Grades 9-12 Science  
Physical Science

The Nature of Science

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Science methods form a creative and dynamic inquiry process that is validated by peer review and argumentation. The results of science provide technologies that improve everyday life.

Unit Goals

1. Students will understand with close analysis of patterns that scientists are able to determine past processes and predict future events.
2. Students will understand that scientists use models to explore systems or objects that would be too difficult to examine otherwise.
3. Students will understand that by studying graphs, they can learn more about a particular experiment and draw conclusions based on primary data.

Big Ideas

1. patterns and analysis of patterns
2. systems and models
3. models and graphs
4. interdependence of science, engineering, and technology
5. influence of engineering, technology, and science on society and the natural world

Enduring Understandings

1. Science is a method of learning and communicating information about the natural world.

Content

1. scientific inquiry
2. scientific law
3. scientific theory
4. standard of measurement
5. types of graphs
6. dependent variable
7. independent variable
8. types of technology
9. scientific ethics
10. scientific notation
11. scientific tools (balances, glassware, thermometers, calculators, computers)
12. controlled experiment
13. hypothesis

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Select appropriate tools to collect, record, analyze, and evaluate data.

**Understand (Levels 1 and 2)**

1. Distinguish between scientific law and theory.
2. Explain the role of ethics in science.
3. Show proficient use of scientific notation.
4. Identify questions and concepts that guide scientific investigations.
5. Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

**Analyze (Level 3)**

1. Differentiate between independent and dependent variables.
2. Analyze the use of different types of technology.
3. Use technology and mathematics to improve investigations and communications.
4. Recognize and analyze explanations and models.
5. Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

**Evaluate (Levels 3 and 4)**

1. Draw logical conclusions based on scientific knowledge and evidence from investigations.
2. Formulate a problem or need, propose designs, and choose among alternative solutions for the problem.
3. Assess appropriate unit of measurement for a given scenario.
4. Assess appropriate use of scientific tools.
5. Communicate and defend a scientific argument.
6. Evaluate a question to determine if it is testable and relevant.
7. Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

**Create (Level 4)**

1. Construct an appropriate graph for a given data set.
2. Design a controlled experiment.
3. Formulate and revise explanations and models using logic and evidence (critical thinking).
4. Develop a complex model that allows for manipulation and testing of a proposed process or system.

Essential Questions

1. What is science?
2. What is critical thinking?
3. Why are evaluation and testing important in the design process?
4. How is scientific inquiry used in a real-life scientific investigation?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, discuss what students already know about the topic, what they want to know, and what they expect to learn.

Class Discussion

Formative: Class Discussion

Use class discussion on a daily basis to discuss what students know or think they know; assess through exit cards or quick show of hands.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from the textbook or "complex text" from sources such as Scientific American or articles from Ebsco Host through INFOhio.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Section Quizzes

Formative: Quiz

Teachers may quiz when necessary to gauge progress.

Unit Test

Summative: Test

Teacher designed, unit appropriate tests may be given at the end of the unit.

Why is Observation Important in Science?

Summative: Lab Assignment

Scientists use a planned, organized approach to solving problems. A key element of this approach is gathering information through detailed observations. See Link for a specific assignment.

Gummy Bear Graphing

Summative: Lab Assignment

How does the size of a gummy bear change when it is soaked in water?

How Do Geometric Shapes Differ in Strength?

Summative: Modeling

If you look at a bridge, a building crane, or the framework of a tall building, you will notice that various geometric shapes make up the structure. In this activity, you will observe the strength of several geometric shapes in terms of their rigidity, or resistance to changing their shape. When scientists make a hypothesis, they often then predict that an event will occur based on their hypothesis. Materials: plastic straws, scissors, ruler, string Procedure: 1. You are going to construct a triangle and a square using straws. Predict which shape will be more resistant to changing shape and write your prediction. 2. Measure and cut the straws into seven segments, each 6 cm long. 3. Measure and cut one 20-cm and one 30-cm length of string. 4. Thread the 30-cm length of string through four straw segments. Bend the corners to form a square. Tie the ends of the string together in a double knot to complete the square. 5. Thread the 20-cm string through three of the straw segments. Bend to form a triangle. Tie the ends of the string together to complete the triangle. 6. Test the strength of the square by gently trying to change its shape. Repeat with the triangle. Record your observations. 7. Propose several ways to make the weaker shape stronger. Draw diagrams showing how to modify the shape to make it more rigid. 8. Test your hypothesis. If necessary, refine your hypothesis and retest it. Repeat this step until you make the shape stronger. Analysis: 1. What modifications made your shape stronger? Why? 2. How might a scientist use a model to test a hypothesis?

The Path of Theory Development

Formative: Cooperative Group Work

Students will gain a better grasp of the evolution of scientific knowledge and the application of scientific method. Materials: index card Have students record at least three observations about psychological, social, or scientific phenomenon in their experience.Mix up the cards and have students suggest an experiment that could be done to test a hypothesis for each observation. Encourage objective discussion of the viability of each experiment suggested.The game can demonstrate that a hypothesis can't be proven, only disproved.For each hypothesis that students disprove with observations, have them create a further hypothesis. Explain that this is how real science develops.

Build and Test a Bridge

Summative: Lab Assignment

Students will combine geometric shapes to build model bridge supports. Then they will use scientific inquiry to determine the maximum load that the bridge can hold. Materials: plastic straws, ruler, scissors, string, cardboard, masses/books, balance Question: What placement of supports produces the strongest bridge? Procedure: Cut the straws into 24 6-cm segments.Thread three straw segments onto a 1-m piece of string. Slide the segments toward one end of the string. Double knot the string to form a triangle. There should be very little string showing between the segments.Thread the long end of the remaining string through two more straw segments. Double knot the string to one unattached corner to form another triangle. Cut off the remaining string, leaving at least 1 cm after the knot. Use the string and one more straw segment to form a tetrahedron.Use the remaining string and straw segments to build three more tetrahedrons.Set the four tetrahedrons on a piece of paper. They will serve as supports for your bridge deck, a 20-cm x 30-cm piece of cardboard.With your teammates, decide where you will place the tetrahedrons on the paper to best support a load placed on the bridge deck.Form a hypothesis about where you will place your tetrahedrons and why that placement will support the most weight. Recall that a hypothesis is an explanation of an observation.Test your hypothesis by placing the tetrahedrons in your chosen locations on the paper. Lay the cardboard "bridge deck" over the top.Use a balance to find the mass of a textbook. Record the mass.Gently place the textbook on the bridge deck. Continue to add massed objects until your bridge collapses. Record the total mass that collapsed the bridge.Examine the deck and supports. Look for possible causes of bridge failure.Was your hypothesis supported? How do you know?What steps of scientific inquiry did you use in this activity? What would you do next to figure out how to make a stronger bridge?Compare your results with those of several other teams. Discuss the placement of your supports and any other factors that may cause your bridge to fail. Extension: Try building supports with straw segments that are shorter (4 cm long) and longer (8 cm long). Test your bridges in the same way with each size of support. Taken from Glencoe Physical Science

Who Contributes CO2?

Summative: Lab Assignment

Students will compare total and per capita carbon dioxide emissions of selected countries, evaluate their results, and graph their data. Objective: Compare and contrast the total carbon dioxide emissions from selected countries; calculate the average annual per capita amount of carbon dioxide produced by each country; form a hypothesis that explains the amount of carbon dioxide produced by each country. Taken from Glencoe Physical Science, p. 33

Care Package

Summative: Modeling

Students will design and make a model of a package that can be safely shipped to a consumer. Objectives: Model packaging and shipping a product for a consumer interest; calculate the cost to produce a consumer product; test your packaging design to see if it keeps the snacks from being damaged Taken from Glencoe Physical Science

Resources

Stage 3: Learning Plan

Learning Experiences

1. Interactive Instruction through Discussion: Students will participate in the Tricky Tracks Activity (See Link.) using inference and observation.
2. Interactive Instruction through Laboratory Groups: Students will participate in Gummy Bear Graphing. (See Assessments.)
3. Interactive Instruction through Laboratory Groups: Students will participate in Why is Observation Important in Science? found in Assessments.
4. Indirect Instruction through Guided Inquiry: How Do Geometric Shapes Differ in Strength? activity found in Assessments.
5. Indirect Instruction through Guided Inquiry: Students will participate in the Build and Test a Bridge activity found in Assessments.
6. Interactive Instruction through Socratic Seminar: Students will discuss reading assignments in Socratic Circles.
7. Interactive Instruction through Cooperative Learning Groups: Students will participate in The Path of Theory Development activity found in Assessments.
8. Direct Instruction through Drill and Practice: Students will practice SI units.
9. Direct Instruction through Drill and Practice: Students will practice measurements.
10. Direct Instruction through Drill and Practice: Students will practice graphing skills.
11. Interactive Instruction through Laboratory Groups: Students will participate in Who contributes CO2? found in Assessments.
12. Experiential Learning through Model Building: Students will participate in Care Package modeling found in Assessments.

Resources

* Tricky Tracks Activity (<http://msed.iit.edu/projectican/trickytracks.html>)

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* TED-ED Talks (<http://ed.ted.com/lessons?category=science-technology>)

Grades 9-12 Science  
Physical Science

Forces and Motion

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

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8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

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Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Forces and Motion

Motion: Introduction to one-dimensional vectors

Motion: Displacement, velocity (constant, average and instantaneous) and acceleration

Motion: Interpreting position vs. time and velocity vs. time graphs

Forces: Force diagrams

Forces: Types of forces (gravity, friction, normal, tension)

Dynamics (how forces affect motion): Objects at rest

Dynamics (how forces affect motion): Objects moving with constant velocity

Dynamics (how forces affect motion): Accelerating objects

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Motion occurs when an object changes its position. A force is a push or a pull.

Unit Goals

1. Students will understand how force affects the motion of an object.
2. Students will understand how graphs represent the motion of an object.
3. Students will understand how the mass of an object relates to the force exerted.
4. Students will understand how an object's position is related to its motion.

