ACADEMIC STANDARDS FOR WISSAHCIKON SCIENCE CURRICULUM GRADES 9-12

Standard 1 – Unifying Themes

- Discriminate among and apply concepts of systems, subsystems, feedback and control to solve complex technological problems.
  - Apply knowledge of control systems concept by designing and modeling control systems that solve specific problems.
  - Apply system analysis to predict results.
  - Compare and contrast several systems that could be applied to solve a single problem.
  - Analyze and describe the effectiveness of systems to not only solve specific problems but to also evaluate a system's inefficiency.
  - Evaluate the causes of a system's inefficiency.
- Describe and apply concepts of models as a method to predict and understand science.
  - Evaluate technological processes by collecting data and applying mathematical models (e.g., process control).
  - Apply knowledge of complex physical models to interpret data and apply mathematical models.
  - Apply mathematical models to science.
- Apply and assess patterns in science.
  - Examine and describe recurring patterns that form the basis of biological classification, chemical periodicity, geological order and astronomical order.
  - Examine and describe physical patterns in motion.
  - Assess and apply recurring patterns in natural and technological systems.
  - Compare and contrast structure and function relationships as they relate to patterns.
  - Assess patterns in nature using mathematical formulas.
- Apply and analyze scale as a way of relating concepts and ideas to one another by some measure.
  - Compare and contrast various forms of dimensional analysis.
  - Assess the use of several units of measurement to the same problem.
  - Analyze and apply appropriate measurement scales when collecting data.
- Describe patterns and evaluate change in nature, physical systems and man made systems.
  - Describe how fundamental science and technology concepts are used to solve practical problems (e.g., momentum, Newton's laws of universal gravitation, tectonics, conservation of mass and energy, cell theory, atomic theory, theory of relativity, Pasteur's Germ Theory, relativity, Galileo's Heliocentric Solar System, gas laws, feedback systems).

- Evaluate fundamental science and technology concepts and their development over time (e.g., DNA, cellular respiration, unified field theory, energy measurement, automation, miniaturization, Copernican and Ptolemaic universe theories).
- Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously).
- Analyze how modules, systems and technologies have changed over time (e.g., germ theory of disease, solar system, cause of fire).
- Explain how correlation of variables does not necessarily imply causation.
- Evaluate the patterns of change within a technology (e.g., changes in engineering in the automotive industry).

Standard 2 – Inquiry and Design

- Apply, understand and evaluate the nature of scientific knowledge.
  - Know and use the ongoing scientific process to continually improve and better understand how things work.
  - Know that science is limited to the study of observable aspects of the world and universe.
  - Critically evaluate the status of existing theories (e.g., germ theory of disease, wave theory of light, classification of subatomic particles, theory of evolution, epidemiology of AIDS).
- Apply process knowledge and organize scientific phenomena in varied ways.
  - Describe materials using precise quantitative and qualitative skills based on observation.
  - Develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions.
  - Use process skills to make inferences and predictions using collected information and to communicate, using space / time relationships, defining operationally.
- Evaluate experimental information for appropriateness and adherence to relevant science processes.
  - Evaluate experimental data correctly within experimental limits.
  - Judge that conclusions are consistent and logical with experimental conditions.
  - Interpret results of experimental research to predict new information or improve a solution.
- Apply the elements of scientific inquiry to solve simple and multi-step problems.
  - Generate questions about objects, organisms and/or events that can be answered through scientific investigations.
  - Evaluate the appropriateness of questions.
  - Design an investigation with adequate control and limited variables to investigate a question.

- Organize experimental information using analytic and descriptive techniques.
- Judge and evaluate the significance of experimental information in answering the question.
- Project additional questions from a research study that could be studied.

- Identify, apply, analyze and use the technological design process to solve problems.
  - Examine and assess all aspects of the problem, prioritize the necessary information and formulate questions that must be answered.
  - Propose, develop and appraise the best solution and develop alternative solutions.
  - Implement and assess the solution.
  - Evaluate and assess the solution, redesign and improve as necessary.
  - Communicate and assess the process and evaluate and present the impacts of the solution.

