Indiana Academic Standards for Integrated Chemistry and Physics
Standards Resource Guide Document

This Teacher Resource Guide has been developed to provide supporting materials to help educators successfully implement the Indiana Academic Standards fo Integrated Chemistry and Physics. These resources are provided to help you in your work to ensure all students meet the rigorous learning expectations set by th Academic Standards. Use of these resources is optional – teachers should decide which resource will work best in their school for their students.
This resource document is a living document and will be frequently updated.
Please send any suggested links and report broken links to:

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The resources, clarifying statements, and vocabulary in this document are for illustrative purposes only, to promote a base of clarity and common understanding Each item illustrates a standard but please note that the resources, clarifying statements, and vocabulary are not intended to limit interpretation or classroom applications of the standards.

Standards 1: Constant Velocity			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.1.1 Develop graphical, mathematical, and pictorial representations (such as a motion map) that describe the relationship between the clock reading (time) and position of an object moving at a constant velocity and apply those representations to qualitatively and quantitatively describe the motion of an object.		Position - the point or area occupied by a physical object in relation to surroundings or coordinate Constant velocity - object travels the same distance every second Motion - the action or process of moving or being moved.	Systems and system models Energy and matter

ICP.1.2 Describe the slope of the graphical representation of position vs. clock reading (time) in terms of the velocity of the object moving in one dimension.		One dimension – only variable with motion is linear	Energy and matter Stability and change
ICP.1.3 Distinguish between the terms "distance" and "displacement", and determine the value of either given a graphical or mathematical representation of position vs. clock reading (time).		Distance - scalar quantity that refers to "how much ground an object has covered" during its motion. Displacement - vector quantity that refers to "how far out of place an object is"; it is the object's overall change in position.	Energy and matter Stability and change
ICP.1.4 Distinguish between the terms "speed," "velocity," "average speed," and "average velocity" and determine the value of any of these measurements given either a graphical or mathematical representation.		Speed – how fast an object is moving Velocity – the rate at which an object changes its position Average speed – distance traveled divided by the time elapsed Average velocity – displacement divided by the time.	Energy and matter Stability and change

Standard 2: Uniform Acceleration			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.2.1 Develop graphical, mathematical, and pictorial representations (such as a motion map) that describe the relationship between the clock reading (time) and velocity of an object moving at a constant acceleration and apply those representations to qualitatively and quantitatively describe the motion of an object in terms of its change in position or velocity.		Constant acceleration – object changing its velocity by the same amount each second	Systems and system models Energy and matter
ICP.2.2 Describe the differences between average velocity and instantaneous velocity and be able to determine either quantity given a graph of position vs clock reading (time).		Average velocity – displacement divided by the time Instantaneous velocity – velocity of an object in motion at a specific point in time	Energy and matter
ICP.2.3 For an object thrown vertically, qualitatively describe or quantitatively determine the velocity and acceleration at various positions during its motion.		Qualitatively – evaluated based on observations Quantitatively – involving the measurement of quantity or amount	Energy and matter Stability and change

Standard 3: Newton's Laws of Motion (One Dimension)			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.3.1 Develop pictorial and graphical representations which show that a single external applied force changes the velocity of an object, and that when no force acts, the velocity of an object remains constant.		Applied force – force that is applied to an object by a person or another object	Cause and effect Scale, proportion, and quantity
ICP.3.2 Construct force diagrams and combine forces to determine the equivalent single net force acting on the object when more than one force is acting on the object.		Force diagrams – diagram showing all the forces acting on an object, the force's direction and its magnitude Net force – sum of all forces acting on an object	Cause and effect Energy and matter
ICP.3.3 Distinguish between forces acting on a body and forces exerted by the body. Categorize forces as contact forces, friction, or action at a distance (field) forces.		Contact forces – force that acts at the point of contact between two objects Friction – the resistance that one surface or object encounters when moving over another Action at a distance forces – vector field that describes a non-contact force acting on a particle at various positions in space	Cause and effect Energy and matter
ICP.3.4 Develop pictorial and graphical representations which show that a non-zero net force on an object results in an acceleration of the object and that the acceleration of an object of constant mass is proportional to the total force acting on it, and inversely proportional to its mass for a constant applied total force.		Constant mass – object that has a definite mass that remains the same during the entire observation.	Cause and effect Energy and matter

