TOPIC: MEASUREMENT AND METHODS

Key Learning: Students will explore and appreciate the necessity of proper scientific measurements and data analysis and understand its uses in addition to its importance in the STEM-related fields.

Unit Essential Question

How and why is proper application of precision, accuracy and units during measurements and calculations essential in the STEM-related fields?

CONCEPT: Units of measurement 3.1.12.A, 3.2.12.D	CONCEPT: Measuring instruments 3.7.12.B	CONCEPT: Data analysis 3.2.12.B, 3.1.12.C
Lesson Essential Questions: - How are the basic fundamental international units of measurement used by scientists identified and how can they be demonstrated? - How can you explore and explain the concepts of System International and demonstrate their uses? - How can units be converted using the factor label method? - How can you explore and explain the values of System International prefixes and demonstrate how measurements represented by these values are utilized?	Lesson Essential Questions: - How can you determine possible sources of error when taking measurements? - How can you identify the proper degree of precision required for an instrument of measurement? - Why is using proper precision necessary when taking measurements? - How can accuracy be compared and contrasted with precision?	Lesson Essential Questions: - How can mathematical relationships of measurements be determined from graphs? - How are acuracy and precision applied to obtained data to determine validity of the data? - How can the relationship between precision and significant figures be identified and demonstrated? - Why is the proper application of significant figures important? - How can you identify and demonstrate the rules for applying significant figures and rounding during calculations?
Vocabulary: Fundamental units, micro, Mega, System International	Vocabulary: Precision, accuracy, repeatability, Avogadro's number	Vocabulary: Significant figures

Additional Info: Classroom discussion, examples and hands-on activities. Use appropriate demonstration tools to emphasize key points of classroom discussion. Review text chapter on material. Written assessment of key points learned. Working with the robotics department using digital indicators to assess the importance of repeatability and precision.

Standards:

3.1.12.A – Apply concepts of systems, subsystems, feedback and control to solve complex technololgical problems.
3.2.12.D – Analyze and use the technological design process to solve problems.
3.7.12.B – Evaluate appropriate instruments and apparatus to accuarately measure materials and processes.
3.2.12.B – Evaluate experimental information for appropriateness and adherence to relevant science processes.
3.1.12.C – Assess and apply patterns in technology.
Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: ONE-DIMENSIONAL KINEMATICS

Key Learning: Students will explore and appreciate the necessity of applying the laws and formulas of one-dimensional motion to real-world applications in the STEM-related fields.

Unit Essential Question

How and why is learning the laws of one-dimensional kinematic motion important for application in the STEM-related fields?

CONCEPT: Translational Motion 3.4.12.C	CONCEPT: Graphical analysis 2.5.11.B	CONCEPT: Vectors 3.4.12.C
Lesson Essential Questions: - How can the variables of an object's motion while in freefall be identified and demonstrated? - How can the prediction of motion be mathematically described? - How can units be identified to familiarize students with the quantities needed to describe motion?	Lesson Essential Questions: - How is the motion of an object determined from a position versus time graph? - How can human error be negated in this concept?	Lesson Essential Questions: - How and why is direction important in the prediction of motion? - How can vector and scalar quantities compare and contrast with each other? - How is the magnitude o the resultant of multiple perpendicular vectors found?
Vocabulary: Distance, displacement, speed, velocity, acceleration, freefall, relativity, rate	Vocabulary: Directly proportional, inversly proportional	Vocabulary: Vector, Scalar, magnitude, resultant, component, perpendicular

Additional Info: Classroom discussion, examples and hands-on activities. Use of the Magnet School "STEM Garden" using the tower, an apple, and measuring instruments to determine acceleration of an objet in freefall due to gravity. Have students collaborate using the iPad as a tool. Incorporating various apps using development and design to enhance learning. Hands-on inquiry-based problem solving ith the aid of model rockets and measuring instruments. Use of appropriate demonstration tools to emphasize key points of classroom discussions. Review text chapter on material. Written assessment of key points learned.
Standards:
3.4.12.C – Apply the principles of motion and force.
2.5.11.B – Use symbols, mathematical terminology, standard notation, mathematical rules, graphing and other types of mathematically appropriate demonstration tools to communicate observations, predictions, concepts, procedures, generalizations, ideas, and results.
Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: TWO-DIMENSIONAL KINEMATICS

Key Learning: Students will explore and appreciate the necessity of applying the laws and formulas of two-dimensional motion to real-world applications in the STEM-related fields.

