RET Lesson Plans

Below are nano-technology related lesson plans created by teachers. The lessons are organized by content area with the grade level noted (grades 6-8 - blue, grades 9-12- yellow, and grades K-12- green). Please note that some of the content areas overlap, so look through several of the sections to see if a lesson might work for your topic (e.g. lesson plans pertaining to physical science may also work great for a chemistry classroom). Many of these lesson plans could be modified to scale up or down for the grade level or academic needs of the students in your classroom. Each lesson plan includes the corresponding Next Generation Science Standards (NGSS) or North Carolina Essential Standards. We hope that you may find these interesting and useful for engaging your students.

Jump to the content area:

General Science

Title	Grade Level	Description
Electrospinning Nanofibers	6-8	Students will have the opportunity to explore characteristics of prepared slides and nanofibers with the use of handheld microscopes and then learn the basics about electrospinning nanofibers while designing a 3D virtual lab simulation in CoSpaces.
Hip Hip Hooray For Nanotechnology	6-8	Nanotechnology is an ever-expanding field that has the potential to change our lives. In this lesson, students will conduct research on a nanotechnology product/idea and learn about the impacts and implications that nanotechnology has on society. Following the research, students will design a Google Drawing poster to teach others about their emerging technology.
Sort It Out: STEM Edition	6-8	Students will begin this lesson by watching the Powers of Ten video to grasp how big our universe is and how small an atom is and sizes in between. Following the video, students will gain a better understanding of size and scale by completing a hands-on activity that challenges them to think about and then arrange technology item cards on a clothesline in order from small to large. Students will then place the corresponding metric value card on the line.
Day 1 Science Activity: Determine Your Device--No Hands!	K-12	How do scientists or professionals manipulate objects when they can't use their hands to do so? In this lesson, students will use a variety of "tools" to construct a tower of Duplos®/ Oversized Legos®. Students should select from various tools that they are familiar with within their home or school environment, but not necessarily in the science classroom (e.g. hot pads, spoons, tongs, tweezers, etc). Students should learn that

		using the right tool for what they are trying to accomplish or the size of the objects being manipulated matters. Students could discuss how the size and scale of any tool matters for what the job is.
Hitting the Bullseye: Measuring Volume with Precision and Accuracy	6-12	This lesson serves as an introduction to precision and accuracy, the metric system and why the scientific community uses it universally, and pieces of lab equipment relating to volume. Students are not expected to have much background knowledge and would benefit the most from this activity by completing it towards the beginning of the year. An emphasis is placed on techniques and strategies promoted by the American Modeling Teachers Association such as whiteboarding and collaboration, as ways to help create a positive learning environment that is supportive of students' social-emotional development.
Informing Your County about our tiny big world	9-12	In this lesson students will create and design a children's book or art piece about nanoparticles that they will then present to their community during a "Nano Science Night." Members of the school and community will be able to come out and see the students' products. Students will also have the opportunity to perform demos for the community related to their nanoparticles.
Nano in nature	6-8	This lesson includes a unique inquiry into one Nano mystery called the Lotus Effect. This lesson includes one activity, one lab, and one very special presentation from an Atomic Force Microscope of the Elephant Ear plant.
Nano Scale: Conceptualizing the Atomic and Celestial World	6-8	The purpose of this lesson is to help students conceptualize scale before students learn about the many instruments that scientists use to quantify and measure in the nano world.
One in a Billion: Lesson on understanding Nano size	6-8	In the previous lesson ("Nano Scale"), students conceptualized scale from the Light Years to Nanometers. This included conceptualizing huge distances or numbers like one billion. This lesson continues to build on the student's understanding of scale for very small items or measurements.
Under Pressure: Using the Power of Pressure to Light the World	9-12	When we think of sustainable energy we usually think of solar energy, wind energy, and maybe sprinkle in a little of geothermal and hydroelectric energy. But, another form of energy we really do not think about is the ability to take something as simple as pushing a doorbell to be an element in potentially creating a source of energy. This lesson aims to look into just that, creating an electrical field through using a piezoelectric response within a material. This lesson will delve into the actual efficiency of piezoelectric response and push students to think of ways we can expand our ideas and even maybe, just maybe, improve upon the design.
Purifying the Present: Harnessing Nanotechnology for Clean Water Futures	9-12	This lesson is designed to introduce students to the basics of nanotechnology with an emphasis on water purification. Students will design, build, and test a water filtration system using nanoparticles and everyday objects.
Powering the Future: Unleashing Energy with Piezoelectric Generators	6-12	Students will be introduced to what piezoelectric materials are, how they function, and how piezoelectric materials can build a generator that produces clean power from applied forces. You will also have the option to extend this lesson and have students design a product that utilizes piezoelectric generators to generate electricity.

