

**2008 NATIONAL SCIENCE OLYMPIAD  
and  
NATIONAL SCIENCE STANDARDS ALIGNMENT**

**C (Senior High) Division**

**ASTRONOMY – Students will demonstrate an understanding of the basic concepts of mathematics and astrophysics relating to variable stars.**

*H.D.4.b,c*

***D. Earth and Space Science – Earth and space science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

H.D.4 Origin and evolution of the universe

- b. Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.
- c. Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

**BOOMILEVER – The objective of this event is to design and build the lightest cantilevered wooden structure which, when attached to a vertical Testing Wall at one end, will support a load up to 15 Kg at the distal end. Teams should maintain and submit a log at check-in containing information about the structures they have built that can be used to improve future designs.**

*H.E.1.b-d*

***E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.***

H.E.1 Abilities of technological design

- b. Propose designs and choose between alternative solutions.
- c. Implement a proposed solution.
- d. Evaluate the solution and its consequences.

**CELL BIOLOGY – This event is a lab-oriented competition integrating content knowledge and process skills in the areas of cell biology and biochemistry.**

*H.C.1.a-f*

***C. Life Science - Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

H.C.1 The cell

- a. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material.
- b. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.
- c. Cells store and use information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires.
- d. Cell functions are regulated. Regulation occurs both through changes in the activity of the functions performed by proteins and through the selective expression of individual genes. This regulation allows cells to respond to their environment and to control and coordinate cell growth and division.
- e. Plant cells contain chloroplasts, the site of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital connection between the sun and the energy needs of living systems.

- f. Cells can differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells. In the development of these multicellular organisms, the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues and organs that comprise the final organism. This differentiation is regulated through the expression of different genes.

**CHEMISTRY LAB – Teams will answer a series of questions or complete a task involving the science processes of chemistry focused in the areas of chemical reactions and energy. No reference materials are allowed. Do not bring a calculator! If needed, calculators will be supplied.**

*H.B.3.a-e*

***B. Physical Science – Physical science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

H.B.3 Chemical reactions

- Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.
- Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.
- A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers, and explosions.
- Chemical reactions can take place in time periods ranging from the few femtoseconds (10<sup>-15</sup> seconds) required for an atom to move a fraction of a chemical bond distance to geologic time scales of billions of years. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature, and on the properties—including shape—of the reacting species.
- Catalysts, such as metal surfaces, accelerate chemical reactions. Chemical reactions in living systems are catalyzed by protein molecules called enzymes.

**CIRCUIT LAB – Students will compete in activities involving knowledge of direct current (DC) Electrical Circuits. The event may include hands-on experimentation and/or problem solving. Students may use non-programmable calculators.**

*H.U.2.a-c*

***U. Unifying Concepts and Processes – Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world.***

H.U.2 Evidence, models, and explanation

- Evidence—Evidence consists of observations and data on which to base scientific explanations. The goal is to help students use evidence to understand interactions and predict changes.
- Models—Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. The goal is to help students learn how to make and use many models, including physical objects, plans, mental constructs, mathematical equations, and computer simulations.
- Explanations—Explanations provide interpretation, meaning, or sense to objects, organisms, or events. Explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements, such as hypotheses, laws, principles, and theories. The goal is to help students create explanations which incorporate a scientific knowledge base, logic, and higher levels of analysis.

**DISEASE DETECTIVES – Students will use their investigative skills in the scientific study of disease, injury, health, and disability in populations or groups of people. There will be a focus on environmental causes of public health problems.**

*H.F.1.a-g – H.F.5.d*

***F. Science in Personal and Social Perspectives – A personal and social perspective of science helps a student to understand and act on personal and social issues. This perspective builds a foundation for future decision making.***

H.F.1 Personal and community health

- Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological—that can reduce and modify hazards.