ICP.3.5 Qualitatively describe and quantitatively determine the magnitude and direction of forces from observing the motion of an object of known mass.		Magnitude - size or extent Direction - course along which someone or something moves	Cause and effect Energy and matter
ICP.3.6 Qualitatively describe and quantitatively determine the acceleration of an object of known mass from observing the forces acting on that object.			Scale, proportion, and quantity
ICP.3.7 Develop pictorial and graphical representations which show that when two objects interact, the forces occur in pairs according to Newton's third law and that the change in motion of each object is dependent on the mass of each object.		Newton's third law - For every action, there is an equal and opposite reaction	Patterns Energy and matter

Standard 4: Energy			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.4.1 Define energy as a quantity that can be represented as being within a system that is distinct from the remainder of the universe and is measured in Joules.		Energy - power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines Joules – SI unit of work or energy, equal to the work done by a force of one newton when its point of application moves one meter in the direction of action of the force, equivalent to one 3600th of a watt-hour	Scale, proportion, and quantity Energy and matter

ICP.4.2 Identify forms of energy present in a system (kinetic, gravitational, elastic, etc.), and pictorially represent the distribution of energies, such as using pie or bar charts.		Kinetic energy – energy that a body possesses by virtue of being in motion Gravitational energy – potential energy associated with the gravitational field. Elastic energy – potential mechanical energy stored in the configuration of a material or physical system as work is performed to distort its volume or shape Pie chart – a type of graph in which a circle is divided into sectors that each represent a proportion of the whole Bar chart – a diagram in which the numerical values of variables are represented by the height or length of lines or rectangles of equal width	Cause and effect Energy and matter
ICP.4.3 Understand and explain that the total energy in a closed system is conserved.		Closed system – a physical system that doesn't exchange any matter with its surroundings, and isn't subject to any force whose source is external to the system Conserved – constant overall total	Patterns Energy and matter
ICP.4.4 Qualitatively and quantitatively analyze various scenarios to describe how energy may be transferred into or out of a system by doing work through an external force or adding or removing heat.		Transferred – move from one place to another Work – when a force that is applied to an object moves that object Heat – energy that spontaneously passes between a system and its surroundings in some way other than through work or the transfer of matter	Patterns Energy and matter

Standard 5: Particle Theory of Matter			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.5.1 Develop pictorial representations which show that matter is made of particles.		Matter – sample that has mass and takes up space Particles – one of the extremely small constituents of matter, as an atom, molecules, or nucleus	Systems and system models
ICP.5.2 Describe the assumptions used to develop the kinetic theory of gasses.		Kinetic theory of gasses – gases are large numbers of submicroscopic particles (atoms or molecules), all of which are in constant rapid motion that has randomness arising from their many collisions with each other and with the walls of the container	Patterns Energy and matter
ICP.5.3 At the particle level, describe the relationship between temperature and the average kinetic energy of particles in the system and describe how a thermometer measures the temperature of a system.		Temperature – degree or intensity of heat present in a substance or object, especially as expressed according to a comparative scale and shown by a thermometer or perceived by touch Average kinetic energy – Each molecule will have (or move with) difrrent speed of movement. In order to study the nature of gas, we need to calculate the average speed of the sample (taking avg. Of kinetic energy of each molecule) Thermometer – instrument for measuring and indicating temperature	Scale, proportion, and quantity Energy and matter

