

Physical Science Concepts and Skills Mastery Chart

9.1.1.1.2

Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
		<u>Understand</u> ...or	
		<u>Explain</u> ...or	<u>Explain</u> is added as higher order skill than <u>Understand</u> .
		<u>Demonstrate</u>	<u>Demonstrate</u> is added as higher order skill than <u>Understand</u> .
	... that scientists conduct investigations...	←	
	1) to discover new aspects of natural worlds		

9.1.1.1.6

Describe how change in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Scientific Knowledge	There is a body of existing scientific knowledge		Students could describe how researchers at CERN are working with scientists from universities around the world and rely on research that has been done by other scientists before them.
Describe		Scientists work together and share research in order to further the body of knowledge available to all scientists.	

Change	Change is often incremental		Pretend you are Rutherford and write a letter to Dalton explaining how you used his research to arrive at his model, and why it is better.
Describe		Identify a discovery that led to another similar discovery and how the first discovery was necessary.	
	2) to explain observed phenomena		
	3) to test the conclusions of prior investigations		
	4) to test the predictions of current theories		

9.1.1.2.1

Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations and draw conclusions supported by evidence from the investigation.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Design and Conduct an experiment	1. Formulate and Test a hypothesis.	<ul style="list-style-type: none"> • Make observations • Use observations to generate questions • Use observations to propose answers 	Design and conduct an experiment
	2. Design an experiment	<ul style="list-style-type: none"> • Variable to change or manipulate • Identify what variable to measure • Identify conditions that are constant 	
	3. Conduct experiment	<ul style="list-style-type: none"> • Use appropriate safety to measure, collect and 	

		record data; organize data	
	4. Analyze data	<ul style="list-style-type: none"> Use appropriate representation to communicate results 	
	5. Make a conclusion	Use evidence to support a claim	

9.1.2.1.1

Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	That engineering designs are a process	Design a engineering solution (prototype) Test the solution (product, design)	
	That engineering designs are critiqued	Critique designs/products of classmates	
	Risks cost benefits are associated with engineering designs	Propose alternative for peer designs Redesign engineering solutions Calculate cost of engineering solution	

9.1.2.2.2

Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Multiple Solutions	There is always more than		Complete engineering design project that evaluate

	one solution		multiple solution
	But the solution vary in effectiveness		
Develop	What design specs are		Description of what problems must be overcome to find solution
Develop		Imagine/create multiple solutions	2+ solutions to stop an egg from breaking when dropped from 2meters.
Evaluate		Judge effectiveness conceptually	Research how parachutes size and material affect fall speed
Evaluate		Judge effectiveness physically	Multiple egg drops to observe physical results of solution
Evaluate		Judge effectiveness mathematically	Calculate the kinetic energy of each prototype
Analyze		Compare each solution effectiveness in solving problems	Combine conceptual, physical and mathematical evaluation to determine which solution best meet design specs.

9.1.3.1.1

Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Describe		Explain how systems function.	
Systems	Systems are the boundaries, subsystems, and relationships among and between specific inputs and respective outputs.		
Specify	Parts of systems	Specify between boundaries and subsystems of a larger system.	Complete a concept map that Identifies a subsystem in a power plant (cooling systems, generators, etc.) and describes how it is a part of

			the system of the power plant as a whole.
Boundaries and Subsystems	Systems have boundaries and are made up of smaller subsystems.		
	Subsystems play specific roles in larger systems.		
Identify	Relationships between different parts of systems.		Student can accurately predict the effects of a dam on the flow of a river.
Inputs / Outputs	Inputs into systems produce specific and predictable outputs		
	Inputs / Outputs include transfers of energy as well as physical , and chemical changes.		