- b. The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted.
- c. Personal choice concerning fitness and health involves multiple factors. Personal goals, peer and social pressures, ethnic and religious beliefs, and understanding of biological consequences can all influence decisions about health practices.
- d. An individual's mood and behavior may be modified by substances. The modification may be beneficial or detrimental depending on the motives, type of substance, duration of use, pattern of use, level of influence, and short- and long-term effects. Students should understand that drugs can result in physical dependence and can increase the risk of injury, accidents, and death.
- e. Selection of foods and eating patterns determine nutritional balance. Nutritional balance has a direct effect on growth and development and personal well-being. Personal and social factors—such as habits, family income, ethnic heritage, body size, advertising, and peer pressure—influence nutritional choices.
- f. Families serve basic health needs, especially for young children. Regardless of the family structure, individuals have families that involve a variety of physical, mental, and social relationships that influence the maintenance and improvement of health.
- g. Sexuality is basic to the physical, mental, and social development of humans. Students should understand that human sexuality involves biological functions, psychological motives, and cultural, ethnic, religious, and technological influences. Sex is a basic and powerful force that has consequences to individuals' health and to society. Students should understand various methods of controlling the reproduction process and that each method has a different type of effectiveness and different health and social consequences.

H.F.5 Natural and human-induced hazards

- d. Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

**ECOLOGY – Students will answer questions involving content knowledge and process skills in the area of ecology and adaptation in featured biomes.**

*H.C.4.a-e – H.C.5.a-f*

***C. Life Science – Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

H.C.4 Interdependence of organisms

- a. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.
- b. Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.
- c. Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- d. Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- e. Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

H.C.5 Matter, energy, and organization in living systems

- a. All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations. With death, and the cessation of energy input, living systems rapidly disintegrate.
- b. The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.
- c. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called ATP.

- d. The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
- e. The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.
- f. As matter and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

**ELECTRIC VEHICLE – Contestants will construct a “vehicle” which uses electrical energy as its sole means of propulsion. They should be able to adjust the vehicle to travel a distance specified by the judges and to predict the time it will take to travel that distance.**

*H.E.1.b-d*

*E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.*

- H.E.1 Abilities of technological design
- b. Propose designs and choose between alternative solutions.
  - c. Implement a proposed solution.
  - d. Evaluate the solution and its consequences.

**EXPERIMENTAL DESIGN – This event will determine a team’s ability to design, conduct, and report the findings of an experiment actually conducted on-site.**

*H.A.1.a-f*

*A. Science as Inquiry – Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.*

- H.A.1 Abilities necessary to do scientific inquiry
- a. Identify questions and concepts that guide scientific investigations.
  - b. Design and conduct scientific investigations.
  - c. Use technology and mathematics to improve investigations and communications.
  - d. Formulate and revise scientific explanations and models using logic and evidence.
  - e. Recognize and analyze alternative explanations and models.
  - f. Communicate and defend a scientific argument.

**FERMI QUESTIONS – A “Fermi Question” is a science related question that seeks a fast, rough estimate of a quantity, which is either difficult or impossible to measure directly. For example, the question “How many drops of water are there in Lake Erie?” requires an estimate of the volume of a drop, the volume of Lake Erie from its approximate dimensions and conversion of units to yield an answer. The answers should be an estimate within an order of magnitude recorded in power(s) of ten.**

*H.A.2.d – H.U.3.c*

*A. Science as Inquiry – Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.*

- H.A.2 Understandings about scientific inquiry
- d. Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.

*U. Unifying Concepts and Processes – Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world.*

- H.U.3 Change, constancy, and measurement
- c. Measurement—Measurement makes quantitative observations about objects, events, or systems. The goal is to help students use tools of measurement and measurement systems and to achieve understandings of scales and rates.

