a-g Chemistry

Basic Course Information

Title: a-g Chemistry

Transcript abbreviations: a-g Chemistry B / 6E1010 , a-g Chemistry A / 6E1003

Length of course: Full Year

Subject area: Laboratory Science (“d”) / Chemistry

UC honors designation? No

Prerequisites: Algebra 1, Biology and/or Physics (Required)

Co-requisites: None

Integrated (Academics / CTE)? No

Grade levels: 10th, 11th, 12th

Course learning environment: Classroom Based

Course Description

Course overview:

Chemistry in the Earth Systems is an NGSS aligned chemistry course where students use science inquiry and lab processes to explore physical science concepts that build comprehension around matter, its properties, and its interactions with other matter and energy. The course emphasizes the students' ability to demonstrate their knowledge of chemistry within the context of the Science and Engineering Practices outlined in the Next Generation Science Standards. The units within this course are presented thematically to provide a context for student learning. Students will investigate concepts in chemical properties and processes to understand how they drive the Earth system and their role in society

The sequence of this course is based on a specific storyline about climate change modeled in the CA State Science Framework. It begins with a tangible example of combustion and food calorimetry and goes on to explore the combustion of fossil fuels and the release of heat, carbon dioxide and water as a fundamental thread that ties together many of the sections of the course and ensures the chemistry concepts are able to be placed in the context of Earth's systems. While many chemistry courses begin with the study of the atom, this course begins with macroscopic observations of a familiar phenomenon (combustion) and then moves to the microscopic, but begins with simple interactions between particles to explain thermal energy and how it is exchanged within systems. Students then apply their understanding of heat flow to see its role in driving plate tectonics within the Earth system. Once the students are firmly thinking about matter as particles, then they undertake the nature of the particles themselves by studying atoms and how their behaviors are categorized into the periodic table. Once students are equipped to model simple chemical reactions, they return to the combustion chemical reaction and consider the impact its product, carbon dioxide, has on the global climate system. Next, students consider more advanced chemical reactions and apply their understanding of chemical equilibrium to the very real problem of ocean acidification, which has been affected due to changes in carbon-dioxide concentrations in the atmosphere. In the end, students will have explored the fundamentals of chemistry and the role it plays in the Earth's geosphere, its hydrosphere and its atmosphere.

Course content:

The shaded background of the following field indicates this course was approved by UC for the 2014-15 school year or earlier. Please refer to the current "a-g" course criteria and guidelines when completing your course submission form.

Unit 1 - Combustion
Description

In this unit students will work to answer the guiding questions: “What is energy, how is it measured?”, “How does it flow within a system?", and "What mechanisms allow us to utilize the energy of our foods and fuels. In this brief introductory unit, students investigate the amount of stored chemical potential energy in food. They make observations of material properties at the bulk scale that they will later explain in the atomic scale. The themes of combustion and CO_2 introduced in this unit will tie together several of the units throughout the course.

Students will begin by examining nutrition labels of different foods where they will find a surprising amount of chemistry and develop and ask questions about what different items mean, like calories, and why they are included on the label. These questions will drive an investigation using a standard calorimetry experiment to measure the energy output of different foods. Students will analyze the data from the whole class, notice patterns, and represent this system with a pictorial model of the components and interactions including energy flows and an explanation of the cause and effect relationships, articulating how the energy transfers from one place to another. The experimental results tend to systematically underestimate of the energy of the food compared to nutrition labels. Students can use their model to speculate about the reasons for the difference.

Before moving on, students should relate the combustion in this experiment to the real world. They should create a list of all the places and situations they observe wherein combustion/burning fossil fuels occurs. They will revisit that list in Unit 5 as they discuss the impact of burning fossil fuels on global climate.

NGSS Core Performance expectations emphasized:

HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the motion of the particles (objects) and energy associated with relative positions of particles (objects).

HS-PS3-4 Plan and conduct an investigations to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Disciplinary Core Ideas in this Segment:

PS3.A Definitions of energy.

