-like properties in the discovery of new medicines.

Career Connection

Students will base their investigations (variations and similarities between regular table sugar, high fructose corn syrup, Stevia, Aspartame, saccharin, sucralose, and Agave) upon products produced by companies (e.g.: Heinz, Marzetti, Dannon). While researching the products and companies, they will also identify the professionals involved in similar processes within the companies and how they use chemistry in their work. Students will identify the connection between the classroom chemistry content and business practices relative to improving and modifying foods.

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Common Misconceptions

- Students think volume and mass measure the same thing. (Minstrell, J., & Krause, P., n.d.)
- Students think big means the same thing as heavy. (Horton, 2007)
- Students think there are 100 cm^3 in 1 m^3.Horton, 2007)

Students often think that:

- Every different substance (e.g., CO_2, H_2O, salt) is made from atoms of that substance, not understanding that all substances come from the same set of elements assembled in different combinations.
- There is only one correct model of the atom.
- Electrons in an atom orbit nuclei like planets orbit the sun.
- Electron clouds are pictures of orbits.
- Electrons can be in any orbit they wish.
- Hydrogen is a typical atom.
- Electrons are physically larger than protons.
- Electrons and protons are the only fundamental particles.
- Physicists currently have the "right" model of the atom.
- Atoms can disappear (decay).
- Substances that are not hard and rigid cannot be solids (Stavy & Stachel, 1985).
- Chemists do not agree on how the "mole" should be defined: three meanings are that a mole is an individual unit of mass, a mole is a portion of substance and a mole is a number. Suggested (Kind, 2004) is that students be shown elements in a whole-number mass ratio, show that the ratio remains fixed regardless of the number of atoms, introduce the masses in grams, then introduce Avogadro's number while reinforcing atom size.
- Compounds with ionic bonds behave as simple molecules; instead, explore students' understanding of simple events like water boiling, sodium chloride and sugar dissolving, and ice melting. Make the events explicit by carrying them out in the students' presence and using molecular models to probe thinking about which bonds break and form (Kind, 2004).
- The first element in a formula is responsible for bond formation; instead, use cognitive conflict to show why atoms form different types of bonds and that atoms form compounds in the most energetically favorable way (Kind, 2004).
- Atoms "want" to form bonds; instead, use electrostatics to explain bond formation (Kind, 2004).
- There are only two types of bonds – covalent and ionic; instead, be consistent in using bonding terminology like "induced dipole-dipole bonds" and "permanent dipole-permanent dipole bonds because it is much more descriptive and clearly explains the kind of interaction involved (Kind, 2004).

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

Macro to Micro Structures is a program produced by Annenberg that deals with the conceptualization of micro processes and environments. It involves teaching chemistry through macro phenomena, which can be observed, and micro processes, which occur on the molecular level and can only be imagined.

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Classroom Portals

Annenberg offers ideas about teaching high school level environmental science using an integrated Earth systems approach at http://www.learner.org/resources/series209.html.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Earth's Resources

- Energy resources
  - Renewable and nonrenewable energy sources and efficiency
  - Alternate energy sources and efficiency
  - Resource availability
  - Mining and resource extraction
- Air and air pollution
  - Primary and secondary contaminants
  - Greenhouse gases
  - Clean Air Act
- Water and water pollution
  - Potable water and water quality
  - Hypoxia, eutrophication
  - Clean Water Act
  - Point source and non-point source contamination
- Soil and land
  - Desertification
  - Mass wasting and erosion
  - Sediment contamination
  - Land use and land management (including food production, agriculture and zoning)
  - Solid and hazardous waste
- Wildlife and wilderness
  - Wildlife and wilderness management
  - Endangered species

Content Elaboration

This topic explores the availability of Earth's resources, extraction of the resources, contamination problems, remediation techniques and the storage/disposal of the resources or by-products. Conservation, protection and sustainability of Earth's resources also are included. This builds upon grades 6-8 within the Earth and Space Science strand (sections pertaining to energy and Earth's resources) and the biology and physical science (in particular chemistry and energy topics) courses at the high school level.

To understand the effects that certain contaminants may have on the environment, scientific investigations and research must be conducted on a local, national and global level. Water, air, land, and biotic field and lab sampling/testing equipment and methods must be utilized with real-world application. Quantifiable field and/or lab data must be used to analyze and draw conclusions regarding air, water or land quality. Examples of types of water-quality testing include: hydraulic conductivity, suspended and dissolved solids, dissolved oxygen, biochemical oxygen demand, temperature, pH, fecal coliform and macro-invertebrate studies. Wetland or woodland delineations and analysis, land use analysis and air monitoring (e.g., particulate matter sizes/amount) are all appropriate field study investigations. Comparative analysis of scientific field or lab data should be used to quantify the environmental quality or conditions. Local data also can be compared to national and international data.

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The study of relevant, local problems can be a way to connect the classroom to the real world. Within Ohio, there are numerous environmental topics that can be investigated. Examples include wetland loss or mitigation, surface or ground water contamination (including sediment, chemical or thermal contamination), acid rain, septic system or sewage overflows/failures, landfill seepage, underground storage tank/pipe releases, deforestation, invasive species, air pollution (e.g., photochemical smog or particulate matter), soil loss/erosion or acid mine drainage.

At the advanced science level, renewable and nonrenewable energy resources topics investigate the effectiveness, risk and efficiency for differing types of energy resources at a local, state, national and global level. This builds upon grades 6-8 within both Earth and Space Science, and physical science at the high school level. Nuclear and geothermal energy are included in this topic.

Feasibility, availability, remediation and environmental cost are included in the extraction, storage, use and disposal of both abiotic and biotic resources. Environmental impact must be evaluated as it pertains to both the environmental and human risk. Examples include chemical hazards, radiation, biological hazards, toxicology and risk analysis studies. Learning about conservation and protection of the environment also requires an understanding of laws and regulations that exist to preserve resources and reduce and/or remediate contamination, but the emphasis should be on the science behind the laws and regulations.

Relating Earth's resources to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect the industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use, management and conservation. New discoveries and research are important parts of this topic.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Choose a specific environmental problem, such as the effect of herbicides in water (e.g., Atrizine), an invasive species (e.g., purple loosestrife or the Asian carp) or carbon monoxide in the atmosphere, and research the history, the scientific data before and after relevant laws were passed, and how this problem is being addressed in other countries/globally. Computer models or programs can be used to predict/analyze the problem or the movement of the contamination. Present scientific evidence and quantifiable data orally, through a poster session or in written form (scientific research paper).
- Design and conduct a field investigation that concentrates on a specific environmental problem (e.g., sediment contamination or acid mine drainage) and how the problem can be remediated. Compare results to similar communities, recommended limits, permit requirements or other published results. Analyze the data and make specific recommendations to limit, remediate, reduce or prevent the problem. Present findings to an authentic audience from the community.
- Research and document land-use planning or management in the community or at a specific location. Attend community meetings pertaining to land-use, land-management or zoning plans. Research questions should include: *What factors are used in determining use? What data is collected and analyzed? What changes are on the horizon?* Discuss in class.

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- Take a field trip to visit the water treatment facility or watch the drilling of a water well. Document observations, including information about how water is treated prior to and after use, specific issues that may impact the source, the location of the original water source, specific tests conducted (materials and methods needed to test and how the tests are conducted, results of the tests), and the steps taken to monitor the water at the source and throughout the process (including from the facility/well into the residence). Discuss with the class.
- Using real-time data, research the most severe environmental problems (and the root causes for the problems) that face the local community, Ohio, the United States or the world. Present evidence (quantitative data) and conclusions orally, through a poster session or in written form (scientific research paper).
- Research and collect specific data for a mass wasting or desertification event (can be present day or historical). Research questions should include: *What factors led to the event? What was the result of the event (how was each of Earth's spheres impacted)? What data is present (analyze the data and draw conclusions)? What laws are related to the event? How can this be prevented in the future?* Record the results graphically or in a scientific report.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The National Ground Water Association offers information, data and resources to support teachers in teaching all aspects of ground water at http://www.ngwa.org/.
- The U.S. Geological Survey outlines current surface water projects within the state of Ohio. Surface water-quality data (including stream gauge and volume data) can be found and used to support local field investigations. There also are links to provide historic surface and ground water data for analysis, at http://oh.water.usgs.gov/projects.htm?Category=Surface+Water.
- The U.S. Environmental Protection Agency offers a risk-assessment information system with specific Ohio risk assessments that can be used to provide background data or specific case studies. This information helps illustrate the types of tests that are included in a risk assessment and also provides different risk levels for specific contaminants. Find it at http://rais.ornl.gov/.
- The U.S. EPA houses an online SCREEN3 computer-modeling program for air pollutants. There also are resources and data explaining the use of computer modeling and air pollution that may be helpful in student research and investigation projects. Find it at http://www.epa.gov/scram001/aqmindex.htm.
- ODNR's website discusses acid mine drainage issue in Ohio. There also are specific links to Ohio watersheds (including maps of the watershed locations) that are in the abatement program and water quality data to study changes within a local area. Find it at http://www.ohiodnr.com/mineral/acid/tabid/10421/Default.aspx.
- The Ohio EPA offers a discussion about Ohio wetlands and the delineation, and qualitative analysis of Ohio wetlands at http://www.epa.state.oh.us/portals/47/facts/ohio_wetlands.pdf.
- The National Park Service provides information about Ohio woodlands and the types of data required to determine woodland quality. Find information addressing riparian woodlands at http://www.oardc.ohio-state.edu/ferel/riparian_home.htm.

