Physical Science Alignment Guide: 8th Grade and High School Course

Guidance:

At its August 27, 2020 meeting, the State Board of Education passed a resolution selecting the following four courses to continue to include end-of-course (EOC) assessments under Senate Bill 367: Algebra I/Coordinate Algebra, American Literature and Composition, Biology, and U.S. History. As a result of this resolution, an EOC assessment for Physical Science will no longer be administered to high school students enrolled in the course. We understand that middle school students may also be enrolled in the high school Physical Science course, and that the standards for this course differ from the 8th grade science standards. Therefore, **we will continue to administer the Physical Science EOC assessment for middle school students enrolled in the high school course.** This EOC assessment will be for middle school students only and will not be administered to high school students enrolled in Physical Science. This means that no changes are being made to Georgia's EOC assessments for middle school students; therefore, Georgia's middle school assessment flexibility waiver still applies to science. Middle school students enrolled in either Physical Science or Biology will take only the EOC and will not take the EOG.

Students taking high school physical science in middle school will not be assessed on the 8th Grade Physical Science GSE. But realizing that our middle grades students have not explicitly had physical science since 5th grade, teachers may want to use this side-by-side guidance document to understand how the standards align and for recommendations about how to address possible pre-requisite standards students may need to be successful in the high school course.

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High School GSE	Middle School GSE (Content in red is specific to middle school and will need to be included in the high school course. Content in black is already addressed as part of the high school course.)	Recommendations (Integrating middle school standard into high school course)
SPS1. Obtain, evaluate, and communicate information from the Periodic Table to explain the relative properties of elements based on patterns of atomic structure. a. Develop and use models to compare and contrast the structure of atoms, ions and isotopes. (*Clarification statement:* Properties include atomic number, atomic mass and the location and charge of subatomic particles.) b. Analyze and interpret data to determine trends of the following: • Number of valence electrons • Types of ions formed by main group elements • Location and properties of metals, nonmetals, and metalloids • Phases at room temperature c. Use the Periodic Table as a model to predict the above properties of main group elements.	**S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures. (*Clarification statement:* Include heterogeneous and homogeneous mixtures. Types of bonds and compounds will be addressed in high school physical science.) c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical (i.e., density, melting point, boiling point) properties of matter. e. Develop models (e.g., atomic-level models, including drawings, and computer representations) by analyzing patterns within the periodic table that illustrate the structure, composition, and	**For S8P1a:** Introduce elements as pure substances with SPS1a, b, or c (compounds are discussed in SPS2); Students build understanding of why elements are considered pure substances. Models of elements will be developed with SPS1a. Mixtures can be added to the discussion of SPS6 later in the semester. The compare and contrast of pure substances and mixtures can be fully addressed at that time. **For S8P1c:** Discuss the properties listed in the middle school standard as part of SPS1b and SPS1c. Make sure students can identify these as chemical or physical properties. Students can plan and carry out an investigation to compare and contrast the properties and analyze and interpret the data in relation to metals, nonmetals, and metalloids (SPS1b). Some of these properties will also be addressed in SPS2a. **For S8P1e:** This is naturally part of SPS1a. Models of simple molecules are included with SPS2.

	characteristics of atoms (protons, neutrons, and electrons) and simple molecules.	

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SPS2. Obtain, evaluate, and communicate information to explain how atoms bond to form stable compounds. a. Analyze and interpret data to predict properties of ionic and covalent compounds. (*Clarification statement:* Properties are limited to types of bonds formed, elemental composition, melting point, boiling point, and conductivity.) b. Develop and use models to predict formulas for stable, binary ionic compounds based on balance of charges. c. Use the International Union of Pure and Applied Chemistry (IUPAC) nomenclature for translating between chemical names and chemical formulas. (*Clarification statement:* Limited to binary covalent and binary ionic, containing main group elements, compounds but excludes polyatomic ions.)	**S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures. (*Clarification statement:* Include heterogeneous and homogeneous mixtures. Types of bonds and compounds will be addressed in high school physical science.) c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical (i.e., density, melting point, boiling point) properties of matter.	**For S8P1a:** Introduce compounds as pure substances, and students build understanding of why they are considered a pure substance with SPS2a-c. Models of compounds will be developed with SPS2b (and possibly SPS2a). Mixtures will be addressed with SPS6. **For S8P1c:** The properties listed are included in SPS2a (with the exception of reactivity, combustibility, and density which were already discussed with SPS1). When discussing the properties in the high school standard, identify the properties as chemical or physical through student investigations. The data that is used to predict the properties of compounds could come from an investigation. Students can compare and contrast chemical and physical properties to meet the middle school standard.

