St. Joseph Public Schools

Science Curriculum

Physical Science

2018 - 2019

Year at a Glance

Name of Unit	Learning Goals	Essential Standards
Measuring	1. Understand the branches of science and scope of physical science 2. Differentiate between science and technology 3. Understand how to measure length in meters, cm, and mm. 4. Convert in the metric system using the "stair-step" method 5. Understand how to measure mass using a triple-beam balance 6. Understand how to measure volume with a graduated cylinder and by multiplying l*w*h 7. Calculate and determine the density of objects	(Prerequisite) Understand how to measure length, mass, volume, and density
Motion	1. Understand difference between speed, velocity and acceleration 2. Identify variables and solve problems for speed and momentum 3. Use data to create a distance vs. time graph 4. Interpret distance vs. time graphs 5. Extrapolate graphs to make predictions 6. Understand momentum 7. Determine the speed of an object that is dropped using v=gt	(Prerequisite) Understand kinematics of motion in 1D and projectile motion

	8. Determine the distance an object will be when dropped from rest using d=1/2gt2 9. Draw components of a vector 10. Understand which component of a velocity vector changes for projectiles and why it changes	
Forces	1. Understand and apply Newton's 1st Law for objects at rest and in motion 2. Understand and solve problems using Newton's 2nd Law 3. Understand that acceleration is directly proportional to net force and inversely proportional to total mass 4. Calculate net force 5. Identify and determine the direction of a variety of forces on objects 6. Calculate weight on different planets using an object's mass and "g" on the planet 7. Understand how air resistance affects objects and how they reach terminal velocity 8. Compare objects in free-fall with air resistance and without air resistance 9. Understand Newton's 3rd Law 10. Identify Action-Reaction Pairs	(Prerequisite) Understand and Apply Newton's 1st Law of inertia 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 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
Energy and Momentum Conservation	1. Understand types of energy 2. Calculate kinetic energy of a particle 3. Calculate potential energy of a particle 4. Understand conservation of energy	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

	5. Identify various energy transformations 6. Use energy diagrams to identify energy transformations 7. Differentiate between work and power 8. Understand the law of conservation of momentum 9. Predict how particles will move in elastic and inelastic collisions	PS3-1 Create a computational model to calculate the change in the 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. 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 motions of particles (objects) and energy associated with the relative position of particles (objects).
Sound	1. Understand parts of a wave 2. Differentiate between longitudinal and transverse waves 3. Understand the relationship between period and frequency 4. Use v = frequency x wavelength to solve problems 5. Determine factors that affect the period of a pendulum 6. Understand how to create a standing wave 7. Understand that waves interfere 8. Understand and state examples of the doppler effect 9. Understand properties of sound waves 10. Understand resonance 11. Understand that beats are caused by interference 12. Understand how to change the pitch of musical instruments	HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Light	1. Interpret a model of the electromagnetic spectrum to rank waves in order of energy, frequency, and wavelength. 2. State several properties of electromagnetic waves 3. Understand primary and secondary colors for mixing light and pigments 4. Understand the law of reflection and applications of plane, concave and convex mirrors 5. Understand refraction and apply it to mirages 6. Determine the focal point of a concave and convex lens. 7. Draw ray diagrams to locate images 8. Label the parts of the eye and understand functions 9. Understand common eye problems	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. 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
Atomic Structure	1. Explain Rutherford's experiment and what he discovered. 2. Describe the size, location, and charge of each part of an atom (protons, neutrons, electrons) 3. Describe what an isotope is and can determine the number of proton and neutrons an atom has using a periodic table. 4. Can determine the number of protons, neutrons, and electrons an atom has based on the atomic number and atomic mass. 5. Draw a diagram of a "Bohr Atom" for any element through Argon by using a periodic table.	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

	6. Describe what a positive and negative ion is. 7. Explain how light is produced by an atom in terms of energy levels. 8. Explain why elements produce different colors when they are ignited.	
Electricity	1. Understand how current, voltage, and resistance are related. 2. Draw schematic diagrams 3. Compare series and parallel circuits 4. Understand parts of an atom 5. Understand charging by friction, conduction, and induction 6. Compare Coulomb's Law and the Universal Law of Gravitation 7. Draw Electric Field Diagrams 8. Understand how capacitors store charge and energy	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 object (Prerequisite) Use mathematical representations of Ohm's law to determine current
Magnetism	1. Understand that magnetism is caused by moving charges 2. Draw magnetic field lines for current-carrying wires and bar magnets 3. Understand electromagnetism and how current produces magnetic fields 4. Understand that changing magnetic fields produce voltage (electromagnetic inductions) 5. Describe conceptually how a motor and generator works 6. Compare energy conversions in a motor and generator. 7. Understand how power is transmitted to our homes.	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 and electric current 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

States of Matter	1. Understand the kinetic molecular theory as it relates to solids, liquids, and gases. 2. Understand how volume and pressure are related in gases (Boyle's Law) 3. Understand how temperature and pressure are related in gases (Charle's Law) 4. Understand Bernoulli's Principle as it relates to airplane wings, storms, and curve balls. 5. Convert between Kelvin, Celsius and Fahrenheit 6. Interpret graphs of Temperature of a substance vs. energy as it relates to the concepts of heat of fusion and heat of vaporization	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.
Molecular Structure	1. Understand that the periodic table is organized based on valence electrons 2. Understand how covalent bonds are formed. 3. Understand forces and energy in covalent bonds 4. Write chemical formulas 5. Understand molecular models and Lewis structures	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 HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
Chemical Reactions	1. Understand the difference between physical and chemical properties	HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction

	2. Identify signs of a chemical reactions 3. Understand the difference between endothermic and exothermic reactions 4. Determine whether an equation is balanced 5. Balance basic chemical equations 6. Understand the energy is needed to break bonds and energy is released when forming bonds	based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. 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. 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. HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Nuclear Reactions	1. Understand that new atoms are created during nuclear reactions 2. Understand the process of fusion and how it relates to stars 3. Understand the process of fission and how it relates to atomic bombs and nuclear power plants. 4. Understand how radioactive isotopes can be used for dating.	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 radioactive decay.