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- The Ohio EPA outlines federal and state environmental laws at http://www.epa.state.oh.us/Rules_and_Laws.aspx.
- The Digital Library for Earth Systems Education offers resources from a number of sources, such as National Geographic, government agencies and other scientific agencies. Grade 9-12 resources are provided at http://www.dlese.org/library/query.do?q=&s=0&gr=02.
- The Solid Waste Authority of Central Ohio resource section offers ideas about landfill tours, information about waste management and specific problems facing Ohio at http://www.swaco.org/SmartKids/Resources.aspx.
- *Science News* and *Science Daily* offer information highlighting science in the news that can be used for class discussions. The information is updated weekly or bi-weekly and provides references and resource sites for more in-depth discussion. Visit http://www.sciencenews.org/ and http://www.sciencedaily.com/.
- NOAA provides real-time data for many of its projects and research missions at http://www.noaa.gov/sciencemissions/bpoilspill.html.
- For an index page for numerous environmental educational resources available through the Ohio EPA and associated agencies, visit http://www.epa.state.oh.us/oeef/ee_resources.aspx.
- Geology.com provides information on current events in all topic areas of geology, including resources and uses of resources, at http://geology.com/.
- The Ohio Department of Natural Resources provides data regarding sustainable water programs that are conducted in Ohio (monitoring programs, water quality testing information and contact information for the ODNR scientists that work in these areas) at http://ohiodnr.com/tabid/18951/Default.aspx.
- NSTA provides learning modules called “SciPacks” that are designed to increase teacher content knowledge through inquiry-based modules. Find a module addressing Earth’s resources and humans at http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/5/SG-27.
- The Ohio Department of Natural Resources’ Project Wet offers training and resources for K-12 teachers that promote deep understanding about all aspects of water and the interconnectedness of all of Earth’s spheres (Earth systems). Training and workshop opportunities can be found at http://www.dnr.state.oh.us/tabid/3501/Default.aspx.
- The College Board provides enduring understandings recommended for AP environmental science which can help to form discussion questions and research for this topic at http://professionals.collegeboard.com/profdownload/cbscs-science-standards-2009.pdf. Appendix A (page 175) of this document contains the environmental science information.
- Project Wet’s *Healthy Water, Healthy People* water quality educators guide offers ideas and resources for teaching all aspects of water and water contamination issues. Ideas for field monitoring, research projects and student investigations as well as teacher training are available at http://www.projectwet.org/water-resources-education/water-quality-education/.

Career Connection

Students will research careers related to environmental science (e.g., environmental engineer, hydrogeologist, water treatment plant operator, inspector, technician). Then, they will visit a water treatment facility and conduct career interviews to gather information about the various careers and their roles at the plant. Students will apply the information to their plan for education and training through high school and beyond.

Common Misconceptions

- Common misconceptions dealing with renewable energy efficiency along with suggestions to overcome these misconceptions through exploration and investigation are available on the website of California State University, Northridge, at http://www.csun.edu/~ml727939/coursework/690/Miha’s%20misconception%20report.doc.
- Misconceptions regarding all aspects of environmental science must be addressed through scientific data analysis, investigation and research. Discussing the conclusions and findings through a professional “gallery walk” can be a very useful way to determine possible misconceptions that exist for the class and address them. Carleton College offers a gallery walk website at http://serc.carleton.edu/introgeo/gallerywalk/misconceptions.html.

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Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

Annenberg offers ideas about teaching high school level environmental science using an integrated Earth systems approach at http://www.learner.org/resources/series209.html.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Global Environmental Problems and Issues

- Human population
- Potable water quality, use and availability
- Climate change
- Sustainability
- Species depletion and extinction
- Air quality
- Food production and availability
- Deforestation and loss of biodiversity
- Waste management (solid and hazardous)

Content Elaboration

This topic is a culminating section that incorporates the previous topics and applies them to a global or international scale. Case studies, developing and using models, collecting and analyzing water and/or air quality data, conducting or researching population studies and methods of connecting to the real world must be emphasized for this topic. Technology can be used for comparative studies to share local data internationally so that specific, quantifiable data can be compared and used in understanding the impact of some of the environmental problems that exist on a global scale. Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. Examples of global topics that can be explored include building water or air filtration models, investigating climate change data, monitoring endangered or invasive species, and studying the environmental effects of increasing human population. Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Investigate and research global human population patterns and changes over time. Example research questions include: *What countries have marked changes in populations at present, in the past? What are the factors that affect population change? What are verifiable relationships related to population (e.g., economic indicators, education levels, laws, resource availability, environmental conditions)?* Provide evidence and data to support conclusions. Document the research in a scientific research paper.

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Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The Digital Library for Earth Systems Education offers resources from a number of sources, such as National Geographic, government agencies and other scientific agencies. Grade 9-12 resources are provided at http://www.dlese.org/library/query.do?q=&s=0&gr=02.
- The College Board provides a document with Earth Science recommendations for grades 6-12 (beginning on page 21). Essential questions and scientific applications are included in this document to encourage investigation and scientific inquiry. In addition, connections to other topics and subjects are suggested to add relevancy and interest for the student. Find it at http://professionals.collegeboard.com/profdownload/cbscs-science-standards-2009.pdf.

Common Misconceptions

- Carleton College lists a number of geologic misconceptions for high school and college-age students at http://serc.carleton.edu/NAGTWorkshops/intro/misconception_list.html.
- Misconceptions regarding all aspects of environmental science must be addressed through scientific data analysis, investigation and research. Discussing the conclusions and findings through a professional "gallery walk" can be a very useful way to determine possible misconceptions that exist for the class and address them. Carleton College offers a gallery walk website at http://serc.carleton.edu/introgeo/gallerywalk/misconceptions.html.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

- EarthComm offers a program that uses many different strategies to reach students of all learning levels at http://www.agiweb.org/earthcomm/. The teaching of environmental science through relating the classroom to the real world is essential for many learners.

Classroom Portals

Annenberg offers ideas about teaching high school level environmental science using an integrated Earth systems approach at http://www.learner.org/resources/series209.html.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Earth's Resources

- Energy resources
  - Renewable and nonrenewable energy sources and efficiency
  - Alternate energy sources and efficiency
  - Resource availability
  - Mining and resource extraction
- Air
  - Primary and secondary contaminants
  - Greenhouse gases

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- Water
  - Potable water and water quality
  - Hypoxia, eutrophication
- Soil and sediment
  - Desertification
  - Mass wasting and erosion
  - Sediment contamination

Content Elaboration

This unit builds on the Earth and Space Science content from elementary school, when renewable/nonrenewable energy, soils, the atmosphere and water are introduced, to grades 6-8 when Earth' spheres, Earth's resources and energy resources are found and then to biology and physical science (in particular water, air, chemistry and energy topics) syllabi at the high school level.

At the high school science level, renewable and nonrenewable energy resources topics investigate the effectiveness and efficiency for differing types of energy resources at a local, state, national and global level. Feasibility, availability and environmental cost are included in the extraction, storage, use and disposal of both abiotic and biotic resources. Modeling (3-D or virtual), simulations and real-world data must be used to investigate energy resources and exploration. The emphasis must be on current, actual data, contemporary science and technological advances in the field of energy resources.

Relating Earth's resources (energy, air, water, soil) to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use and conservation.

Smaller scale investigations, such as a field study to monitor stream quality, construction mud issues, stormwater management, nonpoint source-contamination problems (e.g., road-salt runoff, agricultural runoff, parking lot runoff) or thermal water contamination can be useful in developing a deeper understanding of Earth's resources.

Earth Systems must be used to illustrate the interconnectedness of each of Earth's spheres (the hydrosphere, lithosphere, atmosphere and biosphere) and the relationship between each type of Earth's resources.

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Design and build (virtual, blueprint or 3-D model) an *Eco-House* that uses green technology and allows the house to be *off-grid*. Designate a specific location and research/evaluate the different options that would be efficient and effective for that area. Present the final product (with complete explanation and defense of choices/options) to the class.

