ALEKS®

Chemistry

Next Generation Science Standards (High School)

HS-PS1: Matter and its Interactions

- = ALEKS course topic that addresses the standard

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

- Organization of the Periodic Table
- Using the Periodic Table to identify similar elements
- Identifying the parts of an atom
- Counting the number of protons and electrons in a neutral atom
- Counting protons and electrons in atoms and atomic ions
- Predicting the ions formed by common main-group elements
- Counting valence electrons in a neutral atom
- Predicting whether a compound is ionic or molecular
- Predicting ionic compounds formed by two elements
- Interpreting the electron configuration of a neutral atom in noble-gas notation
- Writing the electron configuration of a neutral atom with s and p electrons only
- Writing the electron configuration of an atom using the Periodic Table
- Identifying elements with a similar valence electron configuration
- Deducing valence electron configuration from trends in successive ionization energies
- Understanding periodic trends in effective nuclear charge
- Deducing the block of an element from an electron configuration
- Understanding periodic trends in atomic size
- Understanding periodic trends in atomic ionizability
- Counting valence electrons in a molecule or polyatomic ion
- Deciding whether a Lewis structure satisfies the octet rule
- Writing Lewis structures for diatomic molecules
- Predicting the single-bonded molecular compounds formed by two elements
- Predicting the relative length and energy of chemical bonds
- Understanding main-group periodic trends in ionization energy
- Understanding main-group periodic trends in atomic radius
- Understanding main-group periodic trends in metallicity
- Predicting the type of bonding in a main-group element
- Ordering the melting points of elements at either end of the Periodic Table

HS-PS1-2: Construct and review an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the Periodic Table, and knowledge of the patterns of chemical properties.

- Balancing chemical equations with interfering coefficients
- Writing a chemical equation from a description of the reaction
- Writing a chemical equation from a molecular movie
- Writing net ionic equations

- Predicting precipitation
- Predicting the products of a neutralization reaction
- Identifying oxidized and reduced reactants in a metal-nonmetal reaction
- Identifying oxidized and reduced reactants in a single-displacement reaction
- Predicting whether simple electrochemical reactions happen
- Identifying combination, decomposition, single and double displacement reactions
- Identifying precipitation, combustion and acid-base reactions
- Predicting the products of a combustion reaction
- Predicting products from a general statement about reactivity
- Predicting the products of a gas-evolving double displacement reaction
- Predicting products from a general statement about reactivity
- Identifying acids and bases by their reaction with water
- Predicting the reactants of a neutralization reaction
- Predicting the qualitative acid-base properties of salts
- Identifying Lewis acids and bases in reactions
- Predicting the products of the reaction of a Group 1A or 2A metal with water
- Predicting the products of the reaction of a Group 1A or 2A metal with oxygen
- Predicting the products of the reaction of elements at either end of the Periodic Table

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

- Distinguishing solid, liquid and gas phases of a pure substance
- Deducing the ions in a binary ionic compound from its empirical formula
- Identifying common polyatomic ions
- Predicting the formula of ionic compounds with common polyatomic ions
- Deducing the ions in a polyatomic ionic compound from its empirical formula
- Predicting the relative electronegativities of atoms
- Predicting bond polarity
- Predicting relative bond polarity
- Predicting the relative ionic character of chemical bonds
- Identifying a molecule from its electrostatic potential map
- Predicting the strength of intermolecular forces from an electrostatic potential map
- Identifying hydrogen-bonding interactions between molecules
- Identifying the intermolecular forces between atoms, ions and molecules
- Identifying the important intermolecular forces in pure compounds
- Predicting the relative strength of the dispersion force between molecules
- Predicting the relative boiling points of pure substances
- Identifying important physical properties of liquids
- Understanding consequences of important physical properties of liquids
- Relating vapor pressure to vaporization
- Understanding the connection between vapor pressure, boiling point, and enthalpy of vaporization
- Predicting the type of solid formed by a compound
- Predicting the relative lattice energy of binary ionic compounds
- Using heat of fusion or vaporization to find the heat needed to melt or boil a substance
- Identifying phase transitions on a heating curve
- Interpreting a heating curve

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

- Understanding the definition of enthalpy
- Using the general properties of reaction enthalpy
- Calculating the heat of reaction from molar reaction enthalpy and the mass of a reactant
- Calculating heat of reaction from constant-pressure calorimetry data
- Calculating heat of reaction from bomb calorimetry data
- Using Hess's Law to calculate net reaction enthalpy
- Writing a standard formation reaction
- Calculating a molar heat of reaction from formation enthalpies
- Solving combustion thermochemistry problems
- Interpreting a reaction energy diagram