Biology/ Life Science

Title	Grade Level	Description
Antibiotic Resistance	9-12	Students will learn about antibiotic resistant (AR) bacteria and why this issue is so important, then they will grow bacteria obtained from local soil in a sealed petri dish and test it for resistance to an antibiotic. Students will upload their data to the PARE project (Prevalence of Antibiotic Resistance in the Environment) for an authentic research experience.
DNA Fingerprinting: PCR and Gel Electrophoresis	9-12	Students will learn about PCR and gel electrophoresis, how they can be used to create a DNA fingerprint, and how to read and interpret a DNA fingerprint. They will then use a kit from MiniPCR to perform PCR and gel electrophoresis in the laboratory, determining whether simulated antibiotic resistant strains of *E. coli* have been found on farms neighboring one with an outbreak.
The Age of Giant Insects	9-12	This activity will explore the common scale size of insects including arthropods such as spiders and other insects by demonstrating that living insects have limits to their size.
The World of the Unseen	9-12	The microscope has allowed scientists to step out of the world controlled by instrument limitations into a world of nano things once unseen. Microscopic innovation has brought a light into the advancement of instruments revolutionizing modern nanotechnology. Students will explore various types of microscopes and their applications.
Microscope Exploration of Plant vs. Animal Cells	6-11	In this lesson, students will be circulating through 6 stations where they will compare the structures and functions of plant and animal cells. Students will gain hands-on experience using a compound microscope by looking at onion cells, cheek cells, and additional prepared slides under the microscope.
From Molecules to Organisms: Atom to Adam	6-8	In this lesson, students will be introduced to the hierarchical organization of multicellular organisms by organizing parts of organisms from simplest to most complex. This lesson can also be used to form background knowledge about relative size and scale in order to help students better understand how structure and function of living things are related.
From Biomolecules to the Biosphere: An Introduction to Size and Scale in Biology	9-12	In this introductory lesson, students will discover that in Biology we study aspects of living things that fall within a vast range of size and scale; from nanosized molecules like DNA, to the entire Biosphere which is the portion of the Earth that supports life, from the bottom of the oceans to the top of the atmosphere.
Photosynthesis to Hydrogen Fuel Technology: Nothing New Under the Sun	9-12	In this lesson students will learn about the natural process of photosynthesis through an Elodea photosynthesis lab and connect it to our goal of producing Hydrogen fuel for clean renewable energy. This lesson is a great way of teaching students how future technologies can be inspired by nature.
Nano-Frog Lab: How Nanostructures of Specialized Cells Affect Organ Function	9-12	In this lesson, the classic Biology frog dissection is amplified by microscope technology to reveal the awe inspiring engineering complexity of living things down to the nanoscale. Students will be taken on a journey from organ to organelle to increase their understanding of how anatomical structures affect biological functions. Students will use proper dissecting and microscope techniques to explore how specialized cells within organ structures make their remarkable functions possible.

