Physical Science Pacing Guide

Physical science should begin the study of higher-level physics and chemistry and continue educating the student in the nature of science. A student who masters these Student Learning Expectations should transition smoothly into other science courses. Students should be expected to use suitable mathematics and collect and analyze data. Instruction and assessment should include both appropriate technology and the safe use of laboratory equipment. Students should be engaged in hands-on laboratory experiences at least 20% of the instructional time.

First Nine Weeks

1. Enduring Understanding - Scientists explore the natural world using similar methodologies of research and thought processes.

1a. Essential Question - What are the guidelines scientists use to aid their understanding of the natural world?

NS.11.PS.1	Recognize the factors that constitute a scientific *theory*
NS.11.PS.2	Explain why scientific theories may be modified or expanded using additional empirical data, verification, and peer review
NS.9.PS.1	Explain why science is limited to natural explanations of how the world works
NS.9.PS.2	Compare and contrast *hypotheses* , *theories* , and *laws*
NS.9.PS.3	Distinguish between a scientific *theory* and the term "theory" used in general conversation
NS.9.PS.4	Summarize the guidelines of science: ~explanations are based on observations, evidence, and testing ~*hypotheses* must be testable ~understandings and/or conclusions may change with additional empirical data ~scientific knowledge must have peer review and verification before acceptance
NS.10.PS.1	Develop and explain the appropriate procedure, *controls* , and *variables* (dependent and independent) in scientific experimentation
NS.10.PS.3	Identify sources of *bias* that could affect experimental outcome
NS.10.PS.4	Gather and analyze data using appropriate summary statistics
NS.10.PS.5	Formulate valid conclusions without *bias*
NS.10.PS.6	Communicate experimental results using appropriate reports, figures, and tables
NS.13.PS.1	Compare and contrast *physical science* concepts in *pure science* and *applied science*
NS.13.PS.2	Discuss why scientists should work within ethical parameters
NS.13.PS.5	Describe in detail the methods used by scientists in their research
NS.13.PS.4	Explain how the cyclical relationship between science and technology results in reciprocal advancements in science and technology

1b. Essential Question - What safety measures must be used when solving scientific problems?	
NS.10.PS.2	Research and apply appropriate safety precautions (refer to ADE Guidelines) when designing and/or conducting scientific investigations
C.3.PS.9	Relate fire safety measures to conditions necessary for *combustion*
2. Enduring Understanding - Motion is understood through forces, speed, acceleration, and mass.	
2a. Essential Question - How does force affect motion?	
P.6.PS.1	Analyze how *force* affects *motion:* one-dimensional (linear) two-dimensional (*projectile* and *rotational*)
P.6.PS.11	Relate the *Law of Conservation of Momentum* to how it affects the movement of objects
2b. Essential Question - How are speed, velocity, and acceleration compared?	
P.6.PS.3	Compare and contrast among *speed*, *velocity* and *acceleration*
P.6.PS.4	Solve problems using the formulas for *speed* and *acceleration:* • $v = \frac{d}{t}$ • $a = \frac{\Delta v}{\Delta t}$ Where a = acceleration, v = speed (velocity), Δt = change in time, Δv = change in velocity, d = distance
P.6.PS.5	Interpret graphs related to *motion:* distance versus time (d-t) *velocity* versus time (v-t) *acceleration* versus time (a-t)
NS.12.PS.1	Use appropriate equipment and technology as tools for solving problems (e.g., balances, scales, calculators, probes, glassware, burners, computer software and hardware)
NS.12.PS.2	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.12.PS.3	Utilize technology to communicate research findings

2c. Essential Understanding - How do forces, speed, mass, and acceleration relate to Newton's Laws of Motion?	
P.6.PS.6	Compare and contrast Newton's three laws of motion
P.6.PS.7	Design and conduct investigations demonstrating Newton's first law of motion
P.6.PS.8	Conduct investigations demonstrating Newton's second law of motion
P.6.PS.9	Design and conduct investigations demonstrating Newton's third law of motion
P.6.PS.10	Calculate force, mass, and *acceleration* using Newton's second law of motion: $F = ma$ Where: F = force, m = mass, a = acceleration
2d. Essential Question - How do gravitational potential energy and kinetic energy affect motion?	
P.6.PS.14	Solve problems by using formulas for *gravitational potential* and *kinetic energy:* • $KE = \frac{1}{2}mv^2$ • $PE = mgh$ Where KE = kinetic energy, PE = potential energy, m = mass, v = velocity