ICP.5.4 Distinguish "temperature" from "thermal energy," compare and contrast the Fahrenheit, Celsius, and Kelvin temperature scales, and convert temperatures between them.		Thermal energy – internal energy of an object due to the kinetic energy of its atoms and/or molecules Fahrenheit – of or denoting a scale of temperature on which water freezes at 32° and boils at 212° under standard conditions Celsius – of or denoting a scale of temperature in which water freezes at 0° and boils at 100° under standard conditions Kelvin – the SI base unit of thermodynamic temperature, equal in magnitude to the degree Celsius	Scale, proportion, and quantity Systems and system models
ICP.5.5 Evaluate graphical or pictorial representations that describe the relationship among the volume, temperature, and number of molecules and the pressure exerted by the system to qualitatively and quantitatively describe how changing any of those variables affects the others.		Volume – the amount of space that a substance or object occupies, or that is enclosed within a container molecules – a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction Pressure – continuous physical force exerted on or against an object by something in contact with it	Patterns Stability and change
ICP.5.6 Describe and demonstrate how the kinetic theory can be extended to describe the properties of liquids and solids by introducing attractive forces between the particles.		Kinetic theory – physical properties of matter in terms of the motions of its constituent particles Liquids – state of matter that flowing freely but of constant volume Solids – state of matter that is firm and stable in shape; not liquid or fluid Constant volume and shape Attractive force – residual attractive or repulsive forces between molecules or atomic groups that do not arise from a covalent bond, or electrostatic interaction of ions or of ionic groups	Systems and system models

ICP.5.7 Analyze a heating / cooling curve to describe how adding or removing thermal energy from a system changes the temperature or state of an object and be able to identify the melting and freezing temperatures of the system.		Heating/cooling curve – line graph that represents the change of phase of matter, typically from a gas to a solid or a liquid to a solid. The independent variable (X-axis) is time and the dependent variable (Y-axis) is temperature Melting temperature– temperature at which a given material changes from a solid to a liquid, or melts Freezing temperature– temperature at which a liquid changes into a solid; the same temperature as the melting point	Cause and effect Energy and matter
ICP.5.8 Collect and use experimental data to determine the number of items in a sample without actually counting them and qualitatively relate this to Avogadro's hypothesis.		Avogadro's hypothesis – Equal volumes of different gases at the same temperature and pressure contain the same number of molecules	Systems and system models

Standard 6: Describing Substances			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.6.1 Distinguish between elements, mixtures, and compounds based on their composition and bonds and be able to construct or sketch particle models to represent them.		Elements – each of more than one hundred substances that cannot be chemically interconverted or broken down into simpler substances and are primary constituents of matter. Each element is distinguished by its atomic number, i.e., the number of protons in the nuclei of its atoms. Mixtures – multiple elements/compounds physically mixed but not chemically bonded, where each maintains its own unique characteristics Compounds – a pure substance composed of two or more elements whose composition is constant. Composition – the nature of something's ingredients or constituents; the way in which a whole or mixture is made up. Ratio of the various components Bonds – Any of several forces, especially the ionic bond, covalent bond, and metallic bond, by which atoms or ions are bound in a molecule or crystal. Particle models – representation of atoms of elements coming together to form compounds	Patterns Systems and system models
ICP.6.2 Develop graphical and mathematical representations to show that mixtures can be made in any proportion and separated based on the properties of the components of the mixture and apply those representations to quantitatively determine the ratio of components.		Ratio – the quantitative relation between two amounts showing the number of times one value contains or is contained within the other	Scale, proportion, and quantity

