"Our mission is to prepare each student to be a successful and responsible member of society."

North Smithfield School District

North Smithfield Scope and Sequence SCIENCE Curriculum: K-12

North Smithfield District Science Curriculum Committee
Clare Arnold, District Curriculum Director
Consultants: East Bay Educational Collaborative Science Specialist Team

High School (Grades 9-12) Curriculum

High School Science Curriculum Table of Contents

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The **GOALS** of the North Smithfield Science Curriculum K-12 are to provide a guaranteed, viable, and sustainable comprehensive curriculum program in science that:

- ✓ Promotes and facilitates the attainment of the standards, by all students K-12, identified in the ***Rhode Island – NECAP Science Grade Span Expectations*** and the National Common Core State Standards for English Language Arts/Literacy for Science.
- ✓ Ensures that all students will have equal access to the highest quality instructional programs and teaching practices in science embedded with high expectations for all students.
- ✓ Facilitates scientific literacy for all students that is essential for all citizens of the 21st century as defined by both state and national standards.
- ✓ Enables all students to be prepared for the 21st century workplace.
- ✓ Engages students in *scientific inquiry* that promotes critical thinking, academic rigor, deeper content understanding, and problem solving skills.
- ✓ Clearly describes how classroom student progress is monitored through ***formative assessment*** including, but not limited to, the use of science notebooks by all students.
- ✓ Identifies how student achievement is monitored at each grade level by periodic common tasks and ***grade level summative assessments*** at strategic intervals during the academic year.
- ✓ Provides a model for regular discussions of student work products among teachers to provide continuous improvement of instruction and thus student achievement.
- ✓ Embeds a workshop based, student centered, model of instruction that addresses the State Common Core ELA-Literacy Science Standards utilizing a "claims/inference & evidence" approach as stated on page 5 of this document.

The recently released writing standards in the ***Common Core State Standards for Literacy in Science*** state that in order to achieve college and career readiness expectations, students need to be able to:

Write arguments focused on *discipline-specific content*.

1. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
2. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
3. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.

To address the above standards the following model of instruction should be incorporated in full as often as possible. When time prevents the full pedagogical model to be implemented then, appropriate portions of it should be used to scaffold student competency and achievement of the "Scientific Inquiry" theme as described in the NECAP documents.

The Scientist's Notebook model includes the following components:

- Formulating investigable questions when given a scientific engaging problem or scenario
  Students K-12 should be provided opportunities to gradually gain competency in their abilities to communicate questions based on initial or prior observations. Students at all grades need to be provided essential or focus questions that are identified in this document to stimulate their inquiry investigations. As they progress to higher grades they need to become able to identify appropriate controls and the variable to be used for the investigation.
- Making Predictions/Formulating Hypotheses
- Planning Investigations: Inquiry investigations whenever possible should be a guided inquiry. "Cook book" procedures have their place when introducing new apparatus or when there is an overriding safety concern such as mixing chemicals by students or to help differentiate instruction whenever appropriate. When time permits students need to develop their own procedures for investigating phenomena.
- Formulating Claims/Inferences from Evidence
- Making Meaning Conference: Students need to communicate and defend their claims based on their evidence as scientists and be skeptical about evidence but, also open minded to alternative or contrary explanations.
- Writing effective conclusions based on student claims & evidence.
- Incorporating and communicating reflections on investigations that suggest alternative methods for investigations and other questions for more investigations

North Smithfield District Science Curriculum is a K-12 instructional program that allows students to construct scientific conceptual understanding, as well as provides students with inquiry skill development, required for critical thinking. The following are brief overviews for high school teachers of the K-8 programs used to provide the foundational knowledge required to engage students in needed rigorous high school study required for the 21st century workplace. Teachers should periodically review and discuss the full curriculum documents for elementary and middle school science to insure alignment of the implemented and achieved curriculum with the intended curriculum of the district..

Full Option Science Systems(FOSS currently is the core of the established instructional program used in the North Smithfield district in grades **Kindergarten through Fifth.** It is a research-based science curriculum used nationally and developed at the Lawrence Hall of Science, University of California at Berkeley. FOSS is also an ongoing research project dedicated to improving the learning and teaching of science. The FOSS project began over 20 years ago during a time of growing concern that our nation was not providing young students with an adequate science education. The FOSS program materials are designed to meet the challenge of providing meaningful science education for all students in diverse American classrooms and to prepare them for life in the 21st century. Development of the FOSS program was, and continues to be, guided by advances in the understanding of how youngsters think and learn.

Full Option Science Systems (FOSS*) K-5 North Smithfield Science Kit Matrix

*Note: Many of the kits identified below do provide instruction that facilitates the connections between the broad Science Themes areas as identified by Rhode Island NECAP K-12 documents identified below. The NECAP themes identified are the primary focus of the FOSS kits identified. *Myself & Others-Kindergarten is a program developed by the Educational Development Center and the National Science Foundation

Grade		Life Science	Earth & Space Science	Physical Science
K-5	5	Environments	Landforms	Mixtures & Solutions
	4		Earth Materials	Matter & Energy Magnetism & Electricity
	3	Structures of Life	Water	Ideas & Inventions
	2	Insects	Pebbles, Sand, & Silt	Solids & Liquids
	1	New Plants	Air & Weather	Balance & Motion
	K	Animals 2X2 & Myself & Others*		*Myself & Others offers Physical Science Connections & Life Science Connections

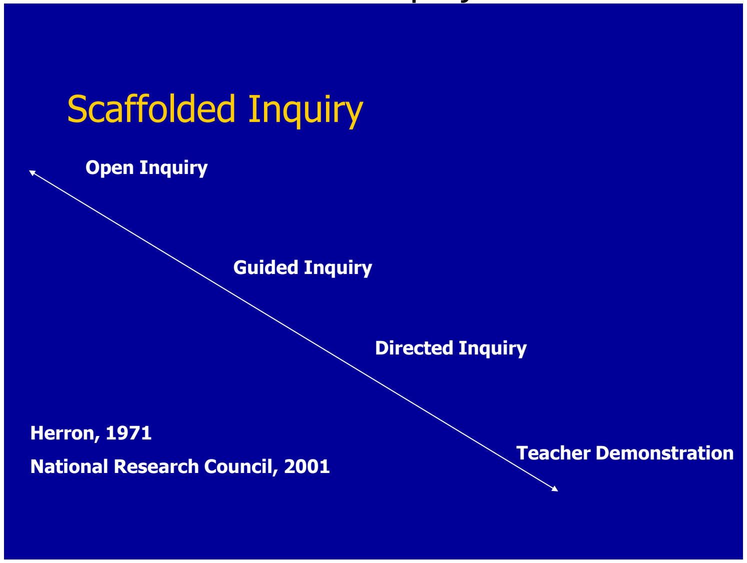
Middle School Science Curriculum Units of Study: ***McDougal Littell Science*** *is the program identified by the North Smithfield District* that provides the tools/resources for this curriculum implementation. The district curriculum committee has identified the specific texts-units, and their related activities when applicable in this program, that are the principal instructional materials for this Rhode Island- NECAP aligned document. Additionally, the district committee emphasizes that as inquiry and its related skills are foundational to the standards/Grade Span Expectations, teachers should incorporate the "Scientist's Notebook Model" pedagogy of instruction developed by the East Bay Educational Collaborative based on national research whenever possible. Further, this is required to provide a continuum of inquiry skill development for students as the model is used in both elementary and high school programs. Also, an important goal for the district is to continue to develop student communication skills, particularly in extended writing on-demand. To that end the district has adopted the **RAISE** model for writing

- **The goals of this publishers program are focused on:**
  Teaching the Big Ideas in science and the curriculum committee has carefully selected which of them provided in the texts are to be focused on.
- Providing hands-on/minds-on activities that engage students' natural curiosity while critical reading and vocabulary support and visuals help develop science literacy. Again, the committee has clearly identified which activities/investigations need to be performed by students. The committee emphasizes that these activities need to be adapted to meet the individualized instructional needs of students but, also emphasizes that they all must be done to the extent feasible to insure the curriculum is guaranteed, viable, and sustainable. **The "Units of Study" are identified below which also correspond to the texts used in the McDougal-Littell series.**

6th Grade	7th Grade	8th Grade
Earth's Atmosphere	Diversity of Life	Matter and Energy
Earth's Surface	Cells and Heredity	Electricity and Magnetism
Space Science	Ecology	Chemical Interactions
Life Over Time	Waves, Sound and Light	Forces and Motion
	Human Biology	Changing Earth

The High School Core Science Sequence builds on foundation of the K-8 curriculum consistent with NECAP standards.

What is inquiry?



The above diagram graphically depicts the continuum of inquiry based instruction which is useful for **differentiating instruction.**

NECAP-RI Grade Span Expectations and Assessment in science are "inquiry based."

Inquiry is a continuum:

According to the National Research Council (NRC 2000) the following descriptions represent the continuum of inquiry. They also are useful when using differentiated instruction.

- Confirmation; students are provided with a question and the answers are known in advance; i.e. Melting point of water
- Teacher Demonstration; usually reserved for the introduction of a new skill/safety/ or for engagement of students to stimulate questions for investigation
- Directed or Structured Inquiry; students are provided the question and procedure but they generate an explanation based on their collected evidence; i.e. Weather patterns in North Smithfield
- Guided Inquiry; students are provided the question for investigation and guiding or leading questions to guide the procedures they design. They identify based on these questions appropriate variables and controls.
- Open Inquiry; students develop investigable questions and procedures, carry out their own designed investigations, and communicate their results. Students identify their own controls and variables to be tested.