Standard 3 – Biological Sciences

- Explain the relationship between structure and function at all levels (including similarities and differences) of organization.
  - Identify and characterize major life forms according to their placement in existing classification groups.
  - Describe organizing schemes of classification keys.
  - Identify and explain interactions among organisms (e.g., mutually beneficial, harmful relationships).
  - Explain and analyze the relationship between structure and function at the molecular, cellular and organ-system level.
  - Describe and explain structural and functional relationships in each of the five (or six) kingdoms.
  - Explain significant biological diversity found in each of the biomes.
- Describe, explain and analyze the chemical and structural basis of living organisms.
  - Describe the relationship between the structure of organic molecules and the function they serve in living organisms.
  - Identify the specialized structures and regions of the cell and the functions of each.
  - Explain how cells store and use information to guide their functions.
  - Explain cell functions and processes in terms of chemical reactions and energy changes.
  - Identify and describe factors affecting metabolic functions (e.g., temperature, acidity, hormones).
  - Evaluate metabolic activities using experimental knowledge of enzymes.
  - Evaluate relationships between structure and functions of different anatomical parts given their structure.
  - Describe potential impact of genome research on the biochemistry and physiology of life.

- Describe and explain gene inheritance and expression at every level (including the molecular level).
  - Compare and contrast the function of mitosis and meiosis.
  - Describe mutations' effects on a trait's expression.
  - Distinguish different reproductive patterns in living things (e.g., budding, spores, fission).
  - Compare random and selective breeding practices and their results (e.g. antibiotic resistant bacteria).
  - Explain the relationship among DNA, genes and chromosomes.
  - Explain different types of inheritance (e.g., multiple allele, sex-influenced traits).
  - Describe the role of DNA in protein synthesis as it relates to gene expression.
  - Analyze gene expression at the molecular level.
  - Describe the roles of nucleic acids in cellular reproduction and protein synthesis.
  - Describe genetic engineering techniques, applications and impacts.
  - Explain birth defects from the standpoint of embryological development and/or changes in genetic makeup.

Standard 4 – Physical Science, Chemistry and Physics

- Explain and apply concepts about the structure and properties of matter.
  - Explain the repeating pattern of chemical properties by using the repeating patterns of atomic structure within the periodic table.
  - Apply rules of systematic nomenclature and formula writing to chemical substances.
  - Classify and describe, in equation form, types of chemical and nuclear reactions.
  - Explain how radioactive isotopes that are subject to decay can be used to estimate the age of materials.
  - Describe phases of matter according to the Kinetic Molecular Theory.
  - Explain how the forces that bind solid, liquids and gases affect their properties.
  - Explain the formation of compounds and their resulting properties using bonding theories (ionic and covalent).
  - Recognize formulas for simple inorganic compounds.
  - Characterize and identify important classes of compounds (e.g., acids, bases, salts).
  - Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations.
  - Describe various types of chemical reactions by applying the laws of conservation of mass and energy.
  - Apply the conservation of energy concept to fields as diverse as mechanics, nuclear particles and studies of the origin of the universe.

- Apply the predictability of nuclear decay to estimate the age of materials that contain radioactive isotopes.
- Apply knowledge of mixtures to appropriate separation techniques.
- Understand that carbon can form several types of compounds.
- Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.