Science and Engineering Practices

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Unit 1: Measuring in the Physical Science Classroom

Unit overview: (Narrative description of unit purpose)
Students will be introduced to the topics of physical science and understand how to measure physical quantities. Students will be understand the difference between length, mass, volume, and density using the metric system and will be able to measure each of these in the lab setting. Students will use the stair-step system to convert within the metric system and use a chart to convert between the metric and english systems.

Learning Goals:

1. Understand the branches of science and scope of physical science
2. Differentiate between science and technology *(Patterns)*

3. Understand how to measure length in meters, cm, and mm. *(Scale, Proportion, and Quantity)*
4. Convert in the metric system using the "stair-step" method *(Scale, Proportion, and Quantity)*
5. Understand how to measure mass using a triple-beam balance *(Scale, Proportion, and Quantity)*
6. Understand how to measure volume with a graduated cylinder and by multiplying l*w*h *(Scale, Proportion, and Quantity)*
7. Calculate and determine the density of objects *(Scale, Proportion, and Quantity)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Length lab

*Students measure quantities in meters, centimeters, and millimeters *(#5 - Using Mathematics and Computational Thinking)*

2. Mass Lab

*Students measure 8 masses using a triple-beam balance *(#5 - Using Mathematics and Computational Thinking)*

3. Volume Lab

*Student measure volume 3 ways and measure volumes of colored water to create a rainbow *(#5 - Using Mathematics and Computational Thinking, #3 Carrying Out an Investigation)*

4. Density Lab

*Students determine the density of a square metal block, hooked mass, and certain volume of water *(#5 - Using Mathematics and Computational Thinking, #3 Carrying Out an Investigation)*

5. Metric Price is Right

*Students compete against each other to estimate physical quantities held up by the teacher *(#5 - Using Mathematics and Computational Thinking)*

6. Padlet

*Students use a program on the computer to create an interactive poster of one of the experiments they did in class. They need to summarize purpose, procedure, and results and include pictures *(#8 Obtaining, Evaluating, and Communicating Information)*

Time Span: (3 weeks)

Assessment: (Methods used for formative and summative)

Immediate feedback on assignments done in class - students correct for accuracy
White-board work for review
Metric "Price is Right"
Kahoot Review
Quizlet Vocabulary Practice
Quiz - on conversions & measuring length
Summative - Test on Measuring including a lab portion

Vocabulary and Key Concepts

Meter	Triple-Beam Balance	Volume
Graduated Cylinder	Liter	Kilogram
Density	Mass	Physical Science

Technology	Religion	centimeter
millimeter		

Unit 1:

Michigan Science Standards	
Essential	Extension
• Students differentiate between length, mass, volume, and density • Students can identify the units associated with length, mass, volume, and density • Students measure length, mass, and volume independently. • Students are able to use the stair-step system to convert between metric units	• Students are able to plan and carry out a lab to measure the density of an object using water displacement • Students can list several science courses and topics included in physical science • Students can differentiate between science, technology, and religion

Unit 2: Motion

Unit overview: (Narrative description of unit purpose)

The purpose of this unit is for students to understand basic terms of motion and differentiate between speed, velocity, and acceleration. Students will be introduced to creating line graphs by using distance vs. time data. They will need to interpret these graphs and relate them to a real life object that is moving. Students will learn to extrapolate data to make predictions. They will gain a general understanding of momentum. Students will need to identify variables to solve problems related to speed and momentum. Students will investigate free-fall and will solve for velocity and distance using free-fall equations. A review of order of operations, exponents, and square roots will be covered in order to do this. Finally students will gain a conceptual understanding of projectile motion and how air resistance affects the trajectory.

Learning Goals:

1. Understand difference between speed, velocity and acceleration *(Patterns)*
2. Identify Variables and solve problems for speed and momentum *(Patterns)*
3. Use data to create a distance vs. time graph *(Patterns)*
4. Interpret distance vs. time graphs *(Patterns)*
5. Extrapolate graphs to make predictions *(Patterns)*
6. Understand momentum *(Patterns)*
7. Determine the speed of an object that is dropped using v=gt *(Patterns)*
8. Determine the distance an object will be when dropped from rest using d=1/2gt2 *(Patterns)*
9. Draw components of a vector *(System and System Models)*
10. Understand which component of a velocity vector changes for projectiles and why it changes *(System and System Models)*

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Marble Lab
   *Students use a hotwheels ramp and photogate timers to determine the speed of a marble - *(Practice #3 Carrying out an investigation and #5 Using Mathematics and Computational Thinking)*

2. Reaction Time Lab
   *Students determine their reaction time using 2 different methods *(#5 - Using Mathematics and Computational Thinking)*

3. Picket Fence Lab
   *Students use a photogate timer and "picket fence" to determine the acceleration of gravity *(Practice #3 Carrying out an investigation, #4 Analyzing and Interpreting Data)*