North Smithfield District Guide for Planning and Assessing Scientific Inquiry Lessons

Scientist's Notebook Process	Science Inquiry - Reasoning Skills			
	Depth of Understanding → Least Most			
Generating Investigable Focus –Essential Questions	Question provided by teacher	Student makes small changes to question provided	Students choose from a pool of class generated questions	Student generates the a question for investigation given an observation(s)
Making Predictions/Hypotheses	Hypotheses and/or prediction provided by teacher/curriculum	Student chooses from possible predictions/hypotheses provided by teachers	Students generate testable hypothesis i.e If I ________then ___will happen because_ (without referring to prior investigation)	Students generate their own investigable hypothesis based on prior investigations/prior knowledge including reasoning for it
Planning Procedures for Inquiry Investigation	Procedure is provided by teacher or program materials in a step-by-step cook book fashion	Teacher facilitates discussion of procedure and limits variations in student procedures (May be appropriate when safety is a concern)	Students discuss and plan investigation based on teacher generated guiding questions (Guided Inquiry)	Student develops own procedure (with or without group input depending on investigation)
Identifying dependent and Independent Variables	Teacher identifies variables and controls/or are provided by program materials	Students identify controls and variables but, may try to test too many at a time or lose track of them.	Students identify some controls and variables for investigations	Students identify errors associated with measurement of controls and variables that are identified by the student(s).
Organizing gathered data/evidence	Students do not collect data or organize it. Data is collected in an organized chart provided and is collected by a group of students without clear participation by student.	Students collect data but give in effective organization of the data and no thought to graphical representation. Student cannot distinguish between data and evidence.	Students effectively organize data but may receive some suggestions from teachers. Student can distinguish between relevant data-evidence and misc. data that may not be relevant to investigation. Student may be provided	Student clearly and effectively can organize relevant data and identifies which data is clear evidence to support or refute hypothesis. Student can graphically represent data.

			direction as to set-up of graphical representation but, student can then accomplish the representation.	
Analysis of Data	Students do not analyze data but, only respond, sometimes inaccurately to teacher questions about data.	Students contribute to analysis of data but, teacher facilitates the meaning overall of the data. Students perform teacher directed mathematical calculations to analyze data.	Students conduct their own data analysis with calculations with some direction by teacher.	Students conduct their own data analysis and appropriately use calculations, statistical methods when appropriate, and graphs.
Identifying evidence and formulating claims based on that evidence.	Students do not identify the evidence on their own. They cannot formulate claims but, use text/program/teacher to formulate claims for them.	Students attempt to formulate claims based on evidence but are often inaccurate or in error. Teacher discusses claims with them to clear up confused relationships.	Students formulate claims based on evidence with some contributions by teacher.	Students completely on their own identify and formulate appropriate claims based on their experimental evidence.
Formulating effective conclusions & Reflections	Students need specific criteria chart/scaffold for writing conclusion. Their conclusions are written without clarity and connection to evidence and limitations to the evidence.	Students with scaffolding by teacher write brief conclusions that attempt to incorporate claims & evidence. No attempt is made to address limitations/error/uuncertatinty of measurements used as evidence.	Students with scaffolding by teacher write conclusions based on evidence appropriately but, do not seek to look at possible alternative explanations and/or include limited discussion of uncertainties of measurement.	Students write effective conclusions that incorporate claims based on evidence. Where appropriate students seek to offer alternative explanations, reflections, and uncertainty in measurements made.

North Smithfield High School Course Design- Physical Science

Grade Level – Nine **Text:** Holt Physical Science, w/ Earth and Space Science 2008.

RI Statements of Enduring Knowledge - (Established Goals):

PS 1 All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another *(independent of size or amount of substance)*

PS 2 Energy is necessary for change to occur in matter. Energy can be stored, transferred and transformed, but cannot be destroyed.

Related Rhode Island GSE's *(Understandings)*	**RI Assessment Targets** **Assessment Evidence ***High Priority**
PS1 (9-11)–1 Students demonstrate an understanding of characteristic properties of matter by … **1a** utilizing appropriate data (related to chemical and physical properties), to distinguish one substance from another or identify an unknown substance. **PS2 (9-11)-5** **Students demonstrate an understanding of energy by…** **5a** describing or diagraming the changes in energy (transformation) that occur in different systems (eg. chemical = exo and endo thermic reactions, biological = food webs, physical = phase changes). *PS1 (9-11)– 4* **Students demonstrate an understanding of the structure of matter by …** **4a** comparing the three subatomic particles of atoms (protons, electrons, neutrons) and their location within an atom, their relative mass, and their charge. **4b** writing formulae for compounds and developing basic (excluding transition elements) models using electron structure. *4c* ***explaining or modeling how the electron configuration of atoms governs how atoms interact with one another (e.g. covalent, hydrogen and ionic bonding).*** **PS2 (9-11) –6** **Students demonstrate an understanding of physical, chemical, and nuclear changes by …** **6c** explaining and/or modeling how the nuclear make-up of atoms governs alpha and beta emissions creating changes in the nucleus of an atom results in the formation of new elements. **6d** explaining the concept of half-life and using the half-life principal to predict the approximate age of a	ESS1 (9-11) SAE+ POC–3 *Explain how internal and external sources of heat (energy) fuel geologic processes (e.g., rock cycle, plate tectonics, sea floor spreading).*

material. **6e** differentiating between fission and fusion in nuclear reactions and their relation to element changes and energy formation. **ESS1 (9-11)—4** **Students demonstrate an understanding of processes and change over time by …** **4a** describing various dating methods to determine the age of different rock structures. **PS3 (9-11)- 8** **Students demonstrate an understanding of forces and motion by…** **8a** predicting and/or graphing the path of an object in different reference planes and explain how and why (forces) it occurs. , **8b** using modeling, illustrating, graphing explain how distance and velocity change over time for a free falling object. **PS2 (9-11) –7** **Students demonstrate an understanding of electromagnetism by…** **7a** explaining through words, diagrams, models, or electrostatic demonstrations the principle that like charges repel and unlike charges attract. **7b** explaining through words, charts, diagrams, and models the effects of distance and the amount of charge on the strength of the electrical force present. **7c** describing the relationship between moving electric charges and magnetic fields. **PS3 (9-11)–10** **Students demonstrate an understanding of waves by …** **10a**. investigating examples of wave phenomena (e.g. ripples in water, sound waves, seismic waves). **10b** comparing and contrasting electromagnetic waves to mechanical waves. **10c** qualifying the relationship between frequency and wavelength of any wave. **ESS1 (9-11)– 1** **Students demonstrate an understanding of processes and change over time within earth**	

systems by … **1a.** plotting the location of mountain ranges and recent earthquakes and volcanic eruptions to identify any existing patterns. **ESS1 (9-11)–2** **Students demonstrate an understanding of processes and change over time within earth systems by …** **2a** using given data (diagrams, charts, narratives, etc.) and advances in technology to explain how scientific knowledge regarding plate tectonics has changed over time. *ESS1 (9-11)–3* Students demonstrate an understanding of processes and change over time within earth systems by … **3b** explaining how convection circulations of the mantle initiate the movement of the crustal plates which then cause plate movement and seismic activity. **3d** explaining how the physical and chemical processes of the Earth alter the crust (e.g. seafloor spreading, hydrologic cycle, weathering, element cycling).	

Unit	Unit Topics – Essential Questions	Instructional Activities / GSE's	Big Ideas (Understandings)
1	**<u>Matter</u>** • How can be matter be classified? • What distinguishes a mixture from a compound? • What are the characteristic properties of a substance? • Why does matter change its state? • What kind of energy do all particles of matter have? **Approximate time spent on unit:** • 15 periods GSE's • GSE 1a, 5a	• Text Reference: Holt Science Spectrum: *Physical Science with Earth and Space Science.* 2008. Chapters 2 and 3 • Chapter Reading Journal • Flame test demonstration • Density of an egg lab • Mystery Mixture Lab Activity (Ref. template *Holt Science Spectrum Disk 1 Microsoft Word - sp08_p32_MAT_ql.doc)* or equivalent Mixture Separation Lab • Demonstration applet: http://phet.colorado.edu/en/simulation/states-of-matter • Satellite Down! Investigation • COMMON TASK: *Busted!* Identification of and unknown powder. **Suggested Resources/Materials:** • Holt Science Spectrum *Teacher's One Stop Planner* Disk 1	• Using appropriate data (related to chemical and physical properties) the student will be able to distinguish one substance from another and identify an unknown substance. • Classifying matter • Characteristic Properties • Properties of matter: Chemical and Physical Properties. • Changes of state • Kinetic Theory
2	**<u>The Structure of the Atom and the Periodic Table</u>** • Why is it important to understand atomic structure? • How are elements classified? • What is the structure of an atom?	Chapters 4 and 5 • Chapter Reading Journal • Atom Modeling Activity • Elements Observation Lab	• Student will be able to compare the three subatomic particles of atoms and their location within the atom, their relative mass and their charge.

	• What is the difference between an atom and a molecule? **Approximate time spent on unit:** • 15 periods **GSE's** GSE PS 1a, 4a, 4b, 4c	**Suggested Resources/Materials:** • Holt Science Spectrum *Teacher's One Stop Planner* Disk 1	• The Structure of the Atom • Modern Atomic Theory (Bohr Model) • Organizing the Elements • Exploring the Periodic Table • Families of Elements
3	**<u>Chemical Bonds and Solution Chemistry</u>** • Why and how do atoms form chemical bonds? • How is matter conserved in chemical reactions? • What can a balanced chemical equation tell you? • What factors affect chemical reaction rates? • How can I explain the properties of a solution? **Approximate time spent on unit:** • 15 periods GSE's: • . (GSE 1a,4b, 4c)	Chapters 6, 7,8, and 9 • Chapter Reading Journal • Is There Iron in Cereal? Lab • Exothermic/Endothermic Lab • Single Replacement $CuCl_2$ + Al foil Lab • Reaction Rates Lab (Chalk + Acetic Acid) • Properties of Water Lab • pH Investigation Lab (Indicators: Litmus, pH paper, red brassica juice) **Suggested Resources/Materials:** • Holt Science Spectrum *Teacher's One Stop Planner* Disk 1	• The student will explain and predict how the electron configurations of atoms govern how atoms interact with one another. (GSE 4b, 4c) • The student will be able to explain chemical reactions by describing or diagramming the changes in energy that occur in different systems. • The student will be able to explain basic water chemistry including pH in terms of hydrogen ion concentrations. • Conservation of Mass. • Compounds and molecules • Ionic and covalent bonding • Acids, bases, and pH
4	**<u>Nuclear Changes</u>** • What is radioactivity? • What is nuclear fission?	Chapter 10 • Half-Life Investigation: *Blockium*	• Students will be able to describe the nuclear make-up of atoms and explain the concept of

