fluorine 9 **F** 18.998	uranium 92 **U** 238.03	nitrogen 7 **N** 14.007	tungsten 74 **W** 183.84	iodine 53 **I** 126.90	thorium 90 **Th** 232.04

CHEMISTRY

Rice University Chapter

Disclaimer:

This is meant for educational purposes only. All experiments must be performed with proper personal protective equipment and standard scientific safety practices.

Rice Fun with Chemistry is not responsible for any risks, hazards and/or mishaps based on the performance of the procedures and use of materials herein. Before beginning any scientific activities, please research carefully the hazards, risks, materials and procedures to ensure personal safety and the safety of others.

EXPERIMENT: Red Cabbage Indicator

TEKS Concepts:

chemical change	*112.18b;5C (6th grade), 112.26b;5E (6th grade)‡, 112.19b;6 (7th grade), 112.27b;6C (7th grade)‡, 112.20b;5E (8th grade),*
concentration	*112.27b;6D (6th grade)‡*
acids & bases, pH	*112.28b;6D (8th grade)‡*

STEM Concepts: pH, acid, base, indicator

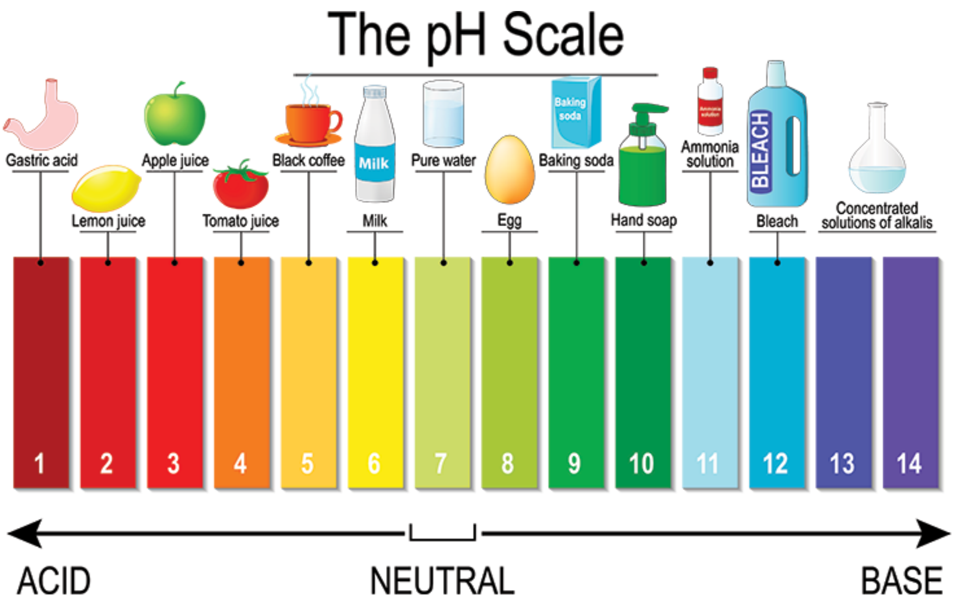
pH: A pH value is a quantification of how many hydrogen or hydroxide ions are in a solution. The more hydrogen ions are in a solution, the more acidic it is. The more hydroxide ions that are in a solution, the more basic (also called alkaline) it is. The pH scale ranges from the values 0-14. Lower values represent a more acidic solution, and higher values represent a more basic solution. Neutral pH is around a value of 7.

Acid: Some common examples of acid include lemon juice, soda, and vinegar.

Base: Some common examples of bases include baking soda, toothpaste, and bleach.

Indicator: An indicator can be used to determine the pH value of an unknown solution, usually by a color change.

‡Denoting TEKS updated in 2021.



Materials: Red cabbage, water, blender, small transparent cups, strainer, lemon-lime soda, toothpaste, clorox, and vinegar.