How Big is Biology? Connecting Biological Hierarchy, Scientific Notation, and Size	9-12	The goal of this introductory lesson is to review the concept of biological hierarchy with AP level students and relate the various levels to relative sizes using greek prefixes and scientific notation. Students will develop a stronger understanding of the relative sizes of structures they will learn throughout the course. Students will also review scientific notation and utilize it with real-world examples.
It's a Snap! Protein Folding and Self Assembly	9-12	In this multi-day lesson, students will explore the process of protein folding. Students will expand their understanding of how and why proteins fold by first modeling the process with a hands-on activity, and then engage with real protein structures using the RCSB database
Water You Talking About? Investigating the Properties of Water	9-12	In this activity, students will explore the properties of water through a series of hands-on activities. After learning about these properties students will design and conduct an experiment to further investigate capillary action.
A Single Letter: How DNA Mutations Can Lead to Disease	9-12	This lesson allows students to gain an understanding of the relationship between DNA and proteins, and how DNA mutations can lead to disease. Students will be introduced to the hemoglobin protein and its role in the body, then explore how a change in one DNA "letter" in the hemoglobin gene leads to the development of sickle cell disease.
From Atom to Organism: Choosing the Best Tool	9-12	This lesson allows students to explore the concept of size and scale as they relate to biological organization levels, as well the necessity of choosing the correct tool when conducting scientific research. Students will create a paper foldable by exploring various visualization tools and techniques, such as light microscopy and scanning electron microscopy, and matching them with biological structures of varying sizes to understand how the tool may be used to "see" structures of interest.
Bioremediation: How Microorganisms Are Used to Clean Up Our Mess	9-12	This lesson serves as an introduction to the topic of bioremediation. Bioremediation is the use of living things, specifically microorganisms like bacteria and fungi, to break down toxic substances (Aliotta & Colley, 2013). Students will view and summarize various resources related to bioremediation, its applications, and its limitations, then construct an answer to an overarching question: How might we use bioremediation to help fix environmental problems caused by humans?
From Nano to Macro: A Yearlong Journey in Conceptual Understanding of Size and Scale	9-12	This lesson is unique in that it encompasses a semester's worth of exploration and conceptual understanding of size and scale. Rather than being a standalone activity, this lesson is a series of shorter conversations and thought exercises that will take place throughout the course. Students will work as a class and individually to develop a better understanding of the size and scale of the nano, micro, and macro worlds by developing a "timeline" throughout the semester that relates the size of the molecules, structures, and topics to one another.
Artificial Photosynthesis: Fuel for the Future?	9-12	This lesson is designed to strengthen students' understanding of photosynthesis, redox reactions, and renewable energy sources. It is related to a biology lesson on photosynthesis as it analyzes how sunlight can be used to split water and provide a source of fuel for cars, industry, and human society. It's a linking activity between biology, chemistry, and environmental science.
Nanotechnology and Privacy	9-12	The lesson will engage students in critical thinking and analysis of texts related to nanotechnology and privacy issues. Students will learn about the potential benefits and risks of nanotechnology and explore the ethical and privacy implications of its applications.

Size and Scale in the Human Body: Skeletal, Muscular, and Nervous Systems	9-12	In this lesson, students will explore the size and scale of the skeletal, muscular, and nervous systems in the human body. They will engage in hands-on activities to measure and compare the sizes of cells, bones, muscles, and nerves. Through hands-on activities, measurements, and in-depth analysis, students will gain a deeper understanding of how these systems vary in size, their relative proportions, and their compactness within the human body.
Bone & Muscle Injuries	9-12	This lesson is a discussion about changes in bone mass density, bone size, blood vessel size and number, muscle size and scar tissue with images of nanoscans of muscle and bone from mice and rats. The injuries discussed are brachial plexus birth injury and an ischemic stroke.
Dealing with a Messy Situation: How Wastewater Treatment Plants Purify Water	9-12	In this lesson, students learn about the basics of how water treatment plants, focusing on the critical role that microbes play in the process. Students work independently in groups to learn how microbes remove excess Carbon, Phosphorus, and Nitrogen from wastewater.