	• What is nuclear fusion? • How can I date an object using radioactive isotopes? **Approximate time spent on unit:** • 5 periods **GSE's:** • (GSE's 6c, 6d, 6e, ESS1-4a)	Carbon-14 Dating Investigation	half-life in terms of nuclear decay. • Cause of radioactivity. • Nuclear fission and fusion. • Various dating methods using radioactive substances.
5	<u>**Motion and Forces**</u> • How can understanding physical properties of motion be used to explain everyday occurrences? • What makes an object speed up, slow down, or change directions? **Approximate time spent on unit:** 15 periods **GSE's:** GSE PS 8a, 8b, 9a, 9b	Chapter 11 and 12 • Chapter Reading Journal • Bowling Ball constant velocity in 1-D investigation with graphing. • Bowling ball ramp activity: Accelerated motion in 1-D or Acceleration of a Marble Lab if weather is bad. • Horizontal Projectile Motion: Independence of Motion in 2-D Common Task: Mousetrap Catapult Project	• Students will be able to calculate speed and acceleration and will interpret and compare both distance-time and speed-time graphs. • Measuring motion • Acceleration • Motion and forces • Students will use Newton's Laws of Motion to explain free-fall and horizontal projectile motion and other uniformly accelerated motion. • Newton's first and second laws • Gravity and the Universal Law of Gravitation • Newton's third law

6	**<u>Work, Power, and Energy</u>** • What is the relationship between energy, work, and power? • Why is potential energy called the energy of position? • What factors does kinetic energy depend on? • What is the law of Conservation of Energy? **Approximate time spent on unit:** 8 periods **GSE's:** GSE's PS 5b)	Chapter 13 • Chapter Reading Journal • Stair Climbing Activity (Work and Power) Energy of a Rolling Ball (page 462 of Textbook)	• Students will categorize the different forms of energy and be able to analyze conservation of energy in energy transformations. • Work, Power • Potential energy • Kinetic energy • Work-Energy Theorem • Conservation of Energy
7	**<u>Electricity and Magnetism</u>** • How do objects acquire an electric charge? • What is the relationship between electricity and magnetism? **Approximate time spent on unit:** 15 periods **GSE's:** GSE's: 7a, 7b, 7c	Chapters 17 and 18 • Chapter Reading Journal • Creating Static Electricity (Lab 52 "Take Home Physics" Page 221 • Magnetism Lab • Electromagnetism Lab • Simple Circuits Lab The 10 minute motor activity	• Students will explain how pairs of charges attract and repel and students will predict how objects will become charged and students will diagram how charges move within objects. • Students will use models to demonstrate how electric currents produce magnetic fields (and vice versa). • Students will explain what causes magnetism with written and drawn descriptions. • Electric charge and force • Current

8	**<u>Waves, Sound, and Light</u>** • How do you know that waves carry energy? • How do the properties of waves determine their uses? • How does relative motion affect wavelength and frequency of waves (Doppler Effect) **Approximate time spent on unit:** 15 periods. **GSE's:** GSE PS10a, 10b, 10c, ES 1.1a	Chapters 15 and 16 • Chapter Reading Journal • Snaky Spring Lab • Wave Interactions Lab • Sound Lab with Doppler Effect Diffraction Grating Lab with Spectrum Analysis	• Students will distinguish between different types of waves. • Students will use and explain the characteristics of waves. • Students will specify the difference between light waves and sound waves by using the properties of electromagnetic and mechanical waves. • Doppler Effect • Characteristics of waves • Wave interactions • Sound • The nature of light
9	**<u>Planet Earth</u>** • Earth's Interior and Plate Tectonics • Earthquakes and Volcanoes • Minerals and Rocks • Weathering and Erosion • How do internal and external sources of heat fuel geologic processes? GSE ESS1a, 2a, 3b, 3d **Approximate time spent on unit: TBD**	Chapter 21 • Chapter Reading Journal • Inquiry Task: The Eurasian and Indian Plates with Tectonic Plate Boundaries (Resource File Ch 21, page 29) • Finding the Epicenter of an Earthquake (Resource File Ch 21, page32) The Speed of t	• Earth's Interior and Plate Tectonics • Earthquakes and Volcanoes • Review rock cycle \
10	**<u>The Universe</u>** • How does the analysis of the spectrum of starlight help us understand the formation of the universe (red shift, blue shift, line spectra)?	Chapter 20 • Chapter Reading Material • Expanding Universe (Balloon Activity)	• The life cycle of stars • Examining the spectra of stars • Galaxies

	• What scientific evidence supports the Big Bang Theory? • What is the relationship between energy produced from nuclear reactions, the origin of elements, and the life cycle of stars? **Approximate time spent on unit: TBD**	• H-R Diagram Activity • Absorption Spectra Lab	• Types of Galaxies • Universe Big Bang Theory

North Smithfield High School Course Design- Biology

Grade Level - Ten

Text: Biology, Miller & Levine, Pearson Publisher

RI Statements of Enduring Knowledge - (Established Goals):

LS 2 Matter cycles and energy flows through an ecosystem.

Related Rhode Island GSE's (Understandings)	**RI Assessment Targets** **Assessment Evidence ***High Priority**
LS2 (9-11)–4 Students demonstrate an understanding of matter and energy flow in an ecosystem by … 4b **explaining how the chemical elements and compounds that make up living things pass through food webs and are combined and recombined in different ways (e.g. nitrogen, carbon cycles, O_2, & H_2O cycles**). **LS2 (9-11)-3** Students demonstrate an understanding of equilibrium in an ecosystem by … 3a **defining and giving an example of equilibrium in an ecosystem.** **3b** describing ways in which humans can modify ecosystems and describe and predict the potential impact (e.g. human population growth; technology; destruction of habitats; agriculture; pollution; and atmospheric changes). 3c **describing ways in which natural events (e.g. floods and fires) can modify ecosystems and describe and predict the potential effects.**	LS2 (9-11) POC+ SAE –4 *Trace the cycling of matter (e.g., carbon cycle) and the flow of energy in a living system from its source through its transformation in cellular, biochemical processes (e.g., photosynthesis, cellular respiration, fermentation).* Text Reference: Prentice Hall Biology Chapter 2 & See Middle School Curriculum for sources of prior student knowledge experiences.. • Activity: McMush: Keys & Locks Demo: Saliva & Starch Text Reference: Prentice Hall Biology Chapter 8 • Text references: Prentice Hall Biology 23-1, 23-4 • Lab Activity: Inferring Function from Structure • Lab Activity: Water loss in plants

LS2 (9-11)–4 Students demonstrate an understanding of matter and energy flow in an ecosystem by … 4a **diagramming <u>the energy flow in an ecosystem that compares the energy at different trophic levels</u>. (e.g. What inferences can you make about energy "loss"& use?).** 4b **explaining <u>how the chemical elements and compounds that make up living things pass through food webs and are combined and recombined in different ways</u> (e.g. nitrogen, carbon cycles, O_2, & H_2O cycles**). **9b** providing <u>an explanation of how the human species impacts the environment and other organisms</u> (e.g. reducing the amount of the earth's surface available to those other species, interfering with their food sources, changing the temperature and chemical composition of their habitats, introducing foreign species into their ecosystems, and altering organisms directly through selective breeding and genetic engineering). **LS1 (9-11)-1** Students demonstrate understanding of structure and function-survival requirements by**…** 1a **<u>explaining the relationships between and amongst the specialized structures of the cell and their functions</u> (e.g. transport of materials, energy transfer, protein building, waste disposal, information feedback, and even movement).** **1b** <u>explaining that most multicellular organisms have specialized cells to survive, while unicellular organisms perform all survival functions. (e.g. nerve cells communicate with other cells, muscle cells contract, unicellular are not specialized).</u> **Students demonstrate understanding of differentiation by…** 1c **<u>comparing the role of various sub-cellular structures in unicellular organisms to comparable structures in multicellular organisms (e.g. oral groove, gullet, food vacuole in Paramecium compared to digestive systems in multicellular organisms).</u>**	• Inquiry Lab: Factors Affecting Plant Growth Text Reference: Prentice Hall Biology Chapter 8 • Demo: Elodea & BTB • Inquiry Lab: Observing Respiration **LS2 (9-11) INQ+SAE -3** Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem. Text Reference: Prentice Hall Biology Chapter 3 • United Streaming Video: Intro to Ecology: Ecosystems & Biomes • Teachers Domain: Video clip: geothermal vents • Web Activity: Geochemical Cycles Activity: Estuary Food Webs & Ecological Pyramids • Teachers Domain: Video clip: geothermal vents • Web Activity: Geochemical Cycles ***LS4 (9-11) NOS+INQ -9*** *Use evidence to make and support conclusions about the ways that humans or other organisms are affected by environmental factors or heredity (e.g., pathogens, diseases, medical advances, pollution, mutations).* Text Reference: Prentice Hall Biology Chapter 4 • United Streaming Video: What Shapes an Ecosystem? • Constructed Response: Why can't you ignore the changing climate? • Inquiry Activity: Fish Kill Mystery • Lab: Dissolved Oxygen Common Task: "Curious Jen"