Procedure: Indicator prep: blend some red cabbage leaves with water and filter with a strainer to remove small leaves. In 4 different glasses, dissolve some amount of acidic/basic material (vinegar, soda, toothpaste, clorox) in some water. Then pour some of the red cabbage juice indicator into the solutions and observe the color change. ***Warning - You should not mix bleach with vinegar, bleach with ammonia, or bleach with rubbing alcohol as toxic gases will form!**

Video: Click here

***Note:** We perform an experiment during our shows using universal indicator, litmus solution, and phenolphthalein, which are readily available on Amazon. We add a few drops of these indicators to individual containers of water, then add a little base (you could use something described above). Afterwards, we add dry ice (available through the grocery store) to increase the acidity of the solution as dry ice introduces carbonic acid into solution, lowering the pH.

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‡Denoting TEKS updated in 2021.

‡Denoting TEKS updated in 2021.

EXPERIMENT: CO_2 Fire Extinguisher

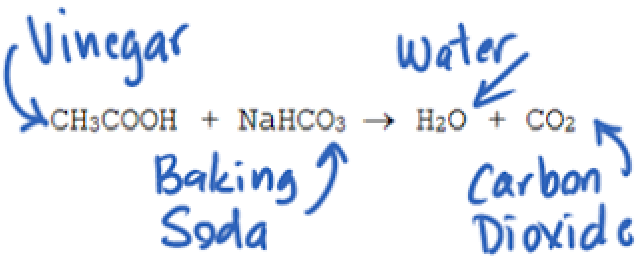
TEKS Concepts:

physical/ chemical change	*112.18b;5C (6th grade), 112.26b;5E (6th grade)‡, 112.19b;6 (7th grade), 112.27b;6C (7th grade)‡, 112.20b;5E (8th grade)*
chemical identity	*112.27b;6A-6B (7th grade)‡ 112.20b;5D (8th grade),*
balancing chemical reactions	*112.28b;6B (8th grade)‡*
mass conservation	*112.28b;6E (8th grade)‡*

STEM Concepts: combustion, acid-base chemistry

Combustion: a chemical reaction between two substances in which heat and light are released. Oxygen is the most common fuel required to begin this chemical reaction. The most common products are carbon dioxide and water vapor.

Acid-Base Chemistry:



Materials: Baking Soda, Vinegar, Lighter, Tealight Candles, Baking Dish, Small Cups, Paper Towels

Procedure: Place tealight candles in a wide baking dish and light tea candle. Mix baking soda and vinegar in a small cup, carefully pouring CO_2 over candles to extinguish flames.

Video: [Click here]

***Note:** We perform an experiment during our shows that includes balloons filled with increasing amounts of baking soda that are securely attached to flasks with vinegar inside. As the baking soda reacts with vinegar, carbon dioxide is produced, thereby inflating the balloon. We like to write the quantity of baking soda added largely on the outside of the balloon so that you can see it when it inflates.

‡Denoting TEKS updated in 2021.

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‡Denoting TEKS updated in 2021.

EXPERIMENT: Density Tubes

TEKS Concepts:

chemical identity	*112.27b;6A-6B (7^{th} grade)‡* *112.20b;5D (8^{th} grade)*
density	*112.18b;6B (6^{th} grade), 112.26b;6D (6^{th} grade)‡*
heterogeneous mixtures	*112.26b;6B (6^{th} grade)‡, 112.28b;6A (8^{th} grade)‡*