Big Ideas

1. cause and effect
2. forces and motion
3. system and system models
4. graphing motion
5. structure and function
6. types of interactions
7. stability and instability in physical systems

Enduring Understandings

1. Newton's laws describe how force affects motion.

Content

1. distance
2. displacement
3. speed
4. distance-time graph
5. velocity
6. relative motion
7. momentum
8. acceleration
9. motion in two dimensions
10. force
11. net force
12. friction
13. mass vs. weight
14. inertia
15. Newton's Laws of Motion

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Identify questions and concepts that guide scientific investigations

**Understand (Levels 1 and 2)**

1. Calculate an object's speed.
2. Explain motion in terms of objects relative to one another.
3. Calculate an object's momentum.
4. Connect acceleration, time, and velocity.
5. Predict an object's acceleration.
6. Compare and contrast straight-line motion, circular motion, and projectile motion.
7. Connect force and motion.
8. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

**Analyze (Level 3)**

1. Differentiate between distance and displacement.
2. Analyze a time-distance graph.
3. Differentiate between speed and velocity.
4. Investigate net force on an object.
5. Differentiate between mass and weight.
6. Analyze data to support the claim that Newtons second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

**Evaluate (Levels 3 and 4)**

1. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

**Create (Level 4)**

1. Prove friction acts on objects.
2. Apply Newton's first law with what happens in a car crash.
3. Apply Newton's second law with the effects of air resistance.
4. Model Newton's third law of motion.
5. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Essential Questions

1. What might be one way to describe or represent motion visually?
2. What are some ways to describe motion?
3. How does motion occur?
4. How do you measure motion?
5. How do you predict motion?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, discuss what students already know about the topic, what they want to know, and what they expect to learn.

Class Discussion

Formative: Class Discussion

On a daily basis, have students discuss what they know or think they know and assess through exit cards or a quick show of hands.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from the textbook "complex text" from sources such as Scientific American or articles from Ebsco Host through INFOhio.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Section Quizzes

Formative: Quiz

Teachers may quiz when necessary to gauge progress.

Unit Test

Summative: Test

Teacher designed, unit appropriate tests may be given at the end of the unit.

How Do You Get There from Here?

Formative: Cooperative Group Work

To record a person's motion in terms of direction and number of steps. Materials: 1 sheet of paper, marker Procedure: Place a sheet of paper labeled north, east, south, and west on the floor.Walk from the paper to one of the three locations your teacher has labeled in the classroom. Have a partner record the number of steps and the directions of movement.Using these measurements, write instructions other students could follow to move from the paper to the location.Repeat steps 2 and 3 for the other locations. Analysis: How did your instructions to each location compare to those written by other groups?How did the descriptions of your movement depend on the point at which you started?

Why Is a Reference Point Useful?

Formative: Cooperative Group Work

To find an object's position, you need to know its distance and direction from a reference point. Materials: sticky note, meter stick, small object Procedure: Put a sticky note at the 50-cm mark of a meterstick. This is your reference point.Place a small object at the 40-cm mark. It is 10 cm in the negative direction from the reference point.Create a data table to record distance in cm, reference direction, and position in cm of the object.Continue moving the object and recording its distance, its reference direction, and its position to complete the table (5 measurements). Analysis: How would the data in the table change if the positions were the same but the reference point was at the 40-cm mark?Why is a reference point useful in describing positions of an object?

Relative Motion: RAFT Writing Activity

Summative: Written Assessment

Students will have an opportunity to demonstrate their understanding of a reading by describing relative motion from different perspectives by using the RAFT technique in Links.

Motion Graphs

Summative: Class Work

Students describe the motion of an object using graphs.

How Can You Graph Motion?

Formative: Class Work

You can represent motion with a distance-time graph. Materials: masking tape, stopwatch, graph paper, ruler, pencil Procedure: Use masking tape to mark a starting point on the floor.As you cross the starting point, start a stopwatch. Stop walking after 2 s. Measure the distance with a meterstick. Record the time and distance.Repeat step 2 by walking at about the same speed for 4 s and then for 6 s.Create a distance-time graph of your data. The line of the graph should be as close to the points as possible. Analysis: Based on the graph, how far would you probably walk at the same speed in 8 s?Look back at the average speed equation. Explain how you could use your graph to find your average walking speed?

Motion and Forces: Basic Simulation

Summative: Online Learning

Sample Learning Goals: Identify when forces are balanced vs unbalanced.Determine the sum of forces (net force) on an object with more than one force on it.Predict the motion of an object with zero net force.Predict the direction of motion given a combination of forces.

Newton's First Law Activities

Summative: Lab Assignment

Students explore Newton's First Law (Law of Inertia) through various demonstrations and activities.

Newton's Third Law Activities

Summative: Lab Assignment

Students engage in activities and demonstrations modeling Newton's Third Law of Motion.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Indirect Instruction through Problem Solving/Graphing: Students will participate in the Graphing Using Motion activity in Assessments.

Experiential Learning through Simulations: Students will participate in Motion and Forces: Basic Simulation discussed in Assessments.

Indirect Instruction through Concept Attainment: Students will understand Relative Motion by completing RAFT writing activity.

1. Interactive Instruction through Brainstorming/Indirection Instruction through Reflective Discussion: Students will view and discuss Mass vs. Weight: Introduction. (See Links.)
2. Interactive Instruction through Lab Groups: Students will participate in Newton's First Law Activities Lab Assignment found in Assessments.
3. Interactive Instruction through Lab Groups: Students will participate in Newton's Third Law Activities Lab Assignment found in Assessments.
4. Interactive Instruction through Peer Partner Learning: Students will participate in How Do You Get There from Here? found in Assessments.
5. Interactive Instruction through Peer Partner Learning: Students will complete Why Is a Reference Point Useful? found in Assessments.
6. Interactive Instruction through Problem Solving: Students will complete How Can You Graph Motion? activity from Assessments.

Resources

* Mass vs. Weight: Intro Video with Discussion Questions (<http://www.pbslearningmedia.org/resource/npe11.sci.phys.maf.massweight/mass-vs-weight-introduction/>)

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. Smart phones
7. Tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* YouTube (<https://www.youtube.com/results?search_query=physical+science+video>)

Grades 9-12 Science  
Physical Science

Energy

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

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Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Energy and Waves

Conservation of energy: Quantifying kinetic energy

Conservation of energy: Quantifying gravitational potential energy

Conservation of energy: Energy is relative

Transfer and transformation of energy (including work)

Thermal energy

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Energy has many forms and can be transferred through work. Thermal energy is a form of energy that can be transferred as well as converted into other forms of energy. Energy can be transformed from one form to another for human use.

Unit Goals

1. Students will understand patterns relating to the transfer of energy.
2. Students will understand how changing variables affect the outcome.
3. Students will understand how graphs represent the energy of an object.
4. Students will understand how energy is conserved in a system.
5. Students will understand efficiency of a machine.

Big Ideas

1. patterns relating to transfer of energy
2. cause and effect relating to manipulation of variables
3. scale, proportion, and quantity relating to manipulation of variables
4. systems and system models relating to graphing
5. energy and matter
6. structure and function related to efficiency

Enduring Understandings

1. Energy can be transferred and transformed from one form into another.

Content

1. work
2. efficiency
3. kinetic energy
4. potential energy
5. gravitational potential energy
6. Law of Conservation of Energy
7. mechanical energy
8. power
9. temperature
10. thermal energy
11. heat
12. heat transfer
13. thermal conductors
14. thermal insulators

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Calculate the work of an object.
2. Calculate the efficiency of a machine.
3. Draw evidence from informational texts to support analysis, reflection, and research.

**Understand (Levels 1 and 2)**

1. Differentiate between the different forms of energy.
2. Calculate changes in thermal energy.
3. Connect thermal energy and temperature.
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

**Analyze (Level 3)**

1. Hypothesize the effect of machines on work.
2. Investigate power generated through motion.
3. Investigate movement of molecules relating to temperature.
4. Differentiate between thermal energy and heat.
5. Investigate the difference between thermal conductors and thermal insulators.
6. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

**Evaluate (Levels 3 and 4)**

1. Apply work to force and motion.
2. Construct a model to demonstrate the exchange of kinetic and potential energy.
3. Construct an analogy illustrating the types of heat transfer.
4. Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
5. Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.
6. Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
7. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).

**Create (Level 4)**

1. Apply Law of Conservation of Energy.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Essential Questions

1. What is work?
2. How do machines make doing work easier?
3. What is the difference between potential energy and kinetic energy?
4. How are power and energy related?
5. How are thermal energy and temperature related?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, discuss what students already know about the topic, what they want to know, and what they expect to learn.

Complex Text

Formative: Reading Task

Teacher can assign "complex text" from sources such as Scientific American articles from Ebsco Host through INFOhio.

Class Discussion

Formative: Class Discussion

On a daily basis, students discuss what they know or think they know and teacher assesses through exit cards or quick show of hands.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Unit Test

Summative: Test

Teacher designed, unit appropriate tests may be given at the end of the unit.

Work vs. Power Lab

Summative: Lab Assignment

Use the attached document to teach the Work vs. Power Lab. Do you do more work climbing stairs quickly or climbing stairs slowly?Does it take more power to climb stairs quickly or climb stairs slowly?

Mechanical Advantage and Efficiency

Summative: Lab Assignment

Students calculate the mechanical advantage and efficiency of an inclined plane. Materials: wooden board, 40 cm long; support for board, 10 cm high; 1-kg mass; spring scale, 0-10 N range Procedure: Set up your inclined plane. It should be 40 cm long and 10 cm high.Using the spring scale, find how much force is needed to lift the 1-kg mass straight up. This is the output force.Calculate the work needed to lift the 1-kg mass 10 cm. This is the inclined plane's output work.Using the spring scale, find how much force is needed to pull the 1-kg mass up the inclined plane. This is the input force.Calculate the work done on the mass as it is pulled up the inclined plane. This is the input work.Using the output force and input force, calculate the mechanical advantage of the inclined plane.Using the output work and input work, calculate the efficiency of the inclined plane. Conclude and Apply Explain how you might improve the efficiency of your inclined plane.Predict how you might increase the mechanical advantage of your inclined plane. Try it!Identify situations in which an inclined plane would be useful.Compare your results with others in the class. Discuss whether you agree about how you might improve the efficiency of the inclined plane. Taken from Glencoe Physical Science

Double Toss Activity

Summative: Lab Assignment

Students use their knowledge of potential and kinetic energy to explore forces and motion as they work together to solve this introductory level Design Challenge.

Bounce Lab

Summative: Lab Assignment

Students observe the relationship between potential and kinetic energy in this Bounce Lab.