9.1.3.3.1

Describe how values and constraints affect science and engineering.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Describe	Science and engineering projects have to be changed because they are constrained by available resources, economics, safety, politics and philosophical values.		
values		Recognize that societal norms, safety issues, environmental impact, and other values might require a science or engineering	Create a pros/cons list regarding the amount of Explain why a proposed experiment is unethical

		project to be rethought	
constraints		Recognize that available resources, cost, laws, and benefits might require a science or engineering project to be rethought.	Create a project using a set of materials Explain how a proposed experiment is unrealistic. Evaluate the cost and benefits of a proposed experiment
affect		Do a cost/benefit analysis of a project based on the impact that it will have upon many different aspects of life.	Write the pros/cons of putting up different types of power plants.
Science/engineering			Design an experiment/project that takes into account both values and constraints in order to accomplish a goal

9.1.3.4.3

Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	What are numbers symbols pictures, graphs	How to use: Numbers, Symbols, Pictures, graphs	Write a balanced chemical equation like Photosynthesis or cell respiration
	How to select numbers, symbols pictures, graphs	Communicate: Scientific ideas, Procedures, Experimental results Relationships	Write a lab report graph interpret data
	Know: Relationships, Scientific ideas, Procedures, Experimental results		Make a graphic organizer that demonstrates the relation between part of a system. Ex. ecosystem

9.1.3.4.6

Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
		Analyze the utility of a modeling system.	Students will use a computer to model an electrical circuit. They will document what parts of the model are realistic or not and what parts of the model were useful or not useful.
		Compare and contrast various modeling systems.	Students will use two different modeling techniques to show plate tectonics. They will
	Models can be used to represent things		Students can give examples of different models. eg) globe for the earth, atom models for the elements,
	Models can be physical, conceptual, mathematical, or computer-based.		Students will work in groups to make at least two different methods to model the atom.
	Models can vary in their effectiveness for representation.		Students will explain how the models of the atom have changed over time as more effective models were developed.

9.2.1.1.3

Explain the arrangement of the elements on the Periodic Table, including the relationships among elements in a given column or row.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	The way in which elements in the Periodic Table are organized	Explain the relationship between elements in a column or row	Predict characteristics of an element based on its location in the periodic table
	The structure of an atom	Show the way in which elements change as you progress horizontally	

		vertically thought the periodic table	
	How an atoms structure determines it properties and reactivity	Explain the way in which the Periodic table is organized	
	What is the difference between a stable and unstable atom	Explain characteristics of an element based on its location in the periodic table	
	What is the What is the etween a stable at	Explain how isotopes are formed and the relationship between isotopes and radioactivity	

9.2.1.2.1

Describe the role of valence electrons in the formation of chemical bonds

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Valence Electrons	<ul style="list-style-type: none"> • Electron configuration • Outer most electrons 	<ul style="list-style-type: none"> • Be able to write out electron configurations • Be able to interpret how many valence electron for each group in the periodic table • Understand how the number of valence electrons governs reactivity of the elements 	
Chemical Bonds	<ul style="list-style-type: none"> • Octet Rule (needed to understand reactive of elements • Element give up or accept electrons in order to become stable • Attraction between ions result in the formation 	<ul style="list-style-type: none"> • Be able to predict whether element will undergo ionic or covalent bonding 	

	<ul style="list-style-type: none"> of an ionic bond Sharing of electrons leads to formation of covalent bonds 		
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9.2.1.2.3

Describe a chemical reaction using words and symbolic equations. Model employees

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	Students should have an understanding of arrangement of atoms, chemical bonds, and symbols	Students should understand and explain words and symbols and balance rearrange the equation	<p>Students should be able to demonstrate the chemical reaction and equation by using symbols and molecule and atoms for example</p> $2 \text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ <p>How many atoms of Hydrogen and oxygen make water? 2 atoms of H₂, 1 atom of O₂</p>

9.2.2.2.4

Use Newton's universal law of gravitation to describe and calculate the attraction between massive objects based on the distance between them.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Newton's universal law of gravitation	Newton's universal law of gravitation		
Describe		Describe attraction between massive objects based on distance	Conceptually compare how different sized planets attract objects differently
Calculate		Calculate attraction between massive objects based on distance	Calculate the weight of a person/object on a different planet in the solar system