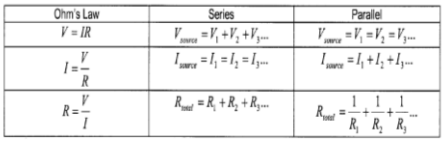
Second Nine Weeks	
1. Enduring Understanding - Thermal energy plays an essential role in Earth's environment.	
1a. Essential Question - What is the difference between thermal energy, heat, and temperature?	
P.5.PS.1	Distinguish among *thermal energy, heat,* and *temperature*
1b. Essential Question - How is thermal energy exchange evidenced in the gas laws, phase changes, and thermal expansion?	
C.2.PS.1	Identify the *kinetic theory* throughout the phases of *matter*
C.2.PS.3	Relate *thermal expansion* to the *kinetic theory*
C.2.PS.4	Compare and contrast *Boyle's law* and *Charles' law*
1c. Essential Question - How can changes in thermal energy be calculated and graphically displayed?	
C.2.PS.2	Create and label *heat* versus *temperature* graphs (*heating curves*): *solid* *liquid* *gas* *triple point* *heat of fusion* *heat of vaporization*
P.5.PS.2	Calculate changes in *thermal energy* using: $q = mc_p\Delta T$ Where q = heat energy, m = mass, c_p = specific heat, ΔT = change in temperature
1d. Essential Question - How can energy conversion be demonstrated?	
P.6.PS.13	Design an experiment to show conversion of *energy:* mechanical (potential and kinetic) chemical thermal *sound* light nuclear
NS.12.PS.1	Use appropriate equipment and technology as tools for solving problems (e.g., balances, scales, calculators, probes, glassware, burners, computer software and hardware)
NS.12.PS.2	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.12.PS.3	Utilize technology to communicate research findings
2. Enduring Understanding - The effect of force on fluids is evidenced in daily life.	
2a. Essential Question - What are the differences between Archimedes', Pascals' and Bernouillis' principles?	
P.6.PS.12	Compare and contrast the effects of forces on fluids: *Archimedes' principle* *Pascal's principle* *Bernoulli's principle*

3. Enduring Understanding - Wave and particle motion are responsible for the transfer of light and sound.	
3a. Essential Question - What are the general characteristics and interactions of waves?	
P.7.PS.1	Compare and contrast a *wave*'s *speed* through various *mediums*
P.7.PS.2	Explain *diffraction* of *waves*
P.7.PS.3	Explain *Doppler effect* using examples
P.7.PS.4	Calculate problems relating to *wave properties:* • $\lambda = vt$ • $f = \frac{1}{T}$ • $v = f\lambda$ *Where* $\lambda = wavelength$, $f = frequency$, $T = period$, $v = velocity$
3b. Essential Question - What are the physical properties of sound?	
P.7.PS.5	Describe how the *physical properties* of *sound waves* affect its perception
3c. Essential Question - How are waves and particles related?	
P.7.PS.6	Define light in terms of *waves* and particles
3d. Essential Question - What are the physical properties of light?	
P.7.PS.7	Explain the formation of color by light and by pigments
P.7.PS.8	Investigate the separation of white light into colors by *diffraction*
P.7.PS.9	Illustrate *constructive* and *destructive interference* of light *waves*
P.7.PS.10	Differentiate among the *reflected images* produced by *concave*, *convex,* and *plane mirrors*
P.7.PS.11	Differentiate between the *refracted images* produced by *concave* and *convex lenses*
3e. Essential Question - What are the current uses of optics and sound?	
P.7.PS.12	Research current uses of *optics* and *sound*
3f. Essential Question - How can energy conversion be demonstrated?	
P.6.PS.13	Design an experiment to show conversion of *energy:* mechanical (potential and kinetic) chemical thermal *sound* light nuclear

Third Nine Weeks

1. Enduring Understanding - Electricity and magnetism play essential roles in the physical world.

1a. Essential Question - How are voltage, current, and resistance calculated?

P.8.PS.1	Calculate *voltage* , *current,* and *resistance* from a *schematic* diagram:  Where: *V* = voltage, *I* = current, *R* = resistance

1b. Essential Question - How are electrical power and energy calculated?

P.6.PS.2	Explain how *motion* is relative to a *reference point*
P.8.PS.3	Calculate *electrical energy* using *electrical power* and time: $E = Pt$ Where: *E* = energy, *P* = power, *t* = time
P.8.PS.2	Calculate *electrical power* using *current* and *voltage: P = IV* Where: *E* = energy, *P* = power, *V* = voltage

1c. Essential Question - How are electromagnets used in step-up and step-down transformers and other applications?

P.8.PS.4	Explain the use of *electromagnets* in step-up and step-down *transformers*
P.8.PS.5	Research current uses of *electromagnets*

2. Enduring Understanding - Matter has specific properties and structure.

2a. Essential Question: What is the relationship between changes in matter and chemical and physical properties?

C.1.PS.1	Compare and contrast *chemical* and *physical properties* of *matter,* including but not limited to *flammability* , *reactivity, density, buoyancy* , *viscosity* , *melting point* and *boiling point*
C.1.PS.2	Compare and contrast *chemical* and *physical changes,* including but not limited to rusting, burning, *evaporation* , *boiling* and *dehydration*
NS.12.PS.1	Use appropriate equipment and technology as tools for solving problems (e.g., balances, scales, calculators, probes, glassware, burners, computer software and hardware)
NS.12.PS.2	Collect and analyze scientific data using appropriate mathematical calculations, figures, and tables
NS.12.PS.3	Utilize technology to communicate research findings

2b. Essential Question: What is the structure of matter?