Chemistry

Title	Grade Level	Description
The Great Tape Ripoff	9-12	This lesson is intended to introduce and expand on the idea that electrons govern the interactions between objects. Special attention is paid to metals and their properties, with a demonstration that shows how properties like color can change at the nano-scale.
Crystal Structures	9-12	Students will learn the application of distance, midpoint and slope in order to determine the crystal structure of a particular data set. Students will also do research on what local gems, stones, or minerals have that crystal structure. Through this lesson plan students will see the physical properties of crystal structures due to the tangible 3D grid.
Becoming an Atom- Atomic Trends	9-12	Students will explore various periodic table trends and the mechanisms behind these trends through a visual and tactile activity. Students will then work in groups to organize their observations to create and propose definitions for each trend. Students will act as electrons in atoms to explore changes in atomic radius, ionic radius, Ionization energy, and Electronegativity, through scaffolded guided questions. Students will track observations and hypotheses mechanisms behind the observations. In groups, utilizing these observations and hypotheses, students will formulate potential explanations for each trend and present these explanations to the class for further review and expansion.
Capture that Phosphorus!	9-12	In this lesson, students will be presented with issues surrounding extracting and recycling phosphorus. They will be told that in order to recycle phosphorus, it has to bond with another element and precipitate out of solution. Students will search for the best element to bond with phosphorus, working in groups to analyze various options. Elements will be analyzed through academic and real-world lenses, looking at stability, accessibility, cost effectiveness, toxicity, environmental impacts, storage and transport restrictions, and solubility in water.
Mole Fun Stations: Conversion Practice	9-12	Students will work in groups, moving through stations to practice single chemical stoichiometry conversions. At each station, they will work with a real-world object (water, chips, soda, salt, etc.) while using measurements or the nutrition facts to practice conversions related to stoichiometry. It is recommended that students use a mole map (included below) to practice setting up dimensional analysis (fence post or train track) methods. Atoms, molecules, and formula units exist on the nano level and it is important to understand how we measure these particles and how they interact in a reaction.
Fun with Forces Lab: An Investigation into Intermolecular Forces	9-12	This lesson is an introduction to intermolecular forces in a high school chemistry class. Students will complete five different stations exploring how intermolecular forces impact properties of substances in chemistry. This lesson would be good to complete after students have completed studies on bonding types and polarity but before they have a really strong understanding of the different types of intermolecular forces.
Protect the Reef	9-12	In this lesson, students will complete a POGIL (process oriented guided inquiry learning) about double replacement reactions that also serves as an introduction to solubility rules. Students will then relate the concept of precipitation reactions to the real world process of the formation of shells and protective coat of coral reefs.