4. Physics Interactive - Horizontal Projectile Motion
   *Students use a computer simulation to evaluate horizontal and vertical components of a projectile. They interpret data to determine how speed affects time of fall and horizontal range and determine a factor that affects time of fall. *(#3 - Planning and Carrying Out an Investigation, #4 - Analyzing and Interpreting Data)*

5. Red Rocket Lab
   *Students launch air-powered rockets at a variety of angles and record the range. They create a graph of the information and interpret results. *(#3 - Carrying Out an Investigation, #4 Analyzing and Interpreting Data)*

6. Classroom Demonstration - Graph Match
   *Students walk in front of a motion detector and try to match a distance vs. time graph
   (#4 Analyzing and Interpreting data)

7. Understanding the Sprint
   *Students complete a worksheet which requires them to determine speeds based on distance and time intervals and then create a graph of speed vs. time *(#5 Using mathematics and computational thinking)*

Time Span: (3 weeks)

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
White-board work for distance vs. time graphs
Kahoot Review
Quizlet Vocabulary Practice
Find Someone Who review sheet on Notesheets 1 &2
Quiz - on Notesheets 1 & 2
Summative - Test on Motion

Vocabulary and Key Concepts

Speed	Velocity	Instantaneous Speed
Acceleration	Momentum	Projectile
Free-Fall	Scalar	Vector
Distance	Displacement	Trajectory
Extrapolate	Photogate timer	Components
constant force		

Unit 2:

Michigan Science Standards

Essential	Extension
• Understand the difference between speed, velocity, and acceleration • Identify variables of distance, velocity, and time to solve problems using a "circle chart" • Identify variable of momentum, mass, and velocity to solve problems using a "circle chart" • Interpret distance vs. time graphs for objects that are stopped, walking, running, moving back at a constant speed, accelerating, decelerating • Plot points on a distance vs. time graph • Understand that momentum is mass in motion • Understand that objects in free-fall increase speed by 10 m/s each second and that gravity = 10m/s/s on earth's surface. • Solve free-fall problems to find v and d • Understand that objects in projectile motion increase speed vertically only • Extrapolate data • Differentiate between vectors and scalars	• State units of speed, velocity, and acceleration • Solve for velocity, distance, or time using the equation v=d/t • Draw a distance vs. time graph for objects that are moving. • Solve problems using p=mv • Solve free-fall problems to determine reaction time. • Identify and analyze horizontal and vertical components for projectiles • State examples of vectors and scalars

Unit 3: Forces and Newton's Laws

Unit overview: (Narrative description of unit purpose)
Students will gain an understanding of each of Newton's Three Laws and apply them to a variety of situations. They calculate net force by adding and subtracting and identify variables to solve for acceleration, mass, or Force. They will be introduced to the words direct relationship and inverse relationship. Students will be introduced to how to make a claim and support it with evidence. They will need to respectfully make an argument to other students to justify their position. Students will understand how to calculate Weight on different planets based on its acceleration due to gravity and see how air resistance affects particles. They will continue to create and interpret graphs. They will construct balloon and paper rockets and test them and apply Newton's three laws to their models.

Learning Goals:

1. Understand and apply Newton's 1st Law for objects at rest and in motion *(Patterns)*
2. Understand and solve problems using Newton's 2nd Law *(Patterns/Cause & Effect)*
3. Understand that acceleration is directly proportional to net force and inversely proportional to total mass *(Patterns)*
4. Calculate net force *(Patterns)*
5. Identify and determine the direction of a variety of forces on objects *(Patterns)*
6. Calculate weight on different planets using an object's mass and "g" on the planet *(Patterns)*
7. Understand how air resistance affects objects and how they reach terminal velocity *(Cause & Effect)*
8. Compare objects in free-fall with air resistance and without air resistance *(Cause & Effect)*
9. Understand Newton's 3rd Law *(Patterns)*
10. Identify Action-Reaction Pairs *(Patterns)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. pHet Computer Lab: Forces - Basics
   *students use a computer simulation to investigate net force *(#4 Interpreting Data, #5 Using Mathematical and Computational Thinking)*

2. Making a Claim & Supporting with Evidence
   *Students watch a video of a truck about to crash. They make a claim about what is going to happen and do research by looking at specific sites to gather evidence on Newton's 1st Law to support the claim *(#1 - Asking Questions, #6 Constructing Explanations, #7 Arguing from Evidence, #8 Obtaining and Evaluating Information)*

3. Physics Interactive - Rocket Sledder
   *Students use a computer simulation to understand the model of a free-body diagram and how forces such as an applied force, friction, and air resistance affect velocity *(#2 - Using and Revising a Model, #4 Analyzing and Interpreting Data)*

4. Lab: effect of Changing Mass on Acceleration
   *Students use a cart and mass set to determine how the mass of a cart affects the acceleration with a certain applied force. *(#3 Carrying Out an Investigation, #4 Analyzing and Interpreting Data, #5 Using Mathematical and Computational Thinking)*

5. Physics Interactive - Gravity
   *Students use a computer simulations to discover how mass and distance affect gravity *(#4-Analyzing and Interpreting Data)*

6. Lab: Coffee Filter & Air Resistance
   *Students use a coffee filter and motion detector to see the effect of mass on terminal velocity. *(#3 Carrying Out an Investigation, #4 Analyzing and Interpreting data)*