C.1.PS.3	Discuss and *model* the relative size and placement of *sub-atomic particles*
C.1.PS.4	Illustrate the placement of *electrons* in the first twenty *elements* using *energy levels* and *orbitals*
C.1.PS.5	Distinguish among *atoms, ions,* and *isotopes*
C.1.PS.6	Model the *valence electrons* using *electron dot structures (Lewis electron dot structures)*

2c. Essential Question - How was the current atomic theory developed?

NS.11.PS.3	Summarize the development of the current *atomic theory*
NS.11.PS.5	Research historical events in *physical science*

2d. Essential Question - How was the Periodic Table developed?

NS.11.PS.4	Analyze the development of the *periodic table*

2e. Essential Question - What is the difference in a nuclear fission and fusion and what emissions are produced by radioactive decay?	
C.2.PS.6	Distinguish between *nuclear fission* and *nuclear fusion*
C.2.PS.7	Compare and contrast the emissions produced by *radioactive decay:* *alpha particles* *beta particles* *gamma rays*
NS.11.PS.6	Research current events and topics in *physical science*
NS.13.PS.3	Evaluate long-range plans concerning resource use and *by-product disposal* for environmental, economic, and political impact
2f. Essential Question - What career opportunities are available in the nuclear field?	
NS.14.PS.1	Research and evaluate physical science careers using the following criteria: educational requirements salary availability of jobs working conditions
3. Enduring Understanding - Bonding determines the structure and function of compounds.	
3a. Essential Question - What role do valence electrons play in forming chemical bonds?	
C.1.PS.7	Explain the role of *valence electrons* in determining *chemical properties*
C.1.PS.8	Explain the role of *valence electrons* in forming *chemical bonds*
C.1.PS..9	Model Bonding: *ionic* *covalent* *metallic*
3b. Essential Question - How are ionic compounds distinguished from covalent compounds?	
C.1.PS.10	Identify commonly used *polyatomic ions*
C.1.PS.11	Write formulas for *ionic* and *covalent compounds*
C.1.PS.12	Name *ionic* and *covalent compounds*
4. Enduring Understanding - Evidence of chemical reactions is observable and the rate of reaction is influenced by several factors.	
4a. Essential Question - What observable evidences indicate a chemical reaction has occurred?	
C.3.PS.8	Identify the observable evidence of a *chemical reaction*: formation of a *precipitate* production of a *gas* color change changes in *heat* and light

Fourth Nine Weeks

1. Enduring Understanding - Evidence of chemical reactions is observable and the rate of reaction is influenced by several factors.	
1a. Essential Question - What factors influence the rate of chemical reactions?	
C.3.PS.7	Examine factors that affect the rate of *chemical reactions,* including but not limited to *temperature* , light, *concentration* , *catalysts, surface area, pressure*
2. Enduring Understanding - Chemical reactions follow the law of conservation of mass.	
2a. Essential Question - How does balancing chemical equations show the conservation of mass?	
C.3.PS.2	Predict the *product(*s) of a *chemical reaction* when given the *reactants* using *chemical symbols* and words
C.3.PS.3	Balance *chemical equations* using the *Law of Conservation of Mass*
3. Enduring Understanding - When chemical reactions occur, energy is transferred and transformed.	
3a. Essential Question - What is the relationship between energy changes and chemical reactions?	
C.3.PS.1	Identify and write balanced *chemical equations:* *decomposition reaction* *synthesis reaction* *single displacement reaction* *double displacement reaction* *combustion reaction*
C.2.PS.5	Compare and contrast *endothermic* and *exothermic reactions* as *energy* is transferred
C.3.PS.5	Compare and contrast the properties of *reactants* and *products* of a *chemical reaction*
3b. Essential Question - What role does activation energy play in chemical reactions?	
C.3.PS.6	Model the role of *activation energy* in *chemical reactions*
4. Enduring Understandings - Chemical reactions have quantitative relationships.	
4a. Essential Question - What quantitative information is identifiable in chemical reactions?	
C.1.PS.13	Identify the *mole* and *amu (atomic mass unit*) as units of measurement in *chemistry*
C.1.PS.14	Calculate the *molar mass* of *compounds* based on *average atomic mass* .
C.3.PS.4	Determine *mole ratio* from a balanced reaction *equation*
5. Enduring Understanding - Organic compounds can be identified by carbon bonding, specific structure, and unique properties.	
5a. Essential Question - What types of bonds occur in organic compounds?	
C.4.PS.1	Summarize carbon bonding: *allotropes* (diamond, graphite*, fullerenes)* carbon-carbon (single, double, triple) *isomers* (branched, straight-chain, ring*)*

5b. Essential Question - How are organic compounds identified?	
C.4.PS.2	Identify *organic compounds* by their: formula structure properties functional groups
C.4.PS.3	Distinguish between *saturated* and *unsaturated hydrocarbons*
5c. Essential Question - What are the specific organic compounds found in the human body and what are their functions?	
C.4.PS.4	Describe *organic compounds* and their functions in the human body: *carbohydrates* *lipids* *proteins* *nucleic acids*
NS.11.PS.6	Research current events and topics in *physical science*
5d. Essential Question - What career opportunities are in the field of biochemistry?	
NS.14.PS.1	Research and evaluate physical science careers using the following criteria: educational requirements salary availability of jobs working conditions