**FIVE STAR SCIENCE – Teams will compete in an academic pentathlon to demonstrate their overall understanding of five major science content areas.**

*H.A.1.a-f – H.B.1-6 – H.C.1-6 – H.D.1-4*

**A. Science as Inquiry – Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.**

- H.A.1 Abilities necessary to do scientific inquiry
- Identify questions and concepts that guide scientific investigations.
  - Design and conduct scientific investigations.
  - Use technology and mathematics to improve investigations and communications.
  - Formulate and revise scientific explanations and models using logic and evidence.
  - Recognize and analyze alternative explanations and models.
  - Communicate and defend a scientific argument.

**B. Physical Science – Physical science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.**

- H.B.1 Structure of atoms
- Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.
  - The atom's nucleus is composed of protons and neutrons, which are much more massive than electrons. When an element has atoms that differ in the number of neutrons, these atoms are called different isotopes of the element.
  - The nuclear forces that hold the nucleus of an atom together, at nuclear distances, are usually stronger than the electric forces that would make it fly apart. Nuclear reactions convert a fraction of the mass of interacting particles into energy, and they can release much greater amounts of energy than atomic interactions. Fission is the splitting of a large nucleus into smaller pieces. Fusion is the joining of two nuclei at extremely high temperature and pressure, and is the process responsible for the energy of the sun and other stars.
  - Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike radiation. The decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate. This predictability can be used to estimate the age of materials that contain radioactive isotopes.

- H.B.2 Structure and properties of matter
- Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. These outer electrons govern the chemical properties of the element.
  - An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number), repeating patterns of physical and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies.
  - Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically.
  - The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.
  - Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.
  - Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

- H.B.3 Chemical reactions
- Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.
  - Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

- c. A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers, and explosions.
- d. Chemical reactions can take place in time periods ranging from the few femtoseconds (10<sup>-15</sup> seconds) required for an atom to move a fraction of a chemical bond distance to geologic time scales of billions of years. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature, and on the properties—including shape—of the reacting species.
- e. Catalysts, such as metal surfaces, accelerate chemical reactions. Chemical reactions in living systems are catalyzed by protein molecules called enzymes.

#### H.B.4 Motions and forces

- a. Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship  $F=ma$ , which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.
- b. Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.
- c. The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, inversely proportional to the square of the distance between them.
- d. Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces such as those exerted by a coiled spring or friction may be traced to electric forces acting between atoms and molecules.
- e. Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.

#### H.B.5 Conservation of energy and increase in disorder

- a. The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.
- b. All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.
- c. Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.
- d. Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.

#### H.B.6 Interactions of energy and matter

- a. Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.
- b. Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.
- c. Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.
- d. In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures some materials become superconductors and offer no resistance to the flow of electrons.

**C. Life Science – Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.**

**H.C.1 The cell**

- a. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material.
- b. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.
- c. Cells store and use information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires.
- d. Cell functions are regulated. Regulation occurs both through changes in the activity of the functions performed by proteins and through the selective expression of individual genes. This regulation allows cells to respond to their environment and to control and coordinate cell growth and division.
- e. Plant cells contain chloroplasts, the site of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital connection between the sun and the energy needs of living systems.
- f. Cells can differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells. In the development of these multicellular organisms, the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues and organs that comprise the final organism. This differentiation is regulated through the expression of different genes.

**H.C.2 Molecular basis of heredity**

- a. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome.
- b. Most of the cells in a human contain two copies of each of 22 different chromosomes. In addition, there is a pair of chromosomes that determines sex: a female contains two X chromosomes and a male contains one X and one Y chromosome. Transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. An egg and a sperm unite to form a new individual. The fact that the human body is formed from cells that contain two copies of each chromosome—and therefore two copies of each gene—explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next.
- c. Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells can create the variation that changes an organism's offspring.

**H.C.3 Biological evolution**

- a. Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.
- b. The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.
- c. Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.
- d. The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.
- e. Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities which reflect their evolutionary relationships. Species is the most fundamental unit of classification.

