# 5.P.2 Physical Science: Matter and Mixtures



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## 5.P.2A.1 Analyze and interpret data from observations and measurements of the physical properties of matter (including volume, shape, movement, and spacing of particles) to explain why matter can be classified as a solid, liquid or gas.

**Essential Knowledge**

It is essential for students to analyze and interpret data demonstrating that matter is anything that has mass and volume. All matter is made up of very small particles too small to be seen. Even though these particles are very small, they give matter its basic properties.

Solids, liquids, and gases can be compared based on their physical properties (including volume, shape, and the movement/spacing of particles):

Solids

- Solids have a definite shape and volume.

- Particles in a solid are very close to one another (dense) and vibrate, but stay in the same place.
- The volume of a solid with rectangular sides can be determined by measuring with a ruler and calculating height x width x length.
- The volume of an irregularly shaped solid can be determined by water displacement in a graduated cylinder. Water displacement in a graduated cylinder can be found when the cylinder is filled with water and measured. The object is then placed in the cylinder and the water level is measured again. Subtract the water level of the graduated cylinder from the water level with the object and that is the volume of the irregularly shaped solid.
- The volume of water displaced equals the volume of the object.

Liquids

- Liquids have a definite volume, but their shape changes according to the shape of their containers.
- The particles are also close to one another, but they are able to move apart from each other and flow from place to place.
- The volume of a liquid can be measured using a beaker, graduated cylinder or graduated syringe.

Gases

- Gases have no definite shape or volume, but take the shape and volume of their containers, filling the space available.
- The particles easily move far apart from each other and spread out through the available space.

It is because of the movement and spacing of particles of matter that the volume and shape of solids, liquids, and gases differ.

*SCIENTIFIC TOOLS used to make observations and measurements of the physical properties of matter (10 x magnifier, metric ruler, tape measure, meter stick, graduated cylinder, beaker, graduated syringe, balance, mass weights)

**Extended Knowledge**

- Name the particles of matter: atoms. Observe models of atoms.
- Identify that the volume of a gas changes when the pressure changes and identify how temperature changes can affect volumes of gases, liquids, and solids

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# 5.P.2B.1 Obtain and communicate information to describe what happens to the properties of substances when two or more substances are mixed together.

**Essential Knowledge**
It is essential for students to obtain and communicate information stating the characteristics of solutions and mixtures.

Mixtures

- Mixtures are composed of two or more substances that are mixed together, but can be separated from each other.
- Mixtures can be made from various combinations of solids, liquids, or gases.
    - Examples of mixtures of solids, could include: trail mix, chef salad, a bucket of gravel and sand
    - Examples of mixtures of solids and liquids, could include: salt water solution, sun tea, mud
    - Examples of mixtures of liquids, could include oil and vinegar salad dressing
    - Examples of mixtures of liquids and gases, could include carbonated soft drinks

- The substances in a mixture do not permanently change in the mixture, but they keep their separate properties (Physical Change).

Solutions

- They are composed of substances that mix so completely that they cannot be distinguished as separate substances; however, they can be separated back into separate substances
- Examples of easy to make solutions could include: sun tea, flavored drink mix, salt water, sugar water, indigestion medicine tablet added to water

Students will analyze and interpret data to support claims that when two substances are mixed, the total amount (mass) of the substances does not change. It may be useful to collaboratively teach 5.P.2B.2, and 5.P.2B.3 along with this standard. Students will develop models to describe mixtures, so you may find it useful to reuse mixtures created with this standard.

**Extended Knowledge**

- Classify mixtures as heterogeneous or homogeneous
- Recall that they can be distinguished from elements and compounds

# 5.P.2B.2 Analyze and interpret data to support claims that when two substances are mixed the total amount (mass) of the substances does not change.

**Essential Understanding**

It is essential for students to analyze and interpret data that demonstrates the amount (mass) of matter does not change when two substances are mixed together, only rearranged to form new substances (Chemical Change).

- Matter can neither be created nor destroyed, but can be changed in form.
    - For example, when making pancakes, you combine ingredients (flour, baking soda, salt, sugar, milk, eggs, and butter) to create pancakes, but you do not create more ingredients, you just mix them together to form a new substance, pancakes.
- Because matter is neither created nor destroyed, the total mass of the materials before mixing materials together is the same as the total mass of materials after they are mixed together.
    - For example, dissolving sugar or salt into water: The separate masses of the sugar and the water measured before they are mixed and dissolved will be the same as the mass of the sugar-water after they are mixed.
- Sometimes, a solution results in a chemical change that may seem like some of the mass is lost. What really happens, however, is that some of the matter is converted into a gas that escapes and cannot be easily measured after the substances have been mixed.
    - For example, when an Alka-Seltzer® tablet is mixed with water the total mass will not equal the mass before mixing because some of the mass has been changed into a gas and escapes (the bubbles that form as the tablet is dissolving).
    - In the pancake example above, it is also likely that the post-mixing mass will not be the same because a chemical reaction occurs when the baking soda is added that results in some of the mass converting into a gas that escapes as bubbles.

Students will obtain and communicate information to describe what happens to the properties of substances when two or more substances are mixed together with 5.P.2B.1, and will analyze and interpret data to support claims that when two substances are mixed the total amount (mass) of the substances does not change with 5.P.2B.3, so you may find it useful to teach these standards collaboratively in order to reuse mixtures.

*SCIENTIFIC TOOLS used to show evidence that when two substances are mixed the total amount (mass) of the substances does not change (balance, mass weights)

**Extended Knowledge**

- Identify simple chemical symbols (H2O---water, NaCl---salt)
- Observe simple balanced chemical equations; recognize that an equation is balanced
- Law of Conservation of Matter

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## 5.P.2B.3 Develop models using observations to describe mixtures, including solutions, based on their characteristics.