Swinging Energy

Summative: Lab Assignment

Students will investigate the behavior of an interrupted pendulum. Objectives: Construct a pendulum to compare the exchange of potential and kinetic energy when a swing is interrupted; measure the starting and ending heights of the pendulum. Taken from Glencoe Physical Science

Temperature and Convection

Formative: Observation

Students will use this lab to observe the effect of convection. Material: 250-mL beaker (2); water, food coloring, small paper clips (4) For preparation, freeze some of the water with food coloring into two colored ice cubes. Also freeze the paper clips into one of these ice cubes. In class, place each ice cube in its own beaker filled with non-colored water. The colored ice cube without paper clips should float, but the one with paper clips should sink. Have students observe as both ice cubes melt. As the colored ice cube without paper clips melts, the colored water sinks to the bottom of that beaker. As the ice cube with the paper clips melts, the colored water doesn't rise. Why didn't the colored water rise when the colored ice cube sank to the bottom? Taken from Glencoe Physical Science

Compare Thermal Conductors

Summative: Lab Assignment

Students will observe the thermal conductivity of plastic, a metallic alloy, and wood. Materials: plastic spoon, metal spoon, wooden spoon, plastic beads (3), butter or wax, beaker, boiling water Obtain a plastic spoon, a metal spoon, and a wooden spoon of similar length.Stick a small, plastic bead to the handle of each spoon with a dab of butter or wax. Each bead should be the same distance from the tip of the spoon.Stand the spoons in a beaker, with the beads hanging over the edge of the beaker.Carefully pour boiling water to a depth of 5 cm in the beaker holding the spoons. Analysis: In what order did the beads fall from the spoons?Describe how heat was transferred from the water to the beads.Rank the spoons in their ability to conduct heat. Taken from Glencoe Physical Science

Can You Make a Change in Matter?

Formative: Cooperative Group Work

You observe many things changing. Birds change their positions when they fly. Bubbles form in boiling water. The filament in a lightbulb glows when you turn on a light. How can you cause a change in matter? Half-fill a foam cup with sand. Place the bulb of a thermometer about halfway into the sand. Do not stir. Record the temperature.Remove the thermometer and place a lid on the cup. Hold down the lid and shake the cup vigorously for 10 minutes.Remove the lid. Measure and record the temperature of the sand. Analysis: What change did you observe in the sand?Predict how you could change your results.What do you think caused the change?

How Can You Describe Temperature?

Formative: Cooperative Group Work

Have you ever used Fahrenheit or Celsius to describe temperature? Why can't you just make up your own temperature scales? Materials: clear plastic straw, permanent marker, clear plastic water bottle, clay, ruler, 50% mixture of rubbing alcohol and water with food coloring Use a ruler and a permanent marker to divide a clear plastic straw into equal parts. Number the lines. Give your scale a name.Add a room-temperature colored alcohol-water mixture to an empty plastic water bottle until it is about 1/4 full.Place one end of the straw into the bottle with the tip just below the surface of the liquid. Seal the straw onto the bottle top with clay.Place the bottle in a hot water bath, and observe the liquid in your straw. Analysis: Why is it important for scientists to use the same scale to measure temperature?What are some ways to make the liquid in your thermometer rise or fall?

How Do Different Materials Affect Thermal Energy Transfer?

Summative: Lab Assignment

Students will use this lab to test the rate of thermal energy transfer through various materials. Materials per group of 3 or 4: tall, 1-L plastic food container, 100-mL graduated cylinder, two alcohol thermometers, rubber band, very hot water, room temperature water, cardboard square, one of these test containers: metal can, foam cup, plastic cup or glass, large baby food jar or glass cup, ceramic cup or glass Procedure: Observe the test containers. Write a hypothesis that explains why you think a certain material will slow the transfer of thermal energy more than others.Create a data table to record the temperature (C) measured in 2 min intervals for test container and outer container.Each lab group will test one container. Stand your test container in the center of a 1-L plastic container.Add 125 mL of hot water to the test container. Measure and record the water's temperature.Add room temperature water to the plastic container until the level in both containers is equal. Measure and record the room temperature water's temperature.Place a cardboard square over the test container. Use two thermometers to take the temperature of the water in both containers every 2 min for 20 min. Record your data in your table.Compare your data with the data gathered by the other teams. Rank the test containers from slowest to fastest thermal energy transfer. Analysis: Did your data support your hypothesis? Why or why not?What happened to the thermal energy of the water in the test container? Why did this happen?

Design an Insulated Container

Summative: Lab Assignment

How can you construct a container that will prevent a frozen fruit pop inside a plastic bag from melting? Think about thermal energy transfer by conduction, convection, and radiation. You will begin with a shoe box, but you can modify it in any way. Consider the materials you have available. Ask yourself what material you can bring from home that might slow the melting of a frozen fruit pop. Materials: aluminum foil, self-sealing plastic bag, balance, creative building materials, office supplies, frozen fruit pop, foam packing peanuts, rubber bands Procedures: Write your ideas about how you can reduce the amount of thermal energy moving by conduction, convection, and radiation; what materials you will use inside and outside your box; what materials you will need to bring from home.Outline the steps in preparing for your box. Have your teacher check your procedures. Decide who will obtain which materials before the next lab period. Design a logo for your container.As a class, decide how many hours you will wait before checking the condition of your frozen fruit pop.Formulate a hypothesis explaining why the materials you use inside your bag will be effective in insulating the frozen fruit pop. Remember, your hypothesis should be a testable explanation based on observations.On the second lab day, follow the steps you have outlined and prepare your container. Check it over one more time to be sure you have accounted for all ways that thermal energy could enter or leave the box.Obtain a frozen fruit pop. Place it inside a self-sealing plastic bag. Seal the bag. Quickly measure and record its mass. Attach your logo and return the pop to the freezer.On the third lab day, remove your frozen fruit pop from the freezer. Do not open the plastic bag. Place your frozen fruit pop in your container and seal it. Place your container in a location assigned by your teacher.After the set amount of time, remove the fruit pop from the container. Open the plastic bag, and pour off any melted juice. Reseal the bag. Measure and record the mass. Analysis: What percentage of your fruit pop remained frozen? How long do you think it would take for the fruit pop to completely melt in your container? Justify your answer.What are some possible ways thermal energy entered your bag? How could you improve the package on another try?How would you modify your design to keep something hot inside the bag? Explain your answer. Make a class graph showing the percentages of the different frozen fruit pops remaining. Discuss why some packages were more or less effective. Extension: Explore designs for portable coolers. What are the most effective portable packages that keep things hot or cold without external cooling or heating?

Resources

Stage 3: Learning Plan

Learning Experiences

1. Interactive Instruction through Laboratory Groups: Students will participate in the Bounce Lab.
2. Interactive Instruction through Laboratory Groups: Students will participate in the Work vs. Power Lab.
3. Direct Instruction through Drill and Practice: Students will complete Work Problems.
4. Direct Instruction through Drill and Practice: Students will complete Power Problems.
5. Direct Instruction through Drill and Practice: Students will complete Gravitational Potential Energy Problems.
6. Direct Instruction through Drill and Practice: Students will complete Kinetic Energy Problems.
7. Interactive Instruction through Laboratory Groups: Students will participate in Mechanical Advantage and Efficiency lab.
8. Direct Instruction through Drill and Practice: Students will complete Specific Heat Problems.
9. Direct Instruction through Demonstration: Students will observe Temperature and Convection demonstrations.
10. Interactive Instruction through Laboratory Groups: Students will participate in Compare Thermal Conductors lab.
11. Interactive Instruction through Cooperative Learning Groups: Students will participate in Can You Make a Change in Matter? lab.
12. Interactive Instruction through Peer Partner Learning: Students will complete How Can You Describe Temperature? in cooperative learning groups.
13. Interactive Instruction through Laboratory Groups: Students will participate in How Do Different Materials Affect Thermal Energy Transfer? lab.
14. Experiential Learning through Conducting Experiments: Students will participate in Design an Insulated Container activity.

Resources

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. Smart phones
7. Tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* Discovery Education (<http://www.discoveryeducation.com/search/page/-/-/lesson-plan/physical%20science/index.cfm>)

Grades 9-12 Science  
Physical Science

Electricity

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

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Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Energy and Waves

Electricity: Movement of electrons

Electricity: Current

Electricity: Electric potential (voltage)

Electricity: Resistors and transfer of energy

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Electricity consists of static and moving electric charges. Like electric charges repel each other, and unlike charges attract each other. An electric current is a flow of electric charge. Electric devices can be placed into series circuits as well as parallel circuits.

Unit Goals

1. Students will understand the flow of electricity.
2. Students will understand how circuit design affects voltage flow.
3. Students will understand the function of series and parallel circuits through models.

Big Ideas

1. patterns relating to flow of electricity
2. how circuit design affects current (voltage) flow
3. structure and function relating to types of circuits
4. system and system models relating to types of circuits

Enduring Understandings

1. Electricity consists of static and moving electric charges.
2. A home is wired with parallel and mixed circuits.

Content

1. charging by contact
2. charging by induction
3. electric field
4. electroscope
5. insulators
6. conductors
7. Law of Conservation of Charge
8. static electricity
9. electric circuit
10. electric current
11. Ohm's Law
12. resistance
13. voltage differences
14. electrical power
15. electrical charges
16. parallel circuits
17. series circuits

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Identify the purpose of an electroscope.
2. Calculate electrical power.
3. Identify questions and concepts that guide scientific investigations.
4. Use technology and mathematics to improve investigations and communications.

**Understand (Levels 1 and 2)**

1. Illustrate static electricity on an object.

**Analyze (Level 3)**

1. Analyze how charged objects interact with each other.
2. Differentiate between conductors and insulators.
3. Compare and contrast parallel circuits with series circuits.
4. Contrast the direction of current with the direction of electron flow.
5. Formulate and revise explanations and models using logic and evidence (critical thinking).
6. Recognize and analyze explanations and models.
7. Communicate and defend a scientific argument.

**Evaluate (Levels 3 and 4)**

1. Apply Ohm's Law.
2. Apply Law of Conservation of Charge.
3. Model the interaction of electric fields.

**Create (Level 4)**

1. Design and test parallel circuits and series circuits.
2. Design and conduct scientific investigations.
3. Design a test of a model to ascertain its reliability.
4. Develop a complex model that allows for manipulation and testing of a proposed process or system.

Essential Questions

1. How do gravitational force and electric force compare?
2. How can objects become electrically charged?
3. When and how does a voltage difference produce an electric current?
4. How do batteries produce a voltage difference in a circuit?
5. How does Ohm's Law relate current, voltage difference, and resistance?
6. How do series circuits differ from parallel circuits?

Stage 2: Assessment Evidence

Charging by Contact: Lab Demo

Summative: Lab Assignment

See directions on attachment.

Conductor and Insulator Lab

Summative: Lab Assignment

Students will determine what objects are thermal conductors, thermal insulators, electrical conductors and electrical insulators.

Electric Field Hockey

Summative: Interactive Media

Sample learning goals: Determine the variables that affect how charged bodies interact.Predict how charged bodies will interact.Describe the strength and direction of the electric field around a charged body.Use free-body diagrams and vector addition to explain interactions.

