Anchorage School District

Biology I, Chemistry I, Geology I, Physics I

FRAMEWORKS

GRADES 9-12

January 11, 1999

TABLE OF CONTENTS

GUIDING PRINCIPLES

1. Science is for all students.

All students, regardless of gender, cultural, or ethnic background, physical or learning disabilities, aspirations, or interest and motivation in science, should have the opportunity to attain high levels of scientific literacy.

2. Learning is an active process.

The curiosity-level and interactive involvement of students must be maintained throughout the grades. Students describe objects and events, ask questions, construct explanations, test explanations in many different ways, and communicate their ideas to others. This implies physical and mental activity. Hand-on activities are not enough. Students must also have "minds-on" experiences. Science teaching must involve students in inquiry-oriented investigations in which they interact with teachers and peers. They must establish connections between their current knowledge of science and real world events. They must apply science content to new problems as they engage in problem-solving, planning, decision-making, and group discussion. Learning science is something students do, not something that is done to them. This principle indicates a need to shift emphasis from teachers presenting information and "covering" science topics to students learning science through active involvement and the teacher becoming a partner in that learning.

3. Comprehensive.

By emphasizing depth rather than breadth, the Frameworks seeks to empower students rather that intimidate them with a collection of isolated and eminently forgettable facts. A more in-depth understanding of science concepts, processes, and investigations will be emphasized. Essential aspects of increasing scientific literacy include a greater understanding of science subject matter, the nature and relevance of science inquiry, and the place of science in society and personal life.

4. All students will have access and opportunity to learn about each of the science concepts which will be taught through the Frameworks.

The essential science concepts identified in the Frameworks are for all students. The structure of Frameworks emphasizes the equal value of each of the four main science content areas. It is an understanding that teachers and students will look for the natural connections among these sciences in their investigations of natural and societal issues.

5. Coherence.

There is a vertical integration of spiraling that revisits concepts and prepares students at higher levels for more complex concepts and skills.

6. Encourages Good Teaching Practices.

The Frameworks emphasizes science process skills. It encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions; as well as by direct instruction. The objectives encourage the students to connect the lessons with their daily lives and with their society. The Frameworks mandates experiential science instruction for all students, not just those who have traditionally succeeded in science classes. It is impossible to teach the ASD Frameworks primarily by lecturing and having students read from textbooks.

7. Encourages Good Testing Practices.

Student achievement of the Frameworks are best assessed using a variety of assessment instruments. Portfolio and performance task assessments are particularly appropriate to the evaluation of student mastery of science content, science process skills, and critical thinking based on evidence. A variety of assessment approaches should be used in conjunction with standard assessment instruments.

8. System Reform in Science Education.

In schools and education in general, change must occur at several levels before all children can benefit from it. The Frameworks, developed in cooperation with national and state reform initiatives, will provide the unity, purpose, and vision that supports the improvement of science programs, teaching, professional development, assessment, and student learning.

RECOMMENDATIONS

The Science Curriculum Committee recommends science pedagogical practices be consistent with national recommendations.

Hands-on activities that include:

- students identifying their own real questions about natural phenomena
- observation activity, often designed by students, aimed at real discovery, employing a wide range of process skills
- students hypothesizing to explain data
- information provided to explain data only after students have engaged in investigation process
- students' reflection to realize concepts and processes learned
- application, either to social issues or further scientific questions

Focus on underlying concepts about how natural phenomena are explained

Questioning, thinking, and problem solving, especially:

- being skeptical, willing to question common beliefs
- accepting ambiguity when data isn't decisive
- willing to modify explanations, open to changing one's opinion
- using logic, planning inquiry, hypothesizing, inferring

Active application of science learning to contemporary, technological, social, and wellness issues

In-depth study of a few important thematic topics

Curiosity about nature and positive attitudes toward science for all students, including females and members of minority groups

Integration of reading, writing, and math in science units

Collaborative small-group work, with training to ensure it is efficient and includes learning for all group members

Teacher facilitating students' investigative steps

Evaluation that focuses on scientific concepts, processes, and attitudes

Educational technologies that enhance learning processes and expand skills and capabilities of all students including:

• the scientific process

• conducting research that includes data gathering, analysis, synthesis, and communication of findings

• application of thinking skills such as sequencing, inference and deduction, and the transfer of such skills into daily use

SCIENCE AS A PROCESS

The processes of scientific inquiry are infused throughout all science learning.

I. Nature of Science

Science actively acquires information about the world in a specific manner. Scientists investigate natural phenomena with skills drawn from many disciplines of science, math, and technology. They develop logical explanations based on observation and experimentation.

1. One of the essential components of higher order thinking is the ability to think about a whole in terms of

its parts and, alternatively, about parts in terms of how they relate to one another and the whole. Understanding systems is fundamental to being able to rationally apply scientific knowledge.

~~1.~~ 2. Scientists assume that the universe is a vast single system in which the basic rules are the same everywhere. Scientists operate on the belief that the rules can be discovered by careful, systematic study.