- Apply and analyze energy sources and conversions and their relationship to heat and temperature.
  - Evaluate mathematical formulas that calculate the efficiency of specific chemical and mechanical systems.
  - Use knowledge of chemical reactions to generate an electrical current.
  - Evaluate energy changes in chemical reactions.
  - Determine the heat involved in illustrative chemical reactions.
  - Use knowledge of conservation of energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion).
  - Explain resistance, current and electro-motive force (Ohm's Law).
  - Use knowledge of oxidation and reduction to balance complex reactions.
  - Apply appropriate thermodynamic concepts (e.g., conservation, entropy) to solve problems relating to energy and heat.
- Distinguish among and apply the principles of motion and force.
  - Identify the relationship of electricity and magnetism as two aspects of a single electromagnetic force.
  - Identify elements of simple machines in compound machines.
  - Explain fluid power systems through the design and construction of appropriate models.
  - Describe sound effects (e.g., Doppler effect, amplitude, frequency, reflection, refraction, absorption, sonar, seismic).
  - Describe light effects (e.g., Doppler effect, dispersion, absorption, emission, spectra, polarization, interference).
  - Describe and measure the motion of sound, light and other objects
  - Evaluate wave properties of frequency, wavelength and speed as applied to sound and light through different media.
  - Know Newton's laws of motion (including inertia, action and reaction) and gravity and apply them to solve problems related to forces and mass.
  - Determine the efficiency of mechanical systems by applying mathematical formulas.
  - Propose and produce modifications to specific mechanical power systems that will improve their efficiency.
  - Analyze the principles of translational motion, velocity and acceleration as they relate to free fall and projectile motion.
  - Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque.
  - Interpret a model that illustrates circular motion and acceleration.
  - Describe inertia, motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.

- Explain and analyze the essential ideas about the composition and structure of the universe.
  - Compare the basic structures of the universe (e.g., galaxy types, nova, black holes, neutron stars).
  - Analyze the Big Bang Theory's use of gravitational and nuclear reaction to explain a possible origin of the universe.
  - Describe the nuclear processes involved in energy production in a star.
  - Explain the "red-shift" and Hubble's use of it to determine stellar distance and movement.
  - Compare absolute versus apparent star magnitude and their relation to stellar distance.
  - Explain the impact of the Copernican and Newtonian thinking on man's view of the universe.
  - Compare the use of visual, radio and x-ray telescopes top collect data regarding the structure and evolution of the universe.
  - Correlate the use of the special theory of relativity and the life of a star.

Standard 5 – Earth Sciences

- Relate, analyze and evaluate earth features and processes that change the earth.
  - Explain several methods of dating earth materials and structures.
  - Apply knowledge of radioactive decay to assess the age of various earth features and objects.
  - Correlate rock units with general geologic time periods in the history of the earth
  - Apply knowledge of geophysical processes to explain the formation and degradation of earth structures (e.g., mineral deposition, cave formations, soil composition).
  - Interpret geological evidence supporting evolution.
- Explain and analyze the availability, location and extraction of earth resources.
  - Describe how the location of earth's major resources has affected a country's strategic decisions.
  - Compare locations of earth features and countries boundaries.
  - Analyze the impact of resources (e.g., coal deposits, rivers) on the life of PA's settlements and cities.
- Analyze atmospheric energy transfers.
  - Describe how weather and climate involve the transfer of energy in and out of the atmosphere.
  - Explain how unequal heating of the air, ocean and land produces wind and ocean currents.
  - Analyze the energy transformations that occur during the greenhouse effect and predict the long-term effects of increased pollutant levels in the atmosphere.

- Analyze the mechanisms that drive a weather phenomena (e.g., El Nino, hurricane, tornado) using the correlation of three methods of heat energy transfer.
- Assess the value of water as a resource.
  - Identify the components of a municipal/agricultural water supply system and a wastewater treatment system.
  - Relate aquatic life to water conditions (e.g., turbidity, temperature, salinity, dissolved oxygen, nitrogen levels, pressure).
  - Assess the natural and man-made factors that affect the availability of clean water (e.g., rock and mineral deposits, man-made pollution).
- Analyze the principles and history of hydrology.
  - Analyze the operation and effectiveness of a water purification and desalination system.
  - Evaluate the pros and cons of surface water appropriation for commercial and electrical use.
  - Analyze the historical development of water use in Pennsylvania (e.g., recovery of Lake Erie).
  - Compare the marine life and type of water found in the intertidal, neritic and bathyal zones.