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- Design an experiment to determine the amount and size of particulate matter in the air at the school or community. Analyze the results using information from the Environmental Protection Agency and the Department of Health (e.g., lung diseases, including emphysema and asthma). Locate specific Ohio data for comparative analysis. Report class findings and recommendations orally or in written form to school administrators.
- Investigate local contamination issues. Research existing laws that apply, recommend ways to reduce or prevent contamination (based on scientific data and research), invite community speakers/professionals and collect samples (water, soil, air) to test. Document findings, determine a way to share findings with the community and present to an authentic audience.
- Research and collect specific data for a mass wasting or desertification event (can be present day or historical). Research questions should include: *What factors led to the event? What was the result of the event (how was each of Earth's spheres impacted)? What data is present (analyze data and draw conclusions)? What laws are related to the event? How can this be prevented in the future?* Record the results graphically or in a scientific report.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The National Ground Water Association offers information, data and resources to support teachers in teaching all aspects of ground water at http://www.ngwa.org/.
- NOAA provides real-time data for many of its projects and research missions at http://www.noaa.gov/sciencemissions/bpoilspill.html.
- *Science News* and *Science Daily* offer information highlighting science in the news that can be used for class discussions. The information is updated weekly or bi-weekly and provides references and resource sites for more in-depth discussion. Visit http://www.sciencenews.org/ and http://www.sciencedaily.com/.
- Geology.com provides information on current events in all topic areas of geology, including resources and uses of resources, at http://geology.com/.
- NSTA provides learning modules called "SciPacks" that are designed to increase teacher content knowledge through inquiry-based modules. Find a module addressing Earth's resources and humans at http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/5/SG-27.
- The Ohio Department of Natural Resources' Project Wet offers training and resources for K-12 teachers that promote deep understanding about all aspects of water and the interconnectedness of all of Earth's spheres (Earth Systems). Training and workshop opportunities can be found at http://www.dnr.state.oh.us/tabid/3501/Default.aspx.
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- Project Wet's *Healthy Water, Healthy People* water quality educators guide offers ideas and resources for teaching all aspects of water and water contamination issues. Ideas for field monitoring, research projects and student investigations as well as teacher training are available at http://www.projectwet.org/water-resources-education/water-quality-education/.

Career Connection

In designing and building an Eco-House, students will include Ohio-based businesses and companies in their presentation. They will identify companies who manufacture qualifying materials, design suitable structures, and construct buildings that meet the specifications. Students will conduct career interviews, workplace visits, and navigate company websites to collect data and information. The explanations for choosing each company will be included in their presentation.

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Common Misconceptions

- Common misconceptions dealing with renewable energy efficiency along with suggestions to overcome these misconceptions through exploration and investigation are available on the website of California State University, Northridge, at http://www.csun.edu/~ml727939/coursework/690/Miha's%20misconception%20report.doc.
- Carleton College lists a number of geologic misconceptions for high school and college-age students at http://serc.carleton.edu/NAGTWorkshops/intro/misconception_list.html.
- Misconceptions regarding all aspects of environmental science must be addressed through scientific data analysis, investigation and research. Discussing the conclusions and findings through a professional "gallery walk" can be a very useful way to determine possible misconceptions that exist for the class and address them. Carleton College offers a gallery walk website at http://serc.carleton.edu/introgeo/gallerywalk/misconceptions.html.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

Annenberg offers ideas about teaching high school level environmental science using an integrated Earth systems approach at http://www.learner.org/resources/series209.html.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Glacial Geology

- Glaciers and glaciation
  - Evidence of past glaciers (including features formed through erosion or deposition)
  - Glacial deposition and erosion (including features formed through erosion or deposition)
  - Data from ice cores
    - Historical changes (glacial ages, amounts, locations, particulate matter, correlation to fossil evidence)
    - Evidence of climate changes throughout Earth's history
  - Glacial distribution and causes of glaciation
  - Types of glaciers – continental (ice sheets, ice caps), alpine/valley (piedmont, valley, cirque, ice caps)
  - Glacial structure, formation and movement

Content Elaboration

This unit builds upon the fourth-grade introduction of Earth's surface (landforms and features, including glacial geology) and the middle school Earth and Space Science strand, with sedimentary, igneous and metamorphic rocks, sediment and soils, the geologic record and Earth's history, the cryosphere and the relationship of the analysis of ice cores in understanding changes in climate over thousands of years. Fossils and fossil evidence within the geologic record is found in the Life Science strand, building from second grade through high school biology.

Tracing and tracking glacial history and present-day data for Ohio, the United States and globally is an emphasis for this unit. Scientific data found in the analysis of the geologic record, ice cores and surficial geology should be used to provide the evidence for changes that have occurred over the history of Earth and are observable in the present day. New discoveries, mapping projects, research, contemporary science and technological advances must be included in the study of glacial geology.

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- Explore the benefits of radiation and how it can be used as a tool to sustain life (sterilization and food irradiation processes, nuclear medicine). Include details about how the radiation works to accomplish the benefit and the extent (limit or range) that the benefit will continue as opposed to becoming a harm to life (plants, animals or human beings) on Earth. Draw conclusions and present an argument based on supporting data as to when radiation poses a threat as opposed to being beneficial. Present findings in multiple formats.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The Rutherford experiment is a simulation that shows high-speed particles bombarding a thin foil. While the simulation is not to scale, it does provide a dynamic visual to help students understand what is happening at the atomic level that explains the experimental evidence.

Common Misconceptions

- Students may think that models are physical copies of the real thing, failing to recognize models as conceptual representations. (AAAS, 1993)
- Students know models can be changed, but at the high school level, they may be limited by thinking that a change in a model means adding new information or that changing a model means replacing a part that was wrong. (AAAS, 1993)
- Students often do not believe models can duplicate reality. (AAAS, 1993)
- Students often think that breaking bonds releases energy. (Ross, 1993)
- When multiple models are presented, they tend to think there is one “right one”. (AAAS, 1993)

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Resources based on the Universal Design for Learning principles are available at www.cast.org.

Classroom Portals

“Teaching High School Science” is a series of videos-on-demand produced by Annenberg that show classroom strategies for implementing inquiry into the high school classroom. While not all of the content is aligned to physical science, the strategies can be applied to any content.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Energy and Waves

- Conservation of energy
  - Quantifying kinetic energy
  - Quantifying gravitational potential energy
  - Energy is relative
- Transfer and transformation of energy (including work)
- Waves
  - Refraction, reflection, diffraction, absorption, superposition
  - Radiant energy and the electromagnetic spectrum
  - Doppler shift

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- Thermal energy
- Electricity
  - Movement of electrons
  - Current
  - Electric potential (voltage)
  - Resistors and transfer of energy

Content Elaboration

Energy and Waves

Building upon knowledge gained in elementary and middle school, major concepts about energy and waves are further developed. Conceptual knowledge will move from qualitative understandings of energy and waves to ones that are more quantitative using mathematical formulas, manipulations and graphical representations.

- ***Conservation of Energy***
  Energy content learned in middle school, specifically conservation of energy and the basic differences between kinetic and potential energy, is elaborated on and quantified in this course. Energy has no direction and has units of Joules (J). Kinetic energy, E_k, can be mathematically represented by $E_k = ½mv^2$. Gravitational potential energy, E_g, can be mathematically represented by $E_g = mgh$,. The amount of energy of an object is measured relative to a reference that is considered to be at a point of zero energy. The reference may be changed to help understand different situations. Only the change in the amount of energy can be measured absolutely. The conservation of energy and equations for kinetic and gravitational potential energy can be used to calculate values associated with energy (i.e., height, mass, speed) for situations involving energy transfer and transformation. Opportunities to quantify energy from data collected in experimental situations (e.g., a swinging pendulum, a car travelling down an incline) must be provided.

[Back to Energy and Waves Outline] [Back to Physical Science Outline]

- ***Transfer and Transformation of Energy***
  In middle school, concepts of energy transfer and transformation were addressed, including conservation of energy, conduction, convection and radiation, the transformation of electrical energy, and the dissipation of energy into thermal energy. Work also was introduced as a method of energy transfer into or out of the system when an outside force moves an object over a distance. In this course, these concepts are further developed. As long as the force, **F**, and displacement, ***Δx,*** are in the same or opposite directions, work, W, can be calculated from the equation $W = F\Delta x$. Energy transformations for a phenomenon can be represented through a series of pie graphs or bar graphs. Equations for work, kinetic energy and potential energy can be combined with the law of conservation of energy to solve problems. When energy is transferred from one system to another, some of the energy is transformed to thermal energy. Since thermal energy involves the random movement of many trillions of subatomic particles, it is less able to be organized to bring about further change. Therefore, even though the total amount of energy remains constant, less energy is available for doing useful work.

[Back to Energy and Waves Outline] [Back to Physical Science Outline]

- ***Waves***
  As addressed in middle school, waves transmit energy from one place to another, can transfer energy between objects and can be described by their speed, wavelength, frequency and amplitude. The relationship between speed, wavelength and frequency also was addressed in middle school Earth and Space Science as the motion of seismic waves through different materials is studied.

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In elementary and middle school, reflection and refraction of light were introduced, as was absorption of radiant energy by transformation into thermal energy. In this course, these processes are addressed from the perspective of waves and expanded to include other types of energy that travel in waves. When a wave encounters a new material, the new material may absorb the energy of the wave by transforming it to another form of energy, usually thermal energy. Waves can be reflected off solid barriers or refracted when a wave travels form one medium into another medium. Waves may undergo diffraction around small obstacles or openings. When two waves traveling through the same medium meet, they pass through each other then continue traveling through the medium as before. When the waves meet, they undergo superposition, demonstrating constructive and destructive interference. Sound travels in waves and undergoes reflection, refraction, interference and diffraction. In the physics syllabus, many of these wave phenomena will be studied further and quantified.