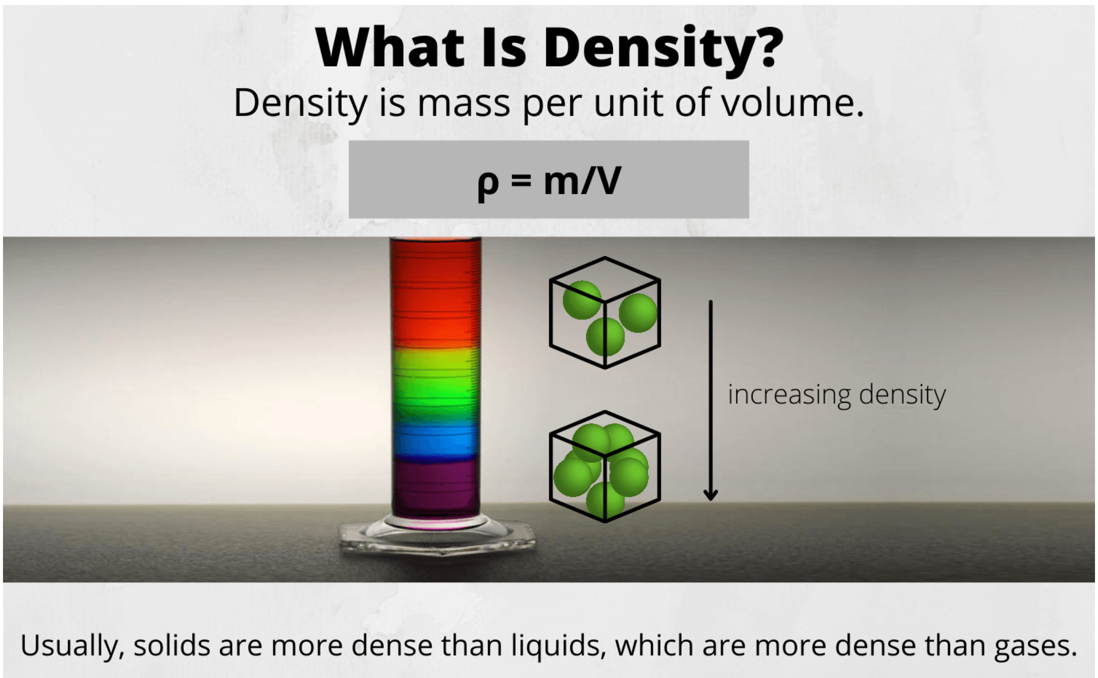
STEM Concepts: density, solubility, miscibility

The density of a material is its mass per unit volume. The different liquids stay in different layers because of their different densities, with the highest-density liquid being at the bottom and lowest-density liquid being on top.

This experiment also presents a great opportunity to learn about solubility! Solubility is the ability of a substance to dissolve in another substance. One way to see this would be to shake up your container and then leave it on the table for a few minutes to separate back out. Did any layers combine to create bigger layers? If so, those substances are said to be soluble.

Miscibility: characteristic of liquids; the ability of two or more substances to mix and form homogenous mixtures.

Mixture: material made up of two or more different chemical substances. A heterogeneous mixture is a mixture with a non-uniform composition. An homogeneous mixture is a mixture with uniform composition.



‡Denoting TEKS updated in 2021.

Materials: turkey baster, transparent glass, rubbing alcohol, dish soap, food coloring, extra virgin olive oil, canola oil, corn syrup, chocolate syrup, honey, whole milk and maple syrup.

Procedure: For a mini-density tube, add the following liquids (in order) slowly to the tube without touching the walls: water, vegetable oil, and rubbing alcohol. For larger density tubes, consider adding in order honey, corn syrup, chocolate syrup, maple syrup, whole milk, dish soap, water with food coloring, vegetable oil, extra virgin olive oil, rubbing alcohol with food coloring.

Video: Click here

Our Tubes: 50 pcs on Amazon for ~$12 (Link)

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‡Denoting TEKS updated in 2021.

EXPERIMENT: Mini-Lava Lamps

TEKS Concepts:

chemical identity	*112.27b;6A-6B (7th grade)‡* *112.20b;5D (8th grade)*
balancing chemical reactions	*112.28b;6B (8th grade)‡*
heterogeneous mixtures	*112.26b;6B (6th grade)‡, 112.28b;6A (8th grade)‡*
density	*112.18b;6B (6th grade), 112.26b;6D (6th grade)‡*

STEM Concepts: chemical reactions, effervescence, gas evolution, solubility, mixtures

Chemical reaction: a process that involves the rearrangement of the molecular structure of a substance.

Evidence of a chemical reaction: color change, formation of a precipitate, formation of a gas, odor change, temperature change.