A Bad Hair Day: Bonding in Hair	9-12	In this lesson, students will be introduced to bonding under the category of forces & interactions via amino acids and the real world phenomena of hair. This lesson features a brief introduction and demonstration, then allows students to complete a self-guided worksheet.
Exploding into Reaction Rates: How Catalysts Affect a Reaction	9-12	Reactions are a common phenomenon in the world of science. The speed these reactions occur can be influenced by a variety of factors, many of which take place at the nano level. Catalyst reactions happen at a nano level and are seen through an increase in the speed of a reaction. This lesson uses mentos and soda bottles to teach factors of reaction rates and the use of a catalyst.
Size & Scale: Measurement, Estimation, and Conversion	9-12	This lesson is designed to teach students about the metric system, relative size, measuring and estimation using a card game, height estimation, and reading measurements in a graduated cylinder.
Chalk & Talk- Periodic Trends	9-12	Students will be able to determine the elemental trends of the periodic table and the mechanisms behind those trends. Students will be able to create, discuss, and elicit their ideas through an interactive, visual lesson where students work in small groups to define and explain the periodic trends supplemented with the data they will collect. The students will behave as if they are the electrons in an electron cloud in atoms and will behave accordingly.
Wake-up Nano-Talk	9-12	Students will be able to research different research instruments in the science lab setting and describe their functionalities. Students will be assigned a specific nano instrument to research and then develop an educational TED talk for the class based on their instrument. Students will be able to gather information to support their discussion and illustrate it using powerpoint presentations, models, and illustrations. Students will present their topic, and provide peer feedback and teacher feedback during each of the TED presentations.
Nano-Al: Hydrogen generation from a high SA metal alloy	9-12	In this activity, students will explore the factors that affect reaction kinetics by creating a metal alloy of Ga-Al. Based on the Ga-Al ratio, Al metal nanoparticles can be produced within the alloy, which can readily react with water to produce hydrogen gas, unlike bulk Al which is passivated by a layer of Al_2O_3.
Finding the Fugitive Phosphorus	9-12	In this lab activity, students will learn about the role of phosphorus in the environment and the problems associated with its excess use in our environment by testing different samples from different water bodies for phosphorus. Additionally, students will practice graphing and making calibration curves.
A Journey from the Macroscale to the Nanoscale Using Dimensional Analysis and Modeling Atomic Radii	9-12	In this lesson everyday objects that can be observed with the naked eye will be used to demonstrate just how small the nanoscale is and will allow students to understand the relative sizes of objects when looking at the nanoscale. After a brief demo with the objects students will be tasked with measuring objects in the classroom, including themselves, and will complete dimensional analysis conversions to discover how many nanometers, micrometers, etc. are in the measured objects. Students will then research the Van Der Waals atomic radii of various elements and develop macroscale models showing the relative size difference of atoms across a period or down a group of the periodic table.
Lights, Electrons, Action! Exploring How Electron Arrangement and Energy Affect Our Perception of Visible Light Using UV Beads	9-12	Students will be introduced to the idea of the unique electron arrangement found in each atom. When these electrons are excited, they move into higher energy levels, then drop back down, releasing this energy in the form of a photon or visible light. Depending on the wavelength of light emitted, we perceive different colors. Every element will release a unique wavelength of light when excited. Students will use white UV beads to demonstrate how absorbed energy can be released as visible light of a specific color. Students will design an

		experiment to answer a specific question of their choice using the UV beads. Students will then learn how upconverting nanoparticles may give us the ability to see lower energy photons situated in the infrared spectrum, potentially giving us the ability to have night vision!