Radiant energy travels in waves and does not require a medium. Sources of light energy (e.g., the sun, a light bulb) radiate energy continually in all directions. Radiant energy has a wide range of frequencies, wavelengths and energies arranged into the electromagnetic spectrum. The electromagnetic spectrum is divided into bands: radio (lowest energy), microwaves, infrared, visible light, X-rays and gamma rays (highest energy) that have different applications in everyday life. Radiant energy of the entire electromagnetic spectrum travels at the same speed in a vacuum. Specific frequency, energy or wavelength ranges of the electromagnetic spectrum are not required. However, the relative positions of the different bands, including the colors of visible light, are important (e.g., ultraviolet has more energy than microwaves). Radiant energy exhibits wave behaviors including reflection, refraction, absorption, superposition and diffraction, depending in part on the nature of the medium. For opaque objects (e.g., paper, a chair, an apple), little if any radiant energy is transmitted into the new material. However the radiant energy can be absorbed, usually increasing the thermal energy of the object and/or the radiant energy can be reflected. For rough objects, the reflection in all directions forms a diffuse reflection and for smooth shiny objects, reflections can result in clear images. Transparent materials transmit most of the energy through the material but smaller amounts of energy may be absorbed or reflected.

Changes in the observed frequency and wavelength of a wave can occur if the wave source and the observer are moving relative to each other. When the source and the observer are moving toward each other, the wavelength is shorter and the observed frequency is higher; when the source and the observer are moving away from each other, the wavelength is longer and the observed frequency is lower. This phenomenon is called the Doppler shift and can be explained using diagrams. This phenomenon is important to current understanding of how the universe was formed and will be applied in later sections of this course. Calculations to measure the apparent change in frequency or wavelength are not appropriate for this course.

[Back to Energy and Waves Outline] [Back to Physical Science Outline]

- ***Thermal Energy***
  In middle school, thermal energy is introduced as the energy of movement of the particles that make up matter. Processes of heat transfer, including conduction, convection and radiation, are studied. In other sections of this course, the role of thermal energy during heating, cooling and phase changes is explored conceptually and graphically. In this course, rates of thermal energy transfer and thermal equilibrium are introduced.

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Thermal conductivity depends on the rate at which thermal energy is transferred from one end of a material to another. Thermal conductors have a high rate of thermal energy transfer and thermal insulators have a slow rate of thermal energy transfer. The rate at which thermal radiation is absorbed or emitted by a system depends on its temperature, color, texture and exposed surface area. All other things being equal, in a given amount of time, black rough surfaces absorb more thermal energy than smooth white surfaces. An object or system is continually absorbing and emitting thermal radiation. If the object or system absorbs more thermal energy than it emits and there is no change in phase, the temperature increases. If the object or system emits more thermal energy than is absorbed and there is no change in phase, the temperature decreases. For an object or system in thermal equilibrium, the amount of thermal energy absorbed is equal to the amount of thermal energy emitted; therefore, the temperature remains constant. In chemistry, changes in thermal energy are quantified for substances that change their temperature.

[Back to Energy and Waves Outline] [Back to Physical Science Outline]

- ***Electricity***

  In earlier grades, these concepts were introduced: electrical conductors and insulators; and a complete loop is needed for an electrical circuit that may be parallel or in a series. In this course, circuits are explained by the flow of electrons, and current, voltage and resistance are introduced conceptually to explain what was observed in middle school. The differences between electrical conductors and insulators can be explained by how freely the electrons flow throughout the material due to how firmly electrons are held by the nucleus.

  By convention, electric current is the rate at which positive charge flows in a circuit. In reality, it is the negatively charged electrons that are actually moving. Current is measured in amperes (A), which is equal to one coulomb of charge per second (C/s). In an electric circuit, the power source supplies the electrons already in the circuit with electric potential energy by doing work to separate opposite charges. For a battery, the energy is provided by a chemical reaction that separates charges on the positive and negative sides of the battery. This separation of charge is what causes the electrons to flow in the circuit. These electrons then transfer energy to other objects and transform electrical energy into other forms (e.g., light, sound, heat) in the resistors. Current continues to flow, even after the electrons transfer their energy. Resistors oppose the rate of charge flow in the circuit. The potential difference or voltage across an energy source is a measure of potential energy in Joules supplied to each coulomb of charge. The volt (V) is the unit of potential difference and is equal to one Joule of energy per coulomb of charge (J/C). Potential difference across the circuit is a property of the energy source and does not depend upon the devices in the circuit. These concepts can be used to explain why current will increase as the potential difference increases and as the resistance decreases. Experiments, investigations and testing (3-D or virtual) must be used to construct a variety of circuits, and measure and compare the potential difference (voltage) and current. Electricity concepts are dealt with conceptually in this course. Calculations with circuits will be addressed in the physics syllabus.

[Back to Energy and Waves Outline] [Back to Physical Science Outline]

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

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Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Design, build and test a ramp system onto which a ball can be placed so that it rolls down a ramp and continues a specific distance on the table. Describe what properties of the system were important (and those not important) in the design. Provide different target distances for the launched ball to travel on the designed course and hit a given target within three trials.
- Investigate the relationship between speed, frequency and wavelength for a transverse wave traveling through a Slinky®. Make claims about what happens to the speed and the wavelength of the wave as the frequency is increased and give evidence to support any claims. For example, use information from the investigation to explore the implications of cell phone usage. Include beneficial and harmful aspects of the use of this technology for a modern convenience. Present findings and draw a conclusion using data and research in multiple formats.

Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- "Energy: Misconceptions and Models" is a downloadable document from the U.K. Department for Education that gives strategies for teaching different models of energy and addressing misconceptions about energy.
- "Waves, Light, and Sound" from The Physics Zone links to many animations of waves that can be used with absent students or students who need more reinforcement. Simulations also may be good to slow down some of the phenomena that students observe in class so they can make observations that are more detailed. Some of the simulations can only be accessed by members, but many of the simulations have unrestricted access.
- Modeling workshops are available nationally that help teachers develop a framework for using guided inquiry in their instruction.

Career Connection

As students explore the flow of electric current, resistors, and transfer of energy, they will identify issues found after a severe storm disrupts electricity across an area. Students will look into how current flows and what occurs during a storm that interrupts or interferes with the transfer of electricity. Students will identify potential problems caused by the storm. Then, they will generate a plan to restore electricity by determining which careers are needed and their respective roles in the process. Students will research aspects of careers, such as: job outlook for these careers in Ohio; current demand; education and training requirements (high school and beyond); and wages, working conditions, and typical tasks.

Common Misconceptions

Students often think that:

- Potential energy is a thing that objects hold (like cereal stored in a closet).
- The only type of potential energy is gravitational.
- Doubling the velocity of a moving object will double its kinetic energy.
- Stored energy is something that causes energy later; it is not energy until it has been released.
- Objects do not have any energy if they are not moving.
- Energy is a thing that can be created and destroyed.
- Energy is literally lost in many energy transformations.
- Gravitational potential energy depends only upon the height of an object.
- Energy can be changed completely from one form to another with no loss of useful energy.

Diverse Learners

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- This tutorial from The Physics Classroom demonstrates the strategy of using energy bar graphs to solve conservation of energy problems.
- Constructing energy bar graphs is a way for students to conceptually organize the energy changes involved in a problem. Once such a diagram is completed, the appropriate equation for a specific problem can be written using an understanding of conservation of matter. Some methods show work done on and by the system as energy flowing into and out of the system. Other methods show work done on and by the system as a part of the bar graph. The second reference shows the equation first, then the diagram. However, students have an easier time drawing the diagram, then writing the equation from the diagram.
- Energy flow diagrams picture energy transformations in an accurate, quantitative and conceptually transparent manner. Energy Flow Diagrams for Teaching Physics Concepts is a paper that was published in *The Physics Teacher* that outlines how to use these tools in the classroom. It proceeds from simple processes to complex socially significant processes such as global warming.

Common Misconceptions

Students often think that:

- Energy gets used up or runs out.
- Something not moving cannot have any energy.
- Force acting on an object does work even if the object does not move.
- Energy is destroyed in transformations from one type to another.
- Energy can be recycled.
- Gravitational potential energy is the only type of potential energy.
- When an object is released to fall, the gravitational potential energy immediately becomes all kinetic energy.
- Energy is not related to Newton's laws.
- Energy is a force.

Diverse Learners

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Classroom Portals

"Teaching High School Science" is a series of videos-on-demand produced by Annenberg that show classroom strategies for implementing inquiry into the high school classroom. While not all of the content is aligned to physical science, the strategies can be applied to any content.

Course Content

The following information may be taught in any order; there is no ODE-recommended sequence.

