**Concept Block Four: Properties of Matter**

1. In this section we will concentrate on the following standard and its components:

**Standard: 5Sd: The student will demonstrate an understanding of properties of matter (Physical Science)**

**5Sd.1:** Recall that matter is made up of particles too small to be seen.

**5Sd.2:** Compare the physical properties of the states of matter (including volume, shape,

and the movement and spacing of particles).

**5Sd.3:** Summarize the characteristics of a mixture, recognizing a solution as a kind of

mixture.

**5Sd.4:** Use the processes of filtration, sifting, magnetic attraction, evaporation,

chromatography, and floatation to separate mixtures.

**5Sd.5:** Explain how the solute and the solvent in a solution determine the concentration.

**5Sd.6:** Explain how temperature change, particle size, and stirring affect the rate of

dissolving.

**5Sd.7:** Illustrate the fact that when some substances are mixed together, they chemically

combine to form a new substance that cannot easily be separated.

**5Sd.8:** Explain how the mixing and dissolving of foreign substances is related to the

pollution of the water, air, and soil.

1. **These concepts correspond to the following sections in the Scott Foresman Textbook:**
2. xit
3. **These concepts are encountered in the following *Reading Street* stories and articles:**

**Concept Block Four Content Summary**

**5Sd.1:** Recall that matter is made up of particles too small to be seen.

* All matter in the universe is made up of **atoms**. These atoms are far too small to be seen without the most powerful electron microscopes, and even then we can’t see them well. Atoms themselves are made up of even smaller **sub-atomic particles** (protons, neutrons, and electrons). All atoms are made of these particles. It is the number and arrangement of protons, neutrons, and electrons that makes them different from one another. All pure substances are made of atoms of the same type. We identify them based on the number of protons they have. For example, all atoms of iron have 26 protons. All atoms of calcium have 20 protons. Every element (pure substance) has a set number of protons. An atom is the tiniest piece of element you can get.
* **Elements** cannot be broken down into other substances. They are the same all the down to the individual atom. When you hold a fleck of gold in your hand you are holding billions of identical atoms each of which has 79 protons in it. Elements are the building materials of matter. They are nicely displayed on the periodic table. It organizes all of the known elements by their proton numbers (atomic #), and groups them by type (metal, non-metal, gas, etc). Elements can be chemically combined to form new substances. Hydrogen and oxygen make water. Sodium and chlorine make table salt; iron and oxygen make rust, etc. These new substances are called compounds. Compounds are two or more elements chemically combined. It is important to remember that elements in compounds are chemically combined, they aren’t just mixed together.

**5Sd.2:** Compare the physical properties of the states of matter (including volume, shape,

and the movement and spacing of particles).

* The key to understanding the physical properties of matter is to think about individual molecules and how they respond to energy. Water molecules are a great example. Water molecules are so tiny that there are billions of them in a single rain drop. Like all molecules, they constantly vibrate in place. As you add energy to water molecules they begin to buzz around more and bump in to each other. If enough energy is added, they will begin to ricochet out into the air as a gas. If you remove energy from them they will calm down and stay together in a liquid. If you cool them down enough, they will pack in tightly together forming a solid, ice. So if we put an ice cube in a pan on a hot stove it will change. The heat will add energy to the tiny molecules. They will begin to buzz more and more. Initially they will slip and slide over each other as a liquid. Eventually they will get so fired up they will jump right out of the pan as water vapor. Water goes through these phase changes (solid to liquid to gas) at temperatures that we regularly encounter. Water is a solid at temperatures below 32 degrees Fahrenheit (0 Celsius); it melts into liquid at the temperatures we like. Most metals remain frozen at room temperature. Iron doesn’t begin to melt until it reaches 2,500 degrees Fahrenheit (1,370 Celsius)!
* Solids have set volumes and shapes, liquids have set volumes, but take the shape of whatever container they are in. Gases have no set volume or shape.

**5Sd.3:** Summarize the characteristics of a mixture, recognizing a solution as a kind of

mixture.