Unit Assignment(s):

Summary of sample assignment – **Introduction to Specific Heat Capacities**

Each student receives a data table with prearranged data showing elapsed time and temperature for different substances (air, water, sand and metal).They create line graphs based on the data for each material and arrange the substances according to the time it takes to heat the substance. Observing that not all materials change temperature at the same rate based on the different specific heats of the substances, they then calculate the substances specific heat values. In addition to the students learning that specific heat values influence the rate at which materials change temperature, they also observe and learn the difference between an endothermic system and an exothermic system. Students will add to what they have learned in this introductory activity as they work to answer the primary questions of this unit. These questions will drive the Calorimeter Lab in which they first work with a partner to predict the relative energy output of various food samples and then measure the energy output of each food sample. Students will burn the samples below a soda calorimeter containing a measured amount of water. The burning food transfers energy to the water in the can that can be calculated by measuring the temperature increase in the water in order to find out the amount of calories. Students will graph the data they collect and add it to a pool of data collected by the class. As they analyze the data from the whole class, they should notice patterns i.e., changes in the mass and the composition of the sample results in corresponding changes in the increase of the temperature of the water.

Unit Lab Activities:

Summary of sample lab – **Energy in Food**

The purpose of this lab is to investigate the amount of energy stored in foods by measuring the change in temperature of a known mass of water. To do this, students will use a soda can calorimeter. First, students will measure10 mL of distilled water using a graduated cylinder and pour into an empty soda can. Next they will secure the can to a ring stand as directed and place the thermometer into the can through to open pop top. Students will then measure and record the initial temperature of the water. They will then measure the mass of the aluminum foil and record this in the data table. Students will measure the mass of a food sample and record this data in the data table. Now they will place the piece of aluminum foil on top of the clay and hold it in place with a pin and will carefully place the food sample on foil so it is leaning against the pin at an angle, They are to lower the can so that the bottom of the can is 2 cm above the top of the food sample. Using the lighter, the students will carefully light the food. As soon as the food stops burning, they are to carefully stir the water with the thermometer. Students will measure the highest temperature of the water and record this final temperature in the data table. After allowing the food to cool and then measuring the mass of the burned food plus the foil, students will subtract the initial mass of the foil from this number and record this value as mass of food after burning. Students are to keep the thermometer in the can and time how long it takes the liquid to return to the initial temperature. Students are to repeat this process with the other food samples they have. After recording their data they will analyze these for patterns and formulate conclusions based on the collected data.

Unit 2 - Heat and Energy in the Earth System

Description

In this unit, students will work to answer the guiding questions: “How is energy transferred and conserved?”, and “How can energy be harnessed to perform useful tasks?” Students will develop models of energy conservation within systems and the mechanisms of heat flow. They relate macroscopic heat transport to atomic scale interactions of particles, which they will apply in later units to construct models of interactions between atoms. They use evidence from Earth's surface to infer the heat transport processes at work in the planet's interior.

An inquiry-driven investigation to monitor temperatures culminates with a scientific explanation resembling the second law of thermodynamics. Students perform experiments such as measuring the temperature of two bodies of water before and after mixing, and the temperatures of metal blocks and water prior to and following immersion. By repeating these investigations with differing quantities of materials, students will apply the concept of scale, proportion, and quantity to predict temperature changes, equilibrium conditions, and magnitudes of energy transferred.

Students will explore the 2nd law of thermodynamics and relate the processes of conduction, convection, and radiation to the motion of individual particles. Students will construct an explanation about why solids are much better at transferring heat by conduction than liquids or gases because of their greater density.

Students will develop models of energy conservation within systems and mechanisms of heat flow and develop a model of Earth's interior and using evidence to support the claim that its interior is transferring heat through the process of convection. Students will apply their model of density driven flow in rock not only to help understand heat transfer, but also to see how these flows give rise to plate tectonics. This model of the macroscopic heat transport that takes place within the earth will be applied to the atomic scale interactions of particles that they will study in later units..

