pennsylvania
DEPARTMENT OF EDUCATION

Introduction

Science, Technology & Engineering, and Environmental Literacy & Sustainability (STEELS) Standards guide the study of the natural and human-made world through inquiry, problem-solving, critical thinking, and authentic exploration. This document displays a curriculum framework for Middle School Physical Science. It is designed to focus curriculum and teaching, provide guidance for multiple approaches to curriculum development, encourage less reliance on textbooks as curriculum, and avoid activity-oriented teaching without focus/purpose.

Science Long Term Transfer Goals

In support of the Curriculum Framework, Long Term Transfer Goals (LTTG) provide the overarching practices that ground the foundation for a robust curriculum; thus, all curriculum should relate to one or more of the LTTGs detailed below – as they highlight the effective uses of understanding, knowledge, and skill that we seek in the long run; i.e., what we want students to be able to do when they confront new challenges – both in and outside of school.

Students will be able to engage as technological and engineering literate members of a global society, using their learning to:

1. Approach science as a reliable and tentative way of knowing and explaining the natural world and designed world.
2. Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions.
3. Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions.
4. Evaluate systems, in order to connect how form determines function and how any change to one component affects the entire system.
5. Explain how the natural and designed worlds are interrelated and the application of scientific knowledge and technology can have beneficial, detrimental, or unintended consequences.

Grade 6-8 Physical Science

Structure and Properties of Matter

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
All forms of matter exist as a result of the combination or rearrangement of atoms.	How do particles combine to form the variety of matter one observes?	**3.2.6-8.A** **Develop models to describe the atomic composition of simple molecules and extended structures.**	**Developing and Using Models** Develop a model to predict and/or describe phenomena.	Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	**Scale, Proportion, and Quantity** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small	atoms molecules bonding compounds elements predict phenomena substance scale models
All forms of matter exist as a result of the combination or rearrangement of atoms.	How do particles combine to form the variety of matter one observes?	**3.2.6-8.B** **Develop a model that predicts and describes changes in the particle motion, temperature and state of a pure substance when thermal energy is added or removed.**	**Developing and Using Models** Develop a model to predict and/or describe phenomena.	Gasses and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	**Cause and effect** Relationships may be used to predict phenomena in natural or designed systems.	gas liquid solid molecular motion temperature thermal energy heat phase change pressure temperature potential energy kinetic energy pure substance

				The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary) The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system,		

				and the state of the material. (secondary)		

Chemical Reactions

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
The atoms of some substances combine or rearrange to form new substances that have different properties.	How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?	**3.2.6-8.C** **Gather and make sense of information to describe how synthetic materials come from natural resources and impact society.**	**Obtaining, Evaluating, and Communicating Information** Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence.	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	reactants molecules substance synthetic material natural resource structure and function properties materials
The atoms of some substances combine or rearrange to form new substances that have different properties.	How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?	**3.2.6-8.D** **Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred**	**Analyzing and Interpreting Data** Analyze and interpret data to determine similarities and differences in findings.	Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic level structure.	reactants products precipitate chemical reaction mixture compounds yields physical properties chemical properties patterns substance atoms molecules macroscopic microscopic

The atoms of some substances combine or rearrange to form new substances that have different properties.	How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?	**3.2.6-8.E** **Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.**	**Developing and Using Models** Develop a model to describe unobservable.	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change.	**Energy and Matter** Matter is conserved because atoms are conserved in physical and chemical processes.	chemical reaction conservation of mass open vs. close system yields reactants products matter models
The atoms of some substances combine or rearrange to form new substances that have different properties.	How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?	**3.2.6-8.F** **Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.**	**Constructing Explanations and Designing Solutions** Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.	Some chemical reactions release energy, others store energy.	**Energy and Matter** The transfer of energy can be tracked as energy flows through a designed or natural system.	chemical reactions thermal energy design device designed system natural system

Forces and Motion

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
A change in motion of interacting objects can be explained and predicted by forces.	How can one predict an object's continued motion, changes in motion, or stability?	**3.2.6-8.G** **Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.**	**Constructing Explanations and Designing Solutions** Apply scientific ideas or principles to design an object, tool, process or system.	For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).	**Systems and System Models** Models can be used to represent systems and their interactions - such as inputs, processes and output - and energy and matter flows within systems.	force net force balanced unbalanced Newton's laws design solution system models
A change in motion of interacting objects can be	How can one predict an object's continued motion,	**3.2.6-8.H** **Plan an investigation to provide evidence that**	**Planning and Carrying Out Investigations**	The motion of an object is determined by the sum of the forces acting on it; if the total	**Stability and Change** Explanations of stability and change in natural or designed	reference point force mass

explained and predicted by forces.	changes in motion, or stability?	**the change in an object's motion depends on the sum of the forces on the object and the mass of the object.**	Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.	systems can be constructed by examining the changes over time and forces at different scales.	acceleration motion dependent variable independent variable stability and change designed system