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

- Understanding how average molecular kinetic energy scales with temperature
- Understanding how average molecular speed scales with temperature and molar mass
- Interpreting a graph of molecular speed distribution
- Predicting how molecular speed distribution changes with temperature and molar mass
- Understanding how molecular collision rate scales with temperature and volume
- Predicting how reaction rate varies with pressure, concentration and temperature
- Calculating average and instantaneous reaction rate from a graph of concentration versus time
- Using a rate law
- Relating activation energy to reaction rate
- Drawing the reaction energy diagram of a catalyzed reaction
- Understanding the qualitative predictions of the Arrhenius equation

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

- Predicting relative forward and reverse rates of reaction in a dynamic equilibrium
- Using Le Chatelier's Principle to predict the result of changing concentration or volume
- Using Le Chatelier's Principle to predict the result of changing temperature
- Writing a concentration equilibrium constant expression
- Writing the concentration equilibrium expression for a heterogeneous equilibrium
- Using an equilibrium constant to predict the direction of spontaneous reaction
- Recognizing equilibrium from a sketch
- Predicting equilibrium composition from a sketch
- Understanding the effect of pH on the solubility of ionic compounds
- Making qualitative estimates of pH change

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

- Using a chemical equation to find moles of product from moles of reactant
- Solving for a reactant using a chemical equation
- Identifying the limiting reactant in a drawing of a mixture
- Understanding theoretical, actual, and percent yield
- Theoretical yield of chemical reactions
- Percent yield of chemical reactions
- Reaction sequence stoichiometry
- Solving for a reactant in solution
- Solving limiting reactant problems in solution

- Determining the volume of base needed to titrate a given mass of acid
- Determining the molar mass of an acid by titration
- Standardizing a base solution by titration
- Solving a redox titration problem

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

- Isotopes
- Interpreting the symbol for a nuclide
- Writing the symbols in a nuclear chemical equation
- Balancing a nuclear chemical equation
- Writing the equation for a typical radioactive decay
- Knowing the properties of the common types of nuclear radiation
- Understanding the common modes of radioactive decay
- Understanding radioactive half life
- Interconverting amount of radioactive decay and half life
- Calculating radioactive activity from half life
- Using isotope ratios to radiodate
- Using activity to radiodate

HS-PS2: Motion and Stability: Forces and Interactions

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TD = Teacher Directed

HS-PS2-1: Analyze data to support the claim that Newton's Second Law of Motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

TD

HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

TD

HS-PS2-3: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

TD

HS-PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

- Understanding that opposite charges attract and like charges repel
- Understanding net electrical charge
- Understanding how electrostatic force scales with charge and separation
- Calculating the magnitude of an electrostatic force using Coulomb's Law

- Understanding how electrostatic forces cancel
- Understanding that electrostatic forces add as vectors

HS-PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

TD

HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

- Distinguishing mixtures from pure substances through physical properties
- Distinguishing physical and chemical properties by a macroscopic description
- Classifying substances from a sketch
- Distinguishing a metal from a nonmetal by physical properties
- Distinguishing an ionic from a molecular compound by physical properties

HS-PS3: Energy

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HS-PS3-1: Create a computational model to calculate the change in energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

- Using conservation of energy with gravitational potential energy
- Using conservation of energy with electrostatic potential energy
- Using conservation of energy to predict the qualitative exchange of kinetic and potential energy

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

- Calculating gravitational potential energy
- Understanding how electrostatic energy scales with charge and separation
- Calculating electrostatic energy using Coulomb's Law
- Understanding how kinetic energy scales with mass and speed
- Calculating kinetic energy

HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

TD

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

- Solving a basic calorimetry problem
- Finding the equilibrium temperature when substances at different temperatures mix

HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

TD

HS-PS4: Waves and their Applications in Technologies for Information Transfer

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HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

- Understanding the organization of the electromagnetic spectrum
- Interconverting the wavelength and frequency of electromagnetic radiation
- Interconverting wavelength, frequency and photon energy

HS-PS4-2: Evaluate questions about the advantages of using digital transmission and storage of information.

TD

HS-PS4-3: Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

TD

HS-PS4-4: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

- Calculating the wavelength of a spectral line from an energy diagram
- Predicting the qualitative features of a line spectrum
- Calculating the wavelength of a line in the spectrum of hydrogen

HS-PS4-5: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

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