Physical Science/ Physics

Title	Grade Level	Description
Polarity is Cool!	8-12	Students will learn about polarity and its application to solubility, hydrophobic properties, and nanotechnology. Demonstrations using gum and chocolate, the lotus effect of the elephant ear plant, and hydrophobic fabric are all a part of this lesson.
Your Super Powers Are Invisible!	9-12	Students will explore how the index of refraction impacts how objects are seen in different mediums. Index of refraction relates to the transmission of light at the nanoscale through macroscale objects.
Going with the flow: viscosity, surface tension, and capillary action	10-12	Students will investigate a variety of properties of fluids and relate them to intermolecular forces, nanoscale structures, and macroscale behavior.
Searching for the Clue in Metric Conversions	9-12	The students will use the metric system in order to understand the importance of unit conversions and the prefixes. Students and the instructor will be involved in large and small group discourse during the class periods using two different exercises. Part one of the lesson will involve an interactive note-taking strategy where students review metric units and unit conversions. Part two of the lesson will involve a “Clue” style activity developed through *clarkcreativeeducation* the where students will gather information through 10 different clues to solve the mystery.
Forces & Attractions: Falling Water	9-12	Students will be able to determine the forces at play in water molecules through different exercises pertaining to water and its adhesive properties. They will observe water accumulate on a penny and gather evidence as to why water is accumulating on the surface without overflowing.
Double Units in Physics: Can you walk faster than a plane flies?	9-12	Within this lesson, students will learn to perform double unit conversions. Students will also be introduced to the concepts of velocity and nano-scale by placing very slow and very fast objects on a number line. Throughout the activity, students will have the opportunity to interact and argue their stance on where the various objects should be placed on the number line (also referred to as the “velocity line” throughout this plan). Finally, students will learn to perform dimensional analysis on double-units and practice using conversion factors to convert the given velocity of each object to meters per second or kilometers per hour.
Intro to Waves: Acoustic Sensing	9-12	In this lesson, students will complete a Slinky activity to produce multiple forms of waves. This will provide a visual of different types of waves and various wave characteristics such as amplitude, wavelength, period, and frequency. Students will then visually represent these characteristics on a poster. A real-world, technological application of longitudinal waves will be explained in acoustic biosensors.
Formation of a Brass Penny and X-Ray Analysis	9-12	In this lesson, students will make a brass penny by first coating the penny in zinc metal and heating it up to promote diffusion of the metals and create the brass alloy. They will explore phase diagrams and x-ray analysis data to determine the phases of brass present in a similar brass penny.
NANOlympics: Investigations into Nano Concepts and Challenges	9-12	In this lesson, students will learn about the concepts and challenges associated with nanotechnology. Students will compete in groups with five different challenges. Students will have eight minutes at each of

		the 5 stations to complete the challenge. The extra class time will be preparation, switching, cleanup and an ending class discussion.
Normal-sized Experts in a Nano-sized World	9-12	In this lesson, students will create Crash Course videos on specific nanoparticles assigned to their groups. They will research the particles' properties, what they're used for, how they're used, and the ethics surrounding their use.
The Photoelectron Spectrum: How electrons interact in different structures	9-12	In this lesson students explore qualitative applications of the photoelectron spectrum and how it is correlated using Coulomb's Law. This will be analyzed through the structure of atoms and ions.
Introduction to Unit Cells and Lattice Structures	9-12	In this lesson, students will learn about the 14 Bravais unit cells and how they are used to visualize the arrangement of atoms in various materials. After a brief introduction to the concepts, students will attempt to model as many structures as possible using multi-colored 5mm magnetic balls.
Go the Distance	9-12	In this lesson students will measure, calculate, and complete dimensional analysis on their individual pace distance, their height, their wingspan, and the length of their pointer finger to look at methodology that scientists use in the field to estimate the distance and size of an object.
Errors in Measurement - Mass and Distance	9-12	When trying to understand the precision and accuracy of a measurement, it is crucial that scientists minimize errors they have in their data. While all measurements involve some degree of error, learning how to assess and work with error is an essential part of making ALL scientific observations. What is the difference between accuracy and precision? How do we make our measurements both more accurate and more precise? Why would two measurements of the same object yield different values? How can we reduce the errors in our measurements? Students will investigate these questions through a series of measurement tasks involving mass and distance, with different objects and different measuring devices.
A Sticky Bookmark	9-12	Students will be able to discuss and compare the strengths of several sized sticky notes. The students will measure the strengths and weaknesses of the multiple sized sticky notes by using several different weighted items. Students will measure out the mass of the items within a ziploc bag and attach it to their sticky notes. Students will collect data, observations, and develop an argument determining the strongest sticky note.
Measurements with Class	9-12	In this activity students are introduced to measuring, estimating, and SI units. Students begin by using common items to measure the lengths of classroom materials. Students are then introduced to grams, meters, and liters, along with common prefixes.
Hands on with Thin Film Interference	9-12	In this short activity students explore thin film Interference. Students begin by learning about thin film interference, before then completing a hands-on activity where they get to explore thin film interference.
The "Middlest" Thing in the Universe	9-12	In this lesson, students will explore the different orders of magnitude at which objects exist in the universe by embarking on a quest to find where the middle of the road is and what lies in there. Students will also be able to compare two scale systems (Imperial and SI) and assess why scientific endeavor favors one over the other.

