PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time: 29 days**			
Unit Title: Kinematics, Graphing, and Tracker Software		**Essential Questions:** **How are an object's velocity, location, acceleration, and time related to one another?** **How can motion be represented verbally, graphically, and algebraically?** **What measurement and data analysis techniques will give us access to data about a real object's motion.**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Given a description of an object's motion, I can solve for an unknown quanity by selecting the proper equation. Given a motion graph of x, v, or a, I can draw the other two graphs. I can use Tracker to analyze motion in a video, graph the data in a spreadsheet, and interpret the trendline equation to identify acceleration and velocity. I can calculate horiontal launch projectile motion problems.	Force Distance Position Displacement Time Speed Velocity Acceleration Instantaneous vs average (speed) Kinematic equations Free Fall Projectile Trajectory Scalar Vector Resultant Velocity	Space Jump https://thewonderofscience.com/phenomenon/2018/7/7/felix-baumgartner-space-jump-world-record Finger Safe saw https://www.ngssphenomena.com/finger-safe-saw/	
Details			Core Ideas for Using Science		
			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time: 17 days (round 1) + 8 days (round 2 with vectors)**			
Unit Title: Newton's Laws		**Essential Questions:** **Why do objects move the way they do?** **What role does inertia play in motion?** **How can the rules of free body diagams aid in setting up a Newton's second law problem?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p66 Physics – P2: Objects can affect other objects at a distance. Motion & Stability – Forces & Interactions Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic). p67 Physics – P3: Changing the movement of an object requires a net force to be acting on it. Motion & Stability – Forces & Interactions Essential HS.P3U1.6 Collect, analyze and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws. Plus HS+Phy.P3U1.3 Develop a mathematical model, using Newton's laws, to predict the motion of an object or system in two dimensions (projectile and circular motion). Essential HS.P3U2.7 Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	I can identify the forces present in a situation, use judgement about whether to include friction and air resistance, and draw a free body diagram. I can apply Newton's 2nd law in both x and y directions to solve for unknown forces.	Newton Mass Weight Inertia Force Acceleration Vector Gravity Vector Scalar Friction Normal force Angle	Inertia: Sled: https://www.ngssphenomena.com/sleddinginertia/ Egg + broom stick Which string will break Leaves on a net: http://imgur.com/NeUUspE, http://questlc.org/phenomena/physics-page-2.html Cooked vs raw egg: https://thewonderofscience.com/phenomenon/2018/7/11/raw-or-boiled-egg-experimentdex Hovercraft / chrome cart / Normal Force vs Weight: Scale in an elevator Friction - sailing stones https://www.ngssphenomena.com/sailinstones/ 3rd law truck tug of war https://www.youtube.com/watch?v=pnoRc43qcZY&feature=youtu.be	
Details			Core Ideas for Using Science		
p66 Newton's second law accurately predicts changes in the motion of macroscopic objects, but it requires revision for subatomic scales or for speeds close to the speed of light. p67			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models		

p07 Newton’s second law accurately predicts changes in the motion of macroscopic objects, but it requires revision for subatomic scales or for speeds close to the speed of light.			As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time: 12 days**			
Unit Title: Energy		**Essential Questions:** **What types of energy are present in a given situation?** **How can conservation of energy help us use observable data to calculate missing information?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p68 Physics – P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event. Energy & Waves Essential HS.P4U1.8 Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings. Essential HS.P4U3.9 Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer. Plus HS+Phy.P4U1.6 Analyze and interpret data to quantitatively describe changes in energy within a system and/or energy flows in and out of a system. Plus HS+Phy.P4U2.7 Design, evaluate, and refine a device that works within given constraints to transfer energy within a system.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	I can identify which types of energy are present in a situation and create a conservation of energy equation that will allow me to solve for for a missing quanitty. I can apply the concept of work as a transfer of energy and mechanical work as F*d to relate energy problems to forces.	Work Power Energy Conservation Potential Mechanical Energy Chemical Kinetic Force Distance Horsepower Watt Joule Newton	Histoy of the transition from caloric to energy http://galileoandeinstein.physics.virginia.edu/more_stuff/TeachingHeat.htm Images http://www.eoht.info/page/Cannon+boring+experiment Importance of observing phenomena (S-P effect) https://en.wikipedia.org/wiki/An_Experimental_Enquiry_Concerning_the_Source_of_the_Heat_which_is_Excited_by_Friction Permanent magnet doesn't run out of energy (W=Fd) Magnet fan debunked https://www.youtube.com/watch?v=AaC1kuBdkzo Magician tip: why use X, why not Y? Rube goldberg filmed up side down https://thewonderofscience.com/phenomenon/2018/7/8/amazing-rube-goldberg-machines Honda Cog commercial rube goldberg Spring Forces - slinky free-fall https://www.ngssphenomena.com/slinky-free-fall/ Really this illustrates how/why/when to incorporate the mass of a spring which we typically ignore. Elasticity: arrow vs concrete https://www.ngssphenomena.com/arrow-vs-concrete/ Elasticity: golf ball extreme compression https://thewonderofscience.com/phenomenon/2018/7/8/slow-motion-golf-ball-collision https://www.youtube.com/watch?v=6TA1s1oNpbkRoller coasters Nuclear Power Plants Light bulbs Bungee jumping	
Details			Core Ideas for Using Science		