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SPS3. Obtain, evaluate, and communicate information to support the Law of Conservation of Matter. a. Plan and carry out investigations to generate evidence supporting the claim that mass is conserved during a chemical reaction. (*Clarification statement:* Limited to synthesis, decomposition, simple replacement, and double replacement reactions.) b. Develop and use a model of a chemical equation to illustrate how the total number of atoms is conserved during a chemical reaction. (*Clarification statement:* Limited to chemical equations that include binary ionic and covalent compounds and will not include equations containing polyatomic ions.)	**S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** d. Construct an argument based on observational evidence to support the claim that when a change in a substance occurs, it can be classified as either chemical or physical. (*Clarification statement:* Evidence could include ability to separate mixtures, development of a gas, formation of a precipitate, change in energy, color, and/or form.) f. Construct an explanation based on evidence to describe conservation of matter in a chemical reaction including the resulting differences between products and reactants. (*Clarification statement:* Evidence could include models such as balanced chemical equations.)	**For S8P1d:** Add the argument based on evidence that a physical and/or chemical change has occurred to the investigation conducted for SPS3a. To assist students with a review of physical changes in matter, consider a guiding question such as, "How can we make new substances from old substances?" Framing the question in this way allows students to develop and apply ideas about both physical and chemical changes. **For S8P1f:** Models, such as balanced chemical equations, would naturally be included in SPS3a and SPS3b. To address the practice, students should construct an explanation based on evidence to describe the conservation of matter as depicted in the models they develop for SPS3a and/or SPS3b.

SPS4. Obtain, evaluate, and communicate information to explain the changes in nuclear structure as a result of fission, fusion and radioactive decay. a. Develop a model that illustrates how the nucleus changes as a result of fission and fusion. b. Use mathematics and computational thinking to explain the process of half-life as it relates to radioactive decay. (*Clarification statement:* Limited to calculations that include whole half-lives.) c. Construct arguments based on evidence about the applications, benefits, and problems of nuclear energy as an alternative energy source.	**Nuclear changes are not addressed in middle school.**	

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SPS5. Obtain, evaluate, and communicate information to compare and contrast the phases of matter as they relate to atomic and molecular motion. a. Ask questions to compare and contrast models depicting the particle arrangement and motion in solids, liquids, gases, and plasmas. b. Plan and carry out investigations to identify the relationships among temperature, pressure, volume, and density of gases in closed systems. (*Clarification statement:* Using specific Gas laws to perform calculations is beyond the scope of his standard; emphasis should focus on the conceptual understanding of the behavior of gases rather than calculations.)	**S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** b. Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed.	**For S8P1b:** Models of particle motion when thermal energy is added or removed is included in SPS5a and SPS5b. Students build understanding of thermal energy changes in relation to temperature and particle motion. (Molecular motion in relation to thermal energy changes is included with SPS7b.) To incorporate S8P1d, students could construct arguments based on observational evidence of how a change is classified as physical.

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SPS6. Obtain, evaluate, and communicate information to explain the properties of solutions. a. Develop and use models to explain the properties (solute/solvent, conductivity, and concentration) of solutions. b. Plan and carry out investigations to determine how temperature, surface area, and agitation affect the rate solutes dissolve in a specific solvent. c. Analyze and interpret data from a solubility curve to determine the effect of temperature on solubility. d. Obtain and communicate information to explain the relationship between the structure and properties (e.g., pH, and color change in the presence of an indicator) of acids and bases. (*Clarification statement:* Limited to only the structure of simple acids and bases (e.g., HCl and NaOH) that demonstrates the presence of an H+ or OH-.) e. Plan and carry out investigations to detect patterns in order to classify common household substances as acidic, basic, or neutral.	**S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures. (*Clarification statement:* Include heterogeneous and homogeneous mixtures. Types of bonds and compounds will be addressed in high school physical science.)	**For S8P1a:** Students understand solutions are mixtures and they use models to discuss the difference between heterogeneous and homogeneous mixtures and compare and contrast models of pure substances and mixtures with SPS6a.

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SPS7. Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system. a. Construct explanations for energy transformations within a system. (*Clarification statement:* Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.) b. Plan and carry out investigations to describe how molecular motion relates to thermal energy changes in terms of conduction, convection, and radiation. c. Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels). d. Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves.	**S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system.** a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object. b. Plan and carry out an investigation to explain the transformation between kinetic and potential energy within a system (e.g., roller coasters, pendulums, rubber bands, etc.). c. Construct an argument to support a claim about the type of energy transformations within a system [e.g., lighting a match (light to heat), turning on a light (electrical to light)]. d. Plan and carry out investigations on the effects of heat transfer on molecular motion as it relates to the collision of atoms (conduction), through space (radiation), or in currents in a liquid or a gas (convection).	**For S8P2a** and **S8P2b:** Integrate into an investigation performed at the beginning of the energy unit before energy transformations (SPS7a). Students should include the transformation of kinetic and potential energy in their explanations. **For S8P2c:** This is naturally part of SPS7a. Students should incorporate constructing arguments about energy transformations. **For S8P2d:** Use an investigation to address the process of how the energy is transferred (mechanisms: contact/collisions, in a vacuum or as electromagnetic waves, bulk movement of matter) and direction of heat transfer (hot to cold) when discussing SPS7b.