Scaling Physics: An introduction to the scale of units in Physics courses	9-12	The range of sizes contained within the curriculum of Physics is vast and often difficult to describe. Despite this difficulty, a working understanding of the differences in sizes of objects within our Universe is necessary if students are to successfully be capable of explaining the interconnected nature of major Physics topics. Students must be able to describe the size of objects and the distances between objects appropriately. In this investigation, students will be introduced to the varying scale of units associated with multiple frames of reference and explore multiples of 10 and the associated prefixes that relate to items scaled by multiples of 10.
Friction Up Close: An in depth look at frictional surfaces	9-12	Ice is smooth. Rocks are rough. The frictional characteristics of materials are often described with simple terms. But why? Why do we slip on ice? Why do tires gain traction on rocks? In this lesson, students will explore these questions. Using high tech microscopic scanning, common objects will become surfaces covered in rocky terrain. Students will review the basics of forces, consider the factors that generate frictional surfaces, and determine on their own how much friction is associated with the objects that make up the world around them.

Earth/ Environmental Science

Title	Grade Level	Description
Face Masks and Air Filters and Global Warming, Oh My!	6-8	This lesson provides students with the opportunity to work through the engineering and design process while applying their knowledge of greenhouse gases, air pollution, and global warming. Students will also gain a glimpse at the growing field of nanoscience as they explore real-world applications of nanofibers.
What's That In The Water?	9-12	In this lesson, students will consider and evaluate the quality of bodies of water in their communities. Bodies of water are subject to various forms of contamination and pollution, particularly by humans.
Toxic "As" Can Be	9-12	The purpose of this lesson is to communicate to students the importance of size and scale in nanotechnology. The topic of chronic arsenic poisoning is sufficiently relevant to students' lives that students should easily connect with the content. To wit, drinking water in the midwest United States and south Asian countries are regions of concern for arsenic in drinking water.
Radiation + Reflection	9-12	In this lesson, students will start off by thinking of solar power. How do we get solar power? Students will learn about energy, the atmosphere, albedo, the electromagnetic spectrum, and alternative energy. How do we use all of this energy we are provided? Students will then explore new high energy, high frequency technology within spectrometry, and how we use this light and energy to better understand our Earth.
Water Use & Abuse	9-12	In this lesson, students will first discover the impact they have on water. Students will also learn about different uses of water including recreational, industrial, and agricultural purposes. After students learn about water use and conservation, they will learn about water abuse. Students will explore the leading culprits of water pollution.
Size, Scale, & Plate Tectonics	9-12	In this lesson, students will learn about different aspects of size and scale, different scales within Environmental science, review the continental drift theory, introduction to plate tectonics theory, and learn about how size and scale relates to the idea of plate tectonics and continental drift.
A Different Kind of Serial Killer	9-12	In this lesson we will discuss how human activities produce waste that ends up in our environment, (e.g, soil, water), and the negative effects on the organisms and threat to biodiversity. Students will gain an understanding of how unseen toxins accumulate in organisms of various ecosystems after completing the serial dilution activity, One Part per Billion. Students will be able to make connections between toxins in the environment and how they can affect the organisms who live in them.
Is Too Much of a Good Thing a Bad Thing?	9-12	This lesson will explain how phosphorus is cycled in our constantly changing ecosystem. This lesson will describe what phosphorus is and its importance to our way of life, as well as problems that arise when too much phosphorus enters an ecosystem.
Where do Rivers Come From?	9-12	This lesson will model the topography of Earth's surface. The lesson will focus on the topography of watersheds in NC. It can be adapted to represent your local region. Students will observe how water flows in drainage basins. At the conclusion of the lesson, students will have a general understanding of the topography of Earth's surface.