LS4 (9-11)-10 **Students demonstrate an understanding of human body systems by …** **10a** explaining how the roles of the immune, endocrine, and nervous systems work together to maintain homeostasis. **10b** investigating the factors that affect homeostasis (e.g. positive and negative feedback). **LS3 (9-11)-6** Students will demonstrate their understanding of the degree of genetic relationships among organisms by … **6a** using given data (diagrams, charts, narratives, etc.) and advances in technology to explain how our understanding of genetic variation has developed over time. **LS3 (9-11) -7** **Students demonstrate an understanding of Natural Selection/ evolution by…** **7a** investigating how information is passed from parents to offspring by encoded molecules (e.g. evidence from electrophoresis, DNA fingerprinting). **7c** citing evidence of how natural selection and its evolutionary consequences provide a scientific explanation for the diversity and unity of past and present life forms on Earth. **LS1 (9-11) –2** **Students demonstrate an understanding of the molecular basis for heredity by …** **2a** describing the DNA structure and relating the DNA sequence to the genetic code. **2b** explaining how DNA may be altered and how this affects genes/heredity (e.g. substitution, insertion, or deletion). **2c** describing how DNA contains the code for the production of specific proteins. **LS3 (9-11) -8 Students demonstrate an understanding of Natural Selection/**	***LS1 (9-11) INQ+SAE+FAF -1*** *Use data and observation to make connections between, to explain, or to justify how specific cell organelles produce/regulate what the cell needs or what a unicellular or multi-cellular organism needs for survival (e.g., protein synthesis, DNA-replication, nerve cells).* • Text Reference: Chapter 7, section 3 • Cell Membrane animation: wisc-online.com • Inquiry Activity: Smelly Balloons • Web Activity: Osmosis & Diffusion, Active & Passive Transport • Inquiry Lab: What do cucumbers have to do with osmosis? • YouTube videos: elodea plasmolysis, red blood cell hemolysis and crenation • Lab: Activity: Using the Microscope • Inquiry Lab: Cell Diversity (Elodea, cheek cells, and various plant cells) • Activity: Comparing a cell to a factory • Lab: Why Are Cells Small? ***LS4 (9-11) NOS+INQ -9*** *Use evidence to make and support conclusions about the ways that humans or other organisms are affected by environmental factors or heredity (e.g., pathogens, diseases, medical advances, pollution, mutations).* ***LS4 (9-11) SAE+FAF -10*** *Explain how the immune system, endocrine system, or nervous system works and draw conclusions about how systems interact to maintain homeostasis in the human body.* Jigsaw Activity: Immune, Endocrine, and Nervous system **LS3 (9-11) NOS -6** *Explain how evidence from technological advances supports*

evolution by… **8a** illustrating that when an environment changes, the survival advantage /disadvantage of some characteristics may change. **8b** distinguish between microevolution (on small scale within a single population –e.g., change in gene frequency within a population) and macroevolution (on a scale that transcends boundaries of a single species – e.g., diversity of all beetle species within the order of insects) and explain how macroevolution accounts for speciation and extinction. **8c** recognizing patterns in molecular and fossil evidence, to provide a scientific explanation for Natural Selection and its evolutionary consequences (e.g. survival, adaptation). **Students demonstrate an understanding of classification of organisms by …** **8d** using data or models (charts, diagrams, table, narratives etc.) to analyze how organisms are organized into a hierarchy of groups and subgroups based on evolutionary relationships. (e.g. creating a taxonomic key to organize a given set of examples).	*or refutes the genetic relationships among groups of organisms (e.g., DNA analysis, protein analysis.* Text Reference: Prentice Hall Biology Chapter 10 • Web Activity: Cells Alive! • Lab Activity: Comparing Plant and Animal Mitosis • Investigation: Using Tissues as Evidence (Lung Cancer) • Stem Cells : Final Word Activity Text Reference: • Lab: Cheek Cell DNA Extraction • Modeling Activity: Build a DNA molecule • Virtual Lab: Gel Electrophoresis http://learn.genetics.utah.edu • Investigation: Interpreting DNA Analysis (PH Forensics: Biodetectives) • Modeling Activity: Transcription • Modeling Activity: Translation • Activity: Transcribe and Translate the insulin gene Mutations creature activity Prentice Hall Biology Chapter 12 &13 • **LS3 (9-11) INQ POC-7** *Given a scenario, provide evidence that demonstrates how sexual reproduction results in a great variety of possible gene combinations and contributes to natural selection (e.g., Darwin's finches, isolation of a species, Tay Sach's disease).* Text Reference: Prentice Hall Biology Chapter 11 • Activity: Punnett Squares: Calculating Probability • Activity: Using Punnett Squares with sex-linked traits, incomplete dominance, codominance, blood type • Human Genetics (ex: Cystic Fibrosis, Tay Sachs,

	albinism, color blindness, sickle cell) • Activity: Dihybrid Crosses • Lab Activity: “Breeding Bunnies” • Activity: “Oompah Loompah Genetics” • Common Task: “Genes-R-Us” ***LS3 (9-11) INQ FAF+POC -8*** *Given information about living or extinct organisms, cite evidence to explain the frequency of inherited characteristics of organisms in a population, OR explain the evolution of varied structures (with defined functions) that affected the organisms’ survival in a specific environment (e.g., giraffe, wind pollination of flowers).* • Text Reference: Prentice Hall Biology Chapter 15 • Activity : Natural Selection: “Toothpicks In Hiding” • Activity: Darwin’s Finches • Activity: Superbug Activity: Evolution: The Molecular Connection

Unit	Unit Topics-Essential Questions	Instructional Activities & Investigations (INQ) Reference GSE(s)	Big Ideas (Understandings)
1	**The Chemistry of Life*:** • Why are the properties of water important to life? • What is the importance of carbon compounds in biology? • Why are chemical reactions important to the study of biology? **What is the role of enzymes?** This unit should be used to review and provide a quick bridge from what is learned in grade nine Physical Science and grade ten Biology since the material is fundamental to student understandings. Estimated 2-3 days	Text Reference: Prentice Hall Biology Chapter 2 & See Middle School Curriculum for sources of prior activities. • Activity: McMush: Keys & Locks Demo: Saliva & Starch	• Prior knowledge of atomic structure and chemical bonding to biological compounds. • Properties of water • The result of enzyme activity on a substrate. • Enzymes act as biological catalysts.

1	**Introduction to Biology*:** What do we know about living things vs. non-living things? This unit should be used to provide a review and quick bridge from what was learned in middle school in life sciences since the material is fundamental to student understandings. It may be incorporated into Unit 1 above review. Time – Relevant GSE's - See LS 1 -1 Middle School and other's from middle school	Text Reference: Prentice Hall Biology Chapter 1-3 & See Middle School Curriculum for sources of prior activities. Inquiry Activity: Sewer Lice	• The distinct characteristics of living things. • Students will distinguish between living and nonliving things.
2	**Ecology/The Biosphere** • What is Ecology? • What is an ecosystem? • How does energy flow in an ecosystem? Time – Relevant GSE's – LS 4.9b,2.4a,2.4b	Text Reference: Prentice Hall Biology Chapter 3 • Teachers Domain: Video clip: geothermal vents • Web Activity: Geochemical Cycles Activity: Estuary Food Webs & Ecological Pyramids	• Categorize the different levels of ecological organization. • Distinguish between different types of producers and consumers. • Diagram the energy flow in an ecosystem that compares the energy at different trophic levels.

3	**“Cycles of Matter & Carbon Compounds”** • How does matter cycle in an ecosystem? • How are nutrients important is living systems? • Why are the properties of water important to life? • What is the importance of carbon compounds in biology? • Why are chemical reactions important to the study of biology? **What is the role of enzymes?** This unit should be used to review and provide a quick bridge from what is learned in grade nine Physical Science and grade ten Biology since the material is fundamental to student understandings. Estimated 2-3 days	• United Streaming video: Intro to Ecology • Ecosystems & Biomes • Biochemical jigsaw activity & presentation	• Chemical elements and compounds make up living things • They pass through food webs, and are combined and recombined in different ways.
4	**Ecosystems & Communities** (Quick review of climate zones-middle school) • How does the greenhouse effect maintain the biosphere’s temperature range? • How do humans contribute to greenhouse gasses, and how does that affect the biosphere’s temperature range? • How do natural evenets modify ecosystems. And how can we predict the potential effects? • What are the main factors that govern aquatic ecosystems? Time – Relevant GSE’s –LS2.3a,2.3b,2.3c	Text Reference: Prentice Hall Biology Chapter 4 • United Streaming Video: What Shapes an Ecosystem? • Constructed Response: Why can’t you ignore the changing climate? • Inquiry Activity: Fish Kill Mystery • Lab: Dissolved Oxygen Common Task: “Curious Jen”	• The factors that determine the Earth’s three main climate zones. • Human actions affect greenhouse gasses. • Abiotic and biotic factors influence an ecosystem. • Compare and contrast community interactions. • Natural events affect ecosystems. • Biomes and aquatic ecosystems and the factors that affect their development.

5	**Cells** • What are the functions of major cell structures? • How does the structure of an organelle determine its function? • How do specialized cells help an organism to function and survive? Time – Relevant GSE's –LS1.1a,1.1b,1.1c LS4-10a, 10b	Text Reference: Prentice Hall Biology Chapter 7 • Lab: Activity: Using the Microscope • Inquiry Lab: Cell Diversity (Elodea, cheek cells, and various plant cells) • Activity: Comparing a cell to a factory	• Proficiency in using a compound microscope. • Past investigations by scientists led to cell theory. • Prokaryotic and eukaryotic cell structure and function. • Identify, sketch, and examine cell structures with the use of a compound microscope. • Compare cell structure and function to the operation of a factory. • Examine, compare and contrast specialized cells. • The "cell as a factory • Compare protists to multi-cellular organisms with emphasis on differentiation and specialization • Explain how the roles of the immune, endocrine, and nervous systems work together to maintain homeostasis • Investigate the factors that affect homeostasis (positive and negative feedback)

<table>
<tr><td>6</td><td>Homeostasis & Transport

How does a cell regulate what enters and exits the cytoplasm>

How is the structure of a cell membrane structured to regulate what enters and leaves the cell?

How does the structure of a cell membrane maintain homeostasis?