7. Lab: Balloon Rocket
   *Students use materials to construct a balloon rocket that can move along a string and get from one side of the room to another (#3 Planning and Carrying Out an Investigation, #2 Developing and Revising a Model)

8. Lab: Paper Rockets

*Students use materials to construct a rocket that is powered by alka-seltzer tablets in order for it to launch off a launch pad *(#3 Planning and Carrying Out an Investigation, #2 Developing and Revising a Model)*

Time Span: (3 weeks)

Assessment: (Methods used for formative and summative)

Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Find Someone Who review sheet on Notesheets 1, 2, 3
Quiz - on Notesheets 1 & 2
Summative - Test on Newton's Laws

Vocabulary and Key Concepts

Mass	Weight	Inertia
Net Force	Newton's 1st Law	Newton's 2nd Law
Newton's 3rd Law	acceleration	kilogram
Newton	air resistance	terminal velocity
tension	friction	force
action-reaction pairs	directly proportional	inversely proportional
Isaac Newton	drag	macroscopic
unbalanced force	velocity	

Unit 3:

Michigan Science Standards	
Essential	Extension
• State each of Newton's 3 Laws and apply to a situation • Identify forces • Determine Net Force • Understand factors that affect the force of gravity • Understand how air resistance affects a falling object • Identify the variables force, mass, and acceleration to solve for the unknown	• Identify action-reaction pairs of complex situations (weight/normal force) • Solve F=ma for more than one force • State what happens to velocity, acceleration, and air resistance for an object that is sky-diving for each position of the trip • List all the factors that affect friction and air resistance • Support arguments with several pieces of evidence

Unit 4: Energy and Momentum Conservation

Unit overview: (Narrative description of unit purpose)

In this unit students will identify types of energy and understand the law of conservation of energy. They will look at energy transformations through the use of energy diagrams. Discussion will take place on the importance of alternative energy. Students will look at a case study to determine if a wind farm is a good idea and analyze the pros and cons from a particular "stakeholders" perspective. Students will also understand the law of conservation of momentum and how it relates to particles in 1D (air track) and 2D (air pucks) for both elastic and completely inelastic collisions. Although a little algebra will be presented, the unit concentrates on a conceptual understanding of conservation principles.

Learning Goals:

1. Understand types of energy *(Energy and Matter)*
2. Calculate kinetic energy of a particle *(Energy and Matter)*
3. Calculate potential energy of a particle *(Energy and Matter)*
4. Understand conservation of energy *(Energy and Matter)*
5. Identify various energy transformations *(Energy and Matter)*
6. Use energy diagrams to identify energy transformations *(Energy and Matter/System and System Models)*
7. Differentiate between work and power *(Energy and Matter)*
8. Understand the law of conservation of momentum *(Patterns)*
9. Predict how particles will move in elastic and inelastic collisions *(Patterns)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. **Wind Energy Case Study**

*Students read a case study for starting a wind farm. Thinking from a stakeholder group, they record pros and cons and share their viewpoint. *(#7 Arguing from Evidence, #8 Obtaining and Evaluating Information)*

2. **Physics Interactive- Roller Coasters**
   *Students observe how speed, potential energy, and kinetic energy relate to a roller coaster. *(#4 Developing and Using Models)*

3. **Physics Interactive - Chart that Motion**
   Students analyze energy diagrams and match descriptions to sets of diagrams(#4 Developing and Using Models)*

4. **Interactive Physics Lab - Egg Drop**
   *Students systematically test egg size, height of drop, and surface type to determine what factors affect the breaking of an egg. *(#Analyzing and Interpreting Data)*

5. **Conservation of Energy Lab**
   *Students roll a superball down ramp and use photogater time to determine final velocity. They calculate the initial potential energy and compare it to the kinetic energy at the bottom. *(#2 Carrying out an investigation, #7 Using Mathematics and Computational Thinking)*

6. **Lab - Muscle Up**
   *Students physically do arm lifts and sit-ups for a certain time interval. Then they calculate the work and power done for each exercise and compare values. *(#2 Carrying out an investigation, #7 Using Mathematics and Computational Thinking)*

7. **Air Track Lab**
   *Students use an air track to predict and observe elastic and completely inelastic collisions for various masses *(#2 Carrying out an investigation, #6 Constructing Explanations)*

8. **Air Puck Class Activity**
   *Students predict what would happen in a variety of 1D and 2D collisions and then determine whether their predictions were correct. *(#2 Carrying out an investigation, #6 Constructing Explanations)*

Time Span: 3 weeks

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Quiz - energy conservation
Summative - Momentum and Energy Conservation
Verbal Questioning after completion of group labs
Find Someone Who Review
EdPuzzle Questions

Vocabulary and Key Concepts

Energy	Thermal Energy	Potential Energy
Kinetic Energy	Work	Power
Pendulum	Force	Newton
Joule	Watt	Momentum
Impulse	Law of Conservation of Energy	Law of Conservation of Momentum
Elastic Collision	Completely Inelastic Collision	Air Track
Friction		

Unit 4:

Michigan Science Standards	
Essential	Extension
• Identify several types of energy • Recognize transformations between potential, kinetic, and thermal energy • Interpret an energy diagram when 1 type of energy changes • State why alternative energy is beneficial • Understand the law of conservation of momentum conceptually for elastic and completely inelastic collisions • Understand that impulse causes a change in momentum • Calculate Work and Power if given in separate steps	• Calculate velocity when given a height. • Interpret energy diagrams when more than 1 type of energy changes • State several pros and cons of alternative energy • Determine final velocity in a completely inelastic collision • Explain why impulse and momentum are important for air bag use using time and force • Calculate Work and Power when given information in one large story problem

Unit 5: Waves and Sound

Unit overview:

Students will understand general properties of transverse and longitudinal waves. Students will gain a deeper understanding of sound including applications such as the doppler effect, resonance, and beats. Students will work on analyzing graphs, specifically identifying variables that affect the period of a pendulum. They will be introduced to creating graphs using a spreadsheet. The will also be introduced to claim, evidence reasoning when experimenting with tuning forks.

