**Mrs. Magorium’s Wonder Emporium: The Science of Toys**

* **Standards:**

3.2.7.A3. Explain how energy transfer can affect the chemical and physical properties of matter.

3.2.7.A4. Describe how reactants change into products in simple chemical reactions.

3.2.8.A3. Explain how changes in matter are accompanied by changes in energy.

* **Introduction and background:**

Babies and young children learn from playing. Toys developed to enhance play. Some of our favorite toys from our childhood have their foundations in science. We are going to learn about the science behind some of these favorite toys.

* **Guiding questions:**

How does science enhance play?

* **Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes, no loose sleeves or long dangly necklaces, etc. **Specific safety instructions are noted within each activity.**

**Fortune Teller Fish**

**Materials:**

One Fortune Teller fish in its package.

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure:**

* Remove fish from protective package.
* Place fortune teller fish in the palm of your hand.
* Observe and record results.
* Take your fortune telling fish with you.

**Happy/Unhappy Balls**

**Materials:**

a package of two seemingly identical black balls

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure:**

* Drop both balls simultaneously.
* Observe and record results.
* Take your happy/unhappy balls with you.

**Unpoppable Bubbles**

**Materials:**

polyvinyl alcohol

deionized water

balance

weigh boat

100 mL graduated cylinder

250 mL glass beaker

hot plate

stir bar

hot hands

1 mL autopipette

Bottle of Aged PVA Solution

bottle labeled New PVA Solution

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. **Caution: hot plates get hot.**

**Procedure**:

* Use the balance to mass out 0.4g of polyvinyl alcohol into the weigh boat.
* Place in 250 mL beaker.
* Use the graduated cylinder to measure out 9.5 mL of distilled water.
* Add to beaker with polyvinyl alcohol.
* Add stir bar.
* Turn on stir function on hot plate to form a small vortex. *Note: it should not splash!*
* Heat up solution and allow to heat and stir until solution is clear.
* Turn off hot plate and stir function and use hot hands to remove beaker from hot plate and set on table.
* Allow solution to cool.
* Decant solution into bottle marked ‘New PVA Solution’.
* Blow bubbles with solution in bottle.
* Observe and record your results.
* Use the autopipette to obtain 1 mL of ‘Aged PVA Solution’. Dispense into small plastic bubble bottle. Shake to mix.
* Blow bubbles with solution in bottle.
* Observe and record your results.
* Clean your station. Be sure to take your bubble solution with you.

From : “the Chemistry (and a little physics) of Soap Bubbles” by David A. Katz. Retrieved 06/25/2013 from <http://www.chymist.com/soap%20bubbles%20part%204.pdf>.

**Swimming Fish**

**Materials:**

paper fish template

tape

scissors

transfer pipette

dish soap

large shallow pan of water

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure**:

* Use the tape to cover the fish on both sides of the paper.
* Cut fish out following outline – including the slit.
* Place the fish in the pan of water.
* Use the transfer pipette to place one drop of dish soap in the circle at the end of the slit in the fish.
* Observe and record your results.
* Empty the water from the pan and refill with clean water for next team.

From “Forty-Seven Easy-to-Do Classic Science Experiments” by Eugene F. Provenzo, Jr., Asterie Baker Provenzo. Retrieved 06/28/2013 from <http://books.google.com/books?id=3Z4mwyZeb5EC&pg=PA7&lpg=PA7&dq=camphor+dancers&source=bl&ots=6bqw9Wi6MQ&sig=F3zFmMOjKJCQ-bznX4WN9BtbcEk&hl=en&sa=X&ei=grXNUeWEIaHH0wHQ94FI&ved=0CCwQ6AEwADgU#v=onepage&q=camphor%20dancers&f=false>

**Instant Snow**

**Materials:**

5 oz cup

sandwich size zipper bag

water

5mL blue spoon

25 mL graduated cylinder

instant snow

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure**:

* Use the blue spoon to measure out one spoon (5 mL) of Insta Snow into the 5 oz cup.
* Use the graduated cylinder to measure 20 ml of water.
* Add the water to the cup.
* Observe and record results.
* Clean your station. Place your snow into a zipper bag and take it with you.

Retrieved 06/28/2013 from <http://www.stevespanglerscience.com/instant-snow-powder.html>

**Latex Rubber Ball**

**Materials:**

latex

vinegar

deionized water

three 50 mL graduated cylinders

disposable cup

wooden stir stick

food color (optional)

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.  ***Caution: this lab uses real latex – be aware of any latex allergies.***

**Procedure**:

* Use the graduated cylinder labeled ‘Latex’ to measure out 20mL of latex and add to the disposable cup.
* Use the graduated cylinder labeled ‘water’ to measure out 20 mL of deionized water and add it to the cup.
* Add two drops food color if desired.
* Use the graduated cylinder labeled ‘vinegar’ to measure out 20 mL of vinegar and add it to the cup.
* Use the stir stick to stir all liquids together.
* Remove the resulting mass from the cup with your fingers.
* Rinse it underwater as you form it into a ball.
* Try to bounce it.
* Observe and record your results.
* Dispose of all waste and clean station for next team. Be sure to take your ball with you.

**Glow Stick Reaction**

**Materials:**

diethyl phthalate

25 ml beaker

9,10 diphenylanthracene (fluorescent dye)

bis (2-carbopentyloxy-3,5,6-trichlorophenyl) oxalate (CPPO)

sodium acetate

3 mL 30% hydrogen peroxide in labeled vial

one scintillation vial

analytical balance

weigh boat

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. **Gloves must be worn for this activity.**

**Procedure**:

* Use the graduated cylinder to measure out 10 mL of diethyl phthalate.
* Obtain 3 mg of the fluorescent dye from the instructor.
* Add it to the 10 mL of diethyl phthalate. Replace the lid on the vial and shake to mix.
* Use a weigh boat and the analytical balance to measure out 50 mg of bis (2-carbopentyloxy-3,5,6-trichlorophenyl) oxalate (CPPO).
* Add the CPPO to the vial. Replace the lid and shake to mix.
* Use a weigh boat and the analytical balance to measure out 100 mg of sodium acetate. Add the sodium acetate to the vial