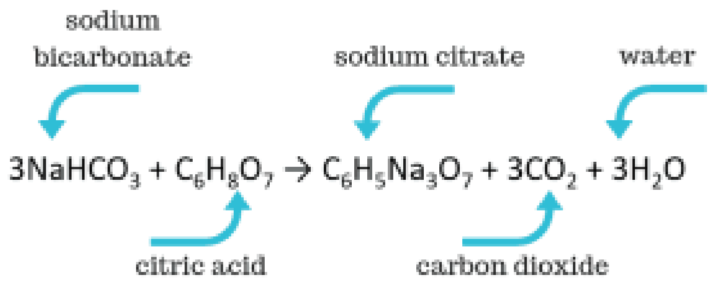
Solubility: the ability of a substance to dissolve in a solvent.

Mixture: material made up of two or more different chemical substances. A heterogeneous mixture is a mixture with a non-uniform composition. An homogeneous mixture is a mixture with uniform composition.

Water is a highly polar molecule while vegetable oil is made up of highly non-polar fatty acids. Hence, both liquids are immiscible generating two layers when mixed together. Due to their difference in densities, the least dense layer (vegetable oil) will remain on top of the mixture. Typical food colorings are water-soluble dyes made up of inorganic compounds that are only soluble in polar solvents, such as water, but insoluble in nonpolar liquids.

The chemical reaction between citric acid and sodium bicarbonate produces water, sodium citrate and carbon dioxide as products. Carbon dioxide is a gas which will look to escape out of the mixture as bubbles. The bubbles of carbon dioxide trapped in water, as they travel through the container, will go up through the vegetable oil. Once the gas has escaped, the water bubbles will then fall back down due to their difference in density. Given the dyes are only soluble in water this colorful lava lamp effect is observed.

‡Denoting TEKS updated in 2021.



Materials: water bottle, vegetable or baby oil, food coloring, alka seltzer tablets.

Procedure: In a half-full water bottle add half the amount of vegetable oil. Add 5-6 drops of food coloring and then drop the ant-acid tablet. Colored water droplets will rise to the surface before sinking down.

Video: Click here

Notes:

EXPERIMENT: PVA + Borax Slime

TEKS Concepts:

matter and energy	*112.26b;5B (6th grade)‡* *112.27b;6E (6th grade)‡*
physical/ chemical change	*112.18b;5C (6th grade)* *112.27b;6C (7th grade)‡*
states of matter	*112.26b;6A (6th grade)‡*

STEM Concepts: chemical bonds, states of matter

In this experiment, a polymer (polyvinyl alcohol) chemically reacts with borax to form a crosslinked polymer network. Individual polymer chains are formed by covalent bonds, which are strong bonds. In making slime, the individual polymer chains are bound together by weak hydrogen bonds. The resulting polymer network is composed of strands of polyvinyl alcohol held together side-by-side by the borate molecules.

The slime product behaves sometimes as a liquid and in other cases as a solid. Such behavior is called "viscoelasticity" and materials are said to be "viscoelastic." Liquids can be poured and solids maintain their shape.

For a more elaborate experiment, different groups of students can use different amounts of sodium borate. For example, have one group add 2 mL of borax to 100 ml of PVOH solution. The other groups should add 4, 8, 12, and 20 mL of borax to the 100 mL of polymer solution, respectively. This should more easily demonstrate the effects of crosslinking on the properties of the polymer, as using more sodium borate results in more crosslinking.

Materials: 4% Polyvinyl Alcohol (PVA) solution, borax, food coloring, spoon

Procedure:

Preparing the Polyvinyl Alcohol (PVA) solution: Prepared 4% PVA liquid solution can be purchased on Amazon. It can also be made by combining 4 g of PVA powder with 100 mL of hot water.

Preparing Borax solution: Dissolve 10 grams of sodium borate in 250 mL of water. You can obtain Borax at the grocery store near the laundry detergent.

In the classroom: Mix the two solutions together in a 10:1 (PVA:borax) ratio in the small cups. Add two to four drops of food coloring of the desired color. Mix well using the plastic spoon or wooden stirrers. A gel should form immediately. Test the properties of slime in the following ways: pull the slime apart slowly, pull the slime apart sharply and quickly, roll the slime into a ball and drop it onto the bench, place a small bit of slime on the bench and hit it hard with your hand, etc.