Waves

- Wave properties
  - Conservation of energy
  - Reflection
  - Refraction
  - Interference
  - Diffraction

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- Light phenomena
  - Ray diagrams (propagation of light)
  - Law of reflection (equal angles)
  - Snell's law
  - Diffraction patterns
  - Wave – Particle duality of light
  - Visible spectrum and color

Content Elaboration

Waves

In earlier grades, the electromagnetic spectrum and basic properties (wavelength, frequency, amplitude) and behaviors of waves (absorption, reflection, transmission, refraction, interference, diffraction) were introduced. In this course, conservation of energy is applied to waves and the measurable properties of waves (wavelength, frequency, amplitude) are used to mathematically describe the behavior of waves (index of refraction, law of reflection, single- and double-slit diffraction). The wavelet model of wave propagation and interactions is not addressed in this course. Waves must be explored experimentally in the laboratory. This may include, but is not limited to, water waves, waves in springs, the interaction of light with mirrors, lenses, barriers with one or two slits, and diffraction gratings.

- ***Wave Properties***

  When a wave reaches a barrier or a new medium, a portion of its energy is reflected at the boundary and a portion of the energy passes into the new medium. Some of the energy that passes to the new medium may be absorbed by the medium and transformed to other forms of energy, usually thermal energy, and some continues as a wave in the new medium. Some of the energy also may be dissipated, no longer part of the wave since it has been transformed into thermal energy or transferred out of the system due to the interaction of the system with surrounding objects. Usually all of these processes occur simultaneously, but the total amount of energy must remain constant.

  When waves bounce off barriers (reflection), the angle at which a wave approaches the barrier (angle of incidence) equals the angle at which the wave reflects off the barrier (angle of reflection). When a wave travels from a two-dimensional (e.g., surface water, seismic waves) or three-dimensional (e.g., sound, electromagnetic waves) medium into another medium in which the wave travels at a different speed, both the speed and the wavelength of the transferred wave change. Depending on the angle between the wave and the boundary, the direction of the wave also can change resulting in refraction. The amount of bending of waves around barriers or small openings (diffraction) increases with decreasing wavelength. When the wavelength is smaller than the obstacle or opening, no noticeable diffraction occurs. Standing waves and interference patterns between two sources are included in this topic. As waves pass through a single or double slit, diffraction patterns are created with alternating lines of constructive and destructive interference. The diffraction patterns demonstrate predictable changes as the width of the slit(s), spacing between the slits and/or the wavelength of waves passing through the slits changes.

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- ***Light phenomena***
  The path of light waves can be represented with ray diagrams to show reflection and refraction through converging lenses, diverging lenses and plane mirrors. Since light is a wave, the law of reflection applies. Snell's law, $n_1 sin\theta_1 = n_2 sin\theta_2$, quantifies refraction in which n is the index of refraction of the medium and θ is the angle the wave enters or leaves the medium, when measured from the normal line. The index of refraction of a material can be calculated by the equation $n = c/v$, where n is the index of refraction of a material, v is the speed of light through the material, and c is the speed of light in a vacuum. Diffraction patterns of light must be addressed, including patterns from diffraction gratings.

  There are two models of how radiant energy travels through space at the speed of light. One model is that the radiation travels in discrete packets of energy called photons that are continuously emitted from an object in all directions. The energy of these photons is directly proportional to the frequency of the electromagnetic radiation. This particle-like model is called the photon model of light energy transfer. A second model is that radiant energy travels like a wave that spreads out in all directions from a source. This wave-like model is called the electromagnetic wave model of light energy transfer. Strong scientific evidence supports both the particle-like model and wave-like model. Depending on the problem scientists are trying to solve, either the particle-like model or the wave-like model of radiant energy transfer is used. Students are not required to know the details of the evidence that supports either model at this level.

  Humans can only perceive a very narrow portion of the electromagnetic spectrum. Radiant energy from the sun or a light bulb filament is a mixture of all the colors of light (visible light spectrum). The different colors correspond to different radiant energies. When white light hits an object, the pigments in the object reflect one or more colors in all directions and absorb the other colors.

[Back to Waves Outline] [Back to Physics Outline]

Expectations for Learning: Cognitive Demands

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning and to develop summative assessment of student learning of science.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

- Design a system involving three refraction tanks and three different lenses so that a beam of light entering the system at a given angle can pass through all three tanks of liquid and leave the other side at a different angle.
- Investigate the refraction of light as it passes from air into a new liquid medium. Draw incident and refracted rays for many different angles and measure the angles of both. Present the material graphically to determine the index of refraction for the liquid.

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Instructional Strategies and Resources

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- "Radio waves and electromagnetic fields" is an interactive simulation from PhET that allows students to explore how electromagnetic radiation is produced. Students can wiggle the transmitter electron manually or have it oscillate automatically and display the field as a curve or as vectors. There is a strip chart that shows the electron positions at the transmitter and at the receiver.
- "Geometric Optics" is an interactive simulation from PhET that illustrates how light rays are refracted by a lens. Students can adjust the focal length of the lens, move the object, move the lens or move the screen and see how the image changes.

Career Connection

Students will examine commonalities among careers within this field, such as sonographer, air traffic controller, optician, photographer, cosmos, and physical therapist. Then, they will research careers that use waves as a necessary aspect of their typical duties, including career interviews, workplace visits, and navigating company websites. Students will apply this information to their plan for education and training through high school and beyond.

Common Misconceptions

Students often think that:

- Waves transport matter.
- There must be a medium for a wave to travel through.
- Waves do not have energy.
- All waves travel the same way.
- Frequency is connected to loudness for all amplitudes.
- Big waves travel faster than small waves in the same medium.
- Different colors of light are different types of waves.
- Pitch is related to intensity.
- Light just is and has no origin.
- Light is a particle.
- Light is a mixture of particles and waves.
- Light waves and radio waves are not the same thing.
- In refraction, the characteristics of light change.
- The speed of light never changes.
- Rays and wave fronts are the same thing.
- There is no interaction between light and matter.
- The addition of all colors of light yields black.
- Double slit interference shows light wave crest and troughs.
- Light exits in the crest of a wave and dark in the trough.
- In refraction, the frequency (color) of light changes.
- Refraction is the bending of waves.

Diverse Learners

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Classroom Portals

"Teaching High School Science" is a series of videos-on-demand produced by Annenberg that show classroom strategies for implementing inquiry into the high school classroom. While not all of the content is aligned to physical science, the strategies can be applied to any content.

Kindergarten

Theme	***A Child's Place in Time and Space***
Strand	***Government***
Topic	***Civic Participation and Skills*** Civic participation embraces the ideal that an individual actively engages in his or her community, state or nation for the common good. Students need to practice effective communication skills including negotiation, compromise and collaboration. Skills in accessing and analyzing information are essential for citizens in a democracy.
Content Statement	***9. Individuals have shared responsibilities toward the achievement of common goals in homes, schools and communities.***

Content Elaborations

Each person in the home, school and community has responsibilities. When individuals share these responsibilities, group goals are more easily accomplished.

For example, children can share responsibilities to take care of a classroom garden.

Expectations for Learning

Identify responsibilities at home and in the school and community and describe how individuals share those responsibilities to achieve common goals.

Instructional Strategies

Initiate a learning project and establish individual and shared responsibilities to accomplish a common goal.

Career Connection

Organize the classroom to represent the larger community with various career-based learning centers (e.g., reading center: communications; toy animals: animal care; kitchen: agriculture or hospitality; dress-up: textiles or retail; toy cars: automotive). Students will role play, recognizing their responsibilities within each center as those of the respective career fields. Lead a discussion with students where they will identify the careers they experienced.

Diverse Learners

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Center for the Social Emotional Foundations for Early Learning (CSEFEL) http://csefel.vanderbilt.edu/

Select *For Teachers/Caregivers* for free resources about developing social skills in young children. Resources also are available for parents.

Connections

Teach with Content Statement 10.

Essential Questions

Grade One

Theme	***Families Now and Long Ago, Near and Far***
Strand	***Economics***
Topic	***Production and Consumption*** Production is the act of combining natural resources, human resources, capital goods and entrepreneurship to make goods and services. Consumption is the use of goods and services.
Content Statement	***12. People produce and consume goods and services in the community.***

Content Elaborations

People in the community work at jobs where they produce goods and services.

- Goods are objects that are capable of satisfying people's wants (e.g., homes, cars, furniture, food, clothing).
- Services are actions that are capable of satisfying people's wants (e.g., medical care, restaurants, hotels, lawn mowing, babysitting).

People also are consumers in the community. Consumer wants are satisfied by using goods and services.

People can be both producers and consumers.

Expectations for Learning

Demonstrate how people are producers and consumers in the community.

Instructional Strategies

Career Connection

Students will conduct a workplace visit to their school cafeteria where they will explore the location that lunch is consumed. Discuss related careers that are involved in the many aspects of consumption (e.g., agriculture: farmers, logistics: shipping and receiving companies, transportation: truck drivers and delivery drivers, business and marketing: retail sales).