			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		
Sequence					
Do caloric theory history after calculating conservaation of energy equations because the evidence against caloric theory requires making comparisons to other forms of energy.					
Start with individual phenomena, then rube goldbergs or other way around?					

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time: 7 days**			
Unit Title: Momentum		**Essential Questions:** **How are Newton's laws and momentum related to one another?** **How do objects behave during a collisoin?** **How does the concept of an isolated or non-isolated system impact the way momentum is analyzed?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p66 Physics – P2: Objects can affect other objects at a distance. Motion & Stability – Forces & Interactions Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic). p67 Physics – P3: Changing the movement of an object requires a net force to be acting on it. Motion & Stability – Forces & Interactions Essential HS.P3U1.6 Collect, analyze and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws. Plus HS+Phy.P3U1.4 Engage in argument from evidence regarding the claim that the total momentum of a system is conserved when there is no net force on the system. Essential HS.P3U2.7 Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends. Plus HS+Phy.P3U2.5 Design, evaluate, and refine a device that minimizes or maximizes the force on a macroscopic object during a collision.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	I can analyze a collision using consevatin of momentum. I can identify whether a system is isolated or not and whether to analyze a problem using momentum or energy.	Force Time Mass Velocity Inelastic collision Elastic collision Momentum Impulse Conservation Recoil	Momentum - why don't woodpeckers get concussions https://thewonderofscience.com/phenomenon/2018/4/30/why-dont-woodpeckers-get-concussions https://www.ngssphenomena.com/woodpecker-slowmo/ killer asteroids https://thewonderofscience.com/phenomenon/2018/7/9/protecting-the-earth-from-killer-asteroids Energy + momentum: Newton's cradle (why can't one ball go twice as high?) Einstein's Big Idea video. What makes a car safe? Why wear helmets? Why do you follow through when hitting a baseball? Aluminum vs wood bats Long range artillery Padded gloves vs. bare hands Why do rockets move in space? Why are you safer in a Hummer vs a Smart Car? Figure skater pulling in arms	

Details			Core Ideas for Using Science		
p66 Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.4 (p. 116)			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Circular Motion		**Essential Questions:** **How do Newton's Laws apply to circuilar motion?** **What are the misconceptions sorrounding centrifugul force and what is the proper use of centripetal force?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p66 Physics – P2: Objects can affect other objects at a distance. Motion & Stability – Forces & Interactions Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic). p67 Physics – P3: Changing the movement of an object requires a net force to be acting on it. Motion & Stability – Forces & Interactions Essential HS.P3U1.6 Collect, analyze and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws. Plus HS+Phy.P3U1.3 Develop a mathematical model, using Newton's laws, to predict the motion of an object or system in two dimensions (projectile and circular motion). Essential HS.P3U2.7 Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Identify when a circular motion problem should be approached using Newton's laws vs conservation of energy.	Radius Orbit Velocity Acceleration Motion Force Centripetal Centrifugal Uniform circular motio Angular Degree Gravity	escape from a cone https://www.ngssphenomena.com/physics-escape/ human loop https://www.ngssphenomena.com/human-loop/ Phenomena Neutron stars Orbits of planets Why are roller coasters so much fun? Centrifuge g-forces Car safety - going around curves - why do you spin out? Leverage	
Details			Core Ideas for Using Science		
p68 Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.		

system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. “Mechanical energy” generally refers to some combination of motion and stored energy in an operating machine. “Chemical			and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time: 4 days**			
Unit Title: Special Relativity		**Essential Questions:** **What is an objects 'true' speed?** **How are length and the rate of time altered by velocity?** **How are clasic paradoxes resolved?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function			Relativity https://www.ngssphenomena.com/who-moves-sky-or-us/	
Details					