9.2.3.2.2

Calculate and explain the energy, work and power involved in energy transfers in a mechanical system.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Energy	Kinetic Energy	Identify and calculate	Given velocity and mass calculate KE Identify when present in a scenario
	Gravitational Potential	Identify and calculate	Given height and mass calculate GPE Identify when present in a scenario
	Heat (Thermal)	Identify	Identify when present in a scenario
	Chemical Potential	Identify	Identify when present in a scenario
	Elastic (spring)	Identify	Identify when present in a scenario
	Light	Identify	Identify when present in a scenario
	Sound	Identify	Identify when present in a scenario
	Nuclear	Identify	Identify when present in a scenario
	Total Energy	Describe that total energy means to add together all the different forms of energy present.	Add up sums of energy in different forms of energy present in a scenario
	Transformation	Describe how energy can change forms	Identify energy transformation in a scenario
Conservation of Energy	Law of conservation of energy	Describe how energy is conserved during transformations	Calculate how much energy is lost to friction given initial GPE and initial KE =0 and final KE and final GPE =0 (Roller coaster example)
Work	$W = F \times d$ Work changes energy from one form to another.	Identify when work is done Calculate how much work is done.	Given force and distance calculate work Identify when work is done in a scenario
Power	Power is the rate of doing work	Calculate power. Compare objects with different powers	Given work and time calculate power Given weight and height of stairs and time compare the amount of power required.

9.2.4.1.1

Compare local and global environmental and economic advantages and disadvantages of generating electricity using various sources or energy.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
How electricity is generated	There are a number of different methods	Research – learn in detail about one or more methods	
Cost/benefit concept	No free lunch – always a trade off in some way	Pick a topic or specific energy – generation method – create list of pros and cons assigning some type of weight and label as local /global	Defend chosen generation method, by pointing out pros and cons, compare to other methods
Comparison		Use a more familiar commodity (Cell phone?) Do a cost/benefit analysis of several brands Class make generators, make wind – power elect. Generator	Write a summary of several methods, including pros and cons

9.3.1.1.5

Describe how experimental and observational evidence led to the theory of plate tectonics.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	Plate Tectonic Theory	Point out observational evidence that leads to plate tectonic theory	Identify Earth structures that are associated with various plate boundaries
			Model how Earth Structures are created by the various plate boundaries
			Show on a map where structures are associated with plate boundaries
			Explain experiment that led to tectonic theory

	Theory of plate tectonics		Explain and demonstrate
	Evidence (experimental and Observational)		Explain Wagner's findings and theories
		Describe plate tectonics	
		Describe plate tectonics evidence (observational)	Describe Hess' Methods and how did that lead to plate tectonics

9.3.2.1.2

Explain how the outward transfer of Earth's internal heat drives the convection circulation in the mantle to move tectonic plates.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
<p>Still needs to be completed</p>			

9.3.2.2.1

Explain how Earth's rotation, ocean currents, configuration of mountain ranges, and composition of the atmosphere influence the absorption and distribution of energy, which contributes to global climatic patterns

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
Explain		Explain how earth's rotation, ocean currents, configuration of mountain ranges, and composition of the atmosphere affect climate.	Predict how a change in ocean current would affect that climate of a particular region.
Earth's Rotation	Characteristics of earth's rotation and revolution around the sun.		
Ocean Currents	How ocean currents determine climate in different parts of the world		
Configuration of mountain ranges	Mountain ranges impede the path of weather systems and affect weather patterns of areas on either side of them.		
Composition of the atmosphere	Characteristics and functions of different layers of the atmosphere		
Absorption and Distribution of energy	Properties of earth systems that affect absorption and distribution of energy		
Global climate patterns			

9.3.3.2.3

Compare and contrast the environmental conditions that make life possible on Earth with conditions found on the other planets and moons of our solar system.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	<h1>Still needs to be completed</h1>		

9.3.3.3.1

Explain how evidence, including the Doppler shift of light from distant stars and cosmic background radiation, is used to understand the composition, early history and expansion of the universe.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
	<h1>Still needs to be completed</h1>		

9.3.4.1.2

Explain how human activity and natural processes are altering the hydrosphere, biosphere, lithosphere and atmosphere, including pollution, topography and climate.

Concept or Skill	What students should know	What students should do	Example of mastery of understanding for this course
<h1>Still needs to be completed</h1>			