

SCIENCE GRADE 9

Adams County/Ohio Valley
Course of Study

Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: A. Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in the composition and scale of the physical universe.
Content Organizer: The Universe

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
1. Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium.				

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Content Organizer: The Universe

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
2. Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago.				

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Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: C. Explain the 4.5 billion-year-history of Earth and the 4 billion-year-history of life on Earth based on observable scientific evidence in the geologic record.
Content Organizer: The Universe

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>3. Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the Solar System.</p>				

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Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: B. Explain that many processes occur in patterns within the Earth's systems.
Content Organizer: Earth Systems

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
4. Explain the relationships of the oceans to the lithosphere and atmosphere (e.g., transfer of energy, ocean currents, landforms).				

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Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: E. Explain the processes that move and shape Earth's surface.
Content Organizer: Processes that Shape Earth

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>5. Explain how the slow movement of material within Earth results from</p> <ul style="list-style-type: none"> a. thermal energy transfer (conduction and convection) from the deep interior b. the action of gravitational forces on regions of different density 				

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Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: E. Explain the processes that move and shape Earth's surface.
Content Organizer: Processes that Shape Earth

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
6. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).				

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Content Standard: Earth and Space Science
Grade 9-10 Benchmarks: E. Explain the processes that move and shape Earth's surface.
Content Organizer: Processes that Shape Earth

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
7. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).				

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Content Standard: Earth and Space Science

Grade 9-10 Benchmarks: F. Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences.

Content Organizer: Historical Perspectives and Scientific Revolutions

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>8. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory).</p>				

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Course of Study

Content Standard: Physical Science
Grade 9-10 Benchmarks: A. Describe that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explain the structure and properties of atoms.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
1. Recognize that all atoms of the same element contain the same number of protons, and elements with the same number of protons may or may not have the same mass. Those with different masses (different numbers of neutrons) are called isotopes.				

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Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
2. Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
3. Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation.				

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Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
4. Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations.				

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Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
5. Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons.				

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Course of Study

Content Standard: Physical Science
Grade 9-10 Benchmarks: B. Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>6. Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals, water).</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: B. Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>7. Show how atoms may be bonded together by losing, gaining or sharing electrons and that in a chemical reaction, the number, type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations).</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: B. Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
8. Demonstrate that the pH scale (0-14) is used to measure acidity and classify substances or solutions as acidic, basic, or neutral.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: C. Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
9. Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, properties of alloys, superconductors and semiconductors).				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: C. Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.
Content Organizer: Nature of Matter

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
10. Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>11. Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion, and during changes of state the temperature remains constant.</p>				

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Adams County/Ohio Valley
Course of Study

Content Standard: Physical Science
Grade 9-10 Benchmarks: E. Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
12. Explain how an object's kinetic energy depends on its mass and its speed $(KE = \frac{1}{2}mv^2)$.				

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Grade 9-10 Benchmarks: E. Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>13. Demonstrate that near Earth’s surface an object’s gravitational potential energy depends upon its weight (mg where m is the object’s mass and g is the acceleration due to gravity) and height (h) above a reference surface ($PE = mgh$).</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>14. Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.)</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
15. Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
16. Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs, hot packs and the burning of fossil fuels).				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: F. Explain how energy may change form or be redistributed but the total quantity of energy is conserved.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>17. Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation).</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: G. Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>18. Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays).</p>				

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Course of Study

Content Standard: Physical Science
Grade 9-10 Benchmarks: G. Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>19. Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium.</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: G. Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter.
Content Organizer: Nature of Energy

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>20. Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material.</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: D. Explain the movement of objects by applying Newton's three laws of motion.
Content Organizer: Forces and Motion

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
21. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: D. Explain the movement of objects by applying Newton's three laws of motion.
Content Organizer: Forces and Motion

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
22. Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it.				

