Ohio Science Grades 9-12
Contents Standards Mapping

PHYSICAL SCIENCE	Boardworks High School Chemistry 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.	Atomic Number and Mass Number Atomic Structure Isotopes
2. Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral.	Atomic Structure
3. Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation.	Radioactivity Types of Radiation
4. 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.	Atomic Number and Mass Number Electron Structure and The Periodic Table The Periodic Table
5. 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.	Formation of Ions
6. 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).	Atomic Structure Intermolecular Forces Ionic Compounds
7. 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).	Conservation of Mass Covalent Bonding Ionic Bonding Metallic Bonding Reacting Masses Types of Formulae
8. Demonstrate that the pH scale (0-14) is used to measure acidity and classify substances or solutions as acidic, basic, or neutral.	pH and Indicators Properties of Acids and Alkalis
9. Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, properties of alloys, superconductors and semiconductors).	*
10. Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity.	*

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=½mv 2).	*
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).	Endothermic Reactions Exothermic Reactions
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).	*
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).	*
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.	*
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.	*
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.	*
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.	*
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. (Fnet=ma. Note that weight is the gravitational force on a mass.)	*
24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.	*

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).	*
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).	Introducing Atoms
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).	Introducing Atoms
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.	Atomic Number and Mass Number Isotopes Radioactivity
2. Explain that humans have used unique bonding of carbon atoms to make a variety of molecules (e.g., plastics).	Polymers
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.	*
Grade 12	
1. Explain how atoms join with one another in various combinations in distinct molecules or in repeating crystal patterns.	Comparing Bonding Covalent Bonding Giant Covalent Structures Ionic Bonding Ionic Compounds Metallic Bonding
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.	Dynamic Equilibrium Equilibrium - Changing Conditions Le Chatelier's Principle
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.	*
6. 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.	*
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
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).	*
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.	*
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.	Half-life Isotopes 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.	Half-life 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.	Electron Configuration Energy Sublevels Orbitals
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 Orbitals 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

* See Boardworks High School Physics for relevant presentations.