* **Mixtures** are physical combinations of substances. When you toss a salad, make a sandwich, or add sugar to your coffee, you are making mixtures. With effort these combinations can be separated. They are not chemically combined; their atoms are not linked together. Their components can be separated with relative ease. They also retain their individual characteristics. This is not the case with compounds. Imagine trying to separate the sodium and chlorine from your salt, or the hydrogen and oxygen from your water and the difference becomes clear.
* **Solutions** are perhaps the most unique types of mixtures. Solutions are created when one substance dissolves in another. Sugar or salt in water are great examples. When mixed in, they seem to disappear, yet if you boil the water out, the sugar and salt remain. They can still be separated. Solutions have two components; the **Solute**, or substance that dissolves (like the sugar and salt) and the **solvent**, or substance that the solute dissolves in (like the water). Water is often referred to as the universal solvent because in time just about everything will dissolve in it, even rocks. The Grand Canyon is a great example. It’s taken millions of years, but the Colorado River has slowly cut its way through the landscape there. Alcohol is frequently used as a solvent to dissolve medicines. Alcohol based mixtures are called **tinctures**.

**5Sd.4:** Use the processes of filtration, sifting, magnetic attraction, evaporation,

chromatography, and floatation to separate mixtures.

* As previously mentioned, one of the main characteristics of mixtures is that they can be separated with relative ease. There are six techniques typically used to separate mixtures:
* Filtration- when small solids are suspended in liquids or gases they can be separated by filtration. In this case, a filter is used that allows liquid or gas to pass while holding back solids. The oil filter in your car is a great example. It cleans your oil by holding back flecks of debris. The air filter in your car or home air conditioner does the same thing. It removes dust from the air. Coffee filters hold on to the coffee grounds while allowing your coffee to pass.
* Sifting is a type filtration. Generally sifters have larger holes and filter out larger particles. Archaeologists use sifters to separate pottery shards and small artifacts from soil. Kids use plastic sifters at the beach to search for shells in sand.
* Magnetic Attraction- Magnets can be used to separate metals from mixtures. They typically use magnets at recycling centers to separate metals from other discarded wastes.
* Evaporation- separates the components of solutions. Boiling sugar water for example removes water vapor, leaving sugar crystals behind. The Earth constantly does this during the water cycle. Sun-heated water evaporates leaving impurities behind. The rain that subsequently falls is relatively clean.
* Chromatography- is a technique that separates the components of a mixture through adsorption. Black ink for example is made by mixing a number of pigments together. These colors can be separated on filter when they travel along with absorbing water. Since the individual pigment particles are different sizes, they travel through the paper at different rates, becoming separated.
* Flotation- When the components of mixtures have different weights, they can sometimes be separated by means of flotation. A dry mixture of sand and wood shavings for example can be separated with the addition of water. In this case, the lighter wood shavings will float to the top where they can be removed. The heavier sand particles will remain behind.

**5Sd.5:** Explain how the solute and the solvent in a solution determine the concentration.

* **Concentration** is the amount of a substance (solute) within another substance (solvent). When you add sugar to tea it dissolves into solution. The amount of sugar in the tea (typically represented as a percentage) is its concentration. To you, the tea tastes weak or strong, to a chemist the solution is **dilute** or **concentrated.** A dilute solution has a small amount of solute in it relative to the solvent (weak or watery). A concentrated solution has a large amount of solute dissolved in it (strong or thick). When you make orange juice from concentrate you add water to the concentrated solution, thereby diluting it to taste. If you keep adding sugar to your glass of tea you will reach a point where the sugar won’t dissolve and ends up sitting in the bottom of your glass. In this case, your tea is **saturated** with sugar, it won’t dissolve any more.

**5Sd.6:** Explain how temperature change, particle size, and stirring affect the rate of

dissolving.

* If you put a drop of food coloring in a glass of water and leave it alone it will eventually turn the water uniformly that color. This is due to the action of the food coloring molecules (remember, they fly around like invisible bullets). As they bump into each other and ricochet off of the glass walls they spread evenly out. Smaller particles spread out faster than large particles.
* Molecular movement increases with heat. Molecules are always buzzing, but they get excited when you heat them up. So, if I put a drop of food coloring in a glass of hot water, it will spread out much faster than a drop placed in cold water.
* Most of us don’t wait for our creamer to make its way through our coffee on its own. We grab a spoon or straw and stir it up. Stirring greatly increases the rate at which substances dissolve.

**5Sd.7:** Illustrate the fact that when some substances are mixed together, they chemically

combine to form a new substance that cannot easily be separated.