‡Denoting TEKS updated in 2021.

Video: Click Here

Notes:

EXPERIMENT: Making Snow with Diapers!

TEKS Concepts:

physical/ chemical change	*112.6b;6E (6th grade)‡* *112.27b;6C (7th grade)‡*

STEM Concepts: polymers, formation of new substance, physical / chemical changes

Sodium polyacrylate is a polymer, which means it is a large chain of molecules made up of many smaller units known as monomers. Superabsorbent polymers expand when they come into contact with liquids like water, because water is drawn into and held by the molecules of the polymer.

Materials: diapers (sodium polyacrylate), water

Procedure:

Part 1 - Making Snow:

Cut out the bottom of the diaper and carefully peel out the white, fluffy cottony stuff. Pour the white powder underneath into a ziplock bag. Add a spoonful of water. The white powder will become more snow-like! When you are done, do not flush the materials down the drain, but throw them away in the trash to prevent clogging.

Part 2 - Hot Ice Tower:

Stove Needed - Preparation: In a pan on the stove, heat 100 g of sodium polyacrylate until melted (about 5 minutes). Once it has all melted, add 25 mL of water. Let the solution simmer for 2 minutes. Make sure the solution remains a liquid when you remove it from heat. If it begins to immediately solidify, add 2-3 mL of water. Pour the solution into a capped bottle and place in the fridge to cool for a few hours.

In the Classroom:

- Pour the solution into a container. Tap the solution quickly, which will cause it to solidify and form hot ice. Invert the container and solid hot ice.
- Place sodium acetate crystals into a small pan, then pour the sodium acetate / water solution onto the crystals. Watch as the mixture solidifies, forming a vertical ice tower.

Video: Click Here

Notes:

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‡Denoting TEKS updated in 2021.

‡Denoting TEKS updated in 2021.

EXPERIMENT: Ice-Cream Lab

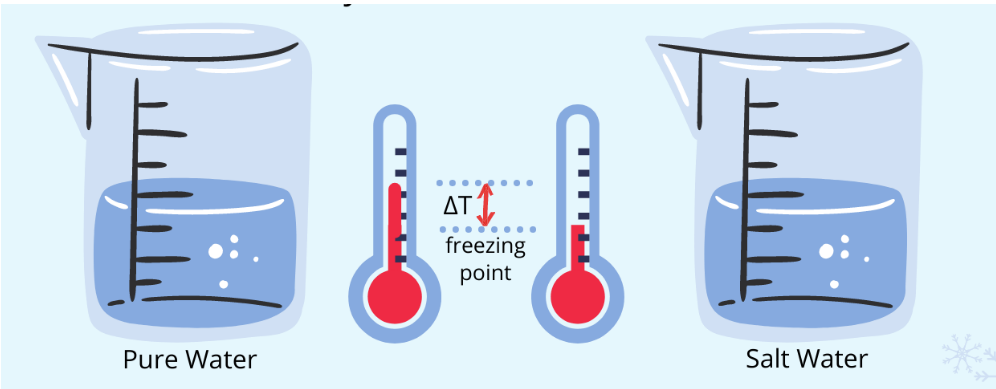
TEKS Concepts:

physical/ chemical change	*112.18b;5C (6th grade), 112.26b;5E (6th grade)‡, 112.19b;6 (7th grade), 112.27b;6C (7th grade)‡, 112.20b;5E (8th grade)*
heterogeneous mixtures	*112.26b;6B (6th grade)‡, 112.28b;6A (8th grade)‡*

STEM Concepts: states of matter, freezing point

Freezing Point Depression: Why does ice cream in a bag work? Pure water freezes at 0 °C (32 °F). The salt lowers the temperature at which water freezes, so with salt ice will melt even when the temperature is below the normal freezing point of water. The temperature that the salt lowers is called the freezing point. When a freezing point is lowered, such as by adding salt to water, the process is called freezing-point depression. In order for the ice to melt, however, it has to absorb heat from its surroundings (single serve coffee creamer), which allows the creamer to freeze.