~~2.~~ 3. Scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way. Testing, revising, and occasional discarding of theories, new and old, never end. This on-going process leads to an increasingly better understanding of how things work in the world.

~~3.~~ 4. Scientific disciplines have been created by humans for organization of information. Many problems are studied by scientists using information and skills from many of these disciplines.

~~4.~~ 5. Interpretation of scientific information can be influenced by personal, societal, and cultural beliefs.

II. Development of Scientific Thought

Science is a human intellectual activity that crosses time and culture.

1. Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

2. Some scientific knowledge is very old and yet is still applicable today.

3. The human ability to shape the future comes from a capacity for generating knowledge, developing new technologies, and for communicating ideas to others.

III. Scientific Inquiry

A. Critical Thinking

The scientific method requires rules, procedures, and critical thinking skills.

1. Notice and criticize the reasoning in arguments in which

    a. fact and opinion are intermingled or the conclusions do not follow logically from the evidence given,

    b. an analogy is not appropriate,

    c. no mention is made of whether the control groups are very much like the experimental group

    d. all members of a group (such as teenagers or chemists) are implied to have nearly identical characteristics that differ from those of other groups,

    e. credibility of the source is not established,

    f. samples are small, biased, or lack controls, or

    g. the faulty, incomplete, or misleading use of numbers is employed.

2. Be aware that there may be more than one good way to interpret a given set of findings.

3. Know that often different explanations can be given for the same evidence and it is not always possible to tell which one is correct.

4. In evaluating a claim, consider contradictory data as well as data which supports the claim.

5. What people expect to observe often affects what they actually do observe. Strong beliefs about what should happen in particular circumstances can prevent them from detecting other results. Scientists should be aware of this danger and take steps to avoid it when designing investigations and examining data.

6. In the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism. In the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.

7. Scientific discoveries are sometimes made unexpectedly, even by accident. But knowledge and creative insight are usually required to recognize the meaning of the unexpected.

B. Scientific Method

The scientific method is a process people use to understand and predict natural phenomena.

1. Good observations and careful experimentation are fundamental to the scientific process. Equally important is the use of logical reasoning and the application of imagination in formulating questions, devising hypotheses ~~and explanations to make sense of the collected evidence.~~, suggesting experimental approaches, and making inferences using collected evidence.

2. When experimentation is not possible for practical or ethical reasons, people try to observe as wide a range of natural occurrences as possible to be able to discern patterns.

3. In addition to observation and experimentation, relevant evidence may be located in reference books, back issues of newspapers and magazines, compact disks, and computer databases, e.g. on-line services.

4. In deciding whether or not a hypothesis is supported, people collect and analyze data. These hypotheses are valuable even if they are unsupported by data.

5. Selection of appropriate measuring instruments and computer interfaces is important. Instruments are used to capture information, make direct measurements, and choose appropriate units for reporting various magnitudes.

6. Data can be organized in tables, graphs, and flow charts to identify the relationships among the data.

7. Possible effects of experimental errors need to be considered in data analysis.

8. The ability to write clear, step-by-step instructions for conducting investigations, operating a piece of equipment properly and safely, or following a procedure is an essential skill in scientific inquiry.

9. Students will understand good experimental design, identify independent and dependent variables, and recognize other variables to be held constant.

10. Measurements contain a certain degree of uncertainty. The precision of the measurement should be reported and considered in evaluating results.

11. Modeling and theories are useful methods to explain phenomena, but are limited based on assumptions.

C. Ethics of Scientific Inquiry

Science has the obligation to use its tools of inquiry in an ethical fashion.

1. Honest, clear, and accurate records are fundamental to good science.

2. Curiosity, honesty, openness, and skepticism are highly regarded in science. Students should know how these qualities are incorporated into the way science is carried out, exhibit these traits in their own lives, and value them in others.

3. In research involving human subjects, the ethics of science require that potential subjects be fully informed about the risks and benefits associated with the research and of their right to refuse to participate. Science ethics also demand that scientists must not knowingly subject coworkers, students, the neighborhood, or the community to health or property risks without their prior knowledge and consent. Because animals cannot make informed choices, special care must be taken in using them in scientific research.

4. When violations of scientific ethical traditions are discovered, they are strongly condemned by the scientific community.

IV. Science, Technology, and Society

Technology is the application of scientific principles. Science, technology, society, and the environment are interrelated with many possibilities for ways that they may affect each other.

1. Technology has strongly influenced the course of history and continues to do so.

2. Technological problems often create a demand for new scientific knowledge and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. The very availability of new technology itself often sparks scientific advances.

3. Technology is essential to science for many purposes such as: access to outer space and other remote locations, sample collection and treatment, measurement, data

collection and storage, computation, and communication of information.

4. Technology cannot always provide successful solutions for problems or fulfill every human need.

5. Societies influence what aspects of technology are developed and how these are used. People control technology (as well as science) and are responsible for its effects.

6. Rarely are technology issues simple and one-sided. Relevant facts alone, even when known and available, usually do not settle matters entirely in favor of one side or another. That is because the contending groups may have different values and priorities.