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Course of Study

Content Standard: Physical Science
Grade 9-10 Benchmarks: D. Explain the movement of objects by applying Newton's three laws of motion.
Content Organizer: Forces and Motion

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>23. Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. ($F_{net} = ma$. Note that weight is the gravitational force on a mass.)</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: D. Explain the movement of objects by applying Newton's three laws of motion.
Content Organizer: Forces and Motion

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: D. Explain the movement of objects by applying Newton's three laws of motion.
Content Organizer: Forces and Motion

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
25. Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight).				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: H. Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences.
Content Organizer: Historical Perspectives and Scientific Revolutions

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>26. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory, Newtonian mechanics).</p>				

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Content Standard: Physical Science
Grade 9-10 Benchmarks: H. Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences.
Content Organizer: Historical Perspectives and Scientific Revolutions

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>27. Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy, nanotechnology, plastics and ceramics and communication technology).</p>				

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Content Standard: Science and Technology
Grade 9-10 Benchmarks: B. Explain that science and technology are interdependent; each drives the other.
Content Organizer: Understanding Technology

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
1. Describe means of comparing the benefits with the risks of technology and how science can inform public policy.				

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Adams County/Ohio Valley
Course of Study

Content Standard: Science and Technology
Grade 9-10 Benchmarks: A. Explain the ways in which the processes of technological design respond to the needs of society.
Content Organizer: Abilities To Do Technological Design

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
2. Identify a problem or need, propose designs and choose among alternative solutions for the problem.				

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Adams County/Ohio Valley
Course of Study

Content Standard: Science and Technology
Grade 9-10 Benchmarks: A. Explain the ways in which the processes of technological design respond to the needs of society.
Content Organizer: Abilities To Do Technological Design

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
3. Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined.				

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Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
1. Distinguish between observations and inferences given a scientific situation.				

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Adams County/Ohio Valley
Course of Study

Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
2. Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, Material Safety Data Sheets [MSDS], eyewash, goggles, and ventilation).				

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Adams County/Ohio Valley
Course of Study

Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
3. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts.				

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Adams County/Ohio Valley
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Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>4. Decide what degree of precision based on the data is adequate; and round off the results of calculator operations to the proper number of significant figures to reasonably reflect those of the inputs.</p>				

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Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
5. Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology.				

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Content Standard: Scientific Inquiry
Grade 9-10 Benchmarks: A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.
Content Organizer: Doing Scientific Inquiry

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
6. Draw logical conclusions based on scientific knowledge and evidence from investigations.				

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Adams County/Ohio Valley
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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: A. Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.
Content Organizer: Nature of Science

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
<p>1. Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose - to better understand a portion of our universe.</p>				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: C. Describe the ethical practices and guidelines in which science operates.
Content Organizer: Nature of Science

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
2. Illustrate that the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigations.				

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Adams County/Ohio Valley
Course of Study

Content Standard: Scientific Ways of Knowing

Grade 9-10 Benchmarks: A. Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world.

Content Organizer: Nature of Science

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
3. Demonstrate that reliable scientific evidence improves the ability of scientists to offer accurate predictions.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: C. Describe the ethical practices and guidelines in which science operates.
Content Organizer: Ethical Practices

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
4. Explain how support of ethical practices in science (e.g., individual observations and confirmations, accurate reporting, peer review and publication) are required to reduce bias.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.
Content Organizer: Scientific Theories

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
5. Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.
Content Organizer: Scientific Theories

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
6. Explain that inquiry fuels observation and experimentation that produce data that are the foundation of scientific disciplines. Theories are explanations of these data.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: B. Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.
Content Organizer: Scientific Theories

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
7. Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: D. Recognize that scientific literacy is part of being a knowledgeable citizen.
Content Organizer: Science and Society

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
8. Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientists, their daily work and their efforts to advance scientific knowledge in their area of study.				

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Content Standard: Scientific Ways of Knowing
Grade 9-10 Benchmarks: D. Recognize that scientific literacy is part of being a knowledgeable citizen.
Content Organizer: Science and Society

Grade level Indicator	OGT Competency Focus	Resources	Instructional Activities/Strategies	Assessment
9. Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.				