Types of Interactions

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
All forces between objects, regardless of size or direction, arise from only a few types of interactions.	What underlying forces explain the variety of interactions observed?	**3.2.6-8.I** **Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**	**Asking Questions and Defining Problems** Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.	magnetic force electric current electromagnetic cause and effect hypothesis scientific principles magnitude natural system designed system
All forces between objects, regardless of size or direction, arise from only a few types of interactions.	What underlying forces explain the variety of interactions observed?	**3.2.6-8.J** **Construct and present arguments using evidence to support the**	**Engaging in Argument from Evidence** Construct and present oral and written arguments	Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small	**Systems and System Models** Models can be used to represent systems and their interactions—such as inputs,	gravitational forces law of universal gravity mass weight

		claim that gravitational interactions are attractive and depend on the masses of interacting objects.	supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	except when one or both of the objects have large mass—e.g., Earth and the sun.	processes and outputs—and energy and matter flows within systems.	models empirical evidence energy flow matter flow inputs outputs
All forces between objects, regardless of size or direction, arise from only a few types of interactions.	What underlying forces explain the variety of interactions observed?	**3.2.6-8.K** **Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.**	**Planning and Carrying Out Investigations** Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can serve as the basis for evidence that can meet the goals of the investigation.	Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.	electric force magnetic force gravitational cause and effect experimental design

Definitions of Energy

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
Energy can be modeled as either motions of particles or as being stored in force fields.	What is energy?	**3.2.6-8.L** **Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass and speed of an object.**	**Analyzing and Interpreting Data** Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	**Scale, Proportion, and Quantity** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.	speed velocity acceleration kinetic energy mass proportional relationships graphical displays

Conservation of Energy and Energy Transfer

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
The total change of energy in any system is always equal to the total energy transferred into or out of the system.	What is meant by conservation of energy? How is energy transferred between objects or systems?	**3.2.6-8.M** **Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.**	**Constructing Explanations and Designing Solutions** Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.	Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. Energy is spontaneously transferred out of hotter regions or objects and into colder ones.	**Energy and Matter** The transfer of energy can be tracked as energy flows through a designed or natural system.	thermal energy temperature heat conductivity energy transfer kinetic energy systems natural system design cycle
The total change of energy in any system is always equal to the total energy transferred into or out of the system.	What is meant by conservation of energy? How is energy transferred between objects or systems?	**3.2.6-8.N** **Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**	**Planning and Carrying Out Investigations** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	**Scale, Proportion, and Quantity** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.	thermal energy energy transfer kinetic energy proportional relationships particles temperature
The total change of energy in any system is always equal to the total energy transferred into or out of the system.	What is meant by conservation of energy? How is energy transferred between objects or systems?	**3.2.6-8.O** **Construct, use, and present arguments to support the claim that when the kinetic energy**	**Developing and Using Models** Develop a model to predict and/or describe phenomena.	Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total	**Scale, Proportion, and Quantity** Time, space, and energy phenomena can be observed at various scales using models	kinetic energy temperature motion matter scale

		of an object changes, energy is transferred to or from the object.		energy of a system depends on the types, states, and amounts of matter present. The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	to study systems that are too large or too small.	model phenomena states of matter systems energy transfer sample

Relationship Between Energy and Energy Forces

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
Forces between objects can result in transfer of energy between these objects.	How are forces related to energy?	**3.2.6-8.P** **Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**	**Developing and Using Models** Develop a model to describe unobservable mechanisms.	A system of objects may also contain stored (potential) energy, depending on their relative positions. When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.	**Systems and System Models** Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.	energy potential energy electric force magnetic force gravitational force system models interactions inputs outputs mechanisms

Wave Properties

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
Waves are repeating patterns of motion that transfer energy and information without transferring matter.	What are the characteristic properties and behaviors of waves?	**3.2.6-8.Q** **Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**	**Using Mathematics and Computational Thinking** Use mathematical representations to describe and/or support scientific conclusions and design solutions.	A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	**Patterns** Graphs and charts can be used to identify patterns in data.	amplitude frequency crest trough wavelength patterns wave design solutions

Electromagnetic Radiation

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave pattern of changing electric and magnetic fields that interact with matter.	What is light? How can one explain the varied effects that involve light? What other forms of electromagnetic radiation are there?	**3.2.6-8.R** **Develop and use a model to describe how waves are reflected, absorbed, or transmitted through various materials.**	**Developing and Using Models** Develop and use a model to describe phenomena.	A sound wave needs a medium through which it is transmitted. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	**Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	waves frequency color light reflection transmission absorption models properties

Information Technologies and Instrumentation

Big Idea	Essential Question	Standard	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts	Vocabulary
Useful modern technologies and instruments have been designed based on an understanding of waves and their interactions with matter.	How are instruments that transmit and detect waves used to extend human senses?	**3.2.6-8.S** **Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.**	**Information Technologies and Instrumentation** Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	**Structure and Function** Structures can be designed to serve particular functions.	waves transmission structure and function design analog digital