Standard 6 – Watersheds and Wetlands

- Categorize stream order in a watershed.
  - Explain the concept of a stream order.
  - Identify the order of watercourses within a major river's watershed.
  - Compare and contrast the physical differences found in the stream continuum from headwater to mouth.
- Explain the relationship among landforms, vegetation and the amount and speed of water that exist within watersheds in the United States.
  - Explain how vegetation affects storm water runoff.
  - Delineate the boundaries of a watershed.
  - Understand that various ecosystems may be contained in a watershed.
  - Examine and describe the ecosystem contained within a specific watershed.
  - Identify and describe the major watersheds in the United States.
- Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
  - Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g., shredder, predator, decomposer).
  - Explain the habitat needs of specific aquatic organisms.
- Analyze the parameters of a watershed.
  - Interpret physical, chemical and biological data as a means of assessing the environment quality of a watershed.
  - Apply appropriate techniques in the analysis of a watershed (e.g., water quality, biological diversity, erosion, sedimentation).

- Analyze the complex and diverse ecosystems of wetlands.
  - Explain the functions of habitat, nutrient production, migration stopover and groundwater recharge as it relates to wetlands.
  - Explain the dynamics of a wetland ecosystem.
  - Describe and analyze different types of wetlands.
- Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
  - Evaluate the effects of natural events on watersheds and wetlands.
  - Evaluate the effects of human activities on watersheds and wetlands.

Standard 7 – Renewable and Nonrenewable Resources

- Explain and analyze the use of renewable and nonrenewable resources and how they supply energy and materials.
  - Identify and compare fuels used in industrial and agricultural societies.
  - Explain the effects on the environment and sustainability through the use of nonrenewable resources.
  - Evaluate the advantages and disadvantages of reusing our natural resources.
- Evaluate and analyze factors affecting the availability of renewable and nonrenewable resources.
  - Evaluate the effect of consumer desires on various natural resources.
  - Evaluate the use of natural resources and offer approaches for using them while diminishing waste.
  - Compare the economics of different areas based on the availability of the natural resources.
- Analyze factors (including man-made systems) that influence the availability, management, and distribution of natural resources.
  - Compare the use of natural resources in different countries.
  - Analyze the costs and benefits of different man-made systems and how they use renewable and nonrenewable natural resources.
  - Analyze the impact of information systems on management and distribution of natural resources.
  - Determine how delivery systems influence the availability of resources at the local, regional and national level.
- Explain different management alternatives involved in recycling and evaluate solid waste management practices.
  - Differentiate between pre/post-consumer and raw materials.
  - Illustrate how one natural resource can be managed through reduction, recycling, reuse or use.
  - Examine and explain the path of a recyclable material from collection to waste, reuse or recycling identifying the market forces.
  - Understand current regulations concerning recycling and solid waste.
  - Research new technologies in the use, reuse or recycling of materials.

Standard 8 – Environmental Health

- Analyze the complexity of environmental health issues.
  - Identify environmental health issues and explain how they have been addressed on a worldwide level.
  - Analyze efforts to prevent, control and/or reduce pollution through cost and benefit analysis and risk management.
  - Describe the impact of occupational exposures as they relate to environmental health issues.
  - Identify invisible pollutants and explain their effects on human health.
  - Explain the relationship between wind direction and velocity as it relates to dispersal and occurrence of pollutants.
  - Explain the different disposal methods used for toxic and hazardous waste.
- Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.
  - Analyze data and explain how point source pollution can be detected and eliminated.
  - Identify and explain ways of detecting pollution by using state-of-the-art technologies.
- Analyze the local, regional and national impacts of environmental health.
  - Analyze the cost of natural disasters in both dollars and loss of natural habitat.
  - Research and analyze the local, state and national laws that deal with point and nonpoint source pollution; evaluate the costs and benefits of these laws.
  - Explain mitigation and its role in environmental health.
  - Explain industry's initiatives to meet state and federal mandates on clean air and water.
  - Describe the impacts of point and nonpoint source pollution on the Chesapeake Bay.
  - Identify and evaluate the costs and benefits of laws regulating air and water quality and waste disposal.
- Explain biological diversity as an indicator of and analyze the need for a healthy environment.
  - Analyze the effects of species extinction on the health of an ecosystem.
  - Research the relationship of some chronic diseases to an environmental pollutant.
  - Explain how man-made systems may affect the environment.

Standard 9 – Agriculture and Society

- Describe the importance of agriculture to society.
  - Compare and contrast the influence of agriculture on a nation's culture, standard of living and foreign trade.

