

Chemical Matrix of Acids and Bases

Overview: If you love the idea of mixing up chemicals and dream of having your own mad science lab, this one is for you. You are going to mix up solids and liquids in a chemical matrix, and see a lot of cool chemical reactions between acids and bases.

What to Learn: After this experiment you'll understand that an *indicator* can change color when you combine it with different materials. Today we will use a cabbage juice indicator, but there are many different kinds. You will see several *chemical reactions* take place (that means things will bubble, ooze, spit, change color and get hot or cold).

Materials

- muffin tin or disposable cups
- popsicle sticks for stirring and mixing
- tablecloths (one for the table, another for the floor)
- isopropyl rubbing alcohol
- hydrogen peroxide
- water
- acetic acid (distilled white vinegar)
- liquid dish soap (add to water)
- head of red cabbage (indicator)
- calcium chloride (AKA "DriEz" or "Ice Melt")
- citric acid (spice section, used for preserving and pickling)
- sodium tetraborate (borax, laundry aisle)
- sodium carbonate (washing soda, laundry aisle)
- sodium bicarbonate (baking soda, baking aisle)
- ammonium nitrate (single-use disposable cold pack)

Experiment

1. Wear your gloves and put your goggles on. No exceptions!
2. After receiving all of your chemicals, start mixing it up! Use the grid provided in the student worksheet to organize chemicals and make notes about your observations.
3. Note: Periodically hold your hand under the muffin cups to test the temperature. If it feels hot, it's an exothermic reaction which is giving off energy in the form of heat, light, explosions, etc. The chemical-bond energy is converted to thermal energy, or heat, in these experiments. If it feels cold, you've made an endothermic reaction, in which energy was absorbed. Heat from the mixture converts to bond energy. Sometimes you'll find that your mixture is so cold that it condenses the water outside the container, like water drops on the outside of an ice-cold glass of water on a hot day.

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Data Table

Describe the chemical reaction observed for each mixture

						Hydrogen Peroxide + Indicator
						Alcohol + Indicator
						Vinegar + Indicator
						Water + Indicator
Sodium Bicarbonate (Baking Soda)	Citric Acid	Ammonium Nitrate (Single-use Cold Pack)	Calcium Chloride ("DriEz" or "Ice Melt")	Sodium Carbonate (Washing Soda)	Sodium Tetraborate (Borax)	

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Reading

In a chemistry class, one of the first things you learn in chemistry is the difference between physical and chemical changes. An example of a physical change is when you change the shape of an object, like wadding up a piece of paper. If you light the paper on fire, you now have a chemical change. You are rearranging the atoms that used to be the molecules that made up the paper into other molecules, such as carbon monoxide, carbon dioxide, ash, and so forth.

How can you tell if you have a chemical change? If something changes color; gives off light, such as chemiluminescent light sticks; absorbs heat (gets cold); or produces heat (gets warm), it's a chemical change.

What about physical changes? Some examples of physical changes include tearing cloth, rolling dough, stretching rubber bands, eating a banana, or blowing bubbles.

About this experiment: Your solutions will turn red, orange, yellow, green, blue, purple, hot, cold, bubbling, foaming, rock hard, oozy, and slimy, and they'll crystallize and gel — depending on what you put in and how much!

What's happening with the indicator? An indicator is a compound that changes color when you dip it in different substances, such as vinegar, alcohol, milk, or baking soda mixed with water. Different indicators are affected differently by acids and bases. Some change color only with an acid, or only with a base. Turmeric, for example, is good only for bases. You can prepare a turmeric indicator by mixing 1 teaspoon turmeric with 1 cup rubbing alcohol.

Why does red cabbage work? Red cabbage juice has anthocyanin, which makes it an excellent indicator for these experiments. Anthocyanin is what gives leaves, stems, fruits, and flowers their colors. Did you know that certain flowers, such as hydrangeas, are blue in acidic soil but turn pink when transplanted to a basic soil? In this experiment, you get the anthocyanin out of the cabbage and into a more useful form so you can use it as a liquid indicator.

Exercises

1. What is an indicator?
2. What examples of chemical changes did you observe?
3. What types of physical changes did you observe?
4. Why did some mixtures get hot? What type of reaction was this?
5. Why did other mixtures get cold? What type of reaction was this?

Answers to exercises

1. What is an indicator? (A compound that changes color when you combine it with different things.)
2. What examples of chemical changes did you observe? (Heat, color change, bubbles, foam, gel, ooze, cold, etc.)
3. What types of physical changes did you observe? (None.)
4. Why did some mixtures get hot? What type of reaction was this? (It was an exothermic reaction, which means energy was given off. The chemical-bond energy was converted to thermal energy, or heat.)
5. Why did other mixtures get cold? What type of reaction was this? (It was an endothermic reaction, which absorbs energy. The heat from the mixture was converted to bond energy.)