- H.C.4 Interdependence of organisms
- The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.
  - Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.
  - Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
  - Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
  - Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

- H.C.5 Matter, energy, and organization in living systems
- All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations. With death, and the cessation of energy input, living systems rapidly disintegrate.
  - The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.
  - The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called ATP.
  - The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
  - The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.
  - As matter and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

- H.C.6 Behavior of organisms
- Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.
  - Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.
  - Like other aspects of an organism's biology, behaviors have evolved through natural selection. Behaviors often have an adaptive logic when viewed in terms of evolutionary principles.
  - Behavioral biology has implications for humans, as it provides links to psychology, sociology, and anthropology.

***D. Earth and Space Science – Earth and space science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

- H.D.1 Energy in the earth system
- Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.
  - The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe.
  - Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
  - Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.

#### H.D.2 Geochemical cycles

- a. The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.
- b. Movement of matter between reservoirs is driven by the earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

#### H.D.3 Origin and evolution of the earth system

- a. The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. The early earth was very different from the planet we live on today.
- b. Geologic time can be estimated by observing rock sequences and using fossils to correlate the sequences at various locations. Current methods include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed.
- c. Interactions among the solid earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system. We can observe some changes such as earthquakes and volcanic eruptions on a human time scale, but many processes such as mountain building and plate movements take place over hundreds of millions of years.
- d. Evidence for one-celled forms of life—the bacteria—extends back more than 3.5 billion years. The evolution of life caused dramatic changes in the composition of the earth's atmosphere, which did not originally contain oxygen.

#### H.D.4 Origin and evolution of the universe

- a. The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state; according to this theory, the universe has been expanding ever since.
- b. Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.
- c. Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

### **FOOD SCIENCE – Students will answer questions and perform experiments pertaining to food chemistry.**

*H.C.5.b,c*

#### ***C. Life Science – Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

#### H.C.5 Matter, energy, and organization in living systems

- b. The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.
- c. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called ATP.

**FORENSICS – Given a scenario and some possible suspects, students will perform a series of tests. These tests, along with other evidence or test results will be used to solve a crime. Students may bring one 8.5 X 11 sheet of paper with hand written notes on either or both sides, and a non-programmable calculator. The notes will be collected at the end of the competition.**

*H.A.1.c,d,f – H.U.2,a,c*

***A. Science as Inquiry – Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.***

H.A.1 Abilities necessary to do scientific inquiry

- c. Use technology and mathematics to improve investigations and communications.
- d. Formulate and revise scientific explanations and models using logic and evidence.
- f. Communicate and defend a scientific argument.

***U. Unifying Concepts and Processes – Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world.***

H.U.2 Evidence, models, and explanation

- a. Evidence–Evidence consists of observations and data on which to base scientific explanations. The goal is to help students use evidence to understand interactions and predict changes.
- c. Explanations–Explanations provide interpretation, meaning, or sense to objects, organisms, or events. Explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements, such as hypotheses, laws, principles, and theories. The goal is to help students create explanations which incorporate a scientific knowledge base, logic, and higher levels of analysis.

**HEALTH SCIENCE – This event encompasses basic anatomy and physiology of the nervous and circulatory system and how they are affected by the use of addictive substances.**

*M.C.1.e,f – H.F.1.d*

***C. Life Science – Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

M.C.1 Structure and function in living systems

- e. The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease. These systems interact with one another.
- f. Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.

***F. Science in Personal and Social Perspectives – A personal and social perceive of science helps a student to understand and act on personal and social issues. This perspective builds a foundation for future decision making.***

H.F.1 Personal and community health

- d. An individual's mood and behavior may be modified by substances. The modification may be beneficial or detrimental depending on the motives, type of substance, duration of use, pattern of use, level of influence, and short- and long-term effects. Students should understand that drugs can result in physical dependence and can increase the risk of injury, accidents, and death.

**HERPETOLOGY – This event will test knowledge of amphibians, turtles, crocodiles, and reptiles.**

*H.C.3.e*

***C. Life Science – Life science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

H.C.3 Biological evolution

- e. Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities which reflect their evolutionary relationships. Species is the most fundamental unit of classification.

