SCIENCE & TECHNOLOGY/ENGINEERING COURSE SYLLABUS
PHYSICAL SCIENCES

Course Title: Physical Science Honors

Department: Chelmsford High School Science/Technology Department

Primary Course Materials: Addison-Wesley Conceptual Physical Science - Explorations (ISBN 0-13-198539-6)

Course Description: This rigorous, laboratory-based course is divided into two areas of study. Concepts covered in basic chemistry include scientific methods and measurement; properties and classification of matter; atomic structure; the periodic table; atomic and formula masses; chemical reactions and equations; and acids and bases. A major research paper and related project will be assigned. Concepts covered in basic physics include measuring and graphing motion; forces; vectors; Newton's Laws of Motion; impulse and momentum and energy conservation and conversions. An engineering-design major project will require the construction of an operative model of trebuchet. Students in this course will be expected to design valid scientific experiments, collect and analyze data, and formulate appropriate conclusions. Graphing skills and algebraic equations will be used to analyze lab data and to solve word problems. Honors students are expected to demonstrate good organizational skills, efficient time management, and independent study skills.

Prerequisites: Recommendation of 8th grade science teacher with a 93 in Earth *Science, a grade of 85 or better in Alge*bra—1A, or geometry taken at the middle school level. Current enrollment in Intermediate Algebra—H/H2.

Essential Questions:

1. How are the basic fundamental sciences of Physics and Chemistry applied across a wide range of academic disciplines?
2. How are Newton's Laws engaged in the classroom to the world around us?
3. What is the importance of the understanding of energy, its conservation, and its wide range of applications to the world and its environment?
4. How are wave phenomena applied through a diverse system of methods?
5. Why is the understanding of simple circuits, their design, and applications important to science, technology, and engineering?

Course Objectives:

1. To engage the students in an intense Physics term to prepare them for the MCAS physics exam.
2. To engage the students in an introductory Chemistry term.

Common Goals:

Thinking and Communicating

1) ☒ Read information critically to develop understanding of concepts, topics and issues.
2) ☒ Write clearly, factually, persuasively and creatively in Standard English.
3) ☒ Speak clearly, factually, persuasively and creatively in Standard English.
4) ☒ Use computers and other technologies to obtain, organize and communicate information and to solve problems.
5) ☒ Conduct research to interpret issues or solve complex problems using a variety of data and information sources.

Gain and Apply Knowledge in and across the Disciplines

6) Gain and Apply Knowledge in:
   a) ☒ Literature and Language
   b) ☒ Mathematics
   c) ☒ Science and Technology
   d) ☒ Social Studies, History and Geography
   e) ☒ Visual and Performing Arts
   f) ☒ Health and Physical Education

Work and Contribute

7) ☒ Demonstrate personal responsibility for planning one's future academic and career options.
8) ☐ Participate in a school or community service activity.
9) ☒ Develop informed opinions about current economic, environmental, political and social issues affecting Massachusetts, the United States and the world and understand how citizens can participate in the political and legal system to affect improvements in these areas.

		I. Scientific Inquiry Skills Standards
☒	**1.**	**Make observations, raise questions, and formulate hypotheses.**
☐	**1A**	Observe the world from a scientific perspective
☐	**1B**	Post questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
☐	**1C**	Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.
☒	**2**	**Design and conduct scientific investigations.**
☐	**2A**	Articulate and explain the major concepts being investigated and the purpose of an investigation.
☐	**2C**	Identify independent and dependent variables.
☐	**2D**	Write procedures that are clear and replicable.
☐	**2E**	Employ appropriate methods for accurately and consistently
☐		• making observations
☐		• making and recording measurements at appropriate levels of precision
☐		• collecting data or evidence in an organized way
☐	**2F**	Properly use instruments, equipment, and materials (e.g., scales, probe ware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
☐	**2G**	Follow safety guidelines.
☒	**3**	**Analyze and interpret results of scientific investigations.**
☐	**3A**	Present relationships between and among variables in appropriate forms.
☐		• represent data and relationships between and among variables in charts and graphs.
☐		• use appropriate technology (e.g., graphing software) and other tools.
☐	**3B**	Use mathematical operations to analyze and interpret data results.
☐	**3C**	Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
☐	**3D**	Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
☐	**3E**	State questions raised by an experiment that may require further investigation.
☒	**4**	**Communicate and apply the results of scientific investigations.**
☐	**4A**	Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
☐	**4B**	Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
☐	**4C**	Explain diagrams and charts that represent relationships of variables.
☐	**4D**	Construct a reasoned argument and respond appropriately to critical comments and questions.
☐	**4E**	Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
☐	**4F**	Use and refine scientific models that stimulate physical processes or phenomena.
☒		**II . Mathematical Skills**
☐		Students are expected to know the content of the *Massachusetts Mathematics Curriculum Framework*, through grade 8. Below are some specific skills from the *Mathematics Framework* that students in this course should have the opportunity to apply:

☐		Construct and use tables and graphs to interpret data sets.
☐		Solve simple algebraic expressions.
☐		Perform basis statistical procedures to analyze the center and spread of data.
☐		Measure with accuracy and precision (e.g., length, volume, mass, temperature, time)
☐		Convert within a unit (e.g., centimeters to meters).
☐		Use common prefixes such as *mill-i*, *cent-i*, and *kilo-*.
☐		Use scientific notation, where appropriate.
☐		Use ratio and proportion to solve problems.
☐		The following skills are not detailed in the *Mathematics Framework*, but are necessary for a solid understanding in this course:
☐		Determine the correct number of significant figures.
☐		Determine percent error from experimental and accepted values.
☐		Use appropriate metric/standard international (SI) units of measurement for mass (g); length (cm); and time (s).
☐		Use the Celsius and Kelvin scales.

Learning Standards from the Massachusetts Curriculum Framework:

☒		**Physical Sciences (Chemistry and Physics), Grades 6-8**
☐		**Properties of Matter**
☐	**1**	Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.
☐	**2**	Differentiated between volume and mass. Define density.
☐	**3**	Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.
☐	**4**	Explain and give examples of how mass is conserved in a closed system.
☐		**Elements, Compounds, and Mixtures**
☐	**5**	Recognize that there are more than 100 elements that combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.
☐	**6**	Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound).
☐	**7**	Give basic examples of elements and compounds.
☐	**8**	Differentiate between mixtures and pure substances.
☐	**9**	Recognize that a substance (element or compound) has a melting point and a boiling point, both of which are independent of the amount of the sample.
☐	**10**	Differentiate between physical changes and chemical changes.
☐		**Motion of Objects**
☐	**11**	Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed.
☐	**12**	Graph and interpret distance vs. time graphs for constant speed.
☐		**Forms of Energy**
☐	**13**	Differentiate between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.
☐		**Heat Energy**
☐	**14**	Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.
☐	**15**	Explain the effect of heat on particle motion through a description of what happens to particles during a change in phase.
☐	**16**	Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.
☒		**Introductory Physics, High School**
☐	**1**	**Motion and Forces**
☐		*Central Concept:* Newton's laws of motion and gravitation describe and predict the motion of most objects.
☐	**1A**	Compare and contrast vector quantities (e.g., displacement, velocity, acceleration force, linear momentum) and scalar quantities (e.g., distance, speed, energy, mass, work).
☐	**1B**	Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.
☐	**1C**	Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.
☐	**1D**	Interpret and apply Newton's three laws of motion.
☐	**1E**	Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.
☐	**1F**	Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.
☐	**1G**	Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.
☐	**1H**	Describe conceptually the forces involved in circular motion.

☐	**2**	**Conservation of Energy and Momentum**
☐		*Central Concept:* The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.
☐	**2A**	Interpret and provide examples that illustrate the law of conservation of energy.
☐	**2B**	Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.
☐	**2C**	Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
☐	**2D**	Describe both qualitatively and quantitatively the concept of power as work done per unit time.
☐	**2E**	Provide and interpret examples showing that linear momentum is the product of mass and velocity, and is always conserved (law of conservation of momentum). Calculate the momentum of an object.
☐	**3**	**Heat and Heat Transfer**
☐		*Central Concept:* Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.
☐	**3A**	Explain how heat energy is transferred by convection, conduction, and radiation.
☐	**3B**	Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
☐	**3C**	Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships among evaporation, condensation, cooling, and warming.
☐	**3D**	Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.
☐	**4**	**Waves**
☐		*Central Concept:* Waves carry energy from place to place without the transfer of matter.
☐	**4A**	Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, period) and explain the relationships among them. Recognize examples of simple harmonic motion.
☐	**4B**	Distinguish between mechanical and electromagnetic waves.
☐	**4C**	Distinguish between the two types of mechanical waves, transverse and longitudinal.
☐	**4D**	Describe qualitatively the basic principles of reflection and refraction of waves.
☐	**4E**	Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas.
☐	**4F**	Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).
☐	**5**	**Electromagnetism**
☐		*Central Concept:* Stationary and moving charged particles result in the phenomena known as electricity and magnetism.
☐	**5A**	Recognize that an electric charge tends to be static on insulators and can move on and in conductors. Explain that energy can produce a separation of charges.
☐	**5B**	Develop qualitative and quantitative understandings of current, voltage, resistance, and the connections among them (Ohm's law).
☐	**5C**	Analyze simple arrangements of electrical components in both series and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, resistance) in a schematic diagram.
☐	**5D**	Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).
☐	**5E**	Explain how electric current is a flow of charge caused by a potential difference (voltage), and how power is equal to current multiplied by voltage.
☐	**5F**	Recognize that moving electric charges produce magnetic forces and moving magnets product electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators and other technologies.
☐	**6**	**Electromagnetic Radiation**
☐		*Central Concept:* Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.