Unit Essential Question

How and why is learning the laws of two-dimensional kinematic motion important for application in the STEM-related fields?

CONCEPT: Horizontal projectiles 3.4.12.C	CONCEPT: Angular projectiles 3.4.12.C	CONCEPT: Circular motion 3.4.12.C
Lesson Essential Questions: - How is the vertical motion of a projectile different from its horizontal motion? - How can mathematical relationships be used to predict the motion of objects launched horizontally? - How can the paths of a horizontal projectile and an object in free fall from the same height be compared and contrasted?	Lesson Essential Questions: - How can the concepts behind horizontal projectiles be applied to predict the motion of projectiles launched at an angle? - How can mathematical relationships be used to predict the motion of objects launched at an angle? - How can the angle of a projectile be used to predict the projectile's range? - How can an experiment be designed to determine the maximum range of a projectile? - How can you determine the max height of a projectile?	Lesson Essential Questions: - How can acceleration and force be related to circular motion? - How can you comapre and contrast rotation and revolution? - How can you apply what you know about speed to determine how the speed of an object moving in a circular path?
Vocabulary: Trajectory, projectile, range	Vocabulary: N/A	Vocabulary: Rotation, revolution, linear speed, tangent, centripetal acceleration, radius, circumference, period, frequency, traction, slippage

Additional Info: Classroom discussion, examples and hands-on activities. Have students collaborate using the iPad as a tool. Incorporating various apps using development and design to enhance learning. Hands-on inquiry-based problem solving ith the aid of model rockets and measuring instruments. Collaboration with the Chambersburg Magnet School Robotics department to develop and design experiments to enhance learning. Use of appropriate appropriate demonstration tools tools to emphasize key points of classroom discussion. Review text chapter on material. Written assessment of key points learned.

Standards:
3.4.12.C – Apply the principles of motion and force.
Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: DYNAMICS

Key Learning: Students will explore and appreciate the necessity of using forces to predict the motion of objects and be able to apply those concepts to real-world applications in the STEM-related fields.

Unit Essential Question

How is the application of the predicting motion from the calculation of force useful in the STEM-related fields?

CONCEPT: Newton's Laws of Motion 3.4.12.C, 3.2.10.B1	CONCEPT: Gravitation 3.7.12.C, 3.2.10.B1, 3.3.10.B1	CONCEPT: Momentum and collisions 3.4.12.C, 3.2.10.B1
Lesson Essential Questions: - How can Newton's first law of motion be used to predict the motion of an object? - How can Newton's second law of motion be used to calcuate the prediction of motion? - How are the variables in the second law of motion interrelated? - How does Newton's third law of motion describe the interaction between objects?	Lesson Essential Questions: - How can the variables that affect the attractive force between two objects be identified and described? - How can the masses of two objects be used to predict the attractive forces between those objects? - How can the distance between two objects be used to predict the attraction between those objects?	Lesson Essential Questions: - How can the knowledge of forces be useful in predicting changes in motion? - How can the law of conservation of momentum be used to predict the results of collisions and interactions? - How can a knowledge of momentum be applied in the design of safer vehicles?
Vocabulary: Force, inertia, friction, mass, weight, pressure	Vocabulary: Universal gravitation	Vocabulary: Momentum, impulse, elastic collision, inelastic collision

Additional Info: Classroom discussion, examples and hands-on activities. Use appropriate demonstration tools to emphasize key points of classroom discussion. Review text chapter on material. Student-centered discussions to apply their knowledge to the explanation of galactic bodies. Hands-on learning through the use of the iPad as a tool in conjunction with collision carts. Use of eggs obtained from the "STEM Garden" to enhance students comprehension of impulse. Inclusion of apples to relate scientific knowledge to historical aspects of Newton's laws of motion. Written assessment of key points learned.

Standards:

3.4.12.C – Apply the principles of motion and force.

3.7.12.C – Evaluate computer operations and concepts as to their effectiveness to solve specific problems.

3.2.10.B1 - Analyze the relationships among the net forces acting on a body, the mass of the body, and the resulting acceleration using Newton's Second Law of Motion. Apply Newton's Law of Universal Gravitation to the forces between two objects. Use Newton's Third Law to explain forces as interactions between bodies. Describe how interactions between objects conserve momentum.

3.3.10.B1 – Explain how gravity is responsible for planetary orbits.