Time –

Relevant GSE's – LS1.1a</td><td>Text Reference:
Prentice Hall Biology
Text Reference: Chapter 7, section 3
Cell Membrane animation: wisc-online.com
Inquiry Activity: Smelly Balloons
Inquiry Lab: What do cucumbers have to do with osmosis?
(Web source) Demonstration:
A microscopic view of Osmosis in plant & animal cells</td><td>The structures in a cell membrane.
The functions of membrane structures.
The processes of diffusion and osmosis.
Applying the terms isotonic, hypertonic, and hypotonic to cells in various solutions.
Formulating hypotheses regarding the effects of osmosis on cells.
Conduct an experiment demonstrating the process of osmosis in a fresh water cell.
Distinguish between active and passive transport.</td></tr>
<tr><td>7</td><td>Photosynthesis
How are plant cells specialized for their particular functions?
How are plant structures adapted for their particular functions?
How does the structure of a leaf enable it to perform photosynthesis?
How are chemical elements and compounds combined and recombined in photosynthesis?
Time –

Relevant GSE's –LS2.4a,2.4b</td><td>Text Reference:
Prentice Hall Biology Chapter 8
Text references: Prentice Hall Biology 23-1, 23-4
Lab Activity: Water loss in plants
Inquiry Lab: Factors Affecting Plant Growth
Lab: Transpiration Rate & Stomata
RI-ITEST Module: Harvesting Light for Photosynthesis</td><td>The structure of a plant leaf cross-section under the microscope.
The functions of leaf structures and their specialized cells and their role in photosynthesis.
The relationship between pigments and wavelengths of light.
The chemical processes involved in the light reactions and Calvin Cycles of photosynthesis.
The recombination of chemical elements and compounds in photosynthesis.</td></tr>
</table>

8	**Cellular Respiration** How do organisms obtain energy from the food that they eat? What is the relationship between photosynthesis and respiration? Time – TBD Relevant GSE's –LS2.4a,2.4b	Text Reference: Prentice Hall Biology Chapter 8 • Demo: Elodea & BTB Inquiry Lab: Observing Respiration Lab: Why are cells small? Lab: Clothespin/Muscle Fatigue	• Compare and contrast photosynthesis and cellular respiration. • Compare and contrast aerobic and anaerobic respiration.
9	**Cell Growth & Division** Why are cells small? How is genetic information passed from one cell to the next? How are cancer cells different from other cells? How are stem cells different from other cells? Time – TBD Relevant GSE's –LS1.1	Text Reference: Prentice Hall Biology Chapter 10 • Web Activity: Cells Alive! • Lab Activity: Comparing Plant and Animal Mitosis • Investigation: Using Tissues as Evidence (Lung Cancer) • Stem Cells : Final Word Activity • Lab: Why Are Cells Small? • Jigsaw Activity: Immune, Endocrine, and Nervous system	• What limits the sizes of cells. • Observing mitotic cells and distinguishing the different stages of mitosis in plant and animal cells. • Sequence the stages of mitosis andthe events that occur at each stage. • Connect the disruption of the cell cycle with cancer development. • Analyze the costs and benefits of stem cell research and therapy.

10	**Introduction to Genetics** How are genetic traits passed on from one generation to the next? Why do some traits appear more often than others? How is information passed from parents to offspring by encoded molecules? Time – Relevant GSE's – LS3.6a,3.7b, 3.7a	Text Reference: Prentice Hall Biology Chapter 11 • Activity: Punnett Squares: Calculating Probability • Activity: Using Punnett Squares with sex-linked traits, incomplete dominance, codominance, blood type • Human Genetics (ex: Cystic Fibrosis, Tay Sachs, albinism, color blindness, sickle cell) • Activity: Dihybrid Crosses • Lab Activity: "Breeding Bunnies" • Activity: "Oompah Loompah Genetics" • Common Task: "Genes-R-Us" • Pipe Cleaner "Babies"- Genetic Recombination Activity • Meiosis Simulation Activity	• Punnett Squares demonstrate the principles of dominance and recessivness, segregation and independent assortment, and to calculate probability. • Distinguish between genotype and phenotype, and homozygous and heterozygous alleles. • Modeling the process of meiosis in the creation of gametes. • Compare and contrast mitosis and meiosis • .Molecular evidence and genetics

11	**DNA & RNA** • How is information passed from parents to offspring? • What is the overall structure of the DNA molecule? • How is the information encoded in DNA used to create traits? Time – Relevant GSE's –LS1.2a,1.2b,1.2c	Text Reference: • Lab: Cheek Cell DNA Extraction • Modeling Activity: Build a DNA molecule • Virtual Lab: Gel Electrophoresis http://learn.genetics.utah.edu • Investigation: Interpreting DNA Analysis (PH Forensics: Biodetectives) • Modeling Activity: Transcription • Modeling Activity: Translation • Activity: Transcribe and Translate the insulin gene Mutations creature activity Prentice Hall Biology Chapter 12 &13	• Information is passed form parents to offspring by encoded molecules. • The process of DNA replication. • Transcribing RNA from DNA. • Translating RNA into amino acids. • Manipulating DNA to create mutations. • What are mutagens?
12	**Evolution** • Why is there such biodiversity on Earth? • What is the evidence supporting the theory of evolution? • What are the differences between macro & micro evolution? • How do environmental changes affect natural selection/evolution? • How is classification based on evolutionary relationships? Time – Relevant GSE's –LS3-7c, LS3-8b, LS3-8c, LS3-8d	Text Reference: Prentice Hall Biology Chapter 15 • Activity : Natural Selection: "Toothpicks In Hiding" • Activity: Darwin's Finches • Activity: Superbug Activity: Evolution: The Molecular Connection	• Genetic variation leads to diversity in a population. • Diversity allows for natural selection in a population when there is competition for resources. • Favorable adaptations lead to increased fitness in a population. • What is the evidence of evolution theory? • What is macro & micro evolution? • How is classification based on evolutionary relationships.

13	**Classification** This unit could be used to provide a summative overview of what has been learned all year in biology to what has been learned in middle school and grade nine. Particular emphasis should be class discussion of the following question. • Has what we have learned, such as DNA sequencing, changed our view of the evolutionary relationships that were important in the past for classification systems of living organisms? Time – Relevant GSE's -	Text Reference: Prentice Hall Biology Chapter 18 (p.521) Activity sample: Analyzing Data: p.528 #3	

North Smithfield High School Course Design- Chemistry
Grade Level – Ten Text

RI Statements of Enduring Knowledge - (Established Goals):
PS 1 All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another *(independent of size or amount of substance)*
PS 2 Energy is necessary for change to occur in matter. Energy can be stored, transferred and transformed, but cannot be destroyed.

Related Rhode Island GSE's *(Understandings)*	RI Assessment Targets Assessment Evidence ***High Priority
PS1 (9-11)–2 **Students demonstrate an understanding of characteristic properties of matter by …** **2a** using given data (diagrams, charts, narratives, etc.) and advances in technology to explain how the understanding of atomic structure has changed over time. *PS1 (9-11)– 4* **Students demonstrate an understanding of the structure of matter by …** **4a** comparing the three subatomic particles of atoms (protons, electrons, neutrons) and their location within an atom, their relative mass, and their charge. *PS1 (9-11)-3* Students demonstrate an understanding of characteristic properties of matter by … **3b** predicting the relative physical and chemical properties of an element based on its location within the Periodic Table **ESS3 (9-11)–5** **Students demonstrate an understanding of the origins and evolution of galaxies and the universe by…** **5a** using appropriate prompts (diagrams, charts, narratives, etc.) students will explain how scientific knowledge regarding the structure of the universe has changed over time due to advances in technology which accumulates new evidence to redefine scientific theories and ideas. **ESS3 (9-11)–6** **Students demonstrate an understanding of the formation of the universe by…** 6a **using data (diagrams, charts, narratives, etc.) to explain how the "Big Bang" theory has developed over time citing evidence to support its occurrence (Doppler Effect/red shift).**	PS 1 (9-11) MAS + NOS-2 * *Scientific thought about atoms has changed over time. Using information (narratives or models of atoms) provided, cite evidence that has changed our understanding of the atom and the development of atomic theory.* **Activities**: • Student-generated atomic models (See department binder) PS 1 (9-11) MAS + FAF-4 * *Model and explain the structure of an atom or explain how an atom's electron configuration, particularly the outermost electron(s), determines how the atom can interact with other atoms.* **Activities**: • Atom-in-a-bag (see department binder) • Pyrotechnics lab (see department binder) ***PS1 (9-11) POC –3*** * *Explain how properties of elements and the location of elements on the periodic table are related.* **Activities**: • Element classification lab (see department binder) • Chemical periodicity graph packet (see department binder) • Periodic Table of Ordinary Things—common task (see department binder) ***PS2 (9-11) INQ+SAE -6 **** *Using information provided about chemical changes, draw*

PS2 (9-11) –6 **Students demonstrate an understanding of physical, chemical, and nuclear changes by …** **6b** identifying whether a given chemical reaction or a biological process will release or consume energy (endothermic and exothermic) based on the information provided (e.g. given a table of energy values for reactants and products or an energy diagram). *ESS1 (9-11)–3* Students demonstrate an understanding of processes and change over time within earth systems by … **3a** explaining how heat (produced by friction, radioactive decay and pressure) affects the Rock Cycle. **3b** explaining how convection circulations of the mantle initiate the movement of the crustal plates which then cause plate movement and seismic activity. *PS1 (9-11)– 4* **Students demonstrate an understanding of the structure of matter by …** **4b** writing formulae for compounds and developing basic (excluding transition elements) models using electron structure. *4c* ***explaining or modeling how the electron configuration of atoms governs how atoms interact with one another (e.g. covalent, hydrogen and ionic bonding).*** **PS2 (9-11) –6** **Students demonstrate an understanding of physical, chemical, and nuclear changes by …** **6a** writing simple balanced chemical equations to represent chemical reactions and illustrate the conservation of matter. *ESS1 (9-11)–3* Students demonstrate an understanding of processes and change over time within earth	*conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions).* **Activities:** • Enthalpy lab (p. 255) • What's Hot Lab (ch. 12 Prentice Hall reference materials ***PS1 (9-11) MAS+ FAF – 4 **** *Model and explain the structure of an atom or explain how an atom's electron configuration, particularly the outermost electron(s), determines how that atom can interact with other atoms.* **Activities:** • Molecular geometry lab (see department binder) • Putting Ions in their hands (see department binder) • Compound-naming race (see department binder) • Double Displacement Lab (Textbook p459 – 460, numbers 8-11) • Visualizing Chemical Formulas and Balancing Reactions (Textbook p.266-267 Parts B & C) • Activity Series Lab (Textbook p. 641-642, numbers 1-6) • Second Semester Common Task, Singled Out (see department binder) • Acid and base lab (Textbook p. 485-488) • How Good is that Antacid ? (ch. 19 Prentice Hall reference materials) ***PS2 (9-11) INQ+SAE -6 **** *Using information provided about chemical changes, draw conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions).* **Activities**:

systems by … **3c** <u>investigating and using evidence to explain that conservation in the amount of earth materials occurs during the Rock Cycle.</u> <u>spreading, hydrologic cycle, weathering, element cycling)</u>. *PS1 (9-11)–1* Students demonstrate an understanding of characteristic properties of matter by … **1b** <u>determining the degree of change in pressure of a given volume of gas when the temperature changes incrementally (doubles, triples, etc.).</u> **3d** <u>explaining how the physical and chemical processes of the Earth alter the crust (e.g. seafloor</u>	• Visualizing a Mole (Flinn Chem Topics Booklet) • Moles of Chalk Lab (See department binder) • Sodium Bicarbonate and Acetic Acid Stoichiometry Lab (See department binder) ***PS1 (9-11) INQ –1**** *Use physical and chemical properties as determined through an investigation to identify a substance.* **Activities**: • Cartesian divers (Textbook, p.369-370, part A) • Graham's Law activity (Flinn binder) Boyle's Law activity (see department binder)