7. People who research and develop technology need to consider human values, limitations and societal / physical constraints.

8. All technologies have effects other than those intended by the design, some of which may have been predictable and some not. Risk analysis is used to minimize the likelihood of unwanted side effects of a new technology. The public perception of risk may depend, however, on psychological factors as well as scientific ones.

9. Some issues cannot be examined usefully in a scientific way. Among them are matters that by their nature cannot be tested objectively and those that are essentially matters of morality.

Biology I

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Biochemistry		
1. A living cell is mainly composed of a small number of chemical elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Carbon, because of its small size and four available bonding electrons, can	• Debate the existence of life without water or carbon.	

join to other carbon atoms in chains and rings to form large and complex molecules.		
2. Complex carbon-based molecules, including proteins, lipids, carbohydrates, and nucleic acids, comprise the primary building blocks of all living things.	• Build models of molecules given either structural or empirical formulas. • Blend a typical fast food meal (burger, fries, soda) and analyze for carbohydrates, fat, and protein by using the appropriate lab tests. • Relate structure to physical properties by using a taste test of different sugars.	
3. The work of the cell is carried out by the many different types of molecules it assembles, mostly proteins. Protein molecules are long, usually folded chains made from a combination of up to 20 different kinds of amino-acid molecules. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes is a consequence of attractions between the chain's parts.	• Select an enzyme substrate system (e.g., catalase / hydrogen peroxide, amylase / starch, protease / gelatin) and investigate factors that affect the rate of enzyme catalyzed reaction (e.g., temperature, pH, enzyme / substrate concentration). Relate the results of the investigation to the need for maintaining a narrow pH and temperature range in human bodies.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Cell Biology		
1. Within the cell are specialized parts for the transport of	• Create generic models representative of plant,	

materials, energy capture and release, protein building, waste disposal, information feedback, and even movement. In addition to these basic cellular functions common to all cells, most cells in multicellular organisms perform some special functions that others do not.	animal, and microorganisms from direct observation or other resources, to illustrate the difference between cells from the representative kingdoms. • Explain that plants and animals all produce a gas during respiration. • Demonstrate yeast respiration by using yeast, molasses and gas tubes. • Demonstrate the importance of light for photosynthesis (e.g., by putting a light screen over geranium leaves) and relate the differing results of subsequent iodine tests for carbohydrates to the plant's growth environments.	
2. Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape and, movement.	• Construct cell models (e.g., phenolphthalein-agar cubes, potato-iodine cubes) to investigate the relationship among cell size, surface to volume ratio and the rates of diffusion into and out of the cell. • Speculate why large organisms have developed from many small cells rather than from one lone cell. • Simulate digestion in a beaker (use for example, dialysis tubing, water, starch, iodine, amylase) and explain the results. • Investigate the effect of concentration gradients on the movement of materials across cell membranes.	
3. The many body cells in an	• Conduct investigations to	

individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Different parts of the instructions are used in different types of cells, influenced by the cell's environment and past history.	observe and describe the changes which take place in a plant seed as it develops into a mature plant and determine how development is affected by internal and external factors, e.g., auxins, nutrients, light. • Observe and describe changes that occur during the development of animals . Explain how environmental factors affect development.	
STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
4. In multicellular organisms, including humans, cells perform specialized functions as parts of sub-systems (e.g., tissues, organs, and organ networks) which work together to maintain optimum conditions for the benefit of the whole organism. Function is related to structure.	• Describe and illustrate how vertebrates, including human, carries on life processes (e.g., obtaining energy, protection, regulation, reproduction). • Classify animal skulls as omnivores, herbivores, or carnivores.	
5. Coordination of these functions is accomplished by specialized cells or groups of cells that monitor stimuli from the organism's internal and external environment enabling the organism to respond to changing environmental conditions.	• Culture bacteria using differential media to demonstrate the limitation of adaptation, such as their pH tolerance range. • Design and construct an experiment through which they can explore the learning behavior of an organism, such as a planarian.	
Genetics		
1. The genetic information passed from parents to offspring is coded in DNA molecules.	• Extract DNA from onion cells.	
2. The genetic information in DNA molecules provides instructions for assembling protein molecules. The code used is virtually the	• Use models to describe the structure of DNA and explain the process whereby DNA directs the synthesis of	

same for all life forms.	proteins from amino acids. Relate the structure of a particular protein such as hemoglobin to the function it performs, noting how errors in amino acid sequencing alters the function.	
3. The similarity of human DNA sequences and the resulting similarity in cell chemistry and anatomy identify human beings as a single species.	• Discuss the difficulty of defining a species and explain the biological meaning of species, e.g., the constant reclassification of some bird species.	
4. The sorting and recombination of genes in sexual reproduction results in a countless possible gene combinations from the offspring of any two parents.	• Use prepared slides and models of plant and animal cell mitosis to describe changes that occur during the cell cycle. • Use models of plants and animal cell meiosis to describe the major events that occur during the reduction division process that forms gametes. Discuss why the number of chromosomes in gametes is one half the chromosome number in body cells. • Culture fungi (e.g., Sordaria) under different conditions to demonstrate both its sexual and asexual life cycles.	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
5. Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting		