ICP.6.3 Cite the evidence that supports the idea that some pure substances are combined of elements in a definite ratio, as for example seen in electrolysis of water.		Pure substances – material that is composed of only one type of particle	Systems and system models Structure and function
ICP.6.4 Given the periodic table, determine the atomic mass, atomic number, and charges for any element.		Periodic table – table of the chemical elements arranged in order of atomic number, usually in rows, so that elements with similar atomic structure (and hence similar chemical properties) appear in vertical columns Atomic mass – mass of an atom of a chemical element expressed in atomic mass units. It is approximately equivalent to the number of protons and neutrons in the atom (the mass number) or to the average number allowing for the relative abundances of different isotopes Atomic number – number of protons in the nucleus of an atom, which determines the chemical properties of an element and its place in the periodic table Charges – an excess or deficiency of electrons in a body	Systems and system models Structure and function
ICP.6.5 Given a periodic table, understand and describe the significance of column location for the elements by calculation of molar ratios of known compounds.		Molar ratios – ratio of moles of one substance to the moles of another substance in a balanced chemical equation	Patterns Scale, proportion, and quantity
ICP.6.6 Develop graphical and mathematical representations that describe the relationship between volume and mass of an object, describe the slope in terms of the object's density, and apply those representations to qualitatively and quantitatively determine the mass or volume of any object.		Density – quantity of mass per unit volume	Scale, proportion, and quantity Structure and function

ICP.6.7 Describe how both density and molecular structure are applicable in distinguishing the properties of gases from those of liquids and solids.		Molecular structure – arrangement of chemical bonds between atoms in a molecule (or in an ion or radical with multiple atoms), specifically which atoms are chemically bonded to what other atoms with what kind of chemical bond, together with any information on the geometric shape of the molecule needed to uniquely identify Gases – fluid substance which expands freely to fill any space available, irrespective of its quantity.	Scale, proportion, and quantity Structure and function

Standard 7: Representing Chemical Change			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.7.1 Pictorially or mathematically represent chemical changes using particle diagrams and chemical equations.		Chemical changes – change that results in the formation of new chemical substances. At the molecular level, chemical change involves making or breaking of bonds between atoms Chemical equations – symbolic representation of a chemical reaction in the form of symbols and formulae, wherein the reactant entities are given on the left-hand side and the product entities on the right-hand side	Patterns Structure and function
ICP.7.2 Demonstrate the Law of Conservation of Matter in terms of atoms and mass of substances by balancing equations.		Law of conservation of matter – any closed system subjected to no external forces, the mass is constant irrespective of its changes in form; the principle that matter cannot be created or destroyed Atoms – the basic unit of a chemical element Balancing equations – number of the atoms involved in the reactants side is equal to the number of atoms in the products side	Scale, proportion, and quantity Structure and function

ICP.7.3 Differentiate the basic types of reactions, for example: synthesis, decomposition, combustion, single replacement, and double replacement.		Synthesis – chemical reaction in which two or more simple substances combine to form a more complex product Decomposition – separation of a chemical compound into elements or simpler compounds Combustion – exothermic reaction in which something reacts with oxygen. The combustion of organic compounds usually takes the form organic compound + oxygen => water + carbon dioxide Single replacement – chemical reaction when an element or ion moves out of one compound and into another - that is, one element is replaced by another in a compound Double replacement – cations and anions switch between two reactants to form new products	Patterns Systems and system models
ICP.7.4 Using balanced equations and stoichiometric calculations, demonstrate the principle of Conservation of Matter in terms of atoms and mass.		Stoichiometric calculations – relationship between the relative quantities of substances taking part in a reaction or forming a compound, typically a ratio of whole integers, relating various amounts/values amongst a chemical reaction.	Scale, proportion, and quantity

Standard 8: Electricity and Magnetism			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.8.1 Describe electrical current in terms of the motion of electrons within a device and relate the rate of motion of the electrons to the amount of current measured.		Electrical current – flow of electric charge Electrons – stable subatomic particle with a charge of negative electricity, found in all atoms and acting as the primary carrier of electricity in solids	Systems and system models Energy and matter

ICP.8.2 Describe the relationship among voltage, current, and resistance for an electrical system consisting of a single voltage source and a single device.		Voltage – electromotive force or potential difference expressed in volts Current – time rate of flow of electric charge, in the direction that a positive moving charge would take and having magnitude equal to the quantity of charge per unit time: measured in amperes Resistance – property of a conductor by virtue of which the passage of current is opposed, causing electric energy to be transformed into heat: equal to the voltage across the conductor divided by the current flowing in the conductor: usually measured in ohms. Electrical system – network of electrical components used to supply, transfer and use electric power	Systems and system models Energy and matter
ICP.8.3 Describe on a macroscopic scale how any distribution of magnetic materials (e.g. iron filings, ferrofluid, etc.) aligns with the magnetic field created by a simple magnet.		Macroscopic scale – visible to the naked eye; not microscopic Magnetic materials – materials studied and used mainly for their magnetic properties Magnetic field – a region around a magnetic material or a moving electric charge within which the force of magnetism acts	Energy and matter