**OCEANOGRAPHY – Students will use process skills to complete tasks related to physical and geological oceanography.**

*M.D.1.b,c,j, – M.D.3.c – H.D.1.b,c*

***D. Earth and Space Science – Earth and space science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

- M.D.1 Structure of the earth system
- b. Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
  - c. Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
  - j. Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.
- M.D.3 Earth in the solar system
- c. Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides.
- H.D.1 Energy in the earth system
- b. The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe.
  - c. Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

**PHYSICS LAB – Students will compete in lab activities in the area of inter conversion work, energy conversions, and/or power. Calculation of conversion efficiencies may be required.**

*H.B.5.b,d – H.B.6.a*

***B. Physical Science – Physical science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

- H.B.5 Conservation of energy and increase in disorder
- b. All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.
  - d. Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.
- H.B.6 Interactions of energy and matter
- a. Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

**REMOTE SENSING: MARS – Participants will use satellite imagery of Mars and other resources to identify and interpret geologic features, answer questions, or solve problems.**

*H.U.2.a-c*

***U. Unifying Concepts and Processes – Unifying concepts and processes help students think about and integrate a range of basic ideas which builds an understanding of the natural world.***

- H.U.2 Evidence, models, and explanation
- a. Evidence–Evidence consists of observations and data on which to base scientific explanations. The goal is to help students use evidence to understand interactions and predict changes.
  - b. Models–Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. The goal is to help students learn how to make and use many models, including physical objects, plans, mental constructs, mathematical equations, and computer simulations.
  - c. Explanations–Explanations provide interpretation, meaning, or sense to objects, organisms, or events. Explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements, such as hypotheses, laws, principles, and theories. The goal is to help students create explanations which incorporate a scientific knowledge base, logic, and higher levels of analysis.

**ROBOT RAMBLE – The object of this event is to design and build a robot capable of performing certain tasks on a prescribed playing field.**

*H.E.1.b-d*

***E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.***

- H.E.1 Abilities of technological design
- b. Propose designs and choose between alternative solutions.
  - c. Implement a proposed solution.
  - d. Evaluate the solution and its consequences.

**ROCKS AND MINERALS – Teams will demonstrate their knowledge of rocks and minerals in a station-based format.**

*M.D.1.d*

***D. Earth and Space Science – Earth and space science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.***

- M.D.1 Structure of the earth system
- d. Some changes in the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.

**SCIENCE OF MUSIC – Prior to the competition each team will build two types of musical instruments (woodwind, percussion, etc.) based on a 12-tone tempered scale, prepare to describe the principles behind their operation and be able to perform a major scale, required melody and a chosen melody.**

*H.E.1.b-d*

***E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.***

- H.E.1 Abilities of technological design
- b. Propose designs and choose between alternative solutions.
  - c. Implement a proposed solution.
  - d. Evaluate the solution and its consequences.

**WRIGHT STUFF – Prior to the tournament, teams will construct and test up to two rubber-powered model monoplanes to achieve maximum flight times. The event must occur inside. The room dimensions (approximate length, width and ceiling height) should be made available to teams in advance of the competition. Directors and supervisors are urged to minimize the effects of environmental factors such as air currents (e.g., doors, fans, etc.).**

*H.E.1.b-d*

***E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.***

- H.E.1 Abilities of technological design
- b. Propose designs and choose between alternative solutions.
  - c. Implement a proposed solution.
  - d. Evaluate the solution and its consequences.

**WRITE IT/DO IT – Technical writing skills are an important part of an engineer's or a scientist's abilities to communicate precisely and clearly. This event will test a competitor's ability to effectively communicate with a colleague in writing by having their partner construct a device from this written description.**

*H.E.1.e*

***E. Science and Technology – An understanding of science and technology establishes connections between the natural and designed world, linking science and technology.***

- H.E.1 Abilities of technological design
- e. Communicate the problem, process, and solution.