Diverse Learners

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Instructional Resources

Lesson Plan: Simple Simon Meets a Producer

http://www.econedlink.org/lessons/index.php?lid=464&type=educator

Using the classic rhyme, *Simple Simon and the Pie-Man*, children are introduced to the concepts of consumer and producer

Connections

Essential Questions

Grade Two

Theme	***People Working Together***
Strand	***Economics***
Topic	***Financial Literacy*** Financial literacy is the ability of individuals to use knowledge and skills to manage limited financial resources effectively for lifetime financial security.
Content Statement	***17. People earn income by working.***

Content Elaborations

First-grade students learned that currency (money) is a means of economic exchange. Second graders understand that people earn income (money) by working at jobs. People spend the money they earn purchasing the things they need and want.

People can save a portion of their income for the purchase of future goods and services.

Expectations for Learning

Explain how people earn income.

Instructional Strategies

Host a Career Day and invite community members to talk about how they earn money in the work that they do. Focus the day on a variety of careers.

Career Connection

Host several career speakers to discuss how they earn money in their job. Include a selection of careers that represent varied levels of education and training, career fields, and workplaces. To prepare, lead a discussion with students where they will create a list of questions to ask the career speakers (e.g., what do you do on a typical day, how much money could someone expect to make starting out, do you need a certificate or license, what education and training is required). Following the career speakers, allow students to reflect upon the information and share their interests related to the different careers.

Diverse Learners

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Instructional Resources

Connections

Essential Questions

Grade Three

Theme	***Communities: Past and Present, Near and Far***
Strand	***Geography***
Topic	***Places and Regions*** A place is a location having distinctive characteristics, which give it meaning and character and distinguish it from other locations. A region is an area with one or more common characteristics, which give it a measure of homogeneity and make it different from surrounding areas. Regions and places are human constructs.
Content Statement	***5. Daily life is influenced by the agriculture, industry and natural resources in different communities.***

Content Elaborations

Artifacts (material objects of a culture such as a tool, an article of clothing or a prepared food) and photographs can be used to help students understand life in the local community. Students examine artifacts and photographs from the past and present, and places far and near to make inferences about the influence of agriculture, industry and natural resources on daily life.

Expectations for Learning

Evaluate the influence of agriculture, industry and natural resources on daily life.

Instructional Strategies

Students communicate with pen pals/e-pals in other communities and ask questions about agriculture, industry and natural resources. Students can collect photographs from the pen pals that show daily life in their communities. The teacher guides students to make inferences about the influence of agriculture, industry and natural resources on daily life in these communities.

Career Connection

As students communicate with pen pals or e-pals in other communities, they will explore the agriculture industry and natural resources throughout their region. Guide students to recognize the influence that agriculture and natural resources have on daily life across communities. Students will generate and exchange responses with their e-pals regarding practices related to agriculture and natural resources. They will ask questions relative to the types of careers available within agriculture and natural resources, and the types of places people work (e.g., large companies, small businesses, entrepreneurs).
Students will learn about the types of careers available throughout their respective communities, and compare and contrast those practices with their own community, particularly in relation to the tools, resources, and technologies available.

Diverse Learners

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Create a collage of materials that are found in the local area to help students make inferences about the influence of agriculture, industry, etc.

Instructional Resources

Connections

	Connections can be made to the Technology Academic Content Standards, Technology and Society Interaction Standard, Benchmark C, regarding how people have made tools to provide food, make clothing and provide protection.
Essential Questions	

Grade Four

Theme	***Ohio in the United States***
Strand	***Economics***
Topic	***Production and Consumption*** Production is the act of combining natural resources, human resources, capital goods and entrepreneurship to make goods and services. Consumption is the use of goods and services.
Content Statement	***23. Entrepreneurs in Ohio and the United States organize productive resources and take risks to make a profit and compete with other producers.***

Content Elaborations

Productive resources (i.e., natural resources, human resources and capital goods) are the resources used to make goods and services.

An entrepreneur is an individual who organizes the use of productive resources to produce goods or services.

Entrepreneurs are willing to take risks to identify and develop new products or start a new business. Entrepreneurs recognize opportunities to use productive resources to make a profit and accept the challenges involved in competing with other producers in the marketplace.

Expectations for Learning

Explain characteristics of entrepreneurship, including the risks and benefits.

Instructional Strategies

To introduce productive resources, have students help you create a list of everything that is needed to make a good (e.g., chocolate chip cookies). Talk with students about where these resources come from and the risks involved in making this product (e.g., W*hat if the price of sugar or chocolate chips rises dramatically?*).

Possible unit question: *Do decisions made by entrepreneurs determine the success of a business?*

Career Connection

Students will role-play that they are coordinating a fundraiser and need to buy the resources needed to make cookies. Students will assume career-based roles (e.g., purchasing, advertising, budgeting, baking, logistics) while addressing aspects of entrepreneurship and production. Then, lead a discussion with students addressing the relationship among these skills to the classroom and the workplace.

Diverse Learners

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Introduce the topic with stories and picture books related to entrepreneurs.

Have the students design and create a product using recycled materials. They will create the marketing and advertisements and sell the product with the proceeds being donated to charity.

Instructional Resources

Connections

Essential Questions

Theme	***Regions and People of the Western Hemisphere***
Strand	***Economics***
Topic	***Financial Literacy*** Financial literacy is the ability of individuals to use knowledge and skills to manage limited financial resources effectively for lifetime financial security.
Content Statement	***18. Workers can improve their ability to earn income by gaining new knowledge, skills and experiences.***

Content Elaborations

An individual's interests, knowledge and abilities can affect career and job choice.

In grade four, students looked at saving portions of income for individual financial well-being and the role of the entrepreneur. In grade five, students build on that understanding by investigating the level of knowledge, skills and experiences required for various jobs and careers:

- Knowledge – degree, certification, license
- Skills – technical, entrepreneurial
- Experiences – entry-level jobs, internship, apprenticeship, life

Expectations for Learning

Identify a career of personal interest and research the knowledge, skills and experiences required to be successful.

Instructional Strategies

Have students draw conclusions from economic data. Provide students with data on average income and expected level of educational achievement for selected occupations. Encourage students to compare education and potential income using critical thinking questions. Ask students to draw at least three conclusions from their data to share with their classmates.

Career Connection

Host career speakers that represent varied levels of education and training, salaries, and industries to share their personal work story. Each speaker will share their knowledge, skills, education, and experiences. Then, lead a discussion where students will address aspects of the presentations and how they support the speaker's work story. Extend student learning by having students research the knowledge, skills and experiences necessary for a career in which they show interest.

Diverse Learners

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Instructional Resources

Lesson Plan: It Pays to Stay in School

http://www.econedlink.org/lessons/index.php?lid=349&type=educator

This lesson plan from the Council for Economic Education poses the question, *Should students be paid to stay in school?* Students are encouraged to create incentives for improving school attendance and performance and in the process are challenged to think about the value of education.

Connections

Connections can be made with the Technology Academic Content Standards, Technology Design Standard, Benchmark B, regarding the world of work with engineering and the need for specialized training in the areas of energy and power, transportation, manufacturing, construction, information and communication, medical, and agricultural and related biotechnologies.

Essential Questions

Grade Six

Theme	***Regions and People of the Eastern Hemisphere***
Strand	***Economics***
Topic	***Economic Decision Making and Skills*** Effective economic decision making requires students to be able to reason logically about key economic issues that affect their lives as consumers, producers, savers, investors and citizens. Economic decision making and skills engage students in the practice of analyzing costs and benefits, collecting and organizing economic evidence, and proposing alternatives to economic problems.
Content Statement	***12. The choices people make have both present and future consequences. The evaluation of choices is relative and may differ across individuals and societies.***

Content Elaborations

This content statement builds on foundational understanding of economic choices and their consequences begun in kindergarten. Students will understand and be able to predict the present and future consequences of personal and collective economic choices. Sixth-grade students will look at how the way people make and evaluate choices and consequences is relative and differs across individuals and societies.

Expectations for Learning

Predict the present and future consequences of an economic decision and explain how individuals and societies may evaluate the choice differently.

Instructional Strategies

Have students investigate the present and future consequences of purchasing an item made locally or imported. Connect to students' lives by allowing them to investigate an appropriate item of their choosing. Students should predict present and future consequences of the purchase and how different people may view those consequences positively and negatively.

Have students investigate a choice made to improve access to water (like the Chinese dam on the Yangtze River) discussing both present and future consequences. Students should be challenged to view the choices from multiple perspectives and think about how the evaluation of choices may differ among individuals and societies based on differing values and priorities (environmentalist views vs. those of a construction worker).

Career Connection

Students will choose a product that is both locally produced and imported. They will compare the price of each product and identify factors that impact the price and availability of the product. Students will investigate the impact on the local economy of buying a locally produced product versus one that is imported, focusing on demands, outlook, and availability of careers needed to create the product (e.g., manufacturing, transportation, logistics).