Ohm's Law

Summative: Lab Assignment

Students work to increase the intensity of a light bulb by testing batteries in series and parallel circuits. They learn about Ohm's law, power, parallel and series circuits, and ways to measure voltage and current.

Series vs. Parallel Lab

Summative: Lab Assignment

Students will compare the characteristics of series circuits to the characteristics of parallel circuits.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit, which may come from the textbook. Teacher can also assign "complex text" from sources such as Scientific American, or articles from Ebsco Host through INFOhio.

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss what they already know about the topic and what they expect to learn.

Unit Test

Summative: Unit Exam

Teacher designed, unit-appropriate tests may be given at the end of the unit.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Interactive Instruction through Lab Groups: Students will participate in Charging by Contact Lab/Demo.
2. Experiential Learning through Conducting Experiments: Students will participate in Conductor and Insulator Lab.
3. Experiential Learning through Simulations: Students will participate in Electric Field Hockey simulation.
4. Interactive Instruction through Lab Groups: Students will participate in Ohm's Law Lab.
5. Interactive Instruction through Lab Groups: Students will participate in Series vs. Parallel Lab.
6. Independent Study through Computer Assisted Instruction: Students will participate in Electricity Webquest (See Links).

Resources

* Electricity Webquest (<http://teacherweb.com/TN/CoalfieldSchool/mikesmith/Electricity_Web_Ques_Web.pdf>)

Technology Integration

1. LCD Projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. Smart Board
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* Electric Circuits ([http://www.thephysicsfront.org/filingcabinet/share.cfm?UID=19592FID=21691](http://www.thephysicsfront.org/filingcabinet/share.cfm?UID=19592&FID=21691))

Grades 9-12 Science  
Physical Science

Waves

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

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Evaluate a question to determine if it is testable and relevant.

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Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

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Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

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Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

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Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

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OH Grade 9-12 OH: Science (2011)

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Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Energy and Waves

Transfer and transformation of energy (including work)

Waves: Refraction, reflection, diffraction, absorption, superposition

Waves: Radiant energy and the electromagnetic spectrum

Waves: Doppler shift

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Waves transfer energy from place to place without transferring matter. Sound waves are longitudinal waves produced by vibrations. Electromagnetic waves transfer energy through matter and through space. Visible light waves are electromagnetic waves that enable us to see.

Unit Goals

1. Students will understand behavior of waves.
2. Students will understand the effect of energy on wave particles.
3. Students will understand wave characteristics through modeling.
4. Students will understand that type of wave relates to function.

Big Ideas

1. patterns relating to behavior of waves
2. cause and effect relation to wave energy
3. systems and system models relating to wave characteristics
4. energy and matter
5. structure and function relating to types of waves and wave function

Enduring Understandings

1. All waves carry energy.
2. The properties of waves depend on the sources of the vibration and the medium in which the wave travels.

Content

1. mechanical waves
2. transverse waves
3. longitudinal waves
4. wavelength
5. period
6. frequency
7. wave speed
8. Law of Reflection
9. refraction
10. diffraction
11. interference
12. amplitude
13. intensity
14. loudness
15. pitch
16. Doppler Effect
17. electromagnetic wave
18. electromagnetic spectrum
19. absorption
20. translucent
21. transparent
22. opaque
23. prisms

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Identify questions and concepts that guide scientific investigations.

**Understand (Levels 1 and 2)**

1. Calculate wave speed.
2. Connect the law of reflection with echoes.
3. Connect amplitude, intensity, and loudness.

**Analyze (Level 3)**

1. Differentiate between transverse and longitudinal waves.
2. Analyze the characteristics of a wave.
3. Differentiate between diffraction, refraction, and interference.
4. Investigate the properties of electromagnetic waves.
5. Investigate the properties of the electromagnetic spectrum.
6. Investigate the behavior of light.

**Evaluate (Levels 3 and 4)**

1. Apply the Doppler Effect to explain changes in pitch.
2. Model the motion of different types of waves.
3. Communicate and defend a scientific argument.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Formulate and revise explanations and models using logic and evidence (critical thinking).

**Create (Level 4)**

1. Design and conduct scientific investigations.

Essential Questions

1. How do waves transfer energy?
2. How do transverse waves differ from longitudinal waves?
3. To what extent are wave length and period related?
4. How do waves interact with media and each other?
5. What is the Doppler Effect?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss that they already know about the topic and what they expect to learn.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from textbook. Teacher can also assign complex text from materials such as Scientific American or articles from Ebsco Host through INFOhio.

Class Discussion

Formative: Class Discussion

On a daily basis, students discuss what they know or think they know, using exit cards, quick show of hands, or class discussion.

Laboratory Work

Summative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Unit Test

Summative: Test

Teacher designed, unit-appropriate tests may be given at the end of the unit.

Wave Speed and Tension

Summative: Lab Assignment

Students will investigate the relationship between wave speed and tension. Materials: coiled-spring toy, meter stick, stopwatch. Procedure: Create a data table measuring the distance (m), wave time (s), and wave speed (m/s) for a total of six waves.Attach one end of the spring to a chair leg so that the spring rests on a smooth floor.Stretch the spring to a length of 1 mMake a longitudinal wave by squeezing several coils together, and then releasing them.Have your partner time how long the wave takes to travel two or three lengths of the spring. Record the time in your data table. Record the distance the wave traveled in your data table.Repeat steps 3-4 two more times for waves 2 and 3.Stretch the spring to a length of 1.5 m. Repeat steps 3 and 4 for waves 4, 5, and 6. Analysis: Calculate the speed of each wave. Use the formula speed = distance/timeCalculate the average speed of the waves on the spring when the spring has a length of 1 m.Calculate the average speed of the waves on the spring when the spring has a length of 1.5 m.Describe how the tension in the spring changes as the length of the spring is increased.Describe how the wave speed depends on the tension. How could you make the waves travel even faster? Test your prediction.Predict how you could increase the speed of waves along a violin string. Communicate: Compare your results with those of other students in your class. Form a hypothesis about what you might observe if the coiled-spring toy were made of another material. How would you test your hypothesis? From Glencoe Physical Science

Waves and Art

Summative: Visual Arts Project

Have students use reflection, refraction, and diffraction to create artwork. The art could be as simple as sketching how refraction distorts objects viewed through water or as involved as photographing the diffraction patterns of light waves. Students might want to research and experiment with how the surface of a video disc diffracts light. Have students explain the phenomena shown in their art. From Glencoe Physical Science

Wavelength, Frequency, and Wave Speed

Summative: Lab Assignment

Students will generate transverse waves with a long spring and measure the speed and frequency of the waves. Materials: long spring, rope, or hose; meterstick; stopwatch. Procedure: Create data table #1 to record the length of spring (m), time for wave to travel spring length (s), and speed of wave (m/s) for a total of three wave trials.Create data table #2 to record the number of waves in 10 s, frequency (Hz), and wavelength (m) for a total of three wave trials.With a partner, lay the long spring, rope, or hose across an open floor and measure its length. Record the length of the spring in data table #1. Make sure that the spring is stretched to the same length for each step.Have your partner hold one end of the spring. Create a single wave pulse by shaking the other end of the spring back and forth.Have a third person use a stopwatch to measure the time needed for the pulse to travel the length of the spring. Record this measurement in data table #1.Repeat steps 4 and 5 two more times.Calculate the speed of waves 1, 2, and 3 in data table #1. Average the speeds of waves 1, 2, and 3 to find the speed of waves on your spring.Create a series of waves with the same wavelength. You make one wavelength when your hand moves left, right, and left again. Count the number of wavelengths that you generate in 10 s. Record this measurement for "wave 4" in the column marked "waves in 10 s" in data table #2.Repeat step 8 two more times. Each time, create a wave with a different wavelength by shaking the spring faster or slower. Analysis: Calculate the frequency of waves 4, 5, and 6. Remember that frequency is the same as the number of waves that pass in one second.Use the equation v = f to find the wavelength of waves 4, 5, and 6. Use the average speed calculated in step 7 for the wave speed.Identify potential sources of error in this lab.Were the three wave speeds that you calculated in step 7 significantly different from one another? Why or why not?Explain why you would average the speeds of the three different pulses to calculate the speed of the waves on the spring.Describe how the wavelength of the waves that you created depends on the frequency of the waves. Communicate: Ask your teacher to set up a contest between the groups in your class. Have each group compete to determine who can create waves with the longest wavelength, the highest frequency, and the largest wave speed. Record the measurements of each group's efforts on the board. From Glencoe Physical Science

Vanished!

Summative: Writing Assignment

While an invisibility cloak might seem like an impractical device, the concepts are now being used to research ways to protect against earthquakes and tsunamis. Write a future news article or prepare a newscast about other unexpected uses of invisibility technology. From Glencoe Physical Science

Measure Sound Intensity

Summative: Lab Assignment

Students will observe how distance and barriers affect sound intensity. Materials: cell phone, metric ruler, sound-level meter, cardboard sheet. Procedures: Increase the ring volume on a cell phone to maximum.Using a metric ruler, place the cell phone 10 cm from a sound-level meter.Ring the cell phone and observe the reading on the sound-level meter.Repeat steps 2 and 3 with the sound-level meter placed at a distance of 30 cm.Repeat steps 2-5 with a cardboard sheet placed between the cell phone and the sound-level meter. Analysis: Compare the intensity when the sound-level meter was at 10 cm and when it was at 30 cm.Explain how the cardboard sheet affected your results. From Glencoe Physical Science

Relating Frequency and Pitch

Summative: Project

Students will compete with each other to build show box mufflers. Materials: show box, packing material, corks, wax paper, cardboard dividers, aluminum foil, sound-level meter, radio or stereo. Each lab group of students needs a show box and cardboard dividers. They should make a hole in each end of the cardboard box. Noise goes in one end and gets measured with the sound meter at the other end. Encourage students to test different materials and designs of mufflers. Interested students can find several automobile muffler designs online. You could tell students to make a mazelike passage for the sound waves to travel through. Allow students to bring extra materials from home. Encourage competition. Who can make the most effective muffler? From Glencoe Physical Science

The Doppler Effect

Formative: Cooperative Group Work

Materials: sponge ball, small electric buzzer, battery, tape. Cut a small opening in the side of the sponge ball. Place the small electric buzzer connected to the battery inside the opening and tape the opening shut. Throw the ball from the front to the back of the room. The increased and decreased pitches caused by the Doppler Effect should be audible. From Glencoe Physical Science