- Compare a contemporary economic issue in agriculture to its historical origin.

- Analyze the management practices in the agriculture business.
  - Define the components of an agriculture system that would result in a minimal waste of resources.
  - Identify the diversity in crop production and analyze the advantages and disadvantages of such diversity.
  - Research and analyze environmental practices related to agricultural systems.
  - Analyze the effects of agricultural practices on the economy.
  - Analyze the impact of nutrient management laws on Pennsylvania agriculture.
  - Assess the role of agriculture cooperatives.
- Assess the influence of and describe how agricultural science has influenced farming practices and Biotechnology.
  - Compare the practices of no-till farming to traditional soil preparation (e.g., plow, disc).
  - Analyze and explain the various practices of nutrient management on the farm.
  - Analyze and explain how farm efficiencies have changed human nutrition.
  - Investigate how bio-engineered crops may influence the food supply.
  - Analyze the use of specific bacteria for the control of agricultural pests.
  - Evaluate the use of feed additives in shifting metabolism to increase muscle mass and reduce fat in farm animals.
- Analyze and research the social, political and economic factors that affect agricultural systems.
  - Analyze the costs and benefits associated with agricultural practices and how they affect economic and human needs.
  - Analyze the costs and benefits of agricultural research practices in society.
  - Research the use of by-products that are the results of agricultural production (e.g., manure handling, bird feathers).
- Analyze the effects of increased efficiency as well as research and development activities as they relate to agriculture.
  - Compare the current market value of both natural and alternative energy sources involved in the production of food and fiber.
  - Analyze the role of research development and technology as it relates to the food and fiber system.
  - Research and analyze energy sources used and/or generated by producing, processing and marketing agricultural products.

Standard 10 – Ecosystems and their Interactions

- Explain the biotic and abiotic components of an ecosystem and their interaction.
  - Analyze the effects of abiotic factors on specific ecosystems.

- Describe how the availability of resources affects organisms in an ecosystem.
- Evaluate the efficiency of energy flow in a food chain.
- Explain trophic levels.
- Identify a specific environmental impact and predict what changes may take place to affect homeostasis.
- Examine and explain how organisms modify their environment to sustain their needs.
- Assess the effects of latitude and altitude on biomes.
- Interpret possible causes of population fluctuations.
- Explain how erosion and sedimentation have changed the quality of soil related habitats.

- Analyze the interdependence of an ecosystem.
  - Analyze the relationships among components of an ecosystem.
  - Evaluate the efficiency of energy flow within an ecosystem.
  - Explain limiting factors and their impact on carrying capacity.
  - Understand how biological diversity impacts the stability of an ecosystem.
  - Analyze the positive or negative impacts of outside influences on an ecosystem.
  - Analyze how different land use practices can affect the quality of soils.
- Analyze how human action and natural changes affect the balance within an ecosystem over time.
  - Identify causes of succession.
  - Analyze consequences of interrupting natural cycles.
  - Analyze the effects of substances that move through natural cycles.
  - Analyze the effects of natural occurrences and their effects on ecosystems.
  - Analyze effects of human action on an ecosystem.
  - Compare the stages of succession and how they influence the cycles existing in an ecosystem.

Standard 11 – Humans and the Environment

- Explain how technology has influenced the sustainability of natural resources over time.
  - Describe how technology has changed the use of natural resources by business and industry.
  - Analyze the effect of natural resource conservation on a product over time (e.g., automobile manufacturing, aluminum can recycling, paper products).
- Analyze technology's role on natural resource sustainability.
  - Explain how technology has decreased the use of raw natural resources.
  - Explain how technology has impacted the efficiency of the use of natural resources.
  - Analyze the role of technology in the reduction of pollution.

- Analyze how pollution has changed in quality, variety and toxicity as the United States developed its industrial base.
  - Analyze historical pollution trends and project them for the future.
  - Compare and contrast historical and current pollution levels at a given location.
- Analyze the international implications of environmental occurrences.
  - Identify natural occurrences that have international impacts (e.g., El Nino, volcano eruptions, earthquakes).
  - Analyze environmental issues and their international implications.