Unit	**Focus Questions** (Essential Questions)	**Instructional Activities & Investigations (INQ)**	**Big Ideas** (Understandings)
1 The Atom	• How have atomic models changed over time ? • How does the development of the modern atomic model influence our lives ? Time: 3 weeks Relevant GSE's—PS 1.2a, PS 1.4a	Text reference: Eisenkraft, pages 19-22, 39-41, 159, 302-305. Student-generated atomic models (See department binder) Flinking (Flinn Binder) and/or Obcertainer Atom-in-a-Bag (Flinn Binder) Pyrotechnics Lab (Textbook p.157-158)	• How models of the atom have changed over time. • Comparing protons, neutrons, and electrons in isotopes, ions, and neutral atoms. • Students write and recognize electron configurations for various elements and ions. • The wave-particle duality nature of light.
2 Chemical Periodicity	• How have scientific theories about the structure of the universe been advanced through the use of sophisticated technology ? • How do periodic trends help us to understand the arrangement of the periodic table ? • How can substances be classified based on their properties ?	Text reference: Eisenkraft, pages 11-12, 104-107, 196-198, 594-596. Element Classification Lab (Textbook p. 7-9) Chemical Periodicity graph packet (See department binder) First semester Common Task, Periodic Table of Ordinary Things (See department binder)	▪ Classify elements as metals, nonmetals, or metalloids. ▪ Compare characteristic properties of a material to those of its constituent elements. ▪ Determine valence electrons based on an element's location in the Periodic Table of the Elements. ▪ Demonstrate an understanding of

	Time: 4 weeks Relevant GSE's—PS 1.3b, ESS 3.5a, ESS 3.6a		characteristic properties of matter by predicting the relative physical and chemical properties of an element based on its location within the Periodic Table.
3 Energy	▪ How can one differentiate between the different types of energy? ▪ How is specific heat calculated? ▪ What is the mathematical relationship between heat and energy? Time: 4-5 weeks Relevant GSE's—PS2.6b	Text reference: Eisenkraft, pages 114-116, 259-262, 312-314, 333-335, 384, 470-473, 514-518, 535-538, 546-548, 555-556, 563-564. Heating/Cooling curve of water lab (Textbook p. 110-112) Cookware Lab (Textbook p. 560-562) Entropy lab activity (Textbook p. 329-331) Enthalpy lab (Textbook, p. 255-258) What's Hot Lab (ch. 12 Prentice Hall reference materials)	▪ . Describe the energy transformations and the roles of kinetic and potential energy as heat energy is transferred to or away from a material. ▪ Explain how energy and disorder change during physical and chemical processes. ▪ Determine if a change results in an increase or decrease in entropy. ▪ Determine if a change will be spontaneous by considering change in enthalpy and change in entropy. ▪ Determine whether energy changes are endothermic or exothermic from a particular point of reference. ▪ Distinguish between heat energy and temperature. ▪ Determine the amount of heat released from the combustion of various fuels. ▪ Explain the concept of specific heat capacity.

4 Chemical Formulas & Bonding	▪ Why are chemical formulas important? ▪ What is the importance of understanding chemical bonding? ▪ How is polarity determined? ▪ How are molecular geometry and polarity related ? Time: 4-5 weeks Relevant GSE's—PS 1.4b, PS 1.4c	Text reference: Eisenkraft, pages 451-453. Chemical Names and Formulas Lab (Textbook p. 450-451, numbers 6-9) Putting Ions in Their Hands (Flinn Binder) Compound-naming race (see department binder) Molecular geometry lab (See department binder)	▪ Predict the charges of ions of various elements. ▪ Determine the formulas of ionic and covalent compounds. ▪ Write the conventional names of ionic and covalent compounds. ▪ Write correct Lewis Dot Structures for various elements and compounds.
5 Chemical Reactions & Equations	▪ How are chemical reactions classified? ▪ How is the Law of Conservation of Matter supported by balanced chemical equations? Time: 4-5 weeks Relevant GSE's—PS 2.6a	Text reference: Eisenkraft, pages 461-463, 270, 279-282, 393-397, 525-528, 489-492. Double Displacement Lab (Textbook p459 – 460, numbers 8-11) Visualizing Chemical Formulas and Balancing Reactions (Textbook p.266-267 Parts B & C) Activity Series Lab (Textbook p. 641-642, numbers 1-6) Second Semester Common Task, Singled Out (see department binder) Acid and base lab (Textbook p. 485-488) How Good is that Antacid ? (ch. 19 Prentice Hall reference materials)	▪ Distinguish between different classes of chemical reactions. ▪ Predict the possible products of single-replacement and double-replacement reactions. Use the Law of Conservation of Matter to balance chemical reactions.
6 The Mole & Stoichiometry	▪ What types of numerical relationships exist in chemical reactions? ▪ How can one determine the amount of product or reactant used or produced in a chemical reaction? Time: 4-5 weeks	Text reference: Eisenkraft, pages 215-217. Visualizing a Mole (Flinn Chem Topics Booklet) Moles of Chalk Lab (See department binder) Sodium Bicarbonate and Acetic Acid Stoichiometry Lab (See department binder)	▪ Determine the percent composition for various compounds. ▪ Determine the empirical formula from the percent composition of various compounds. ▪ Use stoichiometry to determine the amount, mass, or volume of a substance produced or required in a chemical reaction.

	Relevant GSE's—PS 2.6a		Predict quantities of gas produced in chemical reactions.
7 Gas Laws	▪ How can one predict the change in characteristic properties of a gas when pressure and volume are altered? ▪ How can one predict the change in characteristic properties of a gas when temperature and volume are altered? ▪ How can one predict the change in characteristic properties of a gas when temperature, pressure, and volume are altered? Time: 3-4 weeks Relevant GSE's—PS 1.1b	Text reference: Eisenkraft, pages 372-375, 383-385, 393-397, 404-405, 410-413. Cartesian Divers (Textbook p.369-370 Part A) Graham's Law Activity (Flinn Binder) Boyle's Law Activity (See department binder)	▪ Investigate the relationship between the volume and pressure of gases at constant temperature. ▪ Quantify changes in volume or pressure with changes in the other. ▪ Interpret data concerning gas volume and pressure. ▪ Investigate the relationship between temperature and volume of a gas. ▪ Determine the volume of one mole of a gas. Determine the effect of molecular size on molecular motion.

Formative Assessment in the High School Classroom

Science Notebooks and Claims & Evidence

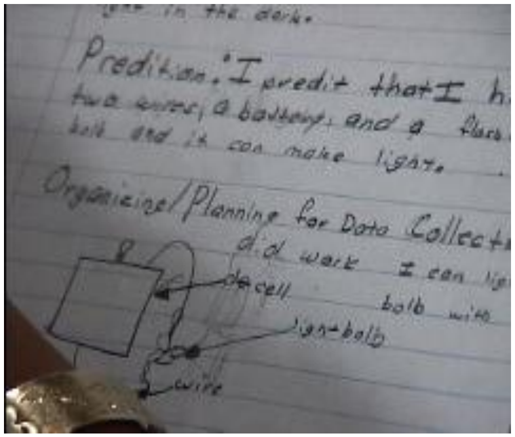
In light of the newly released and adopted National Common Core Standards for Literacy in Science, the use of science notebooks is critical every day. Science notebooks or journals can be used to help students develop, practice, and refine their science understanding, while also enhancing reading, writing, mathematics and communications, to meet these standards. As teachers involve students in inquiry-based science investigations, the need to communicate science learning in new ways has become evident. If students are encouraged to communicate their understanding of concepts through science notebook writings, these notebooks can be an effective strategy to help students learn science. Research has shown that science notebook writing may also be a way for students to strengthen their language skills as they develop an understanding of the world around them. Science notebooks allow teachers to formatively assess students' understanding and provide the timely feedback students need for improving their performance.

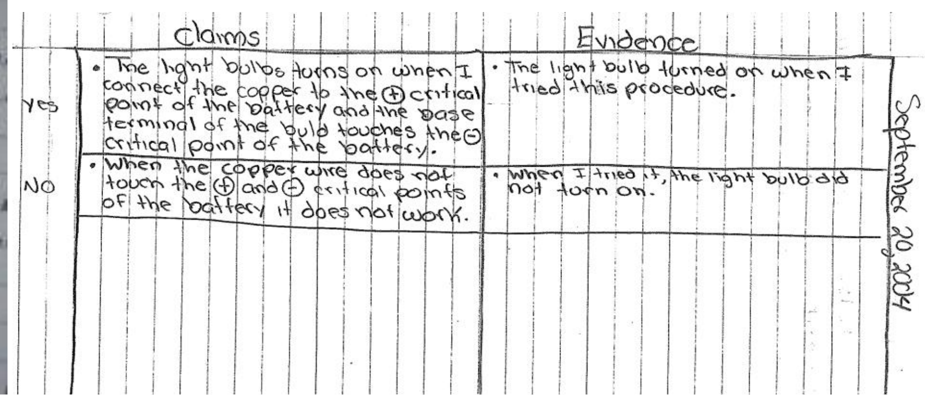
Science notebooks contain a record of information about the students' classroom inquiry experiences and are encouraged to use them as scientists would, before, during, and after all investigations. They are a place where students formulate and record their questions, make predictions, record data, procedures, and results, compose reflections, and communicate findings. Most importantly, notebooks provide a place for students to record new concepts they have learned.

Excellent sources of information about the use of notebooks are the East Bay Educational Collaborative's website at www.ebecri.org and "Using Science Notebooks in the Elementary Classroom" which illustrates the prior experiences that are used in North Smithfield Elementary class rooms with students by Dr, Michael Klentschy NSTA Press whose research (among many others) supports this work..

- The primary formative assessment device to be used at the elementary level is the strategic use of science notebooks and related entries as shown below. Quality effective and timely feedback to students is critical to improving student achievement. The notebooks provide that opportunity.
- The use of NE#CAP-RI released tasks with students also provide an excellent opportunity to provide formative assessment.