features may help, harm, or have little or no effect on the offspring's success in its environment.		
6. Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, the mutations can be passed on to offspring; if they occur in other cells, they can be passed on to descendant cells only. The experiences an organism has during its lifetime can affect its offspring only if the genes in its own sex cells are changed by the experience.	• Identify several causes of mutations and distinguish between beneficial, harmful, and neutral mutations. Explain why exposures to mutagens such as UV light and X-rays should be limited to prevent gene mutation. • Use models of DNA, RNA, amino acids, etc., to demonstrate how mutations affect the structure of proteins, Relate the structural change in the protein to the alteration of a trait; for example, sickle-cell disease is caused by a singe DNA base substitution that affects the structural configuration of hemoglobin molecules found in red blood cells.	
7. After the publication of Origin of Species, biological evolution was supported by the rediscovery of the genetics experiments of an Austrian monk, Gregor Mendel, by the identification of genes and how they are sorted in reproduction, and by the discovery that the genetic code found in DNA is the same for almost all organisms.	• Use Punnet squares and pedigree charts to determine probabilities and patterns of inheritance of traits such as seed shape in pea plants, flower color in snapdragons, and blood type and color blindness in humans. • After using fruit flies, "Fast Plants", or computer software to derive Mendel's Laws of segregation and independent assortment, the students are able to compare and contrast their empirical results with Mendelian ratios. • Construct a timeline showing the development of genetic principles from Mendel to the present by examining historical documents.	

STUDENTS SHOULD KNOWEXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments	
Hot Topics		
1. Current biological issues relate to the science of biology (i.e., drugs, alcohol, HIV, smoking, cloning)	• Simulate the spread of a communicable disease and determine the original source of the disease. • Debate the fairness of adjusted insurance rates for smokers versus non-smokers. • Discuss the economic and ecological impacts of such topics as Spruce Bark Beetle infestation, bottom fishing, endangered species, etc. • Select a pertinent bioethical issue (e.g., manipulating genetic material, in vitro fertilization, use of human growth hormone) and debate the benefits and risks associated with its development. • Use models or laboratory procedures to understand the process of inserting DNA from one organism into the genetic make-up of another organism. Discuss the applications of recombinant DNA technology and the economic implications of allowing organisms created by biotechnology (e.g.,	

	genetically engineered frost-resistant plants, human growth hormone, insulin) to be patented. • Justify a position regarding the use of genetic counseling information for family planning. • Examine a DNA profile, produced by gel electrophoresis, or participate in a simulation activity to identify and compare the DNA "fingerprint" in different samples of DNA. Discuss how DNA fingerprinting is used in criminal trials, cases of disputed parentage, and genetic screening for disease.	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
Diversity of Life		
1. The basis of biological evolutionary theory is that the earth's present-day species developed from earlier, distinctly different species.		
2. Evolution builds on what already exists, so the more variety there is, the more there can be in the future. But evolution does not imply long-term progress in some set direction. Evolutionary changes appear to be like the growth of a bush: some branches survive from the beginning with little or no change, many die out altogether, and others branch	• Gather data, summarize findings, and present critical analysis of evolution on the basis of anatomical and molecular characteristics and other evidence.	

repeatedly, sometimes giving rise to more complex organisms.		
3. Natural selection provides the scientific explanation for the history of life on earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms.	• Analyze successes and failures in terms of natural selection, genetic variation, speciation and adaptation, after using computer simulation software to design plants and animals, and test their survival in various environments, • Research an extinct organism to discover the environmental pressures that may have contributed to its demise.	
4. Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.	• Identify the benefits and risks associated with the widespread use of antibiotics to treat infectious diseases in humans and livestock. • Participate in natural selection simulation activities to determine how environmentally favored traits are perpetuated over generations, while less favorable traits decrease in frequency. Discuss the relationship and significance of genetic variation, natural selection, and the ability to reproduce.	
5. The variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions, and a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.	• Conduct a laboratory investigation or a simulation to demonstrate that variations within a species may enable organisms to survive large scale environmental change. Examples could include exposure of bacteria to UV radiation or aquatic organisms to chlorine.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
6. Molecular evidence substantiates the anatomical evidence for evolution. Additional detail about the sequence in which various lines of descent branched off from one another and the degree of kinship between organisms or species can be estimated from the similarity of their DNA sequences.	• Use a data table showing the differences in amino acid sequences of a molecule (e.g., cytochrome C or hemoglobin) found in a variety of species, and correlate the number of amino acid sequence differences with the probable, evolutionary distance of their relationship. • Use gel electrophoresis or data from to determine the genetic divergence and evolutionary relationship among species of plants and animals.	
7. Life on earth is thought to have begun as simple, one-celled organisms about 4 billion years ago. During the first 2 billion years, only single-cell microorganisms existed, but once cells with nuclei developed, increasingly complex multicellular organisms evolved.	• Create a timeline of Earth's history.	
8. Organisms are classified into a hierarchy of groups and subgroups, based on structural similarities and evolutionary relationships.	• Use a taxonomic key to classify different species of trees and suggest possible evolutionary links between species.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Ecology		
1. The amount of life any environment can support is	• Construct diagrams or flow charts to show how nutrients	

limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials.	and minerals are cycled throughout the living and non-living parts of an ecosystem. Discuss how the cycling of Earth's resources provides living organisms with the chemicals needed to carry out lifes' processes. • Design and conduct an experiment to test the effects of soil mineral deficiency or hormones on plant germination and growth.	
2. The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going.	• Diagram a food chain that includes sun , plants, primary consumers, the frog and the dermestid beetles, after observing dermestid beetles decomposing a frog carcass, • Create a "Bottle Biology" habitat for plants and animals, identify the biotic and abiotic factors in their habitat, and explain their interactions.	
3. At times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment. Layers of energy-rich organic material have been gradually turned into great coal beds and oil deposits by the pressure of the overlying earth. By burning these fossil fuels, stored energy is passed back into the environment as heat and releasing large amounts of carbon dioxide.	• Identify a commonly used resource. Research the methods used to obtain the resource, and the impact the removal of the resource has on the biogeochemical cycles of an ecosystem.	
4. Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of	• Predict the population growth curve over time assuming no hunting pressure or predation of moose in Alaska by using a theoretical model. • Identifv evidence of intra-	

predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.	and interspecies interactions among plants and animals (e.g., competition, predation, parasitism, symbiosis, social behavior) in an environment.	

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5. Human beings are part of the earth's ecosystems. Human activities do, deliberately or inadvertently, alter the equilibrium in ecosystems.	• Test a local water source for nitrate and phosphate pollution associated with fertilizer use, and investigate the consequences of such pollution.	
6. Ecosystems and the biosphere can be stable but currently are NOT. We are now more unstable than the biosphere has been in 70 million years.	• Explore why biodiversity is considered a non-renewable resource and discuss the consequences that result from the reduction of biodiversity. • Select a local, pertinent environmental issue and participate in an activity which addresses this issue (e.g. beach clean-up, stream watch, adopt-a-highway, salmon census). • Use computer simulation software to design an environment and test the effects of biotic and abiotic factors, analyze successes and failures in terms of population ecology and ecosystem dynamics. • Examine a major road crossing to determine its direct and indirect impacts on the local environment. Include in your discussion the effect on local animal and	

	plant populations and on ground water and air quality.	

Chemistry I

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Properties Of Matter		
1. There are differences and similarities among pure substances, solutions, and heterogeneous mixtures.	• Identify pure substances, solutions, and heterogeneous mixtures from given physical properties.	
2. Changes in substances can be classified as chemical and / or physical.	• Conclude whether a reaction is chemical or physical on the basis of evidence such as formation of a precipitate, production of gas, change of color, and / or change in energy.	
3. The concentrations of solutions can be expressed in a variety of units. This concentration affects physical properties of the solution.	• Carry out concentration calculations in molarity, mole fraction, and percent composition. • Using concentrations determine if / and how the boiling point, melting point, vapor pressure, and osmotic pressure change. • Describe solutions as saturated, unsaturated, and supersaturated. • Explain saturation as an equilibrium effect.	
4. There are standard methods of naming and formula writing for elements and compounds (emphasize IUPAC system).	• Name binary compounds that are composed of metals and nonmetals, transitions metals and nonmetals, two nonmetals, and acids.	

	• Name compounds that contain polyatomic ions. • Write formulas from a given name.	
5. Elements can be classified as metal, metalloids or nonmetal.	• Classify an element as a metal, nonmetal, or metalloid on the basis of its properties.	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
6. Substances can be classified as ionic, metallic, covalent network, or molecular and / or acid, base, or neutral.	• Classify a crystalline substance as either ionic, metallic, molecular, or network covalent on the basis of its properties. • Predict the properties of a classified crystal. • Explain the properties of ionic, metallic, molecular, or network covalent crystals from their structure and forces holding them together. • Determine whether a substance is acidic, basic or neutral on the basis of structure, name, changes in indicators, pH, and physical / chemical properties.	
Chemical Change		
1. Chemical changes are described with balanced chemical equations.	• Balance chemical equations given the reactants and products. Recognize reaction types and predict products for simple reactions.	
2. The number of particles is measured in a unit called mole.	• Convert between units of moles, mass, and number of	