Learning Goals:

1. Understand parts of a wave *(Models)*
2. Differentiate between longitudinal and transverse waves *(Structure and Function)*
3. Understand the relationship between period and frequency *(Patterns)*
4. Use v = frequency x wavelength to solve problems *(Patterns)*
5. Determine factors that affect the period of a pendulum *(Cause and Effect)*
6. Understand how to create a standing wave *(Models)*
7. Understand that waves interfere *(Cause and Effect)*
8. Understand and state examples of the doppler effect *(Cause and Effect)*
9. Understand properties of sound waves *(Structure and Function)*
10. Understand resonance *(Cause and Effect)*
11. Understand that beats are caused by interference *(Cause and Effect)*
12. Understand how to change the pitch of musical instruments *(Cause and Effect*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Pendulum Lab - students test 3 variables that might affect the period of a pendulum: mass, amplitude, and length *(#2 Carrying out an investigation; #4 Analyzing and Interpreting Data)*
2. Graphing: Students create graphs for the pendulum lab using computer software (google sheets) *(#5 Using Mathematics and Computational Thinking)*

3. Microphone Lab - students compare waves from their voice and tuning fork using a microphone and computer graphing software. They determine the frequency of the wave. *(#2 Developing and Using Models; #5 Using Mathematics and Computational Thinking)*
4. Speed of Sound Lab - students use a tuning fork and resonance tube to determine the speed of sound by using v=frequency x wavelength *(#3 Carrying Out Investigation #5 Using Mathematics and Computational Thinking)*
5. Computer simulation: Pendulum Activity (students determine how length affects the period of a pendulum and create a graph by hand. *(#2 Using Models,#4 Analyzing and Interpreting Data)*
6. Computer simulation: slinkies - students look at types of waves, frequency, amplitude and interference *(#2 Using Models)*
7. Understanding phenomena: Sound - students use tuning forks to observe various properties of sound then use claim, evidence reasoning to explain what causes different pitches *(#3 Carrying out Investigations, #6 Constructing Explanations)*

Time Span: (3 weeks)

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Quiz - parts of a wave
Summative - Sound and Waves
Verbal Questioning after completion of group labs
EdPuzzle Questions

Vocabulary and Key Concepts

period	decibel	transverse
compression	supersonic	ultrasonic
crest	doppler effect	shock wave
destructive interference	frequency	longitudinal wave
amplitude	wavelength	hertz
constructive interference	trough	rarefaction
standing wave	infrasonic	beats

Unit 5:

Michigan Science Standards	
Essential	Extension
• Understand several wave properties (parts, period, frequency, reflection, interference, doppler effect, beats, resonance) for both transverse and longitudinal (sound) waves. • Use v = frequency x wavelength to solve problems	• Make claims regarding each of these properties and state two pieces of evidence. • Apply properties of sound to explain how various musical instruments function

Unit 6: Light

Unit overview:

Students will understand the electromagnetic spectrum and properties of photons. They will determine and explain which waves are dangerous. Students will look at many properties of light including mixing colored light to produce secondary colors, understanding the law of reflection, and understanding refraction. Students will use ray diagrams to locate real and virtual images. Light boxes are used for several labs, with an emphasis on drawing rays to understand how they are reflected and refracted. Students will understand the function of the eye and which lenses can be used to correct defects.

Learning Goals:

1. Interpret a model of the electromagnetic spectrum to rank waves in order of energy, frequency, and wavelength. *(Models)*
2. State several properties of electromagnetic waves *(Models)*
3. Understand primary and secondary colors for mixing light and pigments *(Patterns)*
4. Understand the law of reflection and applications of plane, concave and convex mirrors *(Patterns)*
5. Understand refraction and apply it to mirages *(Patterns)*
6. Determine the focal point of a converging and diverging lens. *(Models)*
7. Draw ray diagrams to locate images *(Models)*
8. Label the parts of the eye and understand functions *(Models/Structure and Function)*
9. Understand common eye problems *(Structure and Function)*

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Color Lab - Students use colored filters to understand secondary colors and complementary colors *(#3 Carrying out an Investigation, #6 Constructing explanations)*
2. Reflection Lab- Students use a light box and plane mirror to use the law of reflection to locate an image. They use a concave mirror to determine the focal point of the mirror. *(#3 Carrying out an Investigation, #2 Using Models)*

3. Refraction Lab - Students use a light box and plastic shapes to observe refraction *(#3 Carrying out an Investigation, #2 Using Models)*
4. Lens Lab - Students use a light box, converging lens, and diverging lens to determine focal points. *(#3 Carrying out an Investigation, #2 Using Models)*
5. Candle Lab - Students use a lens and candle to observe real images and see how placement of the object affects the size of the image *(#3 Carrying out an Investigation, #4 Interpreting data)*
6. Are Cell Phones dangerous? - Students read an article regarding electromagnetic waves to examine whether cell phones produce dangerous radiation. *(#7 Obtaining, Evaluating, and Communicating Information)*
7. Computer Simulation - Ray Diagrams - students compare images produced by a concave mirror, converging lens, and diverging lens *(#2 Using Models, Analyzing and Interpreting Data)*
8. Light: Particle or Wave? - students look at several online sources to examine properties of light and categorize the properties as either a "particle" or "wave" *(#6 Constructing Explanations and #7 Engaging in Argument from Evidence)*