TOPIC: WORK AND ENERGY

Key Learning: Students will explore and appreciate the necessity of understanding the different forms of energy and how energy is changed between those forms as well as being able to apply that knowledge to real world applications in the STEM-related fields.

Unit Essential Question

How and why is learning and applying the laws of energy transformation necessary in the STEM-related fields?

CONCEPT: Work 3.4.12.B, 3.2.10.B2	CONCEPT: Energy 3.4.12.B, 3.2.10.B2	CONCEPT: Power 3.4.12.B, 3.2.10.B2
Lesson Essential Questions: - Why is it important to understand the conditions necessary for work to be done? - Why is a box sliding along a conveyor belt not considered work done and what conditions would be required to classify it as work? - How can transfers of energy be explained in terms of work?	Lesson Essential Questions: - How can the motion of a falling object be described in terms of work and the transfer of energy? - How can you differentiate between the six key forms of energy? - How can the law of conservation of energy be applied to a person over the course of a day?	Lesson Essential Questions: - How can you compare and contrast the electrical and mechanical definitions of power? - How does power compare and contast with energy? - How can observations of work and energy be used to predict an output of power?
Vocabulary: Work, efficiency, joule	Vocabulary: Kinetic energy, gravitation potential energy, elastic potential energy, mechanical energy, chemical energy, thermal energy, radiant energy, nuclear energy	Vocabulary: Power, machine, watt, horsepower

Additional Info: Classroom discussion supported by text chapter reading activity, supported by related video. Students to complete calculation worksheets. Intercurricular collaborations with the "Power and Energy" course instructor and classes to bridge knowledge between the two courses. Use of the iPad as a tool along with Pasco interfaces to apply in-class concepts to real world applications of work, power, and energy. Additional written assessment on material.

Standards:

3.4.12.B – Applay and analys energy sources and conversions and their relationship to heat and temperature.

3.2.10.B2 – Explain how the overall energy flowing through a system remains constant. Describe the work-energy theorem. Explain the relationships between work and power.

Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: VIBRATIONS AND WAVES

Key Learning: Students will explore and appreciate the necessity of understanding the causes and results of how waves transfer and release energy as well as apply that knowledge to real world applications in the STEM-related fields.

Unit Essential Question

How is the knowledge of the methods of energy transfer through waves necessary in the STEM-related fields?

CONCEPT: Periodic motion 3.4.12.C	CONCEPT: Mechanical waves 3.4.12.C, 3.2.10.B5	CONCEPT: Electromagnetic waves 3.4.12.C, 3.2.10.B5
Lesson Essential Questions: - How can the concepts and theories of circular motion be applied to that of a resonating object? - How can the descriptions of harmonic motion be applied to a resonating object?	Lesson Essential Questions: - How can electromagnetic waves be compared and contasted to mechanical waves? - How is the frequency of waves related to its period? - How can electromagnetic waves be used to describe how the world is observed? - How can the transfer of energy from the sun to humans be described by waves? - How can knowing what happens to waves as the overlap be used to explain fiber optics?	Lesson Essential Questions: - How and why is understanding the sources and properties of waves necessary in designing a frequency generator? - How can a wave be more accurately described through the description of its amplitude and velocity? - How can you compare and contrast the properties of a water wave to a sound wave? - How can electromagnetic waves be used to describe how the world is observed? - How can an experiment be designed to identify the effects on the components of waves as they propagate away from their sources?
Vocabulary: Resonance, frequency, period, simple harmonic motion	Vocabulary: Photon, infrared, ultraviolet, transparent, opaque, wave, medium, crest, trough,	Vocabulary: Wave, medium, crest, trough, amplitude, wavelength, transverse, longitudinal, constructive interference, destructive interference, Doppler effect

Additional Info: Classroom discussion supported by text chapter reading activity, supported by related video. Students to complete calculation worksheet. Application of a knowledge of waves with the aid of the "STEM garden" water reservoir. Understanding of interference through the use of helical springs. Collaboration of the students through the use of the iPad to design and develop a device to demonstrate the Doppler effect. The use of a sonograph to identify how different wavelengths travel through or interfere with various mediums. Collaboration with the Magnet School technology department to familiarize students with the fire triangle. Additional written assessment on material.
Standards:
3.4.12.C – Apply the principles of motion and force.
3.2.10.B5 - Understand that waves transfer energy without transferring matter. Compare and contrast the wave nature of light and sound. Describe the components of the electromagnetic spectrum. Describe the difference between sound and light waves.
Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: LIGHT AND OPTICS

Key Learning: Students will explore and appreciate the necessity of understanding how the wave nature of light explains the formation of images and transfers information, especially in today's real world applications in the STEM-related fields.