Diverse Learners

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Instructional Resources

Connections

Connect to communication skills in the Common Core State Standards for English Language Arts. Use a debate format to have students research and discuss differing points of view on an environmental issue. This activity can connect social studies Content Statements 9, 10, 11, and 12.

Students can investigate the consequences of technology and the role of technology in

	mitigating environmental consequences as described in the Academic Content Standards for Technology.
Essential Questions ***Why can't people have everything they want?***	

Grade Seven

Theme	***World Studies from 750 B.C. to 1600 A.D.: Ancient Greece to the First Global Age***
Strand	***History***
Topic	***Historical Thinking and Skills*** Historical thinking begins with a clear sense of time – past, present and future – and becomes more precise as students progress. Historical thinking includes skills such as locating, researching, analyzing and interpreting primary and secondary sources so that students can begin to understand the relationships among events and draw conclusions.
Content Statement	***1. Historians and archaeologists describe historical events and issues from the perspectives of people living at the time to avoid evaluating the past in terms of today's norms and values.***

Content Elaborations

Development of historical thinking concepts began in earlier grades by having students look at primary source documents to understand that multiple sources and perspectives are needed to build a historical narrative.

Historians and archaeologists provide an accurate account and assessment of a historical event. This requires them to avoid the influence of current norms and values in interpreting and evaluating the past. They generally attempt to describe events through the perspectives of those living at the time. As students examine a historian or archaeologist's interpretation of an event, students should look to see how they meet this standard.

By having students critically evaluate diaries, letters, eyewitness accounts, archaeological artifacts and architecture of particular moments in time, they develop an understanding that history is interpreted. They also become active participants in historical investigation.

Expectations for Learning

Describe historical events and issues from the perspectives of people living at the time, avoiding evaluating the past in terms of today's norms and values.

Instructional Strategies

Examine a variety of primary sources such historical accounts, paintings, maps, diaries and personal accounts to describe a historical event or period.

Students create a written record (e.g., diary, news article, drawing, mural) on a historic event (e.g., opening of the Roman Coliseum) as if the student was alive during the time period.

Students create advertisements on historic events, inventions and people (e.g., Islamic medicine, Roman architecture, Greek or Roman gods and goddesses [Apollo, Aphrodite, Poseidon], democracy [voting], Olympics, trade with Africa) from the perspective of people living at that time.

Career Connection

Students will research the careers and roles involved in the preservation of antiquies (e.g., museum technicians, archivist, curator, preservationist, historian, archaeologist). Through their research, students will explore how archaeological sites are excavated and studied, and how paintings and maps are preserved and studied. Provide students with reliable resources for accessing this content (e.g., American Institute for Conservation of Historic and Artistic Works, click here, Archival preservation and restoration at the Vatican, click here).

Diverse Learners

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Instructional Resources

Motel of the Mysteries by David Macaulay
This book can be used as a discussion starter or as an introduction to an activity in which students create their own version using of the book using artifacts found in their school.

Connections

Essential Question

Theme	***U.S. Studies from 1492 to 1877: Exploration through Reconstruction***
Strand	***Geography***
Topic	***Spatial Thinking and Skills*** Spatial thinking examines the relationships among people, places and environments by mapping and graphing geographic data. Geographic data are compiled, organized, stored and made visible using traditional and geospatial technologies. Students need to be able to access, read, interpret and create maps and other geographic representations as tools of analysis.
Content Statement	***13. Modern and historical maps and other geographic tools are used to analyze how historic events are shaped by geography.***

Content Elaborations

Modern and historical maps, as well as other geographic tools (e.g., GPS, GIS, Internet-based mapping applications, aerial and other photographs, remote sensing images) can be used to analyze how historical events have been influenced by the distribution of natural resources and geographic location.

These tools can be used to understand changes over time. They may be used to help illustrate sectionalism, unification or movement.

Expectations for Learning

Analyze the ways in which historical events are shaped by geography using modern and historical maps and other geographic tools.

Instructional Strategies

Give students a regional map and a list of historical events that took place in the region. Have students brainstorm how geography influenced the events on the list.

Career Connection

Students will explore careers that utilize maps as an important part of their work (e.g., transportation, architecture, engineering). Students will identify various types of maps, addressing questions like: who created it?, what is the purpose?, and who will use it? (representing the various roles involved throughout the process). Students will develop questions about these careers which will guide their research – addressing topics and information they would like to know more about (KWL). Next, students will research careers and identify pathways across career fields that address their questions related to maps.

Diverse Learners

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Instructional Resources

Map Collections

http://memory.loc.gov/ammem/gmdhtml/gmdhome.html

The American Memory site from the Library of Congress contains maps relating to historical events.

Geography and Its Impact on Colonial Life

http://www.loc.gov/teachers/classroommaterials/lessons/tinker/procedure.html

This Library of Congress website has activities and primary sources, including maps, to help students understand how geography impacts historical events.

	Connections
Essential Questions	

American Government

Theme	***How the American people govern themselves at national, state and local levels of government is the basis for this course. Students can impact issues addressed by local governments through service learning and senior projects.***
Topic	***Public Policy*** Federal, state and local governments address problems and issues by making decisions, creating laws, enforcing regulations and taking action.
Content Statement	***22. Individuals and organizations play a role within federal, state and local governments in helping to determine public (domestic and foreign) policy.***

Content Elaborations

Individuals and organizations engage government officials on public policy using several methods. Individuals and organizations can:

- Campaign for candidates who will support their positions once in office;
- Provide information to executive branch officials on the impacts of potential rules and regulations;
- Lobby members of a legislature;
- Provide testimony before legislative committees;
- Prepare briefs to present during judicial proceedings;
- Offer comments during public meetings;
- Conduct letter-writing campaigns; and
- Hold public demonstrations.

Individuals and organizations must know the proper level and branch of government to engage at the various stages of making public policy.

Expectations for Learning

Take different positions on public policy issues and determine an approach for providing effective input to the appropriate level and branch (agency) of the government.

Instructional Strategies

By examining the role individuals and organizations play in helping to determine public policy, opportunities are opened for students to engage in activities related to civic involvement identified earlier in the coursework. This could serve as a senior project.

Have students work collaboratively to identify a public policy issue, identify the appropriate level of government to address the issue, the appropriate agencies involved, and identify appropriate local, state and/or federal officials to contact about the issue.

Career Connection

As students select a public policy issue to analyze, they will reflect on how the policy impacts them and their community (e.g., access to services or benefits, safety and security, rights or responsibilities). Students will describe how their future career might be impacted by the policy (e.g., social and civic responsibility, lobbying, regulations, taxes). Then, they will navigate the agency's website to identify employment opportunities and required minimum qualifications.

Diverse Learners

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at this site. Additional strategies and resources based on the Universal Design for Learning principles can be found at www.cast.org.

Instructional Resources

League of Women Voters of Ohio (LWVO)
http://www.lwvohio.org/

Smart Voter/ LWVO
http://www.smartvoter.org/oh/state/

Connections

Essential Questions

Theme	***This course examines the history of the United States of America from 1877 to the present. The federal republic has withstood challenges to its national security and expanded the rights and roles of its citizens. The episodes of its past have shaped the nature of the country today and prepared it to attend to the challenges of tomorrow. Understanding how these events came to pass and their meaning for today's citizens is the purpose of this course. The concepts of historical thinking introduced in earlier grades continue to build with students locating and analyzing primary and secondary sources from multiple perspectives to draw conclusions.***
Topic	***Industrialization and Progressivism (1877-1920)*** Ignited by post-Civil War demand and fueled by technological advancements, large-scale industrialization began in the United States during the late 1800s. Growing industries enticed foreign immigration, fostered urbanization, gave rise to the American labor movement and developed the infrastructure that facilitated the settling of the West. A period of progressive reform emerged in response to political corruption and practices of big business.
Content Statement	***11. The rise of industrialization led to a rapidly expanding workforce. Labor organizations grew amidst unregulated working conditions and violence toward supporters of organized labor.***

Content Elaborations

The rise of industrialization in the United States in the late 19th and early 20th centuries increased the demand for workers. With this demand, immigrants came from other countries and Americans migrated from other parts of the United States to take jobs in industrial centers.

As a result of the changing nature of work, some members of the working class formed labor organizations (e.g., American Railway Union, American Federation of Labor, Industrial Workers of the World, United Mine Workers of America) to protect their rights. They sought to address issues such as working conditions, wages and terms of employment.

Labor organizations also grew due to the violence toward supporters of organized labor (e.g., Great Railroad Strike, Haymarket Riot, Homestead Strike, Pullman Strike).

Expectations for Learning

Explain the major social and economic effects of industrialization and the influence of the growth of organized labor following Reconstruction in the United States.

Instructional Strategies

In small groups, ask students to create a list of grievances for a simulated labor movement within the classroom and a list of three to five strategies they could employ to achieve redress for the grievances. Next, have the groups identify the strategy they feel would yield the best chance for long-term impact, an American labor organization that used that strategy, and the long-term impact of that labor organization. Debrief the activity by discussing the conditions in the United States that gave rise to labor unions in the late 19th and early 20th centuries.