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Fluid Statics		**Essential Questions:** **How are pressure and depth related?** **How large is the buoyancy force on an object?** **How are mass, density, volume, and buoyancy related to each other?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Do calculations using the pressure/depth equation. Use the buoyacy equation and spot conceptual relationships between the variables in it with other information (for instance, that when an object is floating, the weight = buoyancy)	density, buoyancy, mass, weight, pressure, volume, archimedes principle, submerged	bed of nails https://www.youtube.com/watch?v=P1zfktn4AzU&feature=youtu.be	
Details			Core Ideas for Using Science		
			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Fluid Dynamics		**Essential Questions:** **What are laminar and turbulent flow and separation and how are they related to drag?** **How is lift generated on a wing?** **How can Bernoulli's principle predict pressures around an objecect and what are it's limitations?** **How should streamline information from a wind tunnle be interpreted?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Analyze a streamline diagram for areas of high or low speed. Apply Bernoulli's principle to identify high and low pressure. Identify exceptions to Bernoulli's principle. Explain how a wing generates lift using both Bernoulli's principle and conservation of momentum. Identify factors that increase or dedcrease drag, including separation and turbulence.	Laminar, turbulent, bernoulli, separation, drag, lift, streamline, viscosity	Bike rider laying flat, aerodynamics https://www.ngssphenomena.com/bike-aerodynamics/ Bernoulli Basketball https://www.youtube.com/watch?v=QtP_bh2lMXc&feature=youtu.be	
Details					
			Core Ideas for Using Science		
			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)					
Grade Level: High School		**Time:**			
Unit Title: Electrostatics and Gravity		**Essential Questions:** **How are static electricity and gravity similar to each other?** **What are voltage, electric field, electrc force, and elecctric potential energy; how are they related to each other and how are they different?** **How can invisible abstract concepts be represented graphically?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**

p66 Physics – P2: Objects can affect other objects at a distance. Motion & Stability – Forces & Interactions Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic). p67 Physics – P3: Changing the movement of an object requires a net force to be acting on it. Motion & Stability – Forces & Interactions Essential HS.P3U1.6 Collect, analyze and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws. Plus HS+Phy.P3U1.2 Develop and use mathematical models of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects p76 Earth and Space – E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe. Earth and the Solar System Essential HS.E2U1.16 Construct an explanation of how gravitational forces impact the evolution of planetary motion Plus HS+E.E2U1.13 Analyze and interpret data showing how gravitational forces are influenced by mass, and the distance between objects. Plus HS+E.E2U1.14 Use mathematics and computational thinking to explain the movement of planets and objects in the solar system.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Calculate relationships between voltage, electric field, electrc force, and elecctric potential energy. Know when to use the law of superposition and when not to. Draw and interpret diagrams of electric fields and equipotential lines. Describe similarities between electricity and gravity. Calculate gravitational force and gravitation field using Newton's Universal Gravitation Equation. Use the Universal Gravitation Equation in conjunction with circular motion equations to calculate simple orbits.	Magnet Magnetic Field Electric Field Charge Resistance Battery Ohm Watt Coulomb Volt Ampere Circuit Electrical Potential Electrostatic	Electrostatics: Lightning https://www.ngssphenomena.com/statue-of-lightning/ Lightning High voltage discharges Van de Graff generator Cotton and polyester blankets pulled appart in a dark room. Electroscope needle attracts to a charged object vs compass needle to a magnet - how are electricity and magnetism different? Disassemble a lyden jar Clacking Can static electricity demo compelation https://www.youtube.com/watch?v=ViZNgU-Yt-Y Gravity Phenomena: Cavendish experiment https://thewonderofscience. com/phenomenon/2018/7/12/cavendish-experiment Harder to hit the sun than it is to leave the solar system 1) https://www.youtube.com/watch?v=LHvR1fRTW8g 2) https://www.youtube.com/watch?v=dhDD2KaflSU	
Details			Core Ideas for Using Science		
p66 Newton's laws of motion and gravitation and Coulomb's law provide the			U1: Scientists explain phenomena using evidence obtained from observations and		

Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric fields cause magnetic fields; electric charges or changing magnetic fields cause electric fields. 4 (p. 116) p76 Planetary motions around the sun can be predicted using Kepler’s three empirical laws, which can be explained based on Newton’s theory of gravity. These orbits may also change somewhat due to the gravitational effects from, or collisions			evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Magnetism		**Essential Questions:** **How does a permanent magnet work?** **How is electricity related to a magnetic field?** **How does a changing magnetic field produce electricity?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p66 Physics – P2: Objects can affect other objects at a distance. Motion & Stability – Forces & Interactions Essential HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic). Plus HS+Phy.P2U1.1 Plan and carry out investigations to design, build, and refine a device that works within given constraints to demonstrate that an electric current can produce a magnetic field and that a	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Explain how permanent magnets work. Use the right hand rule to identify the direction of a magnetic field produced by a current. Use Lenz' law to identify the direction of an induced current and induced magnetic field. Use the right hand rule to analyze the relationship between the direction of force and current. Predict the resulting motion.	Magnet Magnetic Field Electric Field Charge Resistance Battery Ohm Watt Coulomb Volt Ampere Circuit Electrical Potential Electrostatic	Energy and Magnetism: assemble magnetic cannon challenge https://thewonderofscience.com/phenomenon/2017/10/8/ps2-motion-and-stability-forces-and-interactions Magnet on Monitor levitating and melting and curie temperature https://www.ngssphenomena.com/levitation-melting/ induction cooker cut in half doesn't cook where there is no pot https://www.youtube.com/watch?v=T3AI1eQ50iE&feature=youtu.be Maglev trains Lenz law demonstration	
Details			Core Ideas for Using Science		
Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric fields cause magnetic fields; electric charges or changing magnetic fields cause electric fields. 4 (p. 116)			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Circuits		**Essential Questions:** **Where will current flow in a circuit?** **How much current and potential difference will be present for a given circuit element?** **How do resistors behave?** **How to capacitors behave?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p68 Physics – P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event. Energy & Waves Plus HS+Phy.P4U1.8 Use mathematics and computational thinking to explain the relationships between power, current, voltage, and resistance.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Explain the behavior of parallel and series resistor circuits. Calculate equivalent resistance of a circuit. Conceptually describe the role of a capacitor in a circuit. Be able to make analogies between circuits and the flow of water through pipes with different elevations and with paddle wheels or spongges in the pipes.	Resistance, current, voltage, potential, Ohm's Law, series, parallel	Digital circuits kits Lightbulb circuit kits	
Details			Core Ideas for Using Science		
			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Waves and Sound		**Essential Questions:** **What are the universal features of waves.** **How are the universal features of waves manifested in the case of sound and how are they percieved?** **How do constructive and destructive interference of different configurations account for a variety of audio phenomena?** **What is the dopplar effect and why does it happen?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p89 Physics – P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event. Energy & Waves Essential HS.P4U1.10 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Describe the frequency and wavelength of a sound. Use the concepts of constructive interference and distructive interference to explain beats, standing waves, and square waves. Apply the doppler effect concept to both sound and light.	Transverse Longitudinal Velocity Sound Mechanical Medium Pitch Volume Resonance Amplitude Frequency Wavelength	Strobe Effect (Waves) https://www.ngssphenomena.com/spinnerdirection/	
Details			Core Ideas for Using Science		
p60 The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. The reflection, refraction, and transmission of waves at an interface between two media can be modeled on the basis of these properties. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Light and Waves		**Essential Questions:** **How are the universal features of waves manifested in the case of light and how are they percieved?** **How do constructive and destructive interference result in double-slit interference patterns?** **How is light produced by emission lines and by black body radiation?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
p89 Physics – P4: The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event. Energy & Waves Essential HS.P4U1.10 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Apply wave concepts to light to explane interference patterns. Identify whether light was produced by emission lines or black body radiation and compare the spectra of them.	Color/ROYGBIV Spectrum Wavelength Frequency c = speed of light Amplitude	Doppler effect - fire truck going by Why is the sky blue? Why do you get cancer? Why do you get a sunburn?	
Details			Core Ideas for Using Science		
p60 The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. The reflection, refraction, and transmission of waves at an interface between two media can be modeled on the basis of these properties. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Quantum Mechanics		**Essential Questions:** **What is the role of probability in quantum phenomena?** **What is an electron cloud and how does it relate to a particle in a box?** **How does radioactive decay relate to a particle in a box?** **What is the experimental evidenece that light is a wave (especially interference patterns) and what is evidence that light is a particle (especially the photoelectric effect)**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Use the phenomena of double slit interfence as explanation and proof of the observer effect, based on cause and effect (not metaphysics). Explain how the quantum model of the atom is based on the phenomea of emission lines.	Probability, interference, observer, wave function, Schrodinger's cat, Heisenberg uncertainty principle		
Details					