Unit Essential Question

How is the transfer of energy through light explained and manipulated to enhance communication in the technological world and STEM-related fields?

CONCEPT: Light 3.2.10.B5, S11.A.1.1	CONCEPT: Reflection 3.4.12.C, 3.4.12.A	CONCEPT: Refraction 3.4.12.C
Lesson Essential Questions: - How can light be used in real-world communications such as the internet and television? - How can energy from the sun in the form of light most efficiently be obtained? - Why does the double-walled vacuum of solar collectors create more intense heat? - How can the knowledge of waves be applied to predicting how different wavelengths of light behave?	Lesson Essential Questions: - How can you compare and contrast the images formed by plane mirrors to those formed by curved mirrors? - How can a knowledge of mirrors be applied to improve the safety of vehicles? - How can the use and knowledge of plane mirrors be applied in the STEM-related fields? - How can the use and knowledge of curved mirrors be applied in the STEM-related fields?	Lesson Essential Questions: - How can you compare and contrast the images formed by plane mirrors to those formed by curved mirrors? - Why is a knowledge of lenses essential in understanding interstellar space and the universe? - How do the images formed by concave lenses compare and contrast to images formed by convex lenses? - How can lenses be used to advance technology? - How do the properties of the medium of lenses vary the the effects of the lens?
Vocabulary: White light, double-walled vacuum	Vocabulary: Virtual image, real image, reflection	Vocabulary: Refraction, concave lens, convex lens

Additional Info: Classroom discussion supported by text chapter reading activity, supported by related video, specifically regarding supernovas and the transfer of light energy. Use of fiber optics to enhance students knowledge of the transfer of light. The use of the iPad as a tool for development and design in addition to lenses and mirrors to compare and contrast different forms of lenses. Students to complete calculation worksheet. Additional written assessment on material.

Standards:

3.4.12.C – Apply the principles of motion and force.

3.4.12.A – Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

S11.A.1.1 – Analyze and explain the nature of science in the search for understanding the natural world and its connection to technological systems.

Other standards are applied as the need arises and can be cited from the appended list.

TOPIC: ELECTRICITY AND MAGNETISM

Key Learning: Students will explore and appreciate the necessity of understanding and applying how electricity and magnetism interrelate and can be used to induce each other and how they apply to the STEM-related fields.

Unit Essential Question

How and why are electro-magnetic forces applied in the prediction of motion and why is this necessary in the STEM-related fields?

CONCEPT: Magnetism 3.2.10.B4, 3.4.10A	CONCEPT: Current 3.2.10.B4	CONCEPT: Electrostatics 3.2.10.B4
Lesson Essential Questions: - How can conduction be compared and contrasted with induction as ways of transferring magnetic charges? - How can poles be compared and contrasted to domains? - How can the navigation abilities of homing pigeons be applied to improve future navigation devices?	Lesson Essential Questions: - How do current and charge interrelate? - How can current, voltage, and resistance be mathematically related to predict each other? - How is electric power related to voltage and current? - How can a circuit be created to test the relationships between current, voltage and resistance? - Why do ammeters and voltmeters need to be connected to circuits in pseries and parallel respectively?	Lesson Essential Questions: - How can the benefits of alternating current be compared and contrasted to those of direct current? - How can a generator be compared and contrasted from a dynamo? - How were Nicola Tesla, Thomas Edison and George Westinghouse important figures in the advancement of the understanding of Electricity?
Vocabulary: Magnetic field, magnetic pole, flux, domain	Vocabulary: Conductor, insulator, current, voltage, watt, resistance	Vocabulary: Electrostatics, Coulomb's law, induction, Farraday, Tesla, Westinghouse, Edison

Additional Info: Classroom discussion supported by text chapter reading activity, supported by related video on meteorology and the dynamics of lightning. Use of the iPad as a tool to collaborate with students intended to design and develop a circuit that will enhance understanding of how current, voltage and resistance are related. Research and assessment of contributions of historical figures in the electromagnetic fields. Students to complete calculation worksheet. Additional written assessment on material.

Standards:

3.4.12.A – Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

3.2.10.B4 – Describe quantitatively the relationships between voltage, current, and resistance to electrical energy and power. Describe the relationship between electricity and magnetism as two aspects of a single electromagnetic force.

Other standards are applied as the need arises and can be cited from the appended list.