Water Treatment- Would You Survive the Elements?	9-12	Students are going to go through this multi-step process with some regular household items and observe how water is purified through a wastewater treatment center. Students get to have a hands-on experience to see how difficult it truly is to separate contaminants like phosphates, nitrates, and more.
Excess Phosphorus in the Environment: Causes and Effects	9-12	This lesson will allow students to complete research and use critical thinking skills to learn about the implications of excess phosphorus in downstream aquatic environments as a result of conventional agriculture practices. Additionally, students will brainstorm ways to reduce, reuse, or recycle in their own lives to do their part to conserve phosphorus, which is a nonrenewable natural resource.
My Local Waterway: A look into the contributing factors of nutrient pollution and a realistic means of addressing them	9-12	Water pollution is an issue that affects many communities, but few people realize just how close to home it can hit. In this lesson, students will realize the possibility of water contamination in their own community and utilize resources to develop potential solutions to addressing this issue

Math

Title	Grade Level	Description
What lies beneath the surface?	8-9 (Math 1)	In this task, students will develop insights into how to extend the process of solving equations—which they have previously examined for one- or two-step equations—so that the process works with multistep equations.The objective of this task is for students to become familiar with surface area and volume formulas and to further their applications of literal equations.
How Small is a Nanometer?	8-9 (Math 1)	Students will be able to understand scientific notation and how to convert between metric units, create and solve one variable linear (quadratic) equations, and have a conceptual understanding of the size of a nanometer.
Why a Gecko Can Scale a Vertical Surface	8-9 (Math 1)	This lesson is designed to model the change in surface area with respect to volume while also describing the relevance and impact of the surface area to volume ratio. The lesson begins with an activity that has students create an exponential growth equation and graph through recognizing a pattern in blocks growth.
Into the Lab- What is Spin Coating?	8-10 (Math 1/2)	This lesson consists of some background information about what spin coating is as well as a teacher demonstration and 2 engaging worksheets. The lesson is perfect for your Math 1 and Math 2 students and for teachers looking to include more science and applications in their math classrooms. The lesson starts off by explaining the process of spin coating which is commonly used in nano labs. The teacher then does a teacher demonstration to further show what spin coating is before having students complete a related worksheet.
May Newton's Force Be With You	9-12 (Math 2)	NC Math 2 introduces inverse functions and has students compare direct variation to inverse variation. Coulomb's Formula is a function that has a combined variation (meaning it includes both direct and inverse variations). Students will use a PHeT simulation to calculate Coulomb's constant. As part of this lesson, students will need to use dimensional analysis to obtain the correct order of magnitude.
Don't Fear the Sphere	9-12 (Math 3)	Students will investigate the volume of spheres that are scaled from nano to macro. They will investigate the impact of a sphere's radius to the scale of the sphere's volume. In this three part lesson, students will 1 - order different spheres of known solids by size using educated guesses, 2 - calculate volume or missing radii of each sphere, and 3 - compare the scales of each sphere's radius and volume.
Piecewise Nano Size	9-12 (Math 3)	Students will practice graphing piecewise functions. These piecewise functions are linear, exponential and quadratic functions. The lesson starts with a blurb about an application of nano-sized wires created by a chemistry lab at UNC-CH. Students then create a graph from a piecewise function and continue to duplicate the graph using horizontal shift transformations to see what possible nanowire shapes would look like.
Regression	11-12 (Math 4)	In NC Math 4, students will also construct regression models for quadratic, logarithmic and sinusoidal functions of bivariate data. Additionally, students will be able to use regression models to

		solve real-world and mathematical problems. In this task, students will learn about bivariate data as well as get familiar with r-value and the purpose it serves in terms of describing data.

STEM Careers

Title	Grade Level	Description
How to pursue a career in nanotechnology after High School	9-12	Students will explore careers that correspond to their interests and values, and then find secondary and postsecondary education and training options to help them meet their career goals.