	particles.	
3. Balanced chemical equations are used to make calculations related to chemical reactions.	• Determine the amount (mass, gas volume, number of particles, or moles) of product formed or reactant used knowing an initial amount of one other chemical present.	
4. Reaction rate will be affected by changes of temperature, concentration, surface area, and use of catalysts.	• Predict and explain the effect on reaction rate and time caused by temperature changes. • Predict and explain the effect on reaction rate and time caused by concentration changes or for solids changes in surface area. • Explain the effect of adding a catalyst to a given reaction. The explanation should include both a potential energy graph and activation energy.	
5. Electron transfer can take place in a chemical reaction.	• Assign oxidation numbers and determine if a particular reaction involves electron transfer. • In a reaction that involves electron transfer identify the chemical oxidized and the chemical reduced. • Balance simple equations involving electron transfer.	
STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
6. H+ transfer can take place in a chemical reaction.	• Identify the acid and base in a reaction involving transfer of H+. • Perform an acid / base titration to determine the	

	concentration of an unknown.	
7. The strength of an acid and / or base is related to its composition and degree to which it breaks down.	• Identify strong or weak acids / bases based on their formulas and names. • Explain the difference between strong, weak, concentrated, and dilute solutions.	
8. The pH scale gives a level of acidity / basicity for a solution based on the concentration of H+ (or hydronium ion) present.	• Experimentally determine pH using indicators, pH meters, and / or test papers. • Interpret pH data to determine level of acidity / basicity.	
9. Many reactions consist of both a forward and reverse reaction occurring simultaneously. Through this process equilibrium can be achieved.	• Explain how to recognize an equilibrium on the basis of properties and explain the dynamic process involved in equilibrium such as vapor pressure, phase change, solubility, and chemical equilibria.	
Structure Of Matter		
1. Physical changes and properties of matter can be explained through sketches, models, and descriptions of the particles.	• Construct sketches or models of solids, liquids, and gases.. Use these to determine how phase changes proceed. • Construct molecular models to determine shape and molecular polarity in simple compounds.	
2. Some physical changes consist of both a forward and reverse process occurring simultaneously. Through this process physical equilibrium can be achieved.	• Identify the opposing changes and discuss their rates, in phase change equilibrium.	
3. Chemical changes and reactions can be explained using sketches, models, and descriptions of the reacting particles and particles produced.	• Use sketches and models to describe chemical reactions.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
4. Kinetic molecular theory explains changes in gas volumes, moles, pressure, and temperature. This allows for calculations to be performed relating these quantities.	• Use the particle model of gases to explain the relationship of pressure, volume, moles, and temperature in gases. • Perform calculations to determine one of the four major variables given the other three (pressure, volume, moles, and temperature) using the ideal gas law. • Determine experimentally the relationships of pressure versus volume, pressure versus temperature, and volume versus temperature. Express these relationships in graphs and interpret these graphs. • Calculate the effect of changes in gaseous systems, using the combined gas law. • Suggest and recognize practical applications using these relationships.	
5. Atoms are made of a positive nucleus surrounded by negative electrons.	• Determine the number of protons and neutrons in the nucleus and the electrons surrounding it for a particular isotope.	
6. An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons.	• Write an electron configuration for any atom including the use of short hand method. • Determine if a bond between atoms is ionic, polar	

	covalent, or nonpolar covalent on the basis of electronegativity or position on the periodic table. • Explain the difference between ionic, polar covalent, or nonpolar covalent bonds.	
7. The nucleus, a tiny fraction of the volume of an atom, is composed of protons and neutrons, each almost two thousand times heavier than an electron. The number of positive protons in the nucleus identifies the element. In a neutral atom, the number of electrons equals the number of protons. An atom may acquire a charge by gaining or losing electrons.	• Construct a mental model showing the positions and sizes of the subatomic particles. • Discuss the formation of ions by gaining or losing electrons only.	
8. Neutrons have a mass that is nearly identical to that of protons and have no electrical charge. Neutrons affect the mass and stability of the nucleus. Isotopes of an element have the same number of protons but differ in the number of neutrons.	• Determine the identity, mass, and reactivity of an element from the number of protons, neutrons, and electrons.	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
9. An element's location on the periodic table can be used to determine similarities and trends among the elements.	• Discuss the evolution of the periodic table as a scientific tool. • Recognize and explain trends on the periodic chart in quantities / properties such as ionization energy, electron affinity, reactivity, metallic character, electronegativity, and atomic size.	

	• Determine the number of valence electrons and charge of an element’s most common ion from the periodic chart. • Compare and contrast families and periods. • Identify elements from particular families such as alkali metals , alkaline earth metals, halogens, and noble gases. • Construct Lewis electron dot structures for simple compounds.	
10. The arrangement of atoms in a molecule determines the molecule's properties. Shapes are particularly important in how molecules interact with others.	• Determine a molecule's shape using Valence Shell Electron Pair Repulsion Theory . • Determine molecular polarity from the shape and bond polarity of a molecule. • Determine the type and strength of intermolecular forces based on molecular polarity. Relate the strength of intermolecular forces to physical properties such as boiling point, melting point, surface tension, solubility, vapor pressure, adhesion, cohesion, and viscosity. • Suggest and recognize practical applications using intermolecular forces.	
11. Nuclear changes are different than chemical changes. The nucleus can change, resulting in a different element and / or radioactivity.	• Distinguish between nuclear and chemical reactions. • Write balanced reactions involving alpha, beta, and gamma emission.	