Science Notebook or Journals Student Entry Types-*The Reading & Writing Connection*





Science notebooks contain information about students' classroom experiences as they construct scientific knowledge/concepts. They are used much as scientists would, before, during, and after all investigations. They are a place where students formulate and record their questions, make predictions, record data, procedures, and results, compose reflections, and communicate findings. Most importantly, notebooks provide a place for students to record new concepts they have learned.

The research supporting the use of notebooks is extensive but, below are a few resources that support this important facet of instruction.

Klentschy, M. and Molina-De La Torre, E. (2004). Students' science notebooks and the inquiry process.

In W. Saul (Ed.). Crossing Borders in Literacy and Science Instruction: Perspectives on Theory and Practice. Newark, DE: International Reading Association Press.

Students benefit from strong scaffolding with respect to building explanations from evidence (Songer and Lee, 2003)

Further, by reviewing hundreds of actual student notebooks, a group of education leaders from the East Bay Educational Collaborative, Dr. Michael Klentschy, and others from Washington State explored how teachers were asking students to record their ideas in their science notebooks. Analysis of the student work revealed eight distinct strategies or "entry types," used most frequently by practicing K-12 teachers. The following describes those eight entry types and offers a rationale for why a teacher might select a given entry type. These types of entries are particularly important to connect science to reading and particularly writing.

Entry Type	***Definition and Purpose***
Glossary Development by Students	In conjunction with a "Word Wall" or "Object Wall" (which is the same except whenever possible the actual object is also clipped to the wall especially at lower grades and where English Language Learners are present) students develop their own definitions asnew words are used in context of investigations and classroom activities.
Drawings	*Definition* Student generated drawings of materials, scientific investigation set-up, observations, or concepts. Three common types of drawings used in science notebooks include: 1. Sketches: Informal pictures of objects or concepts created with little detail. 2. Scientific Illustrations: Detailed, accurate, labeled drawings of observations or concepts. 3. Technical Drawings: A record of a product in such detail that someone could create the product from the drawings.
	Purpose Students use drawings to make their thinking and observations of concrete or abstract ideas visible. Drawings access diverse learning styles, allow entry to the writing process for special needs students and emergent writers, and assist in vocabulary development (e.g. oral explanations, group discussions, labels).
Tables, Charts, and Graphs	*Definition* Formats for recording and organizing data, results, and observations.
	Purpose Students use tables and charts to organize information in a form that is easily read and understood. Recording data in these forms facilitates record keeping. Students use graphs to compare and analyze data, display patterns and trends, and synthesize information to communicate results.

Graphic Organizers	*Definition* Tools that illustrate connections among and between ideas, objects, and information. Examples include, but are not limited to, Venn diagrams, "Box–and-T" charts, and concept maps.	*Purpose* Graphic organizers help students organize ideas to recognize and to communicate connections and relationships.
Notes and Practice Problems	*Definition* A record of ideas, observations, or descriptions of information from multiple sources, including but not limited to direct instruction, hands-on experiences, videos, readings, research, demonstrations, solving equations, responding to guiding questions, or developing vocabulary.	*Purpose* Students use notes and practice problems to construct meaning and practice skills for current use and future reference.
Reflective and Analytical Entries	*Definition* A record of a student's *own* thoughts and ideas, including, but not limited to initial ideas, self-generated questions, reflections, data analysis, reactions, application of knowledge to new situations, and conclusions.	*Purpose* Students use reflective and analytical entries to think about scientific content from their *own* perspective, make sense of data, ask questions about their ideas and learning processes, and clarify and revise their thinking.
Inserts	*Definition* Inserts are artifacts placed within a notebook, including, but not limited to photographs, materials (e.g. flower petals, crystals, chromatography results), and supplemental readings (e.g. newspaper clippings).	*Purpose* Students use inserts to document and to enrich their learning.
Investigation Formats	*Definition* Scaffolds to guide students through a controlled investigation, field investigation, or design process. Examples include, but are not limited to investigation planning sheets or science writing heuristics.	*Purpose* Students use investigation formats to guide their thinking and writing while they design and conduct investigations. Students also use these formats to reflect on and discuss their findings and ideas.

Writing Frames	*Definition* Writing prompts used to focus a student's thinking. Examples include, but are not limited to, "I smelled…I felt…I observed…","My results show…", "The variable I will change is…", or "I think that because…".
	Purpose Students use frames to organize their ideas, prompt their thinking, and structure their written response. Frames help students become more proficient in scientific writing and less reliant upon the prompts.

Further, the following pedagogical model takes the use of notebooks to another level for students. It develops the ability of students to formulate claims or inferences based on evidence as scientists do and constant with the new Common Core Standards.

Specific examples of teacher strategies for Scientist's Notebook and other science-literacy connections used by classroom teachers may be found at EBEC's website:

http://ebecri.org/content/checklists

The "Scientist's Notebook" Model of Instruction K-12

Constructing scientific knowledge is not a casual but a purposeful activity based upon posing questions, determining claims, and providing evidence. K.A.Burke, Iowa State University **The Process of Using Inquiry and the Science Writing Heuristic***

The "Scientist's Notebook" method used in science classes, as a model of instruction (K-12), incorporates and facilitates student scientific writing development based on their claims and supporting evidence for those claims. Students are asked to support any and all claims with evidence gleaned from their investigation of a ***focus question.*** Students share their claims and evidence in a ***"making meaning conference"*** prior to actually writing conclusions. This models the actual work of scientists as they investigate and share and report the results of their work.

Elements:

- Engaging Scenario: (Optional but it is based on the research of Madeline Hunter in literacy.
- Focus Question: (a question that is investigable.)
- Hypothesis/Prediction with reasoning for the prediction based on student prior knowledge.

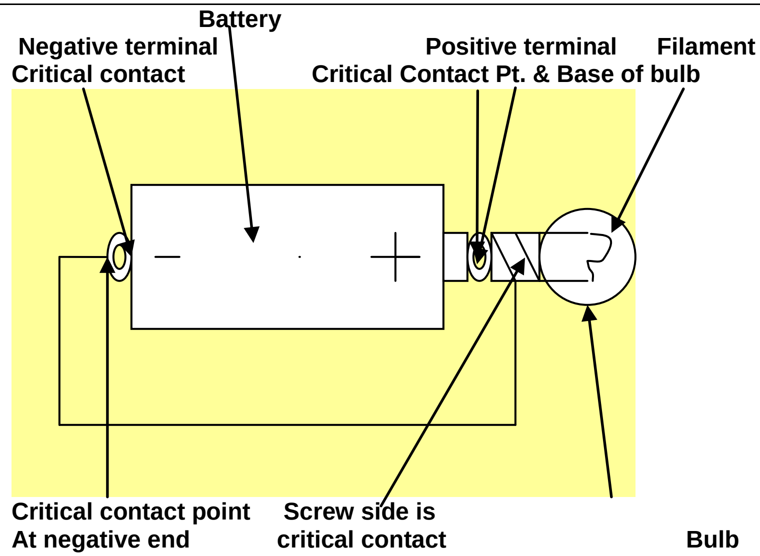
- Planning: Procedures can be based on "guided inquiry" questions developed by the teacher or later "self-determined inquiry" where students develop their own procedures. Opportunities to differentiate instruction based on the needs of students can occur in classrooms such as providing an explicit procedure to Sp.Ed. students where they can "test" it for the rest of class.
- Data and Evidence: Graphic Organizer development with students, tables, graphs, written observations. Hint: Data may not always be evidence to support a claim. An example might be in an experiment to measure the boiling point of a liquid the length of the thermometer can be collected as data but, it is not evidence for the investigation.
- Claims and Evidence
- Making Meaning Conference: Develop class claims and evidence
- Conclusions and Reflections

SAMPLE Claims & Evidence

<table>
<tr>
<td>I claim that:

A complete circuit requires "critical contacts" at the positive and negative ends of a battery.

Based on my investigation I found that:

The base of the bulb is a critical contact point and the "screw threaded contact area" (anywhere) is a critical contact point to make the light bulb work.</td>
<td>

When we connected the bulb as shown above the light worked no matter where the wire touched the side area of the threaded base of the bulb as long as the base or bottom of the bulb was in contact with the positive end.

It also worked when the ends of the battery were reversed. (reverse diagram) rsk-2005</td>
</tr>
</table>

Scientist's Notebook Components	**Purpose**	**Writing Scaffold**
Focus or Essential Question	The question provides a link to the engaging scenario, cannot be answered "yes" or "no" and is investigable	*How does…..?How can…?* *What does….?What can ..?* *Which….?*
Prediction	The prediction provides a reasonable explanation by the learner as to the result of the investigation. Using "because" also activates prior knowledge.	*I think …..will happen because………*
Planning -operational	The general plan determines which variable will be changed and which will be kept constant and what will be observed or measured. The operational plan describes the sequence of events and the materials that will be used to conduct the investigation.	*…. will be changed.* *…. will be kept the same.* *…. will be observed or measured.* operational *First…..* *Second…..* *Next ……* *Finally …..*
Data – Observations/Measurements	Data charts, tables, graphs and labeled diagrams and illustrations	How are we going to record what we are going to observe or measure?
Claims/Evidence	Claims linked to the data collected or observed with justification.	*I know that …….* *I know this because….*
Conclusion	Revisit prediction. What was learned from the evidence?	*My evidence supports my prediction because …* *My evidence does not support my prediction because ….* *In conclusion, …* *Today I learned …*
Reflection	Provides an opportunity for the student to think about their thinking.	*Questions that I have now are …… .I wonder if …….What really surprised me about this investigation was ….I used to think, but now I think….I know that I'm*

Science Notebooks, Claims & Evidence, and RAISE

In light of the newly released and state adopted National Common Core Standards for Literacy in Science, student use of science notebooks is critical every day, K-12 based on numerous research studies. Also, their use is in support of one of the North Smithfield District's overall goals to support the improvement of students' achievement with respect to their writing abilities. Students must develop effective, in depth, and extended writing responses on demand, including Rhode Island's NECAP testing in science as well as other content areas.

The district also has introduced and adopted the **RAISE** model for effective writing in numerous workshops. The implementation of this model, when used with the East Bay Educational Collaborative's **Scientist's Notebook** pedagogical workshop model of instruction for inquiry based science, will translate ultimately to students developing their abilities to write highly effective scientific conclusions for all inquiry experiences. It will also develop their abilities to communicate clearly their scientific conceptual understandings.