Volume Setting and Loudness: Inquiry

Summative: Lab Assignment

Students will compare their preferred listening volumes to thresholds for hearing loss. Question: Which volume settings on a portable music player are safe and which are unsafe? Possible Materials: portable music player, sound-level meter, masking tape, graph paper. Hypothesis: Based on your experiences with portable music players and with loud noises, form a hypothesis that predicts which volume settings are safe and which are unsafe. Designing a Plan: Decide on the volume setting that you will test and in what order.Identify important safety issues to consider before conducting any tests.Describe exactly how you will conduct each test.Identify the controls and variables that you will use in your experiment. Make sure that your plan tests only one variable at a time.Identify the steps that you will use and describe each step precisely.Prepare a data table to record your measurements.Ask your teacher to approve your plan and data table before you begin.Conduct your experiment as planned.Test each volume setting two or three times.Record your test results in your data table. Analysis: Graph sound level (y-axis) vs. volume setting (x-axis). Is there any recognizable relationship between the measured sound level and the corresponding volume setting?Determine which sound level corresponds to your preferred listening volume setting on the portable music player.Describe how the results of the experiment might have been different if you had tested your volume settings with different music. Consider different types of music. Try it.Evaluate whether your results support your hypothesis.Research how loud noises can be unhealthy.Infer whether the portable music player would damage your hearing if you listened to it regularly at the volume you prefer. From Glencoe Physical Science

Investigate Electromagnetic Waves

Formative: Observation

Students will investigate the behavior of electromagnetic waves. Materials: television with remote control, glass, book, paper, metal pan Procedure: Point your television remote control, which uses electromagnetic waves, in different directions and observe whether it will still control the television.Place various materials in front of the television's infrared receiver and observe whether the remote still controls the television. Some materials you might try are glass, a book, your hand, paper, or a metal pan. Analysis: Was it necessary for the remote control to be pointing exactly toward the receiver to control the television? Explain.Did the remote continue to work when the various materials were placed between it and the receiver? Explain. From Glencoe Physical Science

The Speed of Light

Summative: Lab Assignment

Students will calculate the speed of light using a microwave oven and the wave speed equation. Materials: microwave oven with turntable removed, microwave safe plate, waxed paper, push-pin size disks, metric ruler, mini marshmallows, oven mitts. Procedure: Create a data table to record the following: distance between hot spots (cm); wavelength (km); speed of light (km/s)Locate the manufacturer's label on the back or inside of your microwave, and record the microwave's frequency.Cover the plate with wax paper. Spread a single layer of marshmallows onto the plate. Make sure the marshmallows are evenly spread and cover the plate.Microwave the plate for about 45 s. Use oven mitts to remove the plate, and allow the plate to cool.Use the small disks to mark the hot spots where the marshmallow melted the most.For five pairs of nearby hot spots, measure from the center of one disk to the center of a nearby disk. Record your data in your table. Analysis: Determine the wavelength. The distance between hot spots is half a wavelength, d = /2.Wavelengths should have units of kilometers, and the frequency should have units of hertz. Hint: 1 MHz = 1,000,000 Hz.Calculate the speed of light using the equation v = f. Do this for each pair of hot spots.Determine the largest, smallest, and average values for the speed of light.Compare these speeds to the accepted speed of light in air (299,000 km/s).Describe another way that scientists could measure the speed of light. Communicate: Compare your average speed of light with other groups in your class. Identify some reasons why some calculations were closer to the accepted speed of light than others. From Glencoe Physical Science

Investigate the Effects of Microwaves

Formative: Observation

Students will observe how microwave ovens heat food. Materials: microwave ovens, two small beakers, dry sand, water, thermometer. Procedure: Obtain two small beakers. Place 50 mL of dry sand into each.To one of the beakers, add 20 mL of room temperature water and stir well.With a thermometer, record the temperature of the sand in each beaker.Together, microwave both beakers of sand for 10 s and immediately record the temperature again. Analysis: Compare the initial and final temperatures of the wet and dry sand.Infer why there was a difference. From Glencoe Physical Science

Observe Refraction in Water

Summative: Observation

Students will investigate how water bends in light. Materials: penny, table, opaque cup, water. Procedures: Place a penny at the bottom of a short, opaque cup. Set the cup on a table in front of you.Have a partner slowly slide the cup away from you until you cannot see the penny.Without disturbing the penny or the cup and without moving your position, have your partner slowly pour water into the cup until you can see the penny.Reverse roles and repeat the experiment. Analysis: Describe what you observed. Explain how this is possible.Sketch the light path from the penny to your eye after the water was added. From Glencoe Physical Science

Reflection and Refraction

Summative: Lab Assignment

Students observe how light will reflect and refract. Materials: light source, unsharpened pencil, clear rectangular container, water, clay. Procedure: Fill the container with water.Place the container so a light sourcea window or an overhead light reaches it. Do not place the container directly below an overhead light.Stand the pencil on end in the clay and place it by the container. The pencil must be taller than the level of the water. Also, place the pencil on the same side of the container as the light source.Looking down through the surface of the water from the side opposite the pencil, observe the reflection and refraction of the image of the pencil.Draw a diagram of the image and label Reflection and Refraction.Repeat steps 3-5 two more times but position the pencil at two different angles. Analysis: Discuss how the image that you see would change or would be different if the surface of the water were a mirror.Compare what you observed in the lab to a reflection on a calm lake.Predict how the image on the lake would change if there were a strong wind. Design and try an experiment to test your prediction. Communicate: Make a poster of your diagrams and use it to explain reflection and refraction of light waves to your class. From Glencoe Physical Science

Resources

Stage 3: Learning Plan

Learning Experiences

1. Direct Instruction through Drill and Practice: Students will solve Wave Speed Problems.
2. Experiential Learning through Creativity: Students engage in Waves and Art.
3. Interactive Instruction through Laboratory Groups: Students will participate in Wavelength, Frequency, and Wave Speed lab.
4. Experiential Learning through Narrative: Students will write an article regarding Vanished.
5. Interactive Instruction through Laboratory Groups: Students will participate in Measure Sound Intensities lab.
6. Indirect Instruction through Inquiry: Students will participate in Build a Muffler activity.
7. Interactive Instruction through Laboratory Groups: Students will participate in The Doppler Effect activity.
8. Experiential Learning through Conducting Experiments: Students will participate in Volume Settings and Loudness experiment.
9. Interactive Learning through Cooperative Learning Groups: Students will participate in Investigate Electromagnetic Waves activity.
10. Experiential Learning through Conducting Experiments: Students will participate in The Speed of Light experiment.
11. Interactive Learning through Cooperative Learning Groups: Students will participate in Observe Refraction in Water activity.
12. Experiential Learning through Conducting Experiments: Students will participate in Reflection and Refraction experiment.

Resources

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. smart phones
7. tablet computers

Resources

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* Tools4Teaching Science (<http://tools4teachingscience.org/pdf/HS_Physical_Science_video_case.pdf>)

Grades 9-12 Science  
Physical Science

Classification of Matter

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Study of Matter

Classification of matter: Heterogeneous vs. homogeneous

Classification of matter: Properties of matter

Classification of matter: States of matter and its changes

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Matter can be classified by its composition, by its physical properties, and by its chemical properties.

Unit Goals

1. Students will understand that movement of molecules is related to the state of matter.
2. Students will understand how to apply Archimedes', Pascal's, and Bernoulli's principles.
3. Students will understand how to apply gas laws.

Big Ideas

1. movement of molecules related to states of matter
2. systems and system models related to properties of fluids/gases
3. energy and matter related to states of matter

Enduring Understandings

1. Substances can change state and be physically combined into mixtures without changing their chemical identities.
2. All physical and chemical changes absorb or release energy.

Content

1. kinetic theory of matter
2. thermal energy
3. changes of state
4. plasma
5. buoyancy
6. Archimedes' Principle
7. Pascal's Principle
8. Bernoulli's Principle
9. viscosity
10. Boyle's Law
11. Charles's Law
12. Gay-Lussac's Law
13. substance
14. element
15. compound
16. heterogeneous mixture
17. suspension
18. colloids
19. homogeneous mixture
20. solutions
21. physical properties
22. physical change
23. chemical properties
24. chemical change
25. Law of Conservation of Mass

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Relate viscosity to the movement of fluids.
2. Identify questions and concepts that guide scientific investigations.

**Understand (Levels 1 and 2)**

1. Contrast substances and mixtures.
2. Construct a relationship between elements and compounds.
3. Connect thermal energy and temperature
4. Connect Archimedes's principle, Pascal's principle, and Bernoulli's principle to real-world scenarios.

**Analyze (Level 3)**

1. Investigate the kinetic theory of matter.
2. Investigate the movement of molecules related to temperature.
3. Analyze the behavior of gases when temperature, volume, or pressure is changed.
4. Differentiate between physical change and chemical change of matter.
5. Differentiate between physical properties and chemical properties of matter.
6. Investigate mixtures and illustrate the difference.

**Evaluate (Levels 3 and 4)**

1. Evaluate a question to determine if it is testable and relevant.

**Create (Level 4)**

1. Design an experiment to observe the law of conservation of mass.
2. Design and conduct scientific investigations.
3. Design a test of a model to ascertain its reliability.

Essential Questions

1. How do particles move in the different states of matter?
2. What are some applications of Archimedes', Pascal's, and Bernoulli's principles?
3. How is a gas affected when pressure, temperature, or volume change?
4. What are the differences between substances and mixtures?
5. How are suspensions, solutions, and colloids related?
6. How does the law of conservation of mass apply to chemical changes?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss what they already know about the topic and what they expect to learn.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from textbook. Teacher can also assign complex text from sources such as Scientific American or articles from Ebsco Host through INFOhio.

Class Discussions

Formative: Class Discussion

On a daily basis, students indicate what they know or think they know whether through exit cards, quick show of hands, or class discussions.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Unit Test

Summative: Test

Teacher designed, unit-appropriate tests may be given at the end of the unit.

Comparing Densities of Liquids

Formative: Observation

Using the attached handout, students will predict which of the four liquids will have the highest density.

Pure Substances and Mixtures

Summative: Lab Assignment

Students will classify materials based on their appearance and chemical makeup. Materials: salt and iron filings mixture, pepper water, sugar water, graduated cylinder, 250-mL beakers (5), magnet, balance, funnel, filter paper, stirring rod, magnifying lens, hot plate, watch glass. Procedure: Create a data table using the heads substance, color, magnetic attraction, and matter classification. Record all data in your table.Determine the color of each sample.Determine whether each sample is magnetic.Try to separate the salt and iron filings mixture.Try to separate the particles of the pepper-water mixture and sugar-water mixture.Classify each material as an element, a compound, or a mixture. Analysis: Describe the separation methods of the mixture samples.Conclude if the different particles of each sample can be separated using physical properties.Infer how you can identify a substance vs. a mixture.State whether any of the materials used are compounds. Communicate: Compare your results with classmates. Identify possible sources of error that might cause any difference in your data.