	• Discuss relevant applications of nuclear chemistry.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Energy Change		
1. Temperature is a measurement of average kinetic energy. Heat is a measurement of transferable energy.	• Measure temperature and heat in appropriate units. • Interpret a graph of kinetic energy versus number of particles. • Perform an experiment to measure heat flow.	
2. Chemical and physical changes can be classified as exothermic or endothermic. Balanced equations with an energy term can be used to calculate energy changes.	• Identify reactions as either exothermic or endothermic from experimental data or an equation including an energy term. • Determine the energy change for a given mass or moles from an equation with an energy term. • Discuss the transitions between potential and kinetic energy in a chemical reaction.	
3. When energy changes in an isolated atom or molecule, the energy changes in discrete jumps from one value to another. This change in energy occurs when radiation is absorbed or emitted, so the radiation also has discrete energy values.	• Explain the lines in a spectra on the basis of electrons changing between discrete energy levels.	

Geology I

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
History of the Science of Geology		
1. Scientific thought has evolved through the ideas of a stationary and static Earth as geocentric to our present knowledge of a dynamic Earth as a member of the solar system in a minor limb of the Milky Way Galaxy.	• Write a report that traces evolution of scientific thought and how it has shaped the science of geology.	
Matter and Minerals		
1. Matter is composed of atoms and molecules that combine to form the basic minerals of our Earth. Each mineral has a set of unique physical properties.	• Discuss the composition of matter with a basic understanding of atomic structure and how it relates to geochemistry. • Classify the major mineral groups and identify minerals using their physical properties and chemical analysis. • Demonstrate the difference between minerals and rocks.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
2. Rocks are the product of the interactions between minerals. Igneous, sedimentary and metamorphic rocks are classified, identified, and named based upon their mineral composition, formation, and texture.	• Construct a chart of Bowen's reaction series and place the different igneous rocks on the chart in the proper places. • Identify different igneous rocks using their textures and mineral content. • Discuss the lithification process and how it occurs on	

	and within the earth the nature of sedimentary environments. • List types of sedimentary rocks including clastic, chemical and organic and explain the nature of sedimentary environments of each. • Identify and categorize sedimentary rocks according to composition and texture. • Illustrate sedimentary structures and explain inferred environments that would produce them. • Construct a demonstration of how fossils are preserved in sedimentary rock and used to correlate sedimentary strata. • Demonstrate processes of metamorphism including agents of heat, pressure and chemically active fluids. • Compare textural and mineralogical changes that take place to alter original rocks to their metamorphic conclusion. • Identify common metamorphic rocks and classify them using composition and texture. • Illustrate relationships between metamorphism and plate tectonics.	
3. Minerals and rocks have world wide use and economic importance.	• List economic resources found in the three different types of rock .	

	• Students explore the economic value of the Red Dog , Fort Knox Gold , and Usibelli Coal Mining operations.	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
Dynamic Earth		
1. The Earth is composed of layers.	• Construct a model of Earth showing the inner structures. • Illustrate different types of plate boundary and explain forces that accompany these boundaries. • Draw a cross section of the crust at the each of the boundary types and label critical features. • Make a plate puzzle of the earth 250 million years ago, today, and 250 million years in the future.	
2. The crust sections move very slowly. They may press against one another, causing crustal thickening; pulling apart , creating new ocean floor; or sliding past one another, causing a thinning of the continental plate. The ocean floor plates may slide under continental plates, sinking deep into the earth causing crustal deformation.		
3. The crust of the earth, including both the continents and the ocean basins, consist of separate plates that ride on a denser layer of the earth. The slow movement of	• Illustrate by drawing or model current theory on the forces that drive plate tectonics.	

material within this dense layer results from heat flowing from the deep interior and the action of gravitational forces.		
4. Volcanoes form over unusually hot centers in the interior of the earth, along separating plate boundaries, or near descending plates. Earthquakes also occur along plate boundaries. Both of these can have a significant impact upon human activities.	• Diagram different types of volcanoes and using these, explain the physical conditions that cause their shape and structure. • Compare different types of earthquakes and discuss the economic effects of each. • Illustrate how the Richter Scale classifies earthquakes. • Explore the Alaskan economy before and after the 1964 earthquake.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Reshaping the Earth’s Surface		
1. Rocks formed by internal processes are unstable at the earth's surface and are susceptible to processes of weathering and erosion. The net effects of the weathering and erosion processes are soil formation, and a general leveling of the land forms.	• Design a demonstration that will illustrate the following; 1. mass wasting, and creep 2. mechanical weathering (forces of abrasion, frost action, organisms). • Investigate dissolution, hydrolysis (chemical interaction with water) chemical reactions with oxygen, and airborne or waterborne substances. • Demonstrate on a model effects of weathering and erosion processes showing how land forms are reshaped.	