Time Span: 3 weeks

Assessment: (Methods used for formative and summative)

Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Light
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

electromagnetic spectrum	gamma	x-rays

Ultraviolet (UV)	visible spectrum	infrared (IR)
microwaves	radio waves	long radio waves
ionizing radiation	non-ionizing radiation	primary colors of light
secondary colors	complementary colors	pigment
law of reflection	incident beam	reflected beam
refraction	converging lens	diverging lens
focal point	concave mirror	convex mirror
plane mirror	cornea	retina
blind spot	optic nerve	lens
iris	astigmatism	nearsighted
farsighted	upright	inverted
real image	virtual image	photon

Unit 6:

Michigan Science Standards	
Essential	Extension
• Students understand properties of photons and interpret a diagram of the electromagnetic spectrum • Students understand properties of light including mixing primary colors to produce secondary colors, the law of reflection, refraction • Students understand parts and function of the eye • Students understand how lenses and mirrors focus light and create images	• Students draw accurate ray diagrams to produce images • Students can explain how which lenses can be use to correct vision problems • students can explain the difference between an optometrist and opthamologist

Unit 7: Atomic Structure

Unit overview:

The focus of this unit is for students to understand the parts, location, and purpose of the particles that make up an atom. Students will analyze the models of the atom described by Thomson, Rutherford, and Bohr. Students will use the periodic table and isotopic notation to determine the number of protons, electrons, and neutrons in an atom. PHet simulations are used as a guide for modeling the atom.

Learning Goals:

1. Explain Rutherford's experiment and what he discovered. *(System Models)*
2. Describe the size, location, and charge of each part of an atom (protons, neutrons, electrons) *(Scale, Proportion, Quantity)*
3. Describe what an isotope is and can determine the number of proton and neutrons an atom has using a periodic table.*(Structure and Function)*
4. Can determine the number of protons, neutrons, and electrons an atom has based on the atomic number and atomic mass. *(Structure and Function)*
5. Draw a diagram of a "Bohr Atom" for any element through Argon by using a periodic table.*(System Models)*
6. Describe what a positive and negative ion is. *(Structure and Function)*
7. Explain how light is produced by an atom in terms of energy levels. *(Energy and Matter)*
8. Explain why elements produce different colors when they are ignited *(Energy and Matter)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Emission Spectrum - students use a diffraction grating to observe spectral lines of various gases to identify elements. *(#4- Analyzing and Interpreting data)*
2. Flame Test - Teacher burns several solutions and students write qualitative observations regarding the flame color. Students use results to predict other elements. *(#3 -Planning and Carrying out Investigations)*
3. Build an Atom - students use a pHet simulation to determine how protons, neutrons, and electrons affect the element, stability and charge of an atom *(#2 - Developing and Using Models)*

4. Bead Activities - pre-made strings with colored beads represent atoms with specific protons, neutrons, and electrons. Students count the beads and write the atoms in isotopic notation. *(#2 Developing and Using Models)*

Time Span: (2.5 weeks)

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Atomic Structure
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

atom	electron	proton
nucleus	neutron	ion
Rutherford	Gold Foil Experiment	Thomson's Model
isotope	atomic number	mass number
energy	photon	spectroscope

Unit 7:

Michigan Science Standards	
Essential	Extension

Unit 8: Electricity

Unit overview:

In this unit students are introduced to the basic structure of the atom so they can understand how objects are electrically charged on a microscopic and macroscopic level. Students will see demonstrations of how objects are charged by friction, conduction, and induction using charged rods and the Van de Graff. Students will gain a conceptual understanding of Coulomb's Law by comparing it to the Universal Law of Gravitation using a Venn Diagram. Students will draw schematic diagrams and create series and parallel circuits to compare bulb brightness. Students will understand how capacitors are used to store energy. Students will use Ohm's Law to solve problems with current, voltage and resistance.

Learning Goals:

1. Understand parts of an atom *(Scale, Proportion and Quantity)*
2. Understand charging by friction, conduction, and induction *(Stability and Change)*
3. Compare Coulomb's Law and the Universal Law of Gravitation *(Patterns*)
4. Draw Electric Field Diagrams *(Models)*
5. Understand how capacitors store charge and energy *(Energy and Matter)*
6. Understand how current, voltage, and resistance are related. *(Patterns)*
7. Draw schematic diagrams *(Models)*
8. Compare series and parallel circuits *(Patterns)*

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Computer Activity: Coulomb's Law interactive - students determine the relationship between charge and force and distance and force and graph using google forms *(#4 Analyzing and Interpreting Data)*
2. Computer Activity - Electric Field interactive - students observe electric field lines for combinations of positive and negative charges *(#2 Developing and Using Models)*
3. Scotch Tape Lab - students charge pieces of tape and balloons and use reasoning to determine which is positive and negative *(#3 Planning and Carrying Out Investigation)*
4. Battery/Bulb activity - students are given one battery, one wire, and one bulb and are challenged to get it to light. *(#3 Planning and Carrying Out Investigation)*
5. Capacitor Lab - students use a hand crank generator, bulb and capacitor to discover what a capacitor does *(#3 Planning and Carrying Out Investigation)*
6. Series circuit lab - students create series circuits with power sources and bulbs to discover what happens when more bulbs are added *(#3 Planning and Carrying Out Investigation)*
7. Parallel circuit lab - students create parallel circuits with power sources and bulbs to discover what happens when more bulbs are added *(#3 Planning and Carrying Out Investigation)*