States of Matter: Lowering the temperature (freezing) causes a liquid (coffee creamer) to become a solid (ice cream). Freezing occurs when the molecules of a liquid slow down enough that their attractions cause them to arrange themselves into fixed positions as a solid.



Materials: single serve coffee creamers, ice cream rock salt, ice cubes, small tupperware container, small towel.

Procedure: Place a small coffee creamer cup in a small tupperware container. Add some ice cubes and a few spoonfuls of rock salt to the tupperware container. Cover the container with a towel and shake for 5 min (or until the coffee creamer is frozen). Squeeze the coffee creamer cup to feel the texture. If desired, repeat the steps above without adding rock salt and compare the results. Open the coffee creamer, add vanilla or toppings as desired and eat!

Video: Click here

‡Denoting TEKS updated in 2021.

Notes:

‡Denoting TEKS updated in 2021.

EXPERIMENT: Paper Chromatography

STEM Concepts: chromatography, capillary action, colors, solubility

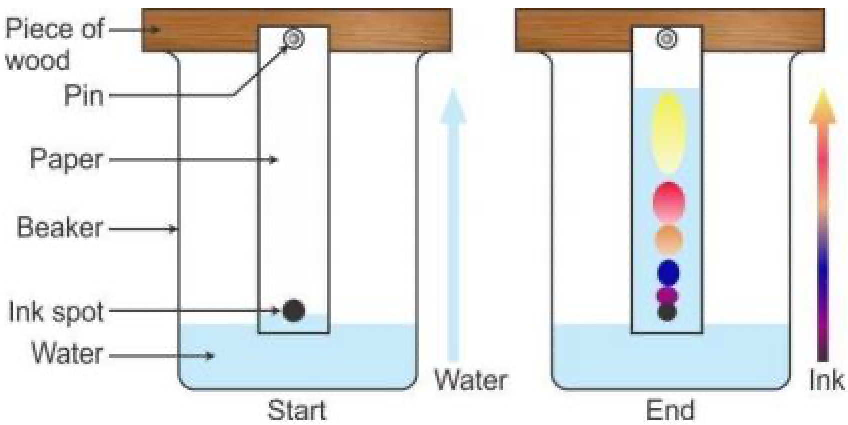
Paper chromatography: technique used to separate dissolved substances based on size and relative solubilities in solvent. Great examples of this include ink from a pen, a colored marker, or a vis-a-vis pen.

Capillary action: liquid flow in porous material due to adhesion, cohesion, and surface tension; when adhesive forces are stronger than cohesive forces, water level rises up a surface (limited by surface tension and gravity)

What's happening?

- The ink in markers is made of various colored pigments that dry on the paper you write on. When the paper is immersed in water, capillary action draws the water up the paper and dissolves the pigments. Different pigments have different rates at which they travel up the paper, which depend on the size of the pigment molecule, solubility in water, and how strongly the pigment is attracted to the paper. These differences result in separation of pigments on the paper over the distance the solvent (water) travels.

Why are there different pigments in black ink? We see the colors that these molecules reflect from white light. For instance, green ink reflects the green part of white light and absorbs the other colors. By mixing different pigments, the resulting product will absorb more light and reflect back less light, causing the product to appear black.



Materials: Vis-a-vis pen, coffee filters or paper towels, water, rod to tape paper towel to, tape

Procedure: Draw a line across the thin end of the paper towel strip about 1" from the bottom. Add some water to the bottom of a beaker. Place the paper into the beaker and let the water develop the paper to separate the colors into bands.

Video: [Click here]

‡Denoting TEKS updated in 2021.

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‡Denoting TEKS updated in 2021.

EXPERIMENT: Non-Newtonian Fluid

TEKS Concepts:

states of matter 112.26b;6A (6th grade)‡

STEM Concepts: states of matter, mixtures

States of Matter: Solid, Liquid and Gas

There are also substances that aren't so easily categorized, like non-Newtonian fluids. Newton described how 'normal' liquids or fluids behave, and he observed that they have a constant viscosity, which describes how easily a liquid flows. However, some liquids, such as non-Newtonian fluids, do not follow this rule.