The RAISE model is in complete alignment with the use of Science Notebooks/journals and can be used with them to help students develop, practice, and refine their science understanding, while also enhancing reading, writing, mathematics and communications, to meet these new standards. As teachers involve students in inquiry-based science investigations, the need to communicate science learning in new ways has become evident. If students are encouraged to communicate their understanding of concepts through science notebook writings, these notebooks can be an effective strategy to help students learn science. Research has shown that science notebook writing may also be a way for students to strengthen their language skills as they develop an understanding of the world around them. Science notebooks allow teachers to formatively assess students' understanding and provide the timely feedback students need for improving their performance.

Science notebooks contain a record of information about the students' classroom inquiry experiences and are encouraged to use them as scientists would, before, during, and after all investigations. They are a place where students formulate and record their questions, make predictions, record data, procedures, and results, compose reflections, and communicate findings. Most importantly, notebooks provide a place for students to record new concepts they have learned.

One primary formative assessment device that should be used at the high school level is the strategic use of science notebooks. High School Science instruction should build on the same practices used in the middle school, deepening opportunities for students to engage in rigorous thinking expressed through their writings. Quality effective and timely feedback to students is critical to improving student achievement. The notebooks provide that opportunity. Further, an overall goal of all instructional content areas is the continued development of student extended writing abilities as required in extended response on-demand tasks for NECAP assessment. The **RAISE model** dovetails with effective scientific conclusion writing development by students.

A Comparison of RAISE* and how it fits with the Scientist's Notebook Model of Instruction* when students write their *scientific conclusion and Constructed Responses for NECAP-RI type assessments:* *RAISE details are courtesy of Clare Arnold, North Smithfield District Curriculum Director
Scientist's Notebook Model details are provided by the East Bay Educational Collaborative

RAISE	Scientist's Notebook Model Effective Conclusion Writing
Writing Prompt	Engaging Scenario for investigation
Focus/Essential Question for Writing	Focus/Essential Question that was investigated
Restate Students are to use (restate) the words from their question	Student rewrites the question as a declarative statement to begin their response.
Answer Students write the required amount of answers to the question	Students re-state their prediction/hypothesis that is a response to the focus/essential question and state what they thought would happen in the investigation and why they thought that answer to the focus question.
Include: (See below)	Students include in the body of their conclusion: **(See below)**
Support with Evidence: Students must support (prove) each and every answer with evidence from the text used. (This is the most important and most challenging part of construted-response!)	Students include their claims/inferences based on their evidence recorded in their investigation. They also include when appropriate other student claims that may have differed from their own and comment on why there may have been differences. They include description of their analysis of their data.
Extend: Students give extra thought about the answer;this can be analysis, judgement, or personal connection to the text.	Students provide reflections on their investigation including analysis of how they might improve their investigation and/or other questions that they might research. At secondary grades students should consider sources of error in measurements, etc. Students provide closure to their conclusion by restating again the beginning of their response in different words….but, beginning this final sentence/statement with the words "In conclusion…"

Science conclusions should be developmentally appropriate and consistent with expectations of other content areas. Conclusions should be three or more paragraphs including paragraphs devoted to: Focus/Controlling idea, Evidence & Claims details, and paragraph(s) that focus on analysis done, and reflections.

High School students should deepen their writing abilities by engaging in "Scientific Abstract Writing" as well as traditional laboratory reports. The elements of abstract writing are defined on the next page:

<u>Scientific Abstract Writing:</u> Opportunities for other extended writing by students in science are afforded not only by traditional reports assigned, or selected by students on topics that are effectively chosen to connect science to real world applications. They also could include in upper grades *<u>science abstract writing</u>*. Beyond a conclusion based on "claims & evidence," abstracts should be written to include the following elements. An effective strategy for introduction of this genre would be to have students examine abstracts actually written be scientists and discuss them. Then students could write and "publish" their abstracts (provide copies for others in their class) to share their research after an investigation. This could become an integral component of instruction and self assessment by students as they could do this after inquiry activities that reflect a "big idea" from each unit.

The elements usually addressed in abstract writing are:

1) Motivation/problem statement: Why do we care about the problem? What practical scientific and/or theoretical problem is yopur research addressing?

2) Methods/procedure/approach: What did you actually do to get your results? (e.g. analyzed 3 experiments, completed a series of 5 inquiry investigations, collaborated and shared the findings of other students doing similar investigations)

3) Results/findings/product: As a result of completing the above elements, what did you learn?

4) Conclusion/implications: What are the larger implications of your findings, especially for the problem/gap identified in step 1? How does this compare to another experiment you have done?

Teachers at the high school level should have students occasionally look at actual scientific abstract samples from science journals and, looking through the lens of "Claims & Evidence," increase both writing and reading capacity of students by analyzing these abstracts. The following steps, modified from Gray, Dickey, and Kosinski (1988), may be helpful to students as they begin to organize their discussion in the form of a **conclusion** that can be further developed into the abstract.:

1. Restate your question, hypothesis, and prediction.
2. Answer the question.
3. Write down the specific data, including results of statistical tests.
4. State whether your results did or did not confirm your prediction and support or negate your hypothesis.
5. Write down what you know about the biology involved in your experiment. How do your results fit in with what you know? What is the significance of your results?
6. List weaknesses you have identified in your experimental design. You will need to tell the reader how these imperfections may have affected your results.
7. List any problems that arose during the experiment itself. Unforeseen difficulties with the procedure may affect the data and should be described in the discussion.

Further References to Inform Instruction:

RI Department of Education Reference Table for NECAP High Emphasis Assessment Targets

Table 2: High-Emphasis Assessment Targets with *Preliminary* DOK Ceilings*			
Science Domains by EK Statement	**Grade 4 Targets with DOK**	**Grade 8 Targets with DOK**	**Grade 11 Targets with DOK**
LS1 Survival of organisms	1 – DOK 2a, b, g 2 – DOK 1a, b	1 – DOK 3h 2 – DOK 2a	1 – DOK 3d 2 – DOK 3d
LS2 Matter and energy in ecosystems	6 – DOK 2a	5 – DOK 2a, d 6 – DOK 2a	3 – DOK 2a
LS3 Organisms change over time		8 – DOK 2a, h	8 – DOK 3a, f
LS4 Humans are similar, yet unique	8 –DOK 2a, h	11 – DOK 2a, b	
PS1 Properties and structure of matter	1 –DOK 3h	1 –DOK 2a, c, d, e, i 2 –DOK 2e, g, j 4 –DOK 2a, b	3 –DOK 2a, b 4 –DOK 3c, g, j
PS2 Energy		6 –DOK 3c, j, l, o	6 –DOK 3a, c, h
PS3 Forces and motion	7 –DOK 2a, j	8 –DOK 2a, e, g, i, j,	8 –DOK 3a, c, h 9 –DOK 2a, b 10 –DOK 2a
ESS1 Earth and earth materials	1 –DOK 2b, e, g 2 –DOK 3c, h 4 –DOK 2a, b 5 –DOK 2a, b	2 –DOK 2a 3 –DOK 2a, b 5 –DOK 3c, d, h, k	1 –DOK 3a, c, d, f, l 3 –DOK 3o
ESS2 Solar system		6 –DOK 2a, g, h, j 8 –DOK 3j, o	
ESS3 Universe and galaxies			6 –DOK 3b, c, d, l, o 7 –DOK 3o 8 –DOK 2a, b
*** See Table 3 on the next pages for a description of Depth of Knowledge (DOK) levels in science. Coding for DOK ceilings are aligned with the descriptions in this Table. For example, "2a" means Level 2 DOK and the description for "a" – Specify and explain the relationship between facts, terms, properties, or variables.**			

Table 3: Sample Descriptors for each of the DOK Levels in Science, based on the work of Norman Webb

Level 1 **Recall & Reproduction**	**Level 2** **Skills & Concepts**	**Level 3** **Strategic Thinking**	**Level 4** **Extended Thinking**
a. Recall or recognize a fact, term, definition, simple procedure (such as one step), or property b. Demonstrate a rote response c. Use a well-known formula d. Represent in words or diagrams a scientific concept or relationship e. Provide or recognize a standard scientific representation for simple phenomenon f. Perform a routine procedure, such as measuring length g. Perform a **simple** science process or a set procedure (like a recipe) h. Perform a clearly defined set of steps i. Identify, calculate, or measure **NOTE: If the knowledge necessary to answer an item automatically provides the answer, it is a Level**	a. Specify and explain the relationship between facts, terms, properties, or variables b. Describe and explain examples and non-examples of science concepts c. Select a procedure according to specified criteria and perform it d. Formulate a routine problem given data and conditions e. Organize, represent, and compare data f. Make a decision as to how to approach the problem g. Classify, organize, or estimate h. Compare data i. Make observations j. Interpret information from a simple graph k. Collect and display data **NOTE: If the knowledge necessary to answer an item <u>does not</u> automatically provide the answer, then the item is at least a Level 2. Most actions imply more than**	a. Interpret information from a complex graph (such as determining features of the graph or aggregating data in the graph) b. Use reasoning, planning, and evidence c. Explain thinking (beyond a simple explanation or using only a word or two to respond) d. Justify a response e. Identify research questions and design investigations for a scientific problem f. Use concepts to solve non-routine problems/more than one possible answer g. Develop a scientific model for a complex situation h. Form conclusions from experimental or observational data i. Complete a multi-	a. Select or devise approach among many alternatives to solve problem b. Based on provided data from a complex experiment that is novel to the student, deduct the fundamental relationship between several controlled variables. c. Conduct an investigation, from specifying a problem to designing and carrying out an experiment, to analyzing its data and forming conclusions d. Relate ideas *within* the content area or *among* content areas e. Develop generalizations of the results obtained and the strategies used and apply them to new problem situations **NOTE: Level 4 activities often require an extended period of time for carrying out multiple steps; however, time alone is not a distinguishing factor if skills and concepts are simply repetitive over time.**

1.	**one step.** **NOTE: Level 3 is complex and abstract. If more than one response is possible, it is at least a Level 3 and calls for use of reasoning, justification, evidence, as support for the response.**	step problem that involves planning and reasoning j. Provide an explanation of a principle k. Justify a response when more than one answer is possible l. Cite evidence and develop a logical argument for concepts m. Conduct a designed investigation n. Research and explain a scientific concept o. Explain phenomena in terms of concepts	