Time Span: (2.5 weeks)

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Light
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

atom	electron	proton

nucleus	neutron	ion
molecule	charge by friction	charge by conduction
induction	capacitor	ohm
voltage	resistance	series circuit
parallel circuit	charge	coulomb
current	amp	insulator
conductor	parallel circuit	coulomb's law
ohm's law	terminal	switch
electric field		

Unit 8:

Michigan Science Standards	
Essential	Extension
• Understand parts of an atom (Nucleus, protons, neutrons, electrons) • Understand charging by friction, conduction, and induction • Compare Coulomb's Law and the Universal Law of Gravitation • Identify what is wrong with electric field diagrams • Understand that capacitors store charge and energy • Solve problems using ohm's law with a circle chart • Draw schematic diagrams • Compare series and parallel circuits	• Understand ions and molecules • Understand lightning and lightning rods • Solve problems using coulomb's law • Draw their own electric field diagrams • Understand HOW capacitors store energy • Solve problems with Ohm's Law using the formula V=IR

Unit 9: Magnetism

Unit overview: (Narrative description of unit purpose)

Students will gain a conceptual understanding of how magnetism and electricity are related. The emphasis is on practical applications of magnetism: motors, generators, transformers, power transmission, electromagnets, solenoids are explained. Students end the day with a one-day engineering challenge of creating a homopolar motor.

Learning Goals:

1. Understand that magnetism is caused by moving charges *(Cause and Effect)*
2. Draw magnetic field lines for current-carrying wires and bar magnets *(Models)*
3. Understand electromagnetism and how current produces magnetic fields *(Cause and Effect)*
4. Understand that changing magnetic fields produce voltage (electromagnetic inductions) *(Cause and Effect)*
5. Describe conceptually how a motor and generator works *(Patterns)*
6. Compare energy conversions in a motor and generator. *(Energy)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Magnetism Activity - student use magnets and iron filings to understand aligned domains and magnetic field lines. *(#3 Planning and Carrying Out Investigation)*
2. Faraday's Law Activity - students use coils, a voltmeter, and bar magnet to create voltage by the process of electromagnetic induction *(#3 Planning and Carrying Out Investigation)*
3. Computer Activity - Faraday's Law - students use a pHet simulation to understand magnetic fields and electromagnetic induction *(#2 Developing and Using Models)*
4. Tiny Dancer Homopolar Motors - students watch videos and are given a battery, neodynium magnetic and wire and must create a working homopolar motor *(#3 Planning and Carrying Out Investigation)*

Time Span: 2 weeks

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Magnetism
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

magnetic pole	magnetic domain	north pole
south pole	transformer	fission
generator	iron	faraday's law
electromagnetic induction	motor	solenoid
electromagnet	voltmeter	voltage
current	charge	volt
amp		

Unit 9: Magnetism

Michigan Science Standards	
Essential	Extension
• understand that moving charges create magnetic fields - relate this to bar magnets and electromagnets • draw field lines for bar magnets • understand that changing magnetic fields create voltage - relate this to generators and transformers • understand energy transformations in motors and generators	• draw field lines for current-carrying wires • Understand how magnetism relates to sea-floor spreading • Understand the job of a geologist and how it relates to magnetism • Understand how plasma and CRT televisions work and relate to electricity and magnetism

Unit 10: States of Matter

Unit overview: (Narrative description of unit purpose)

A large emphasis of this unit is on modeling particle behavior in solids, liquids and gases. This model is used to understand how temperature, pressure, and volume are related in gases. Students utilize algebra skills in converting between temperature scales and there is a large emphasis on reading graphs to make predictions, (including graphs with multiple sets of data.) This unit is concluded with a hot air tissue balloon project. Students follow a pattern to create and launch balloons and then create a "padlet" of the building process. They must relate Boyle's Law, Charle's Law and Bernoulli's Principle to their balloons.

Learning Goals:

1. Understand the kinetic molecular theory as it relates to solids, liquids, and gases. *(Models)*
2. Understand how volume and pressure are related in gases (Boyle's Law) *(Patterns)*

3. Understand how temperature and pressure are related in gases (Charle's Law) *(Patterns)*
4. Understand Bernoulli's Principle as it relates to airplane wings, storms, and curve balls. *(Cause and Effect)*
5. Convert between Kelvin, Celsius and Fahrenheit *(Scale, Proportion, and Quantity)*
6. Interpret graphs of Temperature of a substance vs. energy as it relates to the concepts of heat of fusion and heat of vaporization *(Patterns)*

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Phase Changes Lab - Students start with ice and add heat until boiling. They create a temperature vs. time graph to understand at heat of fusion and heat of vaporization *(#4 Analyzing and Interpreting data)*
2. Specific Heat lab - students mix different temp. water with metal to understand water's high specific heat. *(#4 Analyzing and Interpreting data)*
3. Boyle's Law lab - students use a syringe a vernier pressure sensor to understand boyle's law and analyze graphs. *(#4 Analyzing and Interpreting data)*
4. Density Lab - students mix several liquids and solids to compare densities of substances *(#3 Planning and Carrying Out Investigation)*
5. Computer Activity - students use a pHet simulation to understand the kinetic molecular theory and charle's law. *(#2 Developing and Using Models)*
6. Hot Air Balloon Project - create and fly a tissue paper hot air balloon and relate gas laws to the balloon. *(#6 Constructing Explanations and Designing Solutions)*