The viscosity of a non-Newtonian fluid changes with the amount of pressure applied. In the absence of pressure, it looks and feels like a liquid. But when pressure is applied to it, it looks and feels like a solid.

If you slowly push your finger into a container of non-Newtonian fluid, your finger will glide in until you touch the bottom. But if you pound on the surface of the fluid quickly with your fist, it will resist your fist and it will feel like you're hitting a soft solid.

Other examples of non-Newtonian fluids include ketchup, silly putty and quicksand.

Materials: Cornstarch, water, long and shallow tupperware container, spoon or something to stir the fluid with

Video: Click here

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‡Denoting TEKS updated in 2021.

‡Denoting TEKS updated in 2021.

EXPERIMENT: Dissolving Styrofoam

TEKS Concepts:

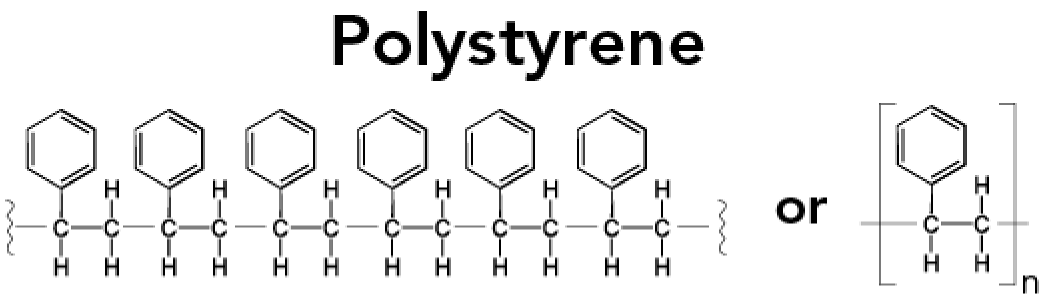
states of matter	*112.26b;6A (6th grade)‡*
homogeneous mixtures	*112.26b;6B (6th grade)‡, 112.28b;6A (8th grade)‡*
solutions	*112.27b;6D (6th grade)‡*

STEM Concepts: solubility, polymers

Why does nail polish “eat away” styrofoam?

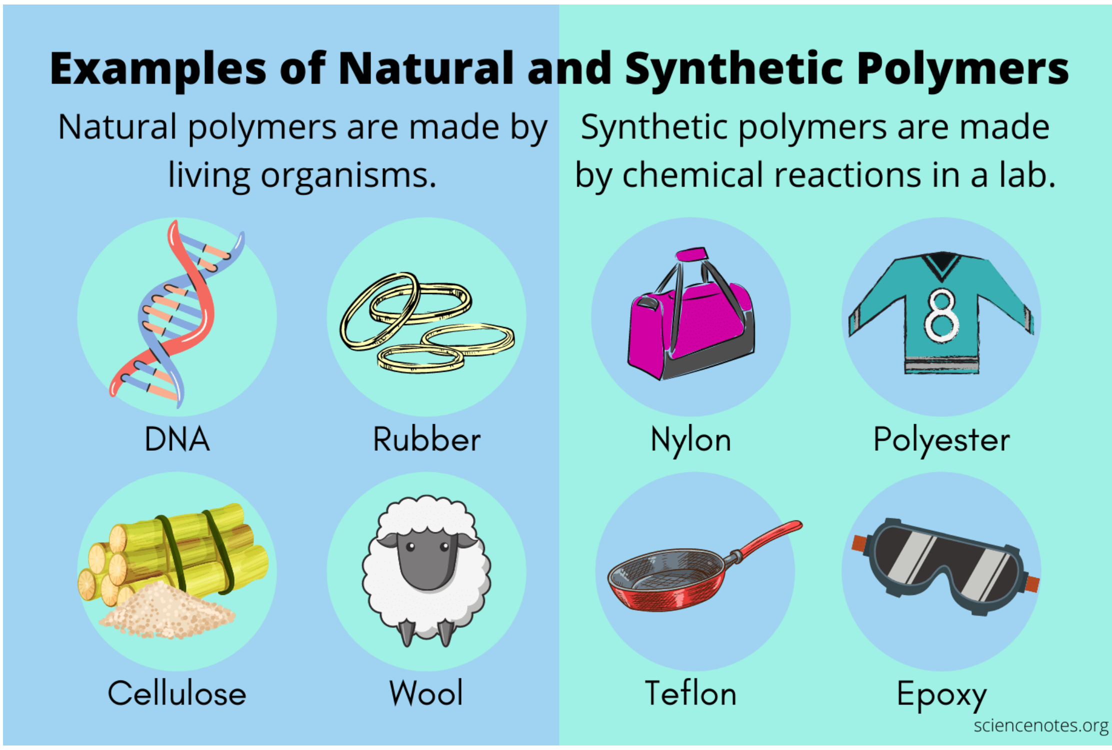
Solubility: the ability to dissolve in a solvent