Standard 9: Waves			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.9.1 Develop qualitative particle models of mechanical waves and explain the relationship of the particles and their interactions in transverse and longitudinal waves, as well as, how waves appear in nature as in water waves and tsunamis,		Mechanical waves – oscillation of matter, and therefore transfers energy through a medium Transverse waves - a wave vibrating at right angles to the direction of its propagation Longitudinal waves – a wave vibrating in the direction of propagation	Cause and effect Systems and system models

ground waves in earth quakes, and sound waves.			
ICP.9.2 Develop and apply a simple mathematical model regarding the relationship among frequency, wavelength, and speed of waves in a medium as well.		Frequency – measurement of the number of times that a repeated event occurs per unit of time Wavelength – distance between waves, distance for one wave to complete Speed – distance a wave travels per unit time Medium – substance that makes possible the transfer of energy from one location to another	Cause and effect
ICP.9.3 Qualitatively describe the reflection and transmission of a mechanical wave at either a fixed or free boundary or interface.		Reflection – process by which a wave, whether light, sound, infrared, or radio waves, hits an object and bounces off it Transmission – allow the passage of (particles, energy, etc) Mechanical wave – wave that is an oscillation of matter, and therefore transfers energy through a medium Fixed boundary – medium is not allowed to move at the boundary point Free boundary – medium is allowed to move at the boundary point	Cause and effect Systems and system models
ICP.9.4 Describe how interacting waves produce different phenomena than singular waves in a medium(e.g. periodic changes in volume of sound or resonance)		Resonance – reinforcement or prolongation of sound by reflection from a surface or by the synchronous vibration of a neighboring object	Energy and matter
ICP.9.5 Describe and provide examples of how modern technologies use mechanical or electromagnetic waves and their interactions to transmit information.		Mechanical wave – wave that is an oscillation of matter, and therefore transfers energy through a medium Electromagnetic waves – electric field couples with a magnetic field	Systems and system models

Standard 10: Nuclear Energy			
Indiana Academic Standard	**Clarifying Statement**	**Highlighted Vocabulary Words from the Standard Defined**	**Crosscutting Concept**
ICP.10.1 Describe and compare/contrast the atomic models suggested by Rutherford and Bohr.		Atomic models – simple explanation/visual of the structure of an atom Rutherford – atom is mostly empty space, with electrons orbiting a fixed, positively charged nucleus in set, predictable paths Bohr – electrons orbit the nucleus at set distances. When an electron changes orbits, it does so in a sudden quantum leap	Patterns Systems and system models
ICP.10.2 Describe the model of the atomic nucleus and explain how the nucleus stays together in spite of the repulsion between protons.		Atomic nucleus – positively charged central core of an atom, consisting of protons and neutrons and containing nearly all its mass Protons – stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron, but of opposite sign	Systems and system models Structure and function
ICP.10.3 Develop and apply simple qualitative models or sketches of the atomic nucleus that illustrate nuclear structures before and after undergoing fusion, fission, or radioactive decay.		Fusion – process or result of joining two or more things together to form a single entity Fission – action of dividing or splitting something into two or more parts Radioactive decay – transformation of an unstable atomic nucleus into a lighter one, in which radiation is released in the form of alpha particles, beta particles, gamma rays, and other particles	Cause and effect Stability and change
ICP.10.4 Distinguish between fusion, fission, and radioactivity and qualitatively compare the amount of energy released in these processes.			Systems and system models

Crosscutting Concepts

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.