**Essential Knowledge**

Mixtures created while obtaining information from 5.P.2.B.1 (trail mix, flavored drink mix, etc.) and analyzing mixtures from 5.P.2.B.2 (pancakes, etc.) could be duplicated.

It is essential for students to develop models demonstrating the characteristics of mixtures and solutions.

- Mixtures are composed of two or more substances that are mixed together but can be separated from each other.
- Solutions are composed of substances that mix so completely that they cannot be distinguished as separate substances.
- Students should create functional models of mixtures and solutions
- Functional models describe how something works and can include simple diagrams and simulations
    - Examples of mixtures could include: Trail Mix, fruit salad, chef salad
    - Examples of solutions could include: flavored drink mixes, salt water, sugar water, sun tea

**Extended Knowledge**

- Identify that mixtures can be heterogeneous or homogeneous or that they can be distinguished from elements and compounds

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## 5.P.2B.4 Construct explanations for how the amount of solute and the solvent determine the concentration of a solution.

**Essential Knowledge**

It is essential for students to construct explanations stating that solutions are types of mixtures and that they are defined by the particles in them.

- The substance in a solution that has the greatest amount is the solvent. It is usually the liquid.
- The substance in a solution that has the least amount is the solute. It is usually the solid.

The relationship of the amount of solute to solvent determines the concentration of a solution.

- The more solute a solution has compared to the amount of solvent, the more concentrated it is said to be.
- When two solutions contain the same amount of solvent, the one with the greater amount of solute is the more concentrated solution
- In order to make a solution more concentrated, more solute is added.
- To make a solution less concentrated, more solvent is added.

*SCIENTIFIC TOOLS used to measurement solute and solvents (measuring cups/spoons, beaker, graduated cylinder, graduated syringe)

**Extended Knowledge**

- Identify specific quantitative relationships (ratios) of solutes and solvents in specific percent concentrations for solutions.

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## 5.P.2B.5 Conduct controlled scientific investigations to test how different variables (including temperature change, particle size, and stirring) affect the rate of dissolving.

**Essential Understanding**

It is essential for students to conduct investigations testing how different amounts of solutes dissolve in solvents in solutions in given times, which is called the rate of dissolving.

Factors which affect the rate of dissolving:

Temperature change

- Usually, if the temperature increases, more of the solute will dissolve faster.

Particle size

- Usually, if the particle sizes are smaller, more of the solute will dissolve faster.

Stirring

- Usually, if the solution is stirred, more of the solute will dissolve faster.

*SCIENTIFIC TOOLS used to test the rate of dissolving (beaker, graduated cylinder, stopwatch, hot plate, coffee maker)

**Extended Knowledge**

- Investigate solubility of solutes
- Investigate and/or identify whether a solution is saturated or unsaturated

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## 5.P.2B.6 Design and test the appropriate method(s) (such as filtration, sifting, attraction to magnets, evaporation, chromatography, or floatation) for separating various mixtures.

**Essential Understanding**

It is essential for students to design solutions using the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, or floatation to separate mixtures.

Filtration

- Filtration is used to separate solid particles from a liquid.
- For example, pouring the mixture through a filter paper in a funnel will trap the solid particles and only allow the particles of the liquid to pass through.
- This method is used in water treatment plants as part of the process for separating dirt and other solid particles from water to produce clean drinking water.

Sifting

- Sifting is used to separate smaller solid particles from larger solid particles.
- For example, the mixture of different sized solid particles can be put into a container that has a screen material at the bottom with holes of a certain size.
- When the mixture is shaken, the smaller particles go through the screen leaving the larger particles in the container.
- Cooks, for example, sift flour to get a small particle size for baking leaving larger particles of flour in the sifter above the screen.

- Sand and gravel companies, for example, separate rocks into different sized particles for road building and other construction projects using this method.

Magnetic attraction

- Magnetic attraction is used to separating magnetic material from a mixture of other substances.
- When a magnet is stirred through the mixture, it pulls out the magnetic material from the mixture.
- A cow magnet, for example, is given to a cow to swallow. It stays in the first stomach of the cow, keeping magnetic materials like wire and other harmful materials that cows swallow from going into the rest of their digestive system.

Evaporation

- Evaporation is used to separate a solid that has dissolved in a liquid solution.
- The solution is heated or left uncovered until all the liquid turns to a gas (evaporates) leaving the solid behind.
- Salt in salt water or ocean water, for example, is separated by heating the solution until all the water evaporates leaving the solid salt in the container.

Chromatography

- Chromatography is used to separate and analyze the solutes in a solution.
- For example, a small amount (2-3 drops) of the solution is put on a piece of filter paper, which is put in a solvent.
- The substances in the solution that dissolve most easily travel the furthest; and substances that do not dissolve easily do not travel very far.
- The bands of color that are formed allow scientists to identify the substances in the solution by comparing them to the location of known substances forming bands of color on different filter papers.

Floatation

- Floatation is used to separate solids that float from the remaining liquid in a mixture.
- The solids are stirred and when they float to the top, they are skimmed off the surface of the liquid and put into a different container.
- This method is used, for example, in some water purification plants.

*SCIENTIFIC TOOLS used to test appropriate methods for separating various mixtures (beaker, graduated cylinder, magnets, filter paper or coffee filters, funnel stand, funnels, screens, strainers, sifters, evaporation trays)

**Extended Knowledge**

- Research mixtures that can be separated, by not by the more simplistic methods we tested.