	sediments moved downslope, and soil is formed.	
2. Running water, glaciers, and wind are the major erosive agents on the earth's surface. Gravity is the driving force behind these processes.	• Show how streams transport material in solution, suspension and in traction. • Demonstrate the results of decreasing gradient on stream erosion and deposition. • Illustrate how movement of glaciers erodes land forms in a characteristic manner. • Design an experiment that shows how ground water forms. • Demonstrate how waves erode the shore line by pounding and scattering material. • Design a model that shows how different forms of erosion (running water, wind, and ice) would appear in a cross-section of exposed sedimentary rock.	
3. Soil is a major resource upon which life depends.	• Write a report that explains the importance of soil as a mineral resource to life on earth,	

STUDENTS SHOULD KNOW	**EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO**	**TEACHER NOTES** Activities / Strategies / Resources / Investigations / Assessments
1. The earth has a history of at least 4 billion years with continually evolving subsystems. Geologic time is the measurement	• Debate current scientific theories to show how the Universe, Solar System and the Earth could have formed	

of time intervals that are punctuated by major changes in the biotic and abiotic environment.	• Construct a time line showing major intervals in earth history , organisms that dominated that unit, and events that opened and closed each unit. • Write a report explaining both absolute and relative geologic dating. Discuss different elements used in radioactive dating, their advantages and limitations.	
2. The material of the continents is older than that of the ocean floors.	• Design a model that illustrates sea floor spreading and explains the idea that continents are older than ocean basins. • Utilize available core data to explain the age of the sea floor using magnetic banding and radioactive dating procedures.	
3. The materials of the crust have been recycled over and over many times.	• Discuss the theory of plate tectonics and different plate boundary types and how they interact.	
4. Fossils show how life has evolved within the framework of the environment.	• Illustrate how fossils form. Discuss different conditions that favor or hinder fossilization. • Discuss the concept of deposition, and show how different environments result in widely varied deposits. • Show how present day organisms are adapted to their environments and fossil organisms were likewise adapted to individual environments of their time.	
5. Fossil distribution shows how life has been shaped by plate movement.	• Demonstrate how widely separated similar species of todav could have arrived at	

	this distribution through plate movement. • Using the idea of plate movement show how climates can dramatically be changed thereby creating new adaptive zones where new species can develop.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
6. Evolution is the theory that explains how life has changed through time.	• Demonstrate the idea that there is an evolution of fossils in the strata. • Using the Law of Superposition show how it leads us to the observation that the lower in the sedimentary column we go the more primitive the life forms.	

Physics I

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
The language of physics is mathematics.		
1. Physics relies on standardized units to define properties and relationships among physical quantities.	• Use and convert units within an appropriate system of measurement (emphasize the SI system of measurement).	

2. Physical phenomena can be analyzed mathematically.	• Calculate the horizontal and vertical velocity components of a thrown object.	
Motion in one and two dimensions can be described mathematically.		
	• Construct graphs representing one and two dimensional motion. • Design and execute an experiment proving that motion on a ramp is accelerated.	
Net forces cause masses to change their motion.		
	• Identify and contrast examples of accelerated and constant velocity motion.	
1. Free Body Diagrams specify which forces are involved in specified situations.	• Construct a Free Body Diagram of an object in uniform circular motion. • Using Newton's Universal Gravitational Law, graph the motion of a satellite around Earth.	
An object with energy can do work.		
1. Total energy can neither be created nor destroyed.	• Calculate the speed of a falling object using Conservation of Mechanical Energy • Identify the flow of energy through a system	
Moving objects possess momentum.		
1. Total momentum can neither be created nor destroyed.	• Demonstrate that total momentum remains unchanged in a collision.	

	• Calculate the changes in motion when two objects collide. • Build a mathematical model of a collision in which neither energy nor momentum changes.	

STUDENTS SHOULD KNOW	EXAMPLES OF WHAT STUDENTS SHOULD BE ABLE TO DO	TEACHER NOTES Activities / Strategies / Resources / Investigations / Assessments
Waves are generated by objects oscillating in simple harmonic motion.		
1. It is common for energy to be transferred by waves.	• Describe how water waves and sound waves are created by oscillating sources	
2. Waves can be categorized by many of their characteristics.	• Identify the qualities of a good oscillator. • Calculate the wavelength of a specific tuning fork.	
Interactions among particles with electric charge are responsible for the structure of matter.		
1. Electric charge appears in two types: positive and negative, which cannot be created or destroyed.	• Determine the magnitude and polarity of electric charge of an object.	
2. Interactions between charged particles occur via their respective electric fields.		
	• Calculate the current and voltage for simple circuits and compare these values to those measured in actual circuits.	
Magnetism, like electric charge, is		

a fundamental property of most matter.		
1. Magnetic charge appears in two types, or poles: north and south.	• Compare the effect on a moving electric charge of a magnetic and electric field. • Experiment with the magnetic fields of various magnets.	
Accelerated electric charges generate self-propagating electric and magnetic fields: electromagnetic radiation.		
	• Calculate the wavelength of electromagnetic radiation produced by an electron moving in a circle.	
When light's speed changes, light's direction changes.		
	• Compare the measured and calculated location of an image created by a lens and mirror.	