

HIGH SCHOOL SCIENCE CHECKLIST

Matter and Energy, Goal 12

Illinois Learning Standard C

Assessment Frameworks

PSAE test questions are derived from this list.

PROPERTIES OF MATTER

- _____ Understand the most familiar elements by name and some of their most familiar properties, such as what state they are in at room temperature and one atmosphere of pressure. Identify the chemical symbols for familiar elements. **AG**
- _____ Understand that the periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure.
- _____ Understand how to relate the position of an element in the periodic table to its chemical properties.
- _____ Understand how to use the periodic table to identify the families of elements (and their properties) known as alkali metals, alkaline Earth metals, halogens, and noble gases.
- _____ Know that there is a kind of periodicity in the physical properties of chemical elements, and that the periodic table arranges them accordingly, and that this way of ordering them corresponds to the order in their atomic structures. Understand that the major groups of chemical elements are: 1. alkali metals, 2. alkaline Earth metals, 3. transition metals, 4. nonmetals (boron family, carbon family, nitrogen family, oxygen family), 5. metalloids, 6. halogens, 7. noble gases, and 8. rare Earth elements. Know why hydrogen is not in any of these groups.
- _____ Know that there are two major different kinds of bonds (ionic and covalent). Know the distinction between a compound and a mixture.
- _____ Understand how to use the periodic table to identify the trends in relative sizes of ions and atoms.
- _____ Understand how to use the periodic table to determine the number of electrons available for bonding. Understand what isotopes are.
- _____ Understand that the nucleus of the atom is much smaller than the whole atom yet contains most of its mass.
- _____ Understand that the transuranium elements were not discovered in nature but synthesized through the use of nuclear accelerators.

_____ Understand the definitions of the different states of matter: solid, liquid, gas, plasma. Define freezing, melting, boiling, condensing, and sublimation. **AG**

_____ Understand that the temperature of water (or any substance) is constant during phase changes, even when heat is being added or removed.

_____ Understand that the kinetic molecular theory explains the properties of gases by the random motion of molecules in them. For example, the collisions of these particles with a surface create an observable pressure on that surface, and their motion explains the diffusion of gases.

_____ Understand how to apply the gas laws to relations between pressure, temperature, and volume of any amount of an ideal gas. Understand Boyle's Law and Charles' Law and how to logically solve problems. **AG**

_____ Understand the values of standard temperature and pressure (STP): 0° Celsius and 1 atm.

_____ Understand how to convert between Celsius and Kelvin temperature scales. Understand that there is no temperature lower than 0 Kelvin, or absolute zero.

THE ATOM

_____ Understand that in chemical reactions, atoms combine into molecules by means of bonds (e.g., by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds).

_____ Know that ions are atoms or groups of atoms that have a positive or negative charge and that polyatomic ions are a group of covalently bonded atoms that act like a single atom when combining with other atoms. Understand that metals tend to form positive ions, and nonmetals tend to form negative ions.

_____ Understand that ionic solids like NaCl (sodium chloride, ordinary table salt) are formed from a three-dimensional repeating pattern of alternating positive and negative ions, held together by electrostatic forces (ionic bonds).

_____ Understand that the conservation of atoms in a chemical reaction, as summarized in a balanced chemical equation, leads to the ability to calculate theoretical masses of reactants and products.

_____ Understand how to balance simple chemical equations.

_____ Understand that the chemical quantity called "one mole" is set by calling the number of atoms in exactly 12 grams of carbon-12 atoms one mole. This number turns out to be 6.02×10^{23} , also known as Avogadro's Number

_____ Understand that energy is exchanged or transformed in all chemical reactions and physical changes of matter. Understand that chemical processes can either release (exothermic) or absorb (endothermic) thermal energy. Understand that energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts. **AG**

ACIDS AND BASES

_____ Understand that most acids, bases, and salts, when dissolved in water, conduct electric current. These three classes of compounds (called electrolytes) form ions in water solutions. Understand the observable properties of acids, bases, and salt solutions.

_____ Understand that among other definitions of acids and bases, acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

_____ Use the pH scale to characterize acid and base solutions. Know the definition of pH as the negative logarithm of the hydronium ion concentration, and understand what the log scale means. **AG**

_____ Distinguish between chemical compounds and solutions and mixtures. Define solute and solvent. Understand the concentration of a solute in terms of grams per liter, parts per million, percent composition, and moles per liter.

ENERGY

_____ Understand that energy, defined somewhat circularly, is “the ability to change matter,” or “the ability to do work.” Understand that energy is defined by the way it is measured or quantified. Understand the difference between potential and kinetic energy. **IT**

_____ Understand that a magnetic field is generated around an electrical current and that the motion of a conducting wire through a magnetic field generates a current through it. Understand that in some substances, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At very low temperatures, some materials offer no resistance to the flow of electrons and become superconductors. **IT**

_____ Understand that an electrically neutral object has particles within it that are charged, but their charges balance each other out. **IT**

_____ Know the first two laws of thermodynamics: (1) Energy is conserved (neither created nor destroyed) and (2) Heat flows naturally from a hot object to a cold object; heat will not flow spontaneously from a cold object to a hot object.

Understand that another statement of the Second Law is that no device is possible whose sole effect is to transform a given amount of heat completely into work.

_____ Recount the concept of entropy and know that entropy in the universe considered as a whole always increases.

LIGHT

_____ Indicate that the speed of light differs in some material from its speed in a vacuum is given by the index of refraction for that material, n . n is the ratio of the speed of light in a vacuum to the speed of light in the material. Also know that light follows the path of least time through various materials and that this is not the same as the shortest distance.

_____ Understand the reflection, refraction, diffraction, and interference properties of light waves.