

Matter and its Interactions Conceptual Flow

Matter is anything that takes up space and has mass.

When substances are mixed together, either a mixture is formed (physical change) or a chemical reaction occurs (chemical change).

When two or more substances are mixed, regardless of whether a reaction occurs, the mass of the starting materials (reactants) is equal to the mass of the ending materials (products). This is known as the Law of Conservation of Mass.
2-PS1-3, 5-PS1-2

Mixtures are made up of multiple pure substances that individually have distinct properties.

Dissolving (a physical reaction) is a process in which a substance disperses into another substance to form a solution, which may have different properties from the solvent (substance in greatest quantity) and the solute (substance(s) in lower quantities).

Solutions can be combinations of solids, liquids, and gases. (Ex: air [N₂, O₂, CO₂] and soda water [H₂O and CO₂]). The parts of a solution cannot be distinguished by the naked eye.

Chemical reactions involve reorganization of atoms. During reaction the way atoms are bonded changes which results in the formation of one or more new substances. The atoms themselves are not changed in a chemical reaction.
MS-PS1-5

Chemical properties of substances can only be observed during chemical reactions. Possible evidence of chemical reactions are: gas production, precipitate formation, color change, temperature change, odor change, or light production.
5-PS1-4, MS-PS1-2

The majority of chemical reactions are irreversible.
2-PS1-4

Changes in chemical energy between the reactants and products result in the overall release (exothermic) or absorption (endothermic) of energy (heat).
MS-PS1-6

The amount of energy released or absorbed during a chemical reaction is dependent on the amount starting material (reactants).
MS-PS3-4

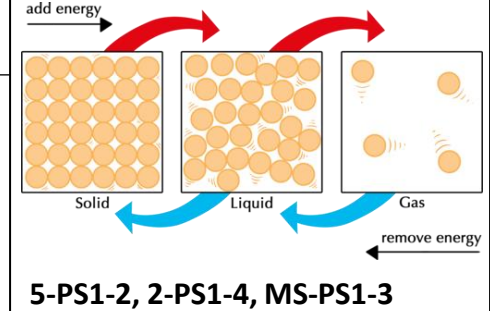
Physical properties determine the ways materials are used.
2-PS1-2

Physical properties can be used to separate mixtures into pure substances.

A physical change is a change that affects the form of a substance but not its chemical composition (Ex: folding paper or melting ice). Many physical changes are reversible, but not all (Ex: ripping paper).

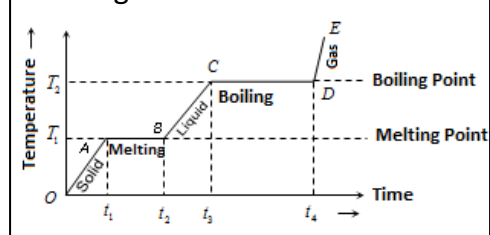
Physical reactions are physical changes that involve changes in thermal energy, pressure, or from mixing substances that do not react chemically. Mass is conserved during physical reactions.

Phase changes (Ex: melting, freezing, evaporating, condensing, etc.) are physical reactions.



Phase changes are reversible by changing the temperature or pressure.
2-PS1-4

Graphing heat vs. temperature of a pure substance results in a heating curve.



Physical properties are properties that can be measured or observed without changing the substance. Physical properties include: color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, solubility, flammability, odor, melting point, density (density should not be covered until middle school), etc.
2-PS1-1, 5-PS1-4, MS-PS1-2

The state of matter is a physical property. There are four states of matter: solid, liquid, gas, and plasma.

In solids, particles are close together and vibrate in a given position (least particle motion). In liquids, particles are close together but are able to move past each other. In gases, particles are far apart and move freely (most particle motion).
MS-PS1-4

Pure substances have characteristic physical properties that can be used to identify them.
5-PS1-3

The process of forming pure substances cannot be reversed without the use of a chemical process.

Metallic compounds/metals can be either made up of multiple types of metals [Ex: brass – copper and zinc] or a single type of metal [Ex: iron] held together by metallic bonds. In metallic bonds atoms are closely packed and the electrons are free to move between them.

Not all metals are compounds (Ex: Cu).

Atoms are the smallest building blocks of matter and the basic units of chemical elements. Atoms are too small to be seen.

Atoms of either the same or different types can join together to form a bond.

Pure substances are made from: one type of atom as individual atoms (Ex: He), one type of atom bonded to another atom of the same type (Ex: O₂), or from multiple types of atoms bonded to each other (Ex: H₂O). For most pure substances, one unit of that substance is too small to be seen.
5-PS1-1

Compounds are made of two or more elements in a specific ratio.

Salts (ionic compounds) are made up of metals bonded to non-metal atoms and are held together by the charges created when electrons transfer between atoms, referred to as ionic bonds (Ex: NaCl).
MS-PS1-1

Elements are the types of atoms. All elements are organized by their properties in the periodic table.

Atoms are made up of protons, neutrons, and electrons. The number of protons defines the type of atom

The number of electrons helps determine if substances are stable. There are specific values of electrons that are stable. Unstable atoms will form bonds to reach stability.

Molecules (molecular compounds) are made up of non-metal atoms held together by the sharing of electrons, referred to as covalent bonds (Ex: H₂O).
MS-PS1-1

Molecules can be either extracted from natural resources or man-made (synthesized) in a lab (Ex: aspirin: C₉H₈O₄).
MS-PS1-3

Natural molecules can be modified to produce different materials (Ex: nylon).
MS-PS1-3

Not all molecules are compounds (Ex: O₂).