Polymer: a substance that has a molecular structure composed of many repeating units. Styrofoam is made of long, plastic polymers that have lots of trapped air in between. This characteristic is the reason styrofoam cups are light and are able to keep the drinks hot or cold. Nail polish contains a compound called acetone. Acetone is a great solvent that quickly dissolves the styrofoam, breaking apart the long polymers and releasing the air in between. A similar process of dissolving happens when sugar and water mixes, just to a smaller extreme.



Polymers are all around us and their preparation, application, and degradation are big money market areas in Chemistry! Some examples of natural and man-made polymers are included below. As the polymers are used or applied and those items become discarded, the polymers eventually make their way into our water sources. If you’re looking for an interesting topic, look up the Great Pacific Garbage Patch! What environmental challenges might polymers present and how could we address this?

‡Denoting TEKS updated in 2021.



Materials: styrofoam ($12/100 pcs on Amazon - link), small pan, nail polish

Procedure: Pour nail polish into a small pan. Slowly press some styrofoam cups or different shapes into the pan and observe how it gets dissolved.

Video: Click here

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‡Denoting TEKS updated in 2021.

EXPERIMENT: Dehydration of Cellulose in Paper

TEKS Concepts:

acids/bases	*112.28b;6D (8th grade)‡*
chemical changes	*112.27b;6C (7th grade)‡ 112.27b;6C (8th grade)‡*

STEM Concepts: chemical change, dehydration reaction, exothermic, acids/bases

Paper is mainly made of cellulose, which is a polymer of a sugar of glucose. Sugars such as glucose and sucrose contain oxygen and hydrogen. Concentrated sulfuric acid, a dehydrating agent, removes the elements of water from the sugar. The black foam that is produced is carbon. This reaction is highly exothermic and fumes of carbon dioxide may be produced.

Materials: paper towels or toilet paper roll, sulfuric acid

Procedure: Pour sulfuric acid onto paper towels or a toilet paper roll. Observe as the sulfuric acid removes the hydrogen and oxygen from the paper, forming foamy black carbon.

Video: Click here

Notes:

‡Denoting TEKS updated in 2021.

EXPERIMENT: Gummy Worms

TEKS Concepts:

states of matter *112.26b;6A (6th grade)‡*

chemical changes *112.27b;6C (7th grade)‡ 112.27b;6C (8th grade)‡*

STEM Concepts: polymers, states of matter

At first, sodium alginate polymers move freely past one another but when we mix them with calcium, the calcium grabs on to the polymers and links them together. When enough polymers become cross-linked, they start to form a structure. The structure we see forming in the liquid is a gel.

Materials: calcium chloride, sodium alginate solution, water, cups, squirt bottles

Procedure: Squirt a small stream of the sodium alginate solution into the cup containing the calcium chloride solution. Carefully pull the "worm" out of the calcium chloride solution with their hands. If the worm breaks, the gooey end can go back into the calcium chloride solution to seal it up.

Video: Click here

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‡Denoting TEKS updated in 2021.