Conservation of Mass: Inquiry

Summative: Lab Assignment

Students will design an experiment to observe the Law of Conservation of Mass. Materials: antacid tablets, empty plastic drink bottle, balloon, beaker, water, spatula, balance, mortar, pestle, funnel, weighing paper. Hypothesis: Based on your understanding of the Law of Conservation of Mass, form a hypothesis about the total mass of antacid tablets and water before and after the tablets are dissolved. Plan: As a group, agree upon and write the hypothesis.Plan an investigation to test your hypothesis. List the steps of your procedure.List the materials that you need to test your hypothesis.Decide upon any needed safety equipment or safety procedures to ensure the safety of your group during the experiment.Have one group member reread your entire procedure aloud to the group to make certain that you have all of the necessary materials and that your procedure can be easily followed.Make sure your teacher approves your plan.Copy the data table to record measurements.While doing this investigation, record your observations and complete the data table. Analyze: Describe the effects of mixing the antacid powder and the water.Compare the total mass of the substances before mixing to the total mass after the reaction.Calculate the percentage of error in the investigation.Graph the mass of the substances before and after the reaction using a bar graph.Explain whether your data support your hypothesis.Infer how mass might have been lost or added between the initial and final weighing of the substances.How does this experiment support the law of conservation of mass? Communicate: Compare the data your group collected with the data collected by the other groups and discuss possible reasons why percent error might not be zero.

Phase Changes

Summative: Lab Assignment

Students will heat ice and graph the temperature changes over time. Materials: 500-mL beaker, ice, thermometer, hot plate. Procedure: Prepare a data table for tracking the temperature of the water in the beaker over time.Gently heat the ice in the beaker. Every 3 minutes, record your observations and the temperature of the water in the beaker. Do not touch the thermometer to the bottom or sides of the container.After the ice in the beaker melts and the water begins to boil, observe the system for several more minutes and record your observations.Turn off the heat and let your system completely cool before you clean up. Analysis: Draw a picture of the system used in this lab.Label the state in which the water started in the beaker, the state into which it changed in the beaker, and the state above the beaker.Draw a temperature vs. time graph using your data from this lab.Explain the shape of your graph in terms of energy. Why are there flat lines in temperature despite the constant addition of heat? Communicate: Compare your graph to those of your classmates. Decide what your curve would look like if you started with water vapor and cooled it.

States of Matter

Summative: Interactive Media

Students will demonstrate knowledge of states of matter and movement of molecules within those states.

Fluid Pressure and Flow

Summative: Interactive Media

Explore pressure in the atmosphere and under water. Reshape a pipe to see how it changes fluid flow speed. Experiment with a leaky water tower to see how the height and water level determine the water trajectory.

Investigating Gas Laws

Summative: Lab Assignment

Students will investigate two of the gas lawsCharles and Boyle'sthrough a lab activity. Students should be utilizing observation, inquiry, and critical thinking skills.

Beginner's Guide to Propulsion Charles and Gay Lussac's Law

Summative: Lab Assignment

After reading the attached websites on Charles and Gay-Lussac's Law and using the Animated Gas Lab, complete the activity to answer questions.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Experiential Learning through Simulations: Students will participate in States of Matter Lab.
2. Direct Instruction through Explicit Teaching/Drill Practice: Students will participate in Buoyancy: Why Things Float activity. (See Links.)
3. Interactive Instruction through Video Discussion: Students will view and discuss in Bill Nye's "Oh Buoyancy" video.
4. Experiential Learning through Simulations: Students will participate in Fluid Pressure and Flow activity.
5. Interactive Instruction through Lab Groups: Students will participate in Investigating Gas Laws lab.
6. Experiential Learning through Simulations: Students will engage in Beginner's Guide to Propulsion Charles and Gay Lussac's Law activity.
7. Direction Instruction through Explicit Teaching/Drill Practice: Students will participate in Physical vs. Chemical Change and "The Code." (See Links.)
8. Interactive Instruction through Lab Groups: Students will participate in Phase Changes lab.
9. Direct Instruction through Drill and Practice: Students will practice pressure equations.
10. Direct Instruction through Drill and Practice: Students will practice Pascal's Principle.
11. Direct Instruction through Drill and Practice: Students will practice Boyle's Law.
12. Direct Instruction through Drill and Practice: Students will practice Charles's Law.
13. Interactive Instruction through Lab Groups: Students will participate in Pure Substances and Mixtures lab.
14. Experiential Learning through Conducing Experiments: Students will conduct Conservation of Mass experiment.

Resources

* Buoyancy: Why Things Float (<http://www.cstephenmurray.com/Acrobatfiles/IPC/Chapter17/chap17no2.pdf>)

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* Teach Engineering (<http://www.teachengineering.org/view_subjectarea.php?url=collection/wpi_/subject_areas/wpi_physical_science/physical_science.xml>)

Grades 9-12 Science  
Physical Science

Atoms and Periodic Trends

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Study of Matter

Atoms: Models of the atom (components)

Atoms: Ions (cations and anions)

Atoms: Isotopes

Periodic trends of the elements: Periodic law

Periodic trends of the elements: Representative groups

Reactions of matter: Nuclear reactions

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

WHST.9-10.2b. 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.

WHST.9-10.2c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

All matter, however solid it appears, is made up of tiny building blocks that are themselves mostly empty space. These "building blocks" are atoms, and they combine to form molecules and all substances of matter. The periodic table is a tool that one learns to read in order to understand properties of the elements. Elements having an unstable nucleus are said to be radioactive. Radioactivity has to do with the breakdown of certain atomic nuclei. Radioactive decay is accompanied by the release of energy.

Unit Goals

1. Understand that atoms make up all things.
2. Have a working understanding of the size of an atom.
3. Be familiar with the different models of the atom that have been presented over the years and the reason that the models have changed over time.
4. Understand that particles make up an atom, protons, neutrons and electrons.
5. Understand that nuclear decay is a process where an atom will release an alpha particle, beta particle, or gamma radiation in order to go from an unstable nucleus to a more stable nucleus. This process releases energy.
6. Know that the periodic table is a system of organizing the elements.
7. Learn to read the periodic table.

Big Ideas

models of the atom

1. properties of elements or compounds
2. radioactive elements
3. the periodic table

Enduring Understandings

1. All things are made of atoms.
2. The atomic model has evolved over time.
3. The number of protons in the atom determines the element.
4. The number of electrons determines charge.
5. Elements in the Periodic Table have a specific arrangement that organizes them into their physical and chemical properties.
6. The periodic table can be used to predict properties of elements.
7. An atom is the smallest particle of an element that still represents that element.

Content

1. atoms
2. atomic models of the atom
3. modern atomic model
4. nuclear decay
5. protons, neutrons and electrons
6. elements in the periodic table
7. alkali metals
8. alkaline earth metals
9. transition elements
10. lanthanide and actinide series
11. ductility, malleability, luster and conductivity of metals
12. nonmetals
13. halogens and elements
14. noble gasses

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Describe the size of an atom.
2. Explain how the atomic model has changed over time.
3. Identify questions and concepts that guide scientific investigations.
4. Read the periodic table.

**Understand (Levels 1 and 2)**

1. Describe why nuclear decay occurs and the products produced by this decay.
2. Make predictions about elements based on their position in the table.

**Analyze (Level 3)**

1. Explain that protons in an atom determine the element, neutrons in the atom determine the isotope, and electrons in the atom determine charge.
2. Formulate and revise explanations and models using logic and evidence (critical thinking).
3. Classify and organize physical and chemical properties of unknown elements into their own periodic table.
4. Classify samples as metal, nonmetal, or metalloid.

**Evaluate (Levels 3 and 4)**

1. Evaluate the characteristics used to create groups on the periodic table.

**Create (Level 4)**

1. Create a model of an atom.
2. Create a periodic table to organize foods.

Essential Questions

1. What is an atom?
2. How would you describe the size of an atom?
3. How has the atomic model changed over time?
4. How does an atom change when its number of protons, neutrons or electrons is changed?
5. What happens during nuclear decay?
6. How are elements arranged in the periodic table?
7. What can you learn about elements from the periodic table?
8. What are the properties of metals, nonmetals and metalloids? Where are each of these located on the periodic table?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss what they already know about the topic and what they expect to learn.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from text book. Teacher can also assign complex text from sources such as Scientific American or articles from Ebsco Host through INFOhio.

Class Discussion

Formative: Class Discussion

On a daily basis, students demonstrate what they know or think they know whether through exit cards, quick show of hands, or class discussions.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Unit Test

Summative: Test

Teacher designed, unit-appropriate tests may be given at the end of the unit.

Build an Atom (Virtual Lab)

Formative: Lab Assignment

Use University of Colorado's PHET Interactive Simulations to build an atom to discover how protons, neutrons and electrons affect the type of atom created. Use of a computer for each student or student pairs is required. Teacher guide is available on the web page under Tips for Teachers.

Find the Missing Spy: A Periodic Table Activity by ECSDM

Formative: Lab Assignment

You will need to download the pictures and the student question sheet from the link provided. Reproduce the "pictures" but cut them apart to give to the students to organize how they see fit. The "people" represent atomic mass and valance numbers. The task is to find the "missing" person, like Mendeleev left space for the missing elements.

A Periodic Table of Foods

Summative: Lab Assignment

Students will create a periodic table to organize foods. Materials: 11 x 17 paper, metric ruler, colored pencils or markers Procedures: Create a list of 20 of your favorite food and drink items.Describe the basic characteristics of each of these items. For example, you might describe the primary ingredient, nutritional value, taste, and color of each item. You could also identify the food group to which each item belongs, such as fruits, vegetables, grains, dairy, meat, and sweet.Create a data table to organize the information that you collect.Construct a periodic table of foods on an 11 x 17 sheet of paper. Determine which characteristics you will use to organize your items. Create groups (columns) of food and drink items that share similar characteristics on your table. For example, potato chips, pretzels, and cheese-flavored crackers could be combined as a group of salty-tasting foods. Create as many groups as you need. You do not need to have the same number of items in every group. Analyze: Evaluate the characteristics you used to create groups on your periodic table. Do the characteristics of each group adequately describe each of its members? Do the characteristics of each group distinguish its members from the members of other groups?Explain the way your rows of food are organized.Analyze the reasons why some items did not necessarily fit into a group.Infer why chemists have not created a periodic table of compounds.

