

**Ohio Science Grades 9-12
Contents Standards Mapping**

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PHYSICAL SCIENCE		Boardworks High School Physics Presentation
Grade 9		
1. Recognize that all atoms of the same element contain the same number of protons, and elements with the same number of protons may or may not have the same mass. Those with different masses (different numbers of neutrons) are called isotopes.		Structure of the Atom *
2. <i>Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral.</i>		*
3. Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation.		Radioactivity Structure of the Atom Types of Radiation
4. <i>Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations.</i>		*
5. <i>Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons.</i>		*
6. <i>Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals and water).</i>		*
7. <i>Show how atoms may be bonded together by losing, gaining or sharing electrons and that in a chemical reaction, the number, type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations).</i>		*
8. <i>Demonstrate that the pH scale (0-14) is used to measure acidity and classify substances or solutions as acidic, basic, or neutral.</i>		*
9. Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, properties of alloys, superconductors and semiconductors).		Conductors and Insulators
10. Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity.		Conductors and Insulators
11. Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion, and during changes of state the temperature remains constant.		Changing State Particles in Action
12. Explain how an object's kinetic energy depends on its mass and its speed ($KE = \frac{1}{2}mv^2$).		Kinetic Energy

13. Demonstrate that near Earth's surface an object's gravitational potential energy depends upon its weight (mg where m is the object's mass and g is the acceleration due to gravity) and height (h) above a reference surface ($PE=mgh$).	–
14. Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.)	Nuclear Fission Nuclear Fusion
15. Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy.	Energy Transfers
16. Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs, hot packs and the burning of fossil fuels).	*
17. Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation).	Conduction and Convection Radiation
18. Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays).	Electromagnetic Waves Gamma Rays X-rays
19. Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium.	Electromagnetic Waves Waves
20. Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material.	Diffraction Interference Refraction Reflection Superposition and Interference
21. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.	Displacement, Velocity and Acceleration
22. Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it.	Acceleration Displacement, Velocity and Acceleration Newton's First Law Newton's Second Law Newton's Third Law Speed and Velocity
23. Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. ($F_{net}=ma$. Note that weight is the gravitational force on a mass.)	Acceleration Newton's Second Law

24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.	Newton's Third Law
25. Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight).	Free-Body Diagrams Friction
26. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory and Newtonian mechanics).	Structure of the Atom
27. Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy, nanotechnology, plastics, ceramics and communication technology).	Newton's First Law Newton's Second Law Newton's Third Law Structure of the Atom
Grade 11	
1. Explain that elements with the same number of protons may or may not have the same mass and those with different masses (different numbers of neutrons) are called isotopes. Some of these are radioactive.	*
2. Explain that humans have used unique bonding of carbon atoms to make a variety of molecules (e.g., plastics).	*
3. Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use).	—
4. Explain how electric motors and generators work (e.g., relate that electricity and magnetism are two aspects of a single electromagnetic force). Investigate that electric charges in motion produce magnetic fields and a changing magnetic field creates an electric field.	Magnetism, Current and Force Motors
Grade 12	
1. Explain how atoms join with one another in various combinations in distinct molecules or in repeating crystal patterns.	*
2. Describe how a physical, chemical or ecological system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small. Large disturbances may cause it to escape that equilibrium and eventually settle into some other state of equilibrium.	*
3. Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe).	—
4. Recognize that at low temperatures some materials become superconducting and offer little or no resistance to the flow of electrons.	—

5. Use and apply the laws of motion to analyze, describe and predict the effects of forces on the motions of objects mathematically.	Acceleration Circular Motion Displacement, Velocity and Acceleration Newton's First Law Newton's Second Law Newton's Third Law Projectiles
6. <i>Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces that would make it fly apart.</i>	–
7. Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars).	Nuclear Fission Nuclear Fusion The Life Cycle of Stars
8. Describe how the observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect). If either is moving towards the other, the observed wavelength is shorter; if either is moving away, the observed wavelength is longer (e.g., weather radar, bat echoes and police radar).	Doppler Effect
9. Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force is proportional to the masses and weakens rapidly with increasing distance between them.	Gravity Gravitational Potential Energy
10. Explain the characteristics of isotopes. The nuclei of radioactive isotopes are unstable and spontaneously decay emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate.	Radioactivity
11. Use the predictability of decay rates and the concept of half-life to explain how radioactive substances can be used in estimating the age of materials.	Radioactive Dating
12. Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules.	*
13. Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts.	Observing Line Spectra The Photoelectric Effect
14. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity).	Nuclear Fission Nuclear Fusion Observing Line Spectra The Photoelectric Effect
15. Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe).	Nuclear Fission The Big Bang Theory