* Recall that mixtures are relatively easy to separate. They are physically combined, so they can be physically separated. Not so with chemically combined substances. Once **chemical reactions** occur, new substances are formed and it is very difficult to separate the original substances back out. For example, oxygen and iron combine to form rust (ferric oxide). Once you’ve allowed something to rust there is no going back. You can scrape away the rust and expose new metal, but the metal that rusted is no more.
* Oxygen is a gas that feeds fires. When you add oxygen to a fire it burns hotter. Hydrogen is a flammable gas. It will burst in to flame when exposed to fire. Both of these elements have unique characteristics. Yet, when you chemically combine oxygen and hydrogen you make water, a new substance with completely different characteristics. On their own, oxygen and hydrogen build fires, combined they put fires out! It also takes extreme measures to break water down. If you zap it with a strong charge of electricity you can get the oxygen and hydrogen apart again, but that’s not easy. That’s why the water we have today is the same water that has been here for millions of years. Water prefers to remain water.

**5Sd.8:** Explain how the mixing and dissolving of foreign substances is related to the

pollution of the water, air, and soil.

* Rivers and streams are essentially big mixtures. They carry lots of things with them as they convey water to lakes and seas. This is a natural process. In fact, suspended soil particles in rivers help build downstream wetlands. However, humans have a nasty habit of making harmful substances available for rivers to pick up. Substances like fertilizers and detergents easily dissolve in stream water and cause problems for stream ecosystems. Rivers also carry oil, trash, and excess soil from construction sites. These substances enter streams in run-off from the land. Oil spills are obvious displays of the hazards of water pollution.
* The air carries many man-made pollutants far and wide. Chemicals from car exhausts and factory smoke stacks enter the air. Smoke from the burning of garbage, wood, and fossil fuels float freely in the air. On their own these substances contribute to asthma and other breathing ailments. Some of these substances combine in the atmosphere creating compounds that contribute to acid rain and ozone depletion.
* Soil can be contaminated as well. Leaky fuel tanks poison soil. Liquids draining from waste sites (leachate) also damage soil. Excess fertilizers, herbicides, and insecticides remain in soil for long periods of time, frequently percolating down to groundwater, or running off into streams.

**Suggested Resources:**

The following links are to sites that provide summaries, activities, and labs that can be used to support your teaching of this subject.

**5Sd.1:** Recall that matter is made up of particles too small to be seen.

<http://www.chem4kids.com/files/matter_intro.html>

<http://www.chem4kids.com/files/atom_intro.html>

<http://www.ducksters.com/science/the_atom.php>

**5Sd.2:** Compare the physical properties of the states of matter (including volume, shape,

and the movement and spacing of particles).

<http://www.neok12.com/States-of-Matter.htm>

<http://www.chem4kids.com/files/matter_states.html>

<http://idahoptv.org/dialogue4kids/season7/matter/facts.cfm>

**5Sd.3:** Summarize the characteristics of a mixture, recognizing a solution as a kind of

mixture.

<http://www.chem4kids.com/files/matter_mixture.html>

<http://www.ducksters.com/science/chemistry/chemical_mixtures.php>

**5Sd.4:** Use the processes of filtration, sifting, magnetic attraction, evaporation,

chromatography, and floatation to separate mixtures.

<http://www.ducksters.com/science/chemistry/separating_mixtures.php>

<http://www.chemistryforkids.net/help/mixtures>

**5Sd.5:** Explain how the solute and the solvent in a solution determine the concentration.

<http://www.chem4kids.com/files/matter_solution.html>

<http://www.buzzle.com/articles/solvent-and-solute.html>

**5Sd.6:** Explain how temperature change, particle size, and stirring affect the rate of

dissolving.

<http://www.turtlediary.com/kids-science-experiments/dissolving-experiment.html>

<http://www.ducksters.com/science/chemistry/solutions_and_dissolving.php>

**5Sd.7:** Illustrate the fact that when some substances are mixed together, they chemically

combine to form a new substance that cannot easily be separated.

<http://www.chem4kids.com/files/matter_chemphys.html>

<http://www.chemistryforkids.net/node?page=4>

**5Sd.8:** Explain how the mixing and dissolving of foreign substances is related to the

pollution of the water, air, and soil.

<http://eschooltoday.com/pollution/water-pollution/causes-of-water-pollution.html>

<http://www.epa.vic.gov.au/Air/AQ4Kids/pollution.asp>