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title: Astronomy,Cosmology, and Nuclear Reactions		**Essential Questions:** **How are nuclear reactions related to star life cycles?** **What happens to a star when the nuclear fuel is consumed?** **What evidence is the big bang theory based on?**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**

p75 Earth and Space – E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe. Earth's Place in the Universe Essential HS.E2U1.15 Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star. Plus HS+E.E2U1.12 Obtain, evaluate, and communicate scientific information about the way stars, throughout their stellar stages, produce elements and energy p77 Earth and Space – E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe. The Universe and its Stars Essential HS.E2U1.17 Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence. Plus HS+E.E2U1.15 Obtain, evaluate, and communicate information on how the nebular theory explains solar system formation with distinct regions characterized by different types of planetary and other bodies. Plus HS+E.E2U1.16 Obtain, evaluate, and communicate information about patterns of size and scale of our solar system, our galaxy, and the universe. Plus HS+E.E2U2.17 Obtain, evaluate, and communicate the impact of technology on human understanding of the formation, scale, and composition of the universe. p65 Chemistry – P1: All matter in the Universe is made of very small particles. Nuclear Processes and Applications of Chemistry Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social,	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function	Compare and contrast fission and fusion. Explain the iron peak in terms of fission and fusion. Describe how nuclear reactions are related to a star's life cycle. Identify how a star will end based on its mass and compare the features of the remnents. Related nucleosynthesis data to the density of the early universe. Explain what is meant and what is not meant by the shape or curvature of space time. Compare CMB data with Nucleosynthesis data, together with galaxy rotation as evidence of dark matter.	fission, fusion, iron peak, white dward, neutron star, black hole, planetary nebula, super nova, nucleosynthesis, CMB, positive/negative curvature,		

Details					
p75 Our Sun is one of many stars that make up the Universe, essentially made of hydrogen. The source of energy that the Sun and all stars radiate comes from nuclear reactions in their central cores. The Sun is one of millions of stars that together make up a galaxy called the Milky Way. 2 (p. 25) Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. Elements other than these remnants of the Big Bang continue to form within the cores of stars. Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight. Heavier			Core Ideas for Using Science		
			U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.		
Scientific understanding can help to identify implications of certain applications but decisions about whether certain actions should be taken will require ethical and moral judgements which are not provided by knowledge of science. There is an important difference between the understanding that science provides about, for example, the need to preserve biodiversity, the factors leading to climate change and the adverse effects of harmful substances and lifestyles, and the actions that may or may not be taken in relation to these issues. Opinions may vary about what action to take but arguments based on scientific evidence should not be a matter of opinion. 2 (p. 33) The total number of neutrons plus protons does not change in any nuclear process. Strong and weak nuclear interactions determine nuclear stability and processes. Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials from the					

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title:		**Essential Questions:**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
Details					

PUSD Science District Instructional Guides (Date Updated: 01/01/2020)

Grade Level: High School		**Time:**			
Unit Title:		**Essential Questions:**			
		Phenomena:			
Standards	**Cross Cutting Concepts**	**Objectives (I Can)**	**Key Vocabulary**	**Resources (Activities/Lessons/Experiments)**	**Assessments**
U1, U2, U3 P2, P3, P4	Crosscutting Concepts: Patterns; Cause and effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Stability and change; Structure and function				
Details					

p66

The application of science in making new materials is an example of how scientific knowledge has led advances in technology and provided engineers with a wider choice in designing constructions. At the same time technological advances have helped scientific developments by improving instruments for observation and measuring, automating processes that might otherwise be too dangerous or time consuming to undertake, and particularly through the

AP Thermo - drinking bird
https://thewonderofscience.com/phenomenon/2017/10/7/drinking-bird

Ray optics: Invisibility fluid
https://www.ngssphenomena.com/invisible-polymer/

Ray optics - blacker than vanta
https://www.youtube.com/watch?v=O0CYc_mC3Uo

Ray optics - arrow reversal
https://www.ngssphenomena.com/looking-through-water/

Wave optics - UV camera
https://thewonderofscience.com/phenomenon/2018/4/29/how-the-sun-sees-you
https://www.ngssphenomena.com/uv-sun-damage/

Sound - recover audio from motion in a video (connect to big bang audio)
https://thewonderofscience.com/phenomenon/2018/7/8/the-visual-microphone-passive-recovery-of-sound-from-video

Quantum - Photoelectic effect
https://thewonderofscience.com/phenomenon/2018/7/7/photoelectric-effect

Misc
https://thewonderofscience.com/phenomenon/2018/7/8/trichroic-prism
https://thewonderofscience.com/phenomenon/2018/7/8/self-leveling-pool-table-on-cruise-ship
https://www.ngssphenomena.com/jupiter-asteroids/
https://thewonderofscience.com/phenomenon/2018/7/9/programmable-droplets-from-mit

Circuits is part of the standards and fluids are not. But fluids are better suited for a standard physics level and circuits are better suited for an AP physics level, meaning that circuits require a lot of nitty gritty calculations that aren't much fun unless the student enjoys that kind of thing, whereas fluids has interesting real world connections without much calculations which is perfect for Standard but would need to be cut as "not something that will be on the tes