☐	**6A**	Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.
☐	**6B**	Describe the electromagnetic spectrum in terms of frequency and wavelength, and identify the locations of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.

Major Evaluation Strategies:

Name of Assessment	**Type of Assessment**		**Common Goals Assessed**	**Standards Assessed**	**Other Objectives Assessed**
	Test	**Performance Assessment**			
MCAS Physics Exam	☒	☐		HS Physics	
Common Final Exam	☒	☐		HS Physics And HS Chemistry	
Unit Tests	☒	☐		Varies	
Physics Labs	☐	☒		HS Physics	
Chemistry Labs	☐	☒		HS Chemistry	
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CONTENT OUTLINE

Introductory Unit: Scientific Method and Mathematical Applications (15 days) Chapter 1

Scientific Method introductory video and group discussions
Discussion of SI units , the metric system, metric conversions, and applications
Discussion of lab safety, and distribution of Safety Contracts
Design of experiments to test a hypothesis

Physics Unit 1: Motion (15 days) Chapter 2, 3, 4

Analyzing the motion of an object

a) calculating speed, velocity and acceleration

b) Understanding through mathematical, graphical and laboratory methods

→ Fining velocity lab

→ Calculating Acceleration lab

→ Introduction to forces

Physics Unit 2: Forces and Momentum (15 days) Chapter 5, 7

Newton;s Laws of Motion	→ Force and Acceleration lab
Gravitational forces	→ Weight vs. Mass lab
Momentum and its conservation	→ Interaction with Newton's 3rd Law of Motion

Physics Unit 3: Energy and its Conservation (15 days) Chapters 6, 9, 10

Work and Power
Forms of energy (Potential, Kinetic, Thermal, nuclear, solar, electrical, chemical,…)
a) Conservation
b) Roller Coaster lab (interaction between Kinetic, Potential & Total Mech. Energy)
Thermal Energy and its transformations
a) Convection, conduction, radiation and their impact on weather
b) Applications of conduction

Physics Unit 4: Waves and their behavioral properties (15 days) Chapters 13, 14, 15, 16

Types and characteristics of waves

a) understanding waves lab → slinky lab
b) Discuss interference and changes to wave forms
c) Standing waves
d) Electromagnetic spectrum and its energy/wave forms

Physics Unit 5: Electricity and Magnetism (15 days) Chapters 11, 12

Laws of Electricity and Magnetism (Ohm's, Coulomb's)
a) understand and analyze simple series and parallel circuits
→ CPO Circuit labs
b) Understand magnets and electromagnetic induction
→Relate back to energy units and discuss turbine electricity generation
→ Magnetic Fields and human interaction

Chemistry Unit 1: Atomic Structure and the Periodic Table (8 days) Chapters 17, 18

Models of the atom
Structure of the atom and its components
Periodic Table → families, groups, periods, properties
Isotopes → Smartie lab
Valence electrons → Lewis Dot diagrams, ions, chemical formulas

Chemistry Unit 2: Substances and their Properties (14 days) Chapters 15, 16, 21, 22

Types of matter and their physical and chemical properties – density, melting point, boiling point, etc.
→ Penny lab
→ Separation of a mixture lab
Phases of matter → Change of State lab

Identify solute, solvent, concentration, saturation
→ Solutions and Concentration lab
Solubility curves and analysis
Chemical Reactions
→ Observing a Chemical Change lab