Career Connection

Students will compare the 19th and 20th century technological advances (e.g., assembly lines, telephone, automobile) to today's technology focusing on jobs that have been phased out and those that have emerged as a result of these advances (e.g., IT, social media, robotics). Students will explore topics, such as:

- Technology has impacted the level of education and training required to be marketable in the current labor market versus in the past (e.g., increased graduation requirements and expectations for education and training beyond high school; increased use of robotics to automatize certain functions that were once completed by people).
- Careers that will be created over the next 10 years that do not exist today and those that do exist today that will be phased out as they are performed through advanced technologies rather than manually.

Students will explore in-demand careers, using current labor market information, and then choose one career to research in more depth.

Diverse Learners

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	at www.cast.org. **Instructional Resources** **Triangle Shirtwaist Factory Fire** http://teachingamericanhistorymd.net/000001/000000/000024/html/t24.html This site from Teaching American History in Maryland provides resources for using primary sources to teach about the Triangle Shirtwaist Factory Fire. **Connections**
Essential Questions	

Contemporary World Issues

Theme	***The dynamics of global interactions among nations and regions present issues that affect all humanity. These dynamics include competing beliefs and goals, methods of engagement, and conflict and cooperation. Contemporary issues have political, economic, social, historic and geographic components. Approaches to addressing global and regional issues reflect historical influences and multiple perspectives. Students can impact global issues through service learning and senior projects.***
Topic	**Civic Participation and Skills** Individuals and groups have the capacity to engage with others to impact global issues.
Content Statement	***4. Individuals can assess how effective communicators address diverse audiences.***

Content Elaborations

As individuals engage with others on global issues, they need to be able to communicate their beliefs and ideas with other individuals and with diverse groups.

Effective communicators, either individuals or groups, adapt communication styles to address diverse audiences by adjusting their use of communication tools, characteristics and conventions (see Content Statement 3).

Examples of communications could include examination of school-level and personal communications (e.g., memos, letters to families, texts, Web posts), as well as pieces from news programs, websites, advertisements or other media students may see in their daily life. For example, news clips may be used to illustrate how politicians use different body language when speaking to different audiences.

Opportunities should be provided for students to practice their own communication skills as they engage with others on global issues.

Expectations for Learning

Assess and practice effective communication methods.

Instructional Strategies

Have students select a person in the public spotlight and assess how effectively the person communicates. *How does this person adjust their communication style for diverse audiences? What tools, characteristics or conventions were most or least effective? Why are some people more dynamic than others when speaking?*

Ask students, *What does it take to be an effective communicator?* Students can brainstorm practices that they expect to see in an effective communicator then look for those characteristics as they observe selected video clips.

Career Connection

Students will brainstorm practices that they expect to see in an effective communicator then look for those characteristics as they observe selected video clips (e.g., Ted Talks at www.ted.com/talks). After viewing videos of three dynamic speakers, students will reflect on how communications skills are essential across all types of jobs (e.g., hospitality, IT, health). Students will apply the information related to communication in their plan for education and training through high school and beyond.

Diverse Learners

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Instructional Resources

Museum of the Moving Image
www.livingroomcandidate.org
The Living Room Candidate offers more than 300 commercials from every presidential election since 1952, as well as lesson plans and an interactive space for students to create their own commercials.

	Connections Effective communication skills are addressed in the English Language Arts Common Core State Standards.
Essential Questions	

Economics and Financial Literacy

Theme	***This course explores the fundamentals that guide individuals and nations as they make choices about how to use limited resources to satisfy their wants. More specifically, it examines the ability of individuals to use knowledge and skills to manage limited financial resources effectively for a lifetime of financial security.***
Topic	***Working and Earning*** Employment provides a means of creating personal income.
Content Statement	***11. Income is determined by many factors including individual skills and abilities, work ethic and market conditions.***

Content Elaborations

Income may be determined by the skills and abilities an individual has. Some skills may require intense training and education. Income may be influenced by an individual's work ethic. One who puts in more hours or demonstrates a better attitude about his or her work may reap a higher income.

Market conditions can influence an individual's income. Economic, social, cultural and political conditions can all affect incomes. Jobs that are in high demand with a limited supply of workers with particular skills often offer higher incomes. Usually, these might be in certain professions that require years of education (e.g., doctors, dentists, lawyers).

Expectations for Learning

Explain how income is determined by many factors including individual skills and abilities, work ethic and market conditions.

Instructional Strategies

Research three professions and create a table for required training and education, potential earnings, job prospects, work expectations and working conditions in a region where the student would like to live. In small groups or as a whole class, chart out the data and discuss trends.

Career Connection

Students will choose one or more profession(s) for which they will conduct a career interview. Through the interview, students will identify various pathways across the career field, and what they can do in high school to prepare for entering into this field (e.g., academic course work, extracurricular activities, work experience).

Diverse Learners

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Instructional Resources

Connections

Essential Questions

Modern World History

Theme	***This course examines world events from 1600 to the present. It explores the impact of the democratic and industrial revolutions, the forces that led to world domination by European powers, the wars that changed empires, the ideas that led to independence movements and the effects of global interdependence. The concepts of historical thinking introduced in earlier grades continue to build with students locating and analyzing primary and secondary sources from multiple perspectives to draw conclusions.***
Topic	***Globalization (1991-Present)*** The global balance of power shifted with the end of the Cold War. Wars, territorial disputes, ethnic and cultural conflicts, acts of terrorism, advances in technology, expansion of human rights, and changes in the global economy present new challenges.
Content Statement	***28. The rapid increase of global population coupled with an increase in life expectancy and mass migrations have created societal and governmental challenges.***

Content Elaborations

The rapid increase of global population in the 20th and 21st centuries coupled with an increase in life expectancy has created societal and governmental challenges. The environmental impact has pressured governments to institute policies to reduce pollution and conserve resources. In response to the population problem in China, the government instituted a one child per couple policy. The increase of the elderly has placed burdens on many countries to provide adequate health care.

Mass migrations have created societal and governmental challenges, including:

- *Brain drain* out of developing countries;
- Tension and conflict in some receiving countries (e.g., immigrants from North Africa and other Arab nations into Europe); and
- Illegal immigration (e.g., U.S., South Africa).

Expectations for Learning

Describe societal and governmental challenges resulting from the rapid increase of global population, increased life expectancy and mass migrations.

Instructional Strategies

Have students collect and interpret data about countries that are experiencing the greatest changes in population. Have them look for causes and effects of population increases or decreases. Have students analyze the societal and governmental challenges that have emerged and brainstorm possible solutions to these issues. Students could be encouraged to write a United Nations resolution proposing their solution.

Career Connection

Students will research an issue impacted by population and life expectancy (e.g., immigration, pollution, workforce). Students will identify careers involved in addressing the issue and influencing official policy (e.g., analyst, government employee, economist). Lastly, they will choose a career to research in more depth, and apply the information to their plan for education and training through high school and beyond.

Diverse Learners

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Instructional Resources

Connections

Essential Questions

World Geography

Theme	***This course builds on students' understanding of geography and spatial thinking. Contemporary issues are explored through the lens of geography. In addition to understanding where physical and cultural features are located and why those features are located as they are, students examine the implications of these spatial arrangements.***
Topic	***Movement*** People interact with other people, places and things every day of their lives. They travel from one place to another, they communicate with each other, and they rely upon products, information and ideas that come from beyond their immediate environment.
Content Statement	***8. Physical, cultural, economic and political factors contribute to human migrations (e.g., drought, religious conflicts, job opportunities, immigration laws).***

Content Elaborations

Human migration is the process of people moving from one country or region to another with the intention of settling in the new location for an extended period of time. Human migration can be characterized as emigration, movement relative to the point of departure, and immigration, movement relative to the destination.

A variety of factors lead to migrations of people. Pull factors are those things that attract people away from a previous location (e.g., Mediterranean climate, respected university system, low cost of living, civil liberties). Push factors are those things that drive people from a previous location (e.g., volcanic activity, ethnic discrimination, recession, crackdown on political dissent).

Expectations for Learning

Explain how physical, cultural, economic and/or political factors contributed to examples of human migrations.

Instructional Strategies

Identify a major human migration (e.g., the Great Migration of the early 20th century in the United States, the Irish emigration of the 1840s and 1850s). Have students research reasons why this migration occurred and use a graphic organizer (e.g., T-chart) to classify the reasons as either *pushes* or *pulls*. Factors influencing the migration can be further classified as physical, cultural, economic and/or political.

Career Connection

Students will research a major human migration that was motivated by economic factors (e.g., job opportunities, cost of living, access to services). During their research, students will compare the factors of the migration event with characteristics of their own community or region, which either pulls or pushes job creation or job loss (e.g., availability of healthcare, culture, education or training programs). Students will identify resources available within their community, or another in which they would like to live and work, by conducting career interviews, workplace visits, and navigating company and agency websites. They will apply this information to their plan for education and training through high school and beyond.

Diverse Learners

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Instructional Resources

Connections

Essential Questions

How do local environments stimulate the movement of people, products and ideas?