Properties of Elements

Summative: Lab Assignment

Students will use the physical and chemical properties of unknown elements to classify and organize them into their own periodic table. Materials: stoppered test tube (6), plastic dishes containing small samples of each element (carbon, magnesium, aluminum, silicon, sulfur, and tin), conductivity apparatus, 1.0M HCl, small hammer, test tubes (6), test tube rack, 10-mL graduated cylinder, spatula, glass-marking pencil. Procedure: Create a table to record the physical and chemical properties of each element.Observe and record the appearance (physical state, color, luster, and texture) of the element sample in each test tube without removing the stoppers.Remove a small sample of each of the elements contained in a plastic petri dish and place it on a hard surface. Gently tap each element sample with a small hammer. If the element is malleable, it will flatten. If it is brittle, it will shatter. Record your results.Use the conductivity tester to determine which elements conduct electricity. Clean the electrodes with water and dry them before testing each element. Record your results.Label each test tube with the symbol for one of the elements in the plastic dishes. Using a graduated cylinder, add 5 mL of water to each test tube.Use a spatula to put a small amount of each element into the corresponding test tube. Record any indication that a chemical reaction might have occurred.Add 5 mL of 1.0M HCl to each test tube. Observe each test tube for at least 1 minute. The formation of bubbles or the production of heat is evidence of a reaction between the acid and the element. Record your observations. (HCl is harmful to the skin, eyes, and clothing)Dispose of all materials as instructed. Analysis: Classify each of your samples as a metal, a nonmetal, or a metalloid.Create a periodic table of the elements examined in this lab. Place elements with like physical and chemical characteristics in the same column.Compare your periodic table to the actual periodic table of the elements. How are they alike? How are they different?Describe any trends among the elements that you observed in the lab.Explain the steps that you would take to classify an unknown element as a metal, a nonmetal, or a metalloid. Communicate: Research metal and nonmetal resources that can be used to build a home. Create a brochure highlighting each element and how it is used in home construction.

Carbon Allotropes

Summative: Modeling

Students will make a working model of the layered graphite structure and use the model to determine the cause-and-effect relationship of the bonding between carbon atoms in graphite and graphite's physical properties. They will also make a model of diamond and investigate diamond's hardness. Materials: thin spaghetti, large gumdrops, thin polystyrene sheets, flat cardboard, toothpicks, scissors. Make the Model: Work in teams of at least two. Collect all the needed equipment.Sketch a model for graphite and a model for diamond. Remember that graphite consists of rings of six carbons bonded in a flat hexagon. In addition, the flat rings in one layer are weakly attached to other flat layers. Diamond has a tetrahedral structure.Select the appropriate materials. How will your model be constructed to show weak and strong attractions?Obtain your teacher's approval of your sketches before proceeding. Testing the Model: Assemble two hexagonal rings of graphite as you have sketched.Examine one of your hexagonal rings. Gently try to push or pull on the structure. Record your observations.Connect the two hexagonal rings.Have one partner hold the bottom layer and the other partner gently pull the top layer sideways. Record your observations.Assemble your model of the diamond.Pushing gently, try to compress the model. Record your observations. Analysis: 1. Compare your models and results with designs and results of other groups. 2. Describe how your models illustrate the different structures found in graphite and diamond. 3. How does the bonding of graphite that you explored in the lab explain graphite's lubricating properties? 4. Discuss how diamond's structure explains its hardness. 5. Describe the results that you obtained from your experiment. 6. Did the results accurately model the properties of graphite and carbon? Explain. 7. Identify at least two ways to improve your models.

Making Models of Isotopes

Summative: Lab Assignment

Students can use the link provided to build three-dimensional models of hydrogen isotopes.

Color Coding the Periodic Table

Summative: Visual Arts Project

Using the attached document, students can color code the periodic table to identify element families and properties.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Experiential Learning through Model Building: Students participate in creating M and M Model of the Atom. (See Links.)
2. Interactive Instruction through Lab Groups: Students participate in creating Periodic Table of Foods.
3. Interactive Instruction through Lab Groups: Students participate in Properties of Elements lab assignment.
4. Experiential Learning through Model Building: Students participate in Carbon Allotropes modeling activity.
5. Experiential Learning through Model Building: Students participate in Making Models of Isotopes.
6. Direct Instruction through Drill and Practice: Students practice Ions.

Resources

* M and M Model of the Atom (<http://www.exo.net/~emuller/activities/M%20and%20M%20Atom%20Model.pdf>)

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* University of Colorado (<http://phet.colorado.edu/en/simulation/build-an-atom>)

Grades 9-12 Science  
Physical Science

Bonding, Compounds, and Chemical Reactions

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 2 NGSS: Disciplinary Core Ideas

ETS1: Engineering Design

Defining and Delimiting an Engineering Problem

A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1) (secondary to KPS2-2)

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model makes sense by comparing the outcomes with what is known about the real world.

Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).

OH Grade 9-12 OH: Science (2011)

HS Physical Science

Science Inquiry and Application During the years of grades 9 through 12 all students must use the following scientific processes to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;

Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: Study of Matter

Bonding and compounds: Bonding (ionic and covalent)

Bonding and compounds: Nomenclature

Reactions of matter: Chemical reactions

Reactions of matter: Nuclear reactions

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

WHST.9-10.1. Write arguments focused on discipline-specific content.

WHST.9-10.1a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audiences knowledge level and concerns.

WHST.9-10.1c. 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.

WHST.9-10.1d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1e. Provide a concluding statement or section that follows from or supports the argument presented.

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-10.2a. Introduce a topic and organize 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.

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WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

WHST.9-10.2e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.2f. 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).

Production and Distribution of Writing 4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge 7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

Draw evidence from literary or informational texts to support analysis, reflection, and research.

WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing 10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Capacities of the Literate Individual

Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

Bonding of atoms and chemical reactions involves a change in energy. Both energy and matter are conserved in these processes.

Unit Goals

1. Understand that bonding occurs between atoms and involves the electrons of the atom.
2. Know that in chemical reactions, bonds are broken and new bonds are formed.
3. Understand that destruction and formation requires energy which is conserved in the reactions.
4. Understand that matter is conserved in any chemical reaction.

Big Ideas

1. electrons in bonds
2. valence electrons and the types of bonds formed
3. chemical reactions
4. breaking and making of bonds which require a change in energy
5. conservation of energy and matter in chemical reactions

Enduring Understandings

1. Electrons in the atom are involved in bonds.
2. The number of valance electrons determines stability of the atom.
3. A compound has different properties from the elements that make it up.
4. In covalent bonds, electrons are shared.
5. In ionic bonds, electrons move from one atom to another.
6. A metallic bond occurs when valence electrons are pooled.
7. In chemical reactions, mass is conserved.
8. There are multiple types of chemical reactions.
9. Chemical reactions always involve the breaking of bonds which requires a change in energy.
10. The rate of a chemical reaction can be changed.

Content

1. the difference between an ionic and covalent bond
2. valence electrons involved in chemical bonding
3. changes that indicate chemical reactions: change in temperature, color or odor, release of light or gas, formation of a solid from two liquids
4. atoms of reactants which rearrange and form products in chemical reactions
5. categories of chemical reactions: synthesis, decomposition, combustion, and single or double-replacement
6. a change in energy which can produce an endothermic or exothermic reaction
7. the rate of a chemical reaction

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Carry out the balancing of simple equations.
2. Write formulas for ionic compounds.

**Understand (Levels 1 and 2)**

1. Determine patterns for atomic bonding and chemical reactivity.

**Analyze (Level 3)**

1. Explain how electrons affect the charge of an atom and how the valence electrons determine what type of bond will be formed.
2. Explain how the rate of a chemical reaction can be increased by increasing surface area, the temperature of, or the concentration of the reactants or by adding a catalyst.
3. Discriminate between the different types of chemical reactions.
4. Discriminate between endothermic and exothermic reactions.
5. Discriminate between reactants and products in a chemical reaction.

**Evaluate (Levels 3 and 4)**

1. Detect if a chemical reaction has occurred by looking for changes in properties and changes in energy of the substances that reacted.

**Create (Level 4)**

Essential Questions

1. What is an energy level?
2. What is a valence electron?
3. What are the different types of chemical bonds? What are the signs that a chemical reaction has occurred?
4. What is a reactant? What is a product?
5. What are the types of chemical reactions?
6. What are energy changes in chemical reactions?
7. How can the rate of a reaction be changed?

Stage 2: Assessment Evidence

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss what students already know about the topic and what they expect to learn.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from textbook. Teacher can also assign complex text such as that found in Scientific American or articles from Ebsco Host through INFOhio.

Formative: Class Discussion

On a daily basis, students demonstrate what they know or think they know whether through exit cards, quick show of hands, or class discussions.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Unit Test

Summative: Unit Exam

Teacher designed, unit-appropriate tests may be given at the end of the unit.

The Atomic Dating Game:

Formative: Lab Assignment

The Atomic Dating game is a lesson that is designed to allow students to determine patterns for atomic bonding and chemical reactivity. It is a standards based, hands-on, interactive lesson that motivates students by using a dating analogy to learn how atoms form ionic and covalent bonds. (Created by Laura Westerman, Dake Junior High school West Irondequoit Center)

Writing Formulas for Ionic Compounds

Formative: Written Assessment

Students will practice writing formulas for ionic compounds.

Supermarket Chemical Reactions in Ziploc Bags

Formative: Lab Assignment

Students can complete this great exploratory lab that takes common substances that react with one another. Focus is mainly on endothermic and exothermic reactions.

Stage 3: Learning Plan

Learning Experiences

1. Interactive Instruction through Laboratory Groups: Students will participate in Supermarket Chemical reactions in Ziploc Bags.
2. Interactive Instruction through Laboratory Groups: Students will participate win the Atomic Dating Game.
3. Interactive Instruction; Small Group and Class Discussions
4. Direct Instruction through Drill and Practice: Students will practice writing Chemical Formulas.
5. Direct Instruction through Drill and Practice: Students will practice Balancing Equations.

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. SmartBoard
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.

Resources

* TED-ED Talks (<http://ed.ted.com/lessons?category=science-technology>)

Grades 9-12 Science  
Physical Science

The Universe

Stage 1: Desired Results

Catholic Standards

DOC All Grades DOC: Catholic Standards

The Profession of Faith

Students will be able to

1. Recognize God in the world's order, beauty, and goodness (CCC 32).

8. Understand that the world was made for the glory of God, the Creator of all things (CCC 290; 293).

Life in Christ

Students will be able to

12. Respect the integrity of all creation, including animals, plants, and all nature (CCC 2415).

Targeted Standards

NGSS Grade 9-12 NGSS: Crosscutting Concepts

Crosscutting Statements

Patterns Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

NGSS Grade 9-12 NGSS: Science and Engineering Practices

Practice 8. Obtaining, evaluating, and communicating information

Obtaining, evaluating, and communicating information in 912 builds on K8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 912 builds on K8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 912 builds on K8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 912 builds on K8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.

Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.

Ask questions to clarify and refine a model, an explanation, or an engineering problem.

Evaluate a question to determine if it is testable and relevant.

Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.

Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.

Practice 2. Developing and using models

Modeling in 912 builds on K8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.

Design a test of a model to ascertain its reliability.

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.

Develop a complex model that allows for manipulation and testing of a proposed process or system.

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigations design to ensure variables are controlled.

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Select appropriate tools to collect, record, analyze, and evaluate data.

Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.

Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Practice 4. Analyzing and interpreting data

Analyzing data in 912 builds on K8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.

Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

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Apply techniques of algebra and functions to represent and solve scientific and engineering problems.

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OH Grade 9-12 OH: Science (2011)

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Design and conduct scientific investigations;

Use technology and mathematics to improve investigations and communications;

Formulate and revise explanations and models using logic and evidence (critical thinking);

Recognize and analyze explanations and models

Communicate and defend a scientific argument.

Course Content: The Universe

History of the universe

Galaxy formation

Stars: Formation; stages of evolution

Stars: Fusion in stars

OH Grades 9-10 OH: Literacy in History/Social Studies, Science, & Technical Subjects 6-12

Writing

Text Types and Purposes 1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.

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WHST.9-10.2d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

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Students Who are College and Career Ready in Reading, Writing, Speaking, Listening, & Language

They demonstrate independence.

Reading: Science & Technical Subjects

Key Ideas and Details 1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

RST.9-10.2. Determine the central ideas or conclusions of a text; trace the texts explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text.

Craft and Structure 4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 910 texts and topics.

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

Assess how point of view or purpose shapes the content and style of a text.

RST.9-10.6. Analyze the authors purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas 7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the authors claim or a recommendation for solving a scientific or technical problem.

Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Read and comprehend complex literary and informational texts independently and proficiently.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 910 text complexity band independently and proficiently.

Catholic Identity

DOC All Grades Catholic Identity

Catholic Social Justice Teachings

Life and Dignity of the Human Person

Rights and Responsibilities

The Dignity of Work and the Rights of Workers

Call to Family, Community, and Participation

Option for the Poor and Vulnerable

Solidarity

Care for God's Creation

The Rights of Children

1. THE RIGHT TO A CATHOLIC COMMUNITY that witnesses to Christ and the Gospel by protecting them from child abuse, including sexual abuse and neglect.

2. THE RIGHT TO A SAFE ENVIRONMENT that promotes care, protection, and security.

3. THE RIGHT TO BE RESPECTED AS INDIVIDUALS with human dignity.

4. THE RIGHT TO WORK ACTIVELY TOWARD THEIR OWN EMPOWERMENT through the development of their gifts and talents.

5. THE RIGHT TO A LEARNING ENVIRONMENT THAT VALUES COOPERATION and challenges its members to critical and reflective thinking in their search for truth.

6. THE RIGHT TO DEVELOP POSITIVE, RESPONSIBLE AND CARING ATTITUDES AND BEHAVIORS TOWARD OTHERS and to recognize the rights of others to be safe and free from harassment and abuse.

7. THE RIGHT TO LEARN THE SKILL OF SELF PROTECTION by identifying safe and unsafe situations.

8. THE RIGHT TO LEARN RESPONSIBILITY for themselves and their actions.

9. THE RIGHT TO MAKE RESPONSIBLE DECISIONS founded on religious conviction.

10. THE RIGHT TO GUIDANCE FROM THE CHURCH in their development as loving people.

Summary

The life cycle of every star is determined by its mass, luminosity, magnitude, temperature, and composition. Observations of the galaxy expansion, cosmic background radiation, and the Big Bang Theory describe an expanding universe that is about 14 billion years old.

Unit Goals

1. Students will understand the patterns associated with an expanding universe.
2. Students will understand the patterns in the life cycle of a star.
3. Students will understand the formation of galaxies and the universe.
4. Students will understand the correlation between galaxy shape and its properties.
5. Students will understand the idea that the universe is expanding.

Big Ideas

1. patterns relating to universe expansion and life cycle of stars
2. systems and system models relating to formation of galaxies/universe
3. structure and function relating to galaxy shape with properties
4. stability and change relating to universe expansion

Enduring Understandings

1. As technology allows scientists to learn more about the universe, modifications in how we identify different features must occur.

Content

1. properties of the sun
2. zones of the sun
3. applications of solar energy
4. spectra
5. H-R diagram
6. classification of stars
7. brightness of stars
8. Doppler shifts
9. life cycle of stars
10. nuclear fusion
11. spectroscopy
12. Hubble Space Telescope
13. reflecting and refracting telescope
14. galaxy classification
15. Milky Way Galaxy
16. distance in space
17. redshift
18. Big Bang Theory
19. cosmic background radiation

Skills

**Bloom's Taxonomy/DOK**

**Remember (Level 1)**

1. Summarize the processes of energy production in the sun.
2. Measure the distance between stars.

**Understand (Levels 1 and 2)**

1. Compare the three types of spectra (continuous, absorption, and emission).
2. Contrast brightness and luminosity.
3. Compare different types of star clusters.
4. Explain properties of stars by using the H-R Diagram.
5. Contrast redshift and blueshift in regard to universe age.
6. Explain how the universe would be different if massive stars did not explode at the end of their lives.
7. Compare the types of galaxies found in the universe.
8. Distinguish between reflecting and refracting telescopes and how they work.
9. Distinguish whether there is a balance between pressure and gravity in main-sequence stars, white dwarfs, neutron stars, and black holes.
10. Classify the galaxy Earth is a part of using identifiable properties as evidence.

**Analyze (Level 3)**

1. Investigate the relative properties (diameter, mass, density) and zones of the sun.
2. Assess the benefits of technology spinoffs to society (NASA technologies passed on for industrial use).

**Evaluate (Levels 3 and 4)**

1. Model the uniform expansion of the universe.

**Create (Level 4)**

1. Design a model to explain parallax.
2. Connect cosmic background radiation with the development of the Big Bang Theory.
3. Connect the Doppler shift in star colors with the Doppler shift in sound waves.
4. Hypothesize why only the most massive stars are important contributors in enriching the galaxy with heavy elements.
5. Connect the use of technology with the advancements in the Hubble Space Telescope.

Essential Questions

1. What kinds of stars exist?
2. What is the life cycle of a star?
3. What is the universe and how is it organized?
4. Does the universe have a beginning and an end?
5. How do astronomers study the universe?

Stage 2: Assessment Evidence

Exploring the Spectrum

Summative: Lab Assignment

This activity should help students accomplish the following: understand that light sources give off spectrums and spectral linesmake connections between personal observations and the spectral lines found in star lightunderstand the Doppler Effect and that red shifted spectral lines indicate that a star is moving away from the observerapply these observations as evidence for the Big Bang Theory.

The Expanding Universe Lab

Summative: Lab Assignment

In this activity, students will use Hubble Space Telescope Images to view how objects in the Universe change and create scientific models of the Universe.

H-R Diagram

Summative: Lab Assignment

In this lab students will investigate the relationship between the temperature, brightness, and diameter of stars.

Nuclear Fusion: How Are Elements Created In the Stars?

Summative: Lab Assignment

In this activity, students will use models of marshmallows to explain nuclear fusion and how radiation is generated by stars.

Time Travel to the Edge of the Universe and Back!

Summative: Lab Assignment

Students will study the size of the universecalculate the time to travel to near and distant destinationsconstruct a time scale model of the universe by using time travel distances

What's in the Stars?

Summative: Lab Assignment

This lesson guide integrates a series of activities designed to look at stellar evolution and composition.

Laboratory Work

Formative: Lab Assignment

Teachers can assign labs from the laboratory manual, create their own labs, or use labs from web sources, many of which are listed in the reference section. Laboratory exercises are a necessary part of high school science; however, not all schools have the same equipment, so any variety of labs may be used to aid students in their understanding of unit concepts. They can be formative, exploring a new concept, or summative, showing a practical application of concept knowledge.

Teacher Directed Reading

Formative: Reading Task

Teacher assigns reading appropriate to unit which may come from textbook. Teacher can also assign complex text found i sources such as Scientific American or articles from Ebsco Host through INFOhio.

KWL Chart

Diagnostic: Self Assessment

Before beginning a unit, students discuss what they already know about the topic and what they expect to learn.

Class Discussion

Formative: Class Discussion

On a daily basis, students demonstrate what they know or think they know whether through exit cards, quick show of hands, or class discussions.

Unit Test

Summative: Unit Exam

Teacher designed, unit-appropriate tests may be given at the end of the unit.

Resources

Stage 3: Learning Plan

Learning Experiences

1. Interactive Instruction through Lab groups/Indirect Instruction/Problem solving: Students will participate in Exploring the Spectrum Lab.
2. Experiential Learning through Model building/Interactive Instruction/Lab groups: Students will participate in The Expanding Universe Lab
3. Direct Instruction through Drill Practice: Students will complete Gravity Exploration Worksheet.
4. Direct Instruction through Structured Overview: Students will participate in Newton's Laws and Orbit activity.
5. Interactive Instruction through Lab Groups: Students will participate in H-R Diagram Lab.
6. Interactive Instruction through Discussion: Students will participate in The Beginnings of a Telescope activity.
7. Interactive Instruction through Labs Groups: Students will participate in NASA: The Life Cycles of Stars activity. (See Links in Resources.)
8. Interactive Instruction through Lab Group: Students will participate in NASA: What's In the Stars? activity. (See Links in Resources.)
9. Experiential Learning through Model Building: Students will engage in Time Travel to the Edge of the Universe and Back! Activity.

Resources

* The Beginnings of a Telescope (<http://www.pbslearningmedia.org/resource/phy03.sci.engin.design.galileotele/the-beginnings-of-the-telescope/>)

Technology Integration

1. LCD projector
2. PowerPoint
3. Internet resources
4. Online video clips
5. Smart Board
6. smart phones
7. tablet computers

Resources

**Books**

1. McGraw Hill Education (2012). *Glencoe Physical Science.* New York: Glencoe/McGraw Hill.
2. McGraw Hill Education (2013). *Glencoe Earth Science.* New York: Glencoe/McGraw Hill.

Resources

* YouTube (<https://www.youtube.com/results?search_query=physical+science+video>)