Time Span: (Length of Unit) - 3 weeks

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review

Quizlet Vocabulary Practice
Summative - Atomic and Molecular Structure
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

specific heat	Melting Point	Evaporation
bimetallic strip	Condensation	sublimation
Bernoulli's Principle	freezing point	conduction
Kelvin	convection	radiation
Celsius	solid	liquid
fahrenheit	gas	plasma
Absolute Zero	ion	heat transfer
volume	boyle's law	charle's law
kinetic energy		

Unit 10: States of Matter

Michigan Science Standards

Essential •	Extension •

Unit 11: Molecular Structure

Unit overview: (Narrative description of unit purpose)

The focus of this unit is for students to understand why atoms form bonds based on their valence electrons and energy. PHet simulations are used as a guide for modeling the atom. Students will understand basic organization of the periodic table and how valence electrons impact bonding. Several models for bonding are introduced including electrons cloud simulations, structural representations, lewis structures, and 3D modeling kits. Students will be able to draw models of molecules based on the chemical formula.

Learning Goals:

1. Understand that the periodic table is organized based on valence electrons *(Patterns)*
2. Understand how covalent bonds are formed. *(Structure and Function)*
3. Understand forces and energy in covalent bonds *(Structure and Function)*
4. Write chemical formulas *(Patterns)*
5. Understand molecular models and Lewis structures *(Models)*

Engineering Practices:
(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. 3-D Modeling - students create models of molecules using a kit and identify their shape. *(#2 Developing and Using Models)*
2. Solubility Lab - students mix polar and nonpolar substances with other polar/nonpolar substances to determine and observe the level solubility *(#3 Planning and Carrying out an investigation)*

Time Span: (Length of Unit) - 2 weeks

Assessment: (Methods used for formative and summative)
Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Light
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

proton	electron	neutron
electron	energy	covalent bond
nucleus	molecule	valence electrons
polar	nonpolar	solution
solute	solvent	bent
dissolve	Lewis structure	linear
pyramidal	tetrahedral	
electron cloud		

potential energy	field	Bohr

Unit 11: Molecular Structure

Michigan Science Standards	
Essential •	Extension •

Unit 12: Chemical Reactions

Unit overview: (Narrative description of unit purpose)

The goal of this unit is to understand that new molecules are formed when a chemical reaction occurs. They will recognize that atoms are not created or destroyed, but rearranged. It requires energy to break bonds and energy is released when bonds are formed. They will do several hands-on experiments to experience the four signs of chemical reactions: release of gas, color change, temperature change and/or a precipitate. Student will need to recognize if equations are balanced by drawing models of the molecules. They will also practice balancing basic equations.

Learning Goals:

1. Understand the difference between physical and chemical properties *(Patterns)*
2. Identify signs of a chemical reactions *(Cause and Effect)*
3. Understand the difference between endothermic and exothermic reactions *(Energy and Matter)*
4. Determine whether an equation is balanced *(Scale, Proportion, Quantity)*
5. Balance basic chemical equations *(Scale, Proportion, Quantity)*
6. Understand the energy is needed to break bonds and energy is released *(Energy and Matter)*

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

1. Sandwich Bag Chemistry - students mix white powders in a sandwich bag to identify signs of a chemical reaction. *(#3 Planning an Carrying out and investigation)*
2. Copper Chloride and Aluminum Foil - students put aluminum foil in a solution of copper chloride to identify signs that a chemical reaction takes place. *(#6 Constructing explanations)*
3. Hydrogen Peroxide Lab - Students observe how the rate of a reaction is affected by temperature *(#4 Analyzing and Interpreting data)*
4. Balancing Equations Activity - students use modeling kits to balance equations. *(#2 Developing and Using Models)*

Time Span: (Length of Unit) - 2 weeks

Assessment: (Methods used for formative and summative)

Immediate feedback on assignments done in class - students correct for accuracy
Kahoot Review
Quizlet Vocabulary Practice
Summative - Chemical Reactions
Verbal Questioning after completion of group labs

Vocabulary and Key Concepts

molecule	coefficient	hydrogen peroxide
chemical formula	chemical reaction	physical properties
malleable	brittle	chemical properties
precipitate	erlenmyer flask	beaker
test tube	bonds	potential energy
endothermic	exothermic	reactant
product		

Unit 12: Chemical Reactions

Michigan Science Standards	
Essential	Extension
•	•

Unit 13: Nuclear Reactions

Unit overview: (Narrative description of unit purpose)

Learning Goals:

1. Understand that new atoms are created during nuclear reactions
2. Understand the process of fusion and how it relates to stars
3. Understand the process of fission and how it relates to atomic bombs and nuclear power plants.
4. Understand how radioactive isotopes can be used for dating

Engineering Practices:

(Include labs, models, activities linked to a specific practice- e.g. *graphing motion lab- Practice #4*)

Time Span: (Length of Unit)- 2 weeks

Assessment: (Methods used for formative and summative)

Vocabulary and Key Concepts

Unit 13: Nuclear Reactions

Michigan Science Standards	
Essential •	Extension •