Chemical versus Physical Changes

What are physical and chemical changes?

Chemical Changes

These are processes in which one or more chemicals are changed into one or more different chemicals.[1] Another way to think about a chemical change is that bonds are broken and new bonds are formed between different atoms[2]. Color changes, bubbling, heat release, or burning are often indicators that chemical changes are occurring. The changes are generally not reversible.

Adding vinegar to baking soda is a classic example of a chemical change where sodium bicarbonate (baking soda) is reacted with acetic acid and water (vinegar) releasing carbon dioxide and making sodium acetate. This produces bubbling which is the carbon dioxide (CO_2) gas being released. Even if the all of the CO_2 gas is captured, it alone cannot be introduced back to the sodium acetate in water to make sodium bicarbonate again.

Physical Changes

These are changes in size, shape, or state. Another way to think about a physical change is any change not involving a change in the substance's chemical identity[3]. The most interesting of these is the change in state, like the changes from solid to liquid to gas and back. The key with physical changes is that they are "easily" reversible.

There are many simple examples of physical changes, like melting ice (solid water) to liquid then boiling of water turning liquid to steam (gaseous water). A somewhat more interesting example is dissolving salt into water. The solid disappears but just the application of heat can boil the water off and get the salt back in the same form.

Resources

[1] http://www.biology-online.org/dictionary/Chemical_change
[2] http://en.wikipedia.org/wiki/Chemical_Change
[3] http://en.wikipedia.org/wiki/Physical_change
[4] http://www.nbtc.cornell.edu/education/kitlib/getlessonplan.php?id=55 -

Why are chemical and physical changes important?

These concepts underlie what is happening in just about everything in our daily lives. Driving a car (burning gas is a chemical change) and almost all the plastics we use are made by chemical reactions of different components. One of the traditional means of producing energy involves the boiling of water to produce steam to turn a turbine thereby producing electricity.

Goal of experiment

The goal of this experiment is to see some examples of chemical and physical changes with the aim of understanding what they are and what the differences are between the two.

Items needed for the experiment

Chemical Change - Making Slime
Elmer's All-Purpose Glue (not the school variety)
Borax
Water
Plastic cups (2 per experiment)
Tongue depressors (One per experiment)
Plastic Bags (1 per experiment)
Food Coloring (various colors)
Waste Jug

Physical change - Change of State
Ice
Erlenmeyer flask or glass bottle
Hot Plate
Balloon

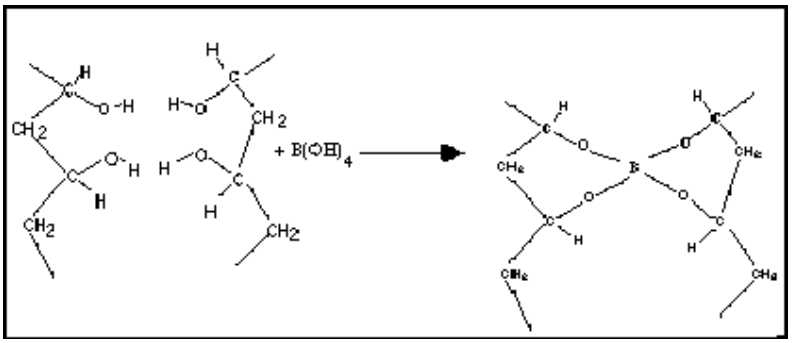
Physical Change - Dissolving Salt
Table Salt
Water
Cups
Black paper
Hot plate.

Instructions for the demonstration

Chemical Change - Making Slime
(This can be done at just about any scale so generic volumes are given.)
The glue should be mixed 50/50 with water and stirred vigorously.
The borax should be dissolved in water to saturation (until no more borax will dissolve).
Fill one of the cups about a 1/3 full of the glue solution.
Add some food coloring to the cup of glue solution and mix.
Add an equal volume of borax solution to the cup of glue solution slowly, stirring vigorously.
Once all of the borax is added make sure everything is mixed then pour off the excess liquid to a waste jug.
Students can now play with the slime. Though the material is not hazardous obviously it should not be eaten and as always once done in the Chemistry lab students should wash their hands after playing with the slime.

The slime can be stored in the plastic bags, if it is left out of the bags for a long time it will dry out.

The chemical reaction occurring is a crosslinking (or connection of two molecules together) of the Polyvinyl Alcohol molecules (in the Elmer's glue) where the borate in the borax is the crosslinker. The crosslinking makes it much harder for the molecules to move around each other thus making a solid material. The structure traps water, which is what allows the molecules to slide around each other. Below is a depiction of what is going on chemically.



Images showing the molecules before and after reaction of borate with the polyvinyl alcohol.[4]

Physical change - Change of State

Add the ice to the Erlenmeyer flask or glass bottle and place balloon on top so it is sealed
Heat the flask on the hot plate and point out the water forming as the ice melts.
Also point out when the balloon starts to blow up as steam begins to form.
Once the balloon starts to blow up significantly shut off the hot plate and wait.
Point out when the balloon starts to deflate and the water forming as the steam condenses.

Physical Changes - Dissolving Salt

Take the table salt and dissolve it in the water in about a 1:10 volume ratio of salt to water.
You may want to use warm water and may need to stir it until all of the solid is gone.
Put the paper on the hot plate.
Put four or five drops of water onto the black paper.
Heat the paper until it dries and a white ring appears.

The ring is the salt that was added to the water.

The dissolving of the salt changes the physical form of the NaCl but does not permanently change it chemically so when the water is removed you recover salt again as NaCl.

Resources

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Work Sheet

Name:_____

Salt in Water: Add water to your salt. Stir the salt and water until the salt disappears/dissolves. Put a few drops of the water on your black paper and with the help of the GE scientist dry it on the hot plate.
Look at the Paper. What do you see? Was this a chemical change, physical change, or Neither? Why?

_____
_____
_____
_____

Sand and Water: What do you think happens when you add sand to a new cup of water? Now add some sand to a new cup of water.
What Happens? Was this a chemical change, physical change, or Neither? Why?

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_____

Baking Soda and Vinegar: With the help of the GE Scientist add your baking soda to the vinegar.
What Happens? Was this a chemical change, physical change, or Neither? Why?

_____
_____
_____
_____

Mix the colored glue with the borax solution. What happens?
Was this a chemical change, physical change, or Neither? Why?

_____
_____
_____
_____
_____

CHEMICAL vs. PHYSICAL CHANGES

There are 3-5 great activities for the kids to explore, observe, compare and contrast the difference between physical and chemical changes during a chemistry unit.

NYS Standard 4: The Physical Setting

Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

P.I. - 3.1 Observe and describe properties of materials, using appropriate tools.

- 3.1a
- 3.1b
- 3.1c
- 3.1e
- 3.1f
- 3.1g

P.I. – 3.2 Describe chemical and physical changes, including changes in states of matter.

- 3.2a
- 3.2b
- 3.2c

Key Idea 4: Energy exists in many forms and when these forms change energy is conserved.

P.I. – 4.1 Describe a variety of forms of energy and the changes that occur in objects when they interact with those forms of energy.

- 4.1a
- 4.1b
- 4.1c
- 4.1d
- 4.1g

P.I. – 4.2 Observe the way one form of energy can be transferred into another form of energy present in common situations.

- 4.2b