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SPS8. Obtain, evaluate, and communicate information to explain the relationships among force, mass, and motion. a. Plan and carry out an investigation and analyze the motion of an object using mathematical and graphical models. (*Clarification statement:* Mathematical and graphical models could include distance, displacement, speed, velocity, time and acceleration.) b. Construct an explanation based on experimental evidence to support the claims presented in Newton's three laws of motion. (*Clarification statement:* Evidence could demonstrate relationships among force, mass, velocity, and acceleration.) c. Analyze and interpret data to identify the relationship between mass and gravitational force for falling objects. d. Use mathematics and computational thinking to identify the relationships between work, mechanical advantage, and simple machines.	**S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.** a. Analyze and interpret data to identify patterns in the relationships between speed and distance, and velocity and acceleration. (*Clarification statement:* Students should be able to analyze motion graphs, but students should not be expected to calculate velocity or acceleration.) b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object. c. Construct an argument from evidence to support the claim that the amount of force needed to accelerate an object is proportional to its mass (inertia). **S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.** a. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact.	**For S8P3a:** This is naturally part of SPS8a. **For S8P3b:** Discuss balanced and unbalanced forces with SPS8b. **For S8P3c:** Discuss the proportional relationship between force and mass with SPS8b. Students should incorporate constructing arguments about force and mass proportion. **For S8P5a:** Students build an understanding of gravitational fields existing between objects exerting forces on each other even when the objects are not in contact with SPS8c. Incorporate constructing arguments from evidence. Electric and magnetic fields are addressed with SPS10.

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SPS9. Obtain, evaluate, and communicate information to explain the properties of waves. a. Analyze and interpret data to identify the relationships among wavelength, frequency, and energy in electromagnetic waves and amplitude and energy in mechanical waves.	**S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves.** f. Develop and use a model (e.g., simulations, graphs, illustrations) to predict and describe the relationships between wave properties (e.g., frequency, amplitude, and wavelength) and energy.	**For S8P4f:** This is addressed in SPS9a with the development and use of models based on the data.
b. Ask questions to compare and contrast the characteristics of electromagnetic and mechanical waves.	b. Construct an explanation using data to illustrate the relationship between the electromagnetic spectrum and energy.	**For S8P4b:** This is addressed with SPS9a with the construction of an explanation using data.
c. Develop models based on experimental evidence that illustrate the phenomena of reflection, refraction, interference, and diffraction.	a. Ask questions to develop explanations about the similarities and differences between electromagnetic and mechanical waves. (*Clarification statement:* Include transverse and longitudinal waves and wave parts such as crest, trough, compressions, and rarefactions.)	**For S8P4a:** This is addressed in SPS9b. (make sure characteristics/terms are used in compare and contrast).
d. Analyze and interpret data to explain how different media affect the speed of sound and light waves. e. Develop and use models to explain the changes in sound waves associated with the Doppler Effect.	d. Develop and use a model to compare and contrast how light and sound waves are reflected, refracted, absorbed, diffracted or transmitted through various materials. (*Clarification statement:* Include echo and how color is seen but do not cover interference and scattering.)	**For S8P4d:** This is addressed in SPS9c with the addition of absorption and transmittance.
	g. Develop and use models to demonstrate the effects that lenses have on light (i.e., formation an image) and their possible technological applications.	**For S8P4g:** This could be addressed with SPS9c (refraction) and/or SPS9d (media and speed of light).
	e. Analyze and interpret data to predict patterns in the relationship between density of media and wave behavior (i.e., speed).	**For S8P4e:** This is addressed in SPS9d with a focus on density of media affecting the speed of waves.

	c. Design a device to illustrate practical applications of the electromagnetic spectrum (e.g., communication, medical, military).	**For S8P4c:** Integrate after Doppler Effect (SPS9e)—could discuss the technological applications of Doppler Effect and lead into applications of the electromagnetic spectrum.

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SPS10. Obtain, evaluate, and communicate information to explain the properties of and relationships between electricity and magnetism. a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance. b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits. (*Clarification statement:* Advantages and disadvantages of series and parallel circuits should be addressed.) c. Plan and carry out investigations to determine the relationship between magnetism and the movement of electrical charge. (*Clarification statement:* Investigations could include electromagnets, simple motors, and generators.)	**S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.** a. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact. b. Plan and carry out investigations to demonstrate the distribution of charge in conductors and insulators. (*Clarification statement:* Include conduction, induction, and friction.) c. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) that affect the strength of electric and magnetic forces. (*Clarification statement:* Including, but not limited to, generators or motors.)	**For S8P5a and S8P5b:** Students build understanding of fields, forces, and distribution of charge before SPS10a; consider using an investigation for charge distribution and argumentation for field forces. **For S8P5c:** This can be integrated with SPS10c using an investigation to identify the factors affecting the strength of electric and magnetic forces.