NGSS Core performance expectations emphasized:

HS-PS3-2 Develop and Use Models to Illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects)and energy associated with the relative positions of particles (objects)

HS-ESS2-3 Develop a model based on evidence of Earth's Interior to describe the cycling of matter by thermal convection

Unit Assignment(s):

Unit Assignment :

Summary of sample assignment- **Earth's Interior Temperature**

Each student receives a handout of data showing depth in km and temperature in degrees C of the temperature of the Earth's interior, melting point of the Earth's mantle and the melting point of the Earth's core. They construct three line graphs of the data on one graph, plotting depth versus Temperature of the Earth's interior. Student's learn the temperatures of the surface of the earth vary greatly compared to the mantle and the core due to different densities, varying distances from the core, and differing rock compositions.

Unit Lab Activities:

Summary of lab assignment- **Thermal Energy Transfer**

Students will plan and conduct an investigation in the Thermal Energy Transfer lab to provide evidence that the transfer of thermal energy, when two components of different temperature are combined within a closed system, results in a more uniform energy distribution among the components in the system. In this inquiry-driven lab, students will be provided with equipment and material that will allow them to measure the temperature of two bodies of water before and after mixing, or the temperatures of metal blocks and water prior to, and following immersion. Students will repeat these investigations with differing quantities of materials and record and analyze collected data. Using their analysis students can apply the concept of scale, proportion, and quantity to predict temperature changes, equilibrium conditions, and magnitudes of energy transferred. Students will then be able to further analyze their data in order to construct an explanation about why solids, because of their greater density, are much better at transferring heat by conduction than liquids or gases.

Unit 3 - Atoms, Elements and Molecules

Description

In this unit, students will work to answer the guiding questions: “What is inside atoms and how does this affect how they interact?" and "What models can we use to predict the outcomes of chemical reactions?” Students recognize patterns in the properties and behavior of elements, as illustrated on the periodic table. They use these patterns to develop a model of the interior structure of atoms and to predict how different atoms will interact based on their electron configurations. They use chemical equations to represent these interactions and begin to make simple stoichiometric calculations.

Students will build a mental model of how the periodic table is arranged by using a physical model to arrange color chips from a paint store Into a matrix based on color and hue. Students will understand the power of such models by predicting the existence of color/hue chips that were removed from the final matrix before the chips were distributed, mirroring the process Mendeleev used to predict the existence of elements not yet known.

Students will further deepen their understanding of the atoms' nucleus by studying various subatomic particles and the nuclear processes that can occur within the nucleus during radioactive decay, radioactive capture, fission and fusion processes. The half-lives and isotopes of certain elements such as carbon-14 and its use in radiocarbon dating is studied. The zone of stability chart will be analyzed and used to make predictions to determine which atoms have a greater nuclear stability and the reasons why.

As students analyze plots of the properties of the elements as a function of atomic number, they should notice and discuss trends and patterns such as the comparatively low ionization energies of the alkali metals versus the high ionization energies of the noble gasses.

Students should understand the basis for trends and patterns in the periodic table, and be able to explain the types of chemical reactions and resulting bonds that occur between elements.

Students will use chemical equations as mathematical models to illustrate the cycle of matter within these chemical systems. Students will apply these basic principles of stoichiometry through inquiry based laboratory investigations, problem solving, and reinforcement with smart device apps and programs.

NGSS core performance expectations emphasized:

HS-PS1·1Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-7 Use mathematical representations to support the claim that atoms and therefore mass are conserved during a chemical reaction.

HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

Disciplinary Core Ideas in this segment:

PS1.A: Structure and Properties of Matter

PS1.B: Chemical Reactions

PS1.C: Nuclear Processes

PS3.A: Definitions of Energy

Unit Assignment(s):

Unit Assignment:

Summary of sample assignment- **Life on the Edge**

Using a periodic table, the student will complete a handout discovering the arrangements of electrons within atoms. As they work on this assignment, they will learn how the number of electrons change as they move from left to right across a period, also learn what do the atoms have in common within each group on the table. In addition, they will practice drawing shell models of atoms, how many total electrons an atom has and summarize patterns they discover across the periodic table.

Unit Lab Activities:

Summary of a sample lab: **Line Emission Spectra and Flame Tests Lab**

Students observe an incandescent light bulb and individual wavelengths of emitted light from an elemental gas discharge tube using a spectroscope. They record their observations using colored pencils drawing a full spectrum for the light bulb and discrete lines for the discharge tubes onto a lab worksheet and analyze and compare the differences in emitted light between the two. In the flame tests lab, the student burns different salt solutions containing metal ions which excites the atom's electrons to a higher energy level and then they fall back down to a lower energy (resting) state and emit light with a specific wavelength. The students complete a lab worksheet indicating the color of light observed and learn that different salt solutions containing the same metal ion will emit the same wavelength of light, therefore being a method of identifying an element.

Unit 4 - Chemical Reactions

Description

In this unit, students will work to answer the guiding questions: “What holds atoms together in molecules? and "How do chemical reactions absorb and release energy?" Students compare the strength of different types of bonds and attractions and develop models of how energy is stored and released in chemical reactions.

When students conduct an investigation to measure the conductivity of different solutions{salts, acids, bases, hydrocarbons, and oxides), they gather evidence that there must be some relationship between electricity and material properties and when they Investigate the boiling points of water with different concentrations of salt and other solutes, they gather evidence that the salt must somehow be 'attracting' the water and preventing It from escaping as a gas. Students also notice patterns in the results of these experiments where materials that conduct electricity when they dissolve have a larger effect on boiling point.

Students will use this evidence to support a model of different types of chemical bonds and attractions and learn how the nucleus of one atom has enough attractive force to pull one, two, or three electrons away from nuclei that does not have the same attractive force on its own electrons. Students will also investigate other forms of attraction such as polar attractions and intermolecular forces, investigate properties like surface tension and viscosity, and provide a model-based explanation of how these properties relate to microscopic electromagnetic attractions. Students will also develop and explain models of covalent, polar covalent, and ionic bonding and build on their model of the ionic bond breaking between sodium and chlorine when salt is dissolved in water.

NGSS core performance expectations emphasized:

HS-PSI-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

H5-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes In total bond energy.

H5-PS1·5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1·7 Use mathematical representations to support the dalm that atomsand therefore mass are conserved during a chemical reaction.

Disciplinary Core Ideas In this segment:
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
PS2.B: Types of Reactions
PS3.B: Conservation of Energy and Energy Transfer
PS3.C: Relationship Between Energy and Forces

Unit Assignment(s):
Unit Assignment:

Summary of sample assignment- **Electron Glue and Bonding**

Students work with a partner and read the "Four Models of Bonding" handout. After reading the handout students get 16 substance cards that they sort based on the substances physical and chemical properties listed on the card. The four categories of bonding the students can place the cards into are: Ionic, Network Covalent, Metallic, and Molecular Covalent. They complete a results table and then answer a series of questions based on their arrangement. Students learn the four different types of bonding within substances and their chemical and physical properties associated with them.

Unit Lab Activities:

Summary of a sample lab: **"You Light Up My Life"**

Using a data table, the student will write predictions about the conductivity and dissolvability of substances such as salt, sand, aluminum, paraffin (wax), ethanol, calcium chloride, sucrose, copper (II) sulfate and other substances. Then using a handheld conductivity tester, they will test the substance before being dissolved in water and record their observations and then again test its conductivity in distilled water and record their observations. The students learn about solubility and conductivity. Also, that covalently bonded substances do not conduct electricity and ionically bonded substances only conduct when they are dissolved (dissociated) into charged particles, called ions.

Unit 5 - Chemistry of Climate Change

Description

In this unit, students will work to answer the guiding questions: "What regulates weather and climate?”, and "What effects are humans having on the climate?” In answering these questions, students apply their understanding of chemical reactions to global climate. Students develop models of energy flow in Earth's climate as they revisit combustion reactions (Unit 1) to focus on emissions from fossil fuel energy sources. They apply models of the structures of molecules to explain how different molecules trap heat in the atmosphere and then evaluate different chemical engineering solutions that can reduce the impacts of climate change. Many of the key issues illustrated build on concepts related to thermodynamics and energy balances within systems (Unit 2) and the products of chemical reactions (Unit 4).

Students analyze the past data related to earth's climate including atmospheric composition, average temperature and solar cycles to refine and inform their models of energy flow in the Earth's climate system. Finally, students will evaluate the scientific arguments made in media sources using a checklist called the Science Toolkit and discuss the content and graphs from different sources and construct an argument about which graph contains stronger evidence.

NGSS core performance expectations emphasized:

HS-ESS-2 Analyze geoscience data to make the claim that one change to earth’s surface can create feedbacks that cause changes to other earth systems.

H5-ESS2-4 Use a model to describe how variations in the flow of energy into and out of earth’s systems result in changes of climate.

H5-ESS2-6 Develop a quantitative model to describe the cycling of carbon among hydrosphere, atmosphere, geosphere, and biosphere.

Disciplinary Core Ideas In this segment:

ESS2.A: Earth Materials and Systems

ESS1.B: Earth and the Solar System

ESS2.D: Weather and Climate

ESS3.A: Natural Resources

ESS3.D: Global Climate Change

Unit Assignment(s):

Unit Assignment:

Summary of sample assignment- Plotting Historic Climate Data

Students will plot historic climate data provided by the teacher on chart paper and display their posters around the classroom. Students will next analyze the past data and draw a graph predicting the next five years, extrapolating both the long term trend of increasing CO_2 and the annual variation and then calculate the year in which atmospheric CO_2 will reach 540 ppm (approximately double the pre-industrial CO2 levels) assuming the current rate of CO_2 emissions continue. Students will then compare their predictions and discuss assumptions they made about how quickly the CO_2 would increase.

Unit Lab Activities:

Summary of a sample lab- **Greenhouse Warming in a jar**

Each team of lab students has two jars with thermometers that can be inserted through a lid and affixed using clay sealing the jar and insuring that the thermometer stays in one place. Two ring stands with 150 watt light bulbs are horizontally placed equidistant from each jar. One jar contains a votive candle which is lit and then extinguished (this jar represents the CO2 enhanced atmosphere). The students let the jars come to thermal equilibrium and then turn on the lights and begin recording each jar's temperature every minute onto a data table for 20 minutes. The data is then plotted onto a graph of time vs. temperature for both jars. Students learn in this lab that a CO2 enriched environment (representative of the earth) will warm up to a higher temperature and retain the heat compared a non CO2 enriched environment. At the end of the lab, a class discussion of how humans are affecting our global climate due to burning of fossil fuels is discussed and students attach a quick write about that topic to their graph.

Unit 6 - The Dynamics of Chemical Reactions and Acidification

Description

In this unit, students will work to answer the guiding questions: “How can you alter chemical equilibrium and reaction rates?”, and “How can you predict the relative quantities of products in a chemical reaction?”

Students will investigate the effects of fossil fuel combustion on ocean chemistry, develop models of equilibrium in chemical reactions, and design systems that can shift the equilibrium. During this unit, students conduct original research on the interaction between ocean water and shell-building organisms.

Throughout the unit, students will gather evidence to construct a scientific explanation about what causes these variations in the rates of chemical changes in the ocean and investigate the response of reaction rates to varying temperatures and concentrations of reactants.

Once students understand the effect of changing the concentration of reactants and products on reaction rates, they are ready to apply their understanding to novel situations. By applying Le Chatelier's principle, students can predict ways to increase the amount of product in a chemical reaction and refine the design of a chemical system by first measuring the output and then testing the effectiveness of changing the temperature and relative concentrations of reactants and products.

Students will examine data showing trends in CO_2 concentrations in the ocean and atmosphere as evidence of a balancing feedback between two of Earth's systems that slows the rate of climate change and then design a simple investigation to generate CO_2 (gas released by a baking soda/vinegar reaction, a burning candle, or cell respiration in yeast) and measure the resulting pH. Students will also investigate the effect that temperature and salinity have on the ability of CO_2 to dissolve into the water and then apply their models of chemical equilibrium to predict the impacts of changing CO_2 levels in the ocean on these organisms.

As students apply their model of equilibrium reactions from Le Chatelier's principle, they see that as the concentration of CO_2 increases, the system compensates by producing more products on the right side.

NGSS core performance expectations emphasized:

HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing temperature or concentration of the reacting particles of the rate at which reaction occurs.

H5-PS1-6 Refine the design of a chemical system by specifying a change in condition that would produce increased amounts of products at equilibrium.

H5-ESS2-6 Develop a quantitative model to describe the cycling of carbon among hydrosphere, atmosphere, geosphere, and biosphere.

Disciplinary Core Ideas In this segment:

PS1.B: Chemical Reactions

ESS2.A: Earth Materials and Systems

ESS2.D: Weather and Climate

ESS3.C: Human Impacts on Earth Systems

Unit Assignment(s):

Unit Assignment:

Summary of sample assignment- **Ocean Acidification – Cause and Effect**

Students begin this lesson obtaining information about ocean acidification by watching a short video. The students take notes about different features of the film. One group records all the statistics in the film, while another records facts that are stated but not supported by statistics. All groups track the cause and effect relationships described in the film. After the film, students pair up and discuss the parts of the movie that they found most powerful and the parts that they found weakest. They correlate those reactions with the observations of statistics and other statements not supported by numbers. Working in teams, students complete a table summarizing all the cause and effect relationships mentioned in the movie. They identify which spheres within Earth's systems are involved in each relationship, how CO_2 is involved, and how the change might affect humans. Students then annotate a diagram of the carbon cycle circling and labeling how the cause and effect relationships in the movie relate to sections of the carbon cycle. During class discussion, students chart chains of cause and effect relationships that involve different spheres in Earth's system of systems. Students articulate the ways in which ocean acidification has large, global causes and that its effects reverberate throughout the system, including our economies. Students will make a list of questions about the cause and effect relationships they found most interesting. These questions will form the foundation of student research projects over the next few class sessions.

Unit Lab Activities:

Summary of a sample lab – **Producing CO_2**

Working with a partner, students investigate the response of reaction rates to varying temperatures and concentrations of reactants by mixing baking soda (sodium hydrogen carbonate, $NaHCO_3$) and vinegar (acetic add, CH_3COOH) into sealed recloseable plastic bags. Students will gauge the speed and degree of the reaction by the rate and amount of CO_2 gas produced by the increase in the volume of the bag in a water bath to measure displacement of water: $NaHCO_3(aq) + CH_3COOH(aq) + CO_2(g) + H_2O(l) + CH_3COONa(aq)$. Students investigate the role of the quantity of molecular collisions by repeating the activity with different concentrations of vinegar and then investigate the role temperature by warming and cooling the reactants while keeping their concentrations constant. By observing the swelling of the bags in response to varying temperatures and concentrations, students will discover that those factors that increase the number and energy of the of molecular collisions (increased concentration and temperature of reactants) result in increased reaction rates. Combining lab data, observations, and experimental evidence, students will complete a lab write up using detailed explanations stating the factors influencing chemical reaction rates.

Course Materials

Textbooks

Title	Author	Publisher	Edition	Website	Primary
CA Standards-based textbook (This course is aligned to the Chemistry: Matter and Change textbook, but it is designed to work with any CA standards aligned textbook.)	Thandi Buthelezi, Laurel Dingrando, Nicholas Hainen, Cheryl Winstrom, Dinah Zike	Glencoe-McGraw Hill	2008	www.mheducation.com	Yes

Manuals

Title	Author	Publisher	Edition	Website	Read In Entirety
Argument-Driven Inquiry in Chemistry: Lab Investigations for Grades 9-12	Victor Sampson, Peter Carafano, Patrick Enderle, Steve Fannin, Jonathan Grooms, Sherry A. Southerland, Carol Stallworth, and Kiesha Williams	NSTA Press – National Science Teachers Association	2016	www.nsta.org	No

Websites

Title	Author(s)/Editor(s)/ Compiler(s)	Affiliated Institution or Organization	URL

NASA – Global Climate Change, Earth Observations and Earth Observatory		National Aeronautic and Space Administration	www.nasa.gov/ames
NOAA – Resource Collections		National Oceanic and Atmospheric Administration	www.noaa.gov/education
USGS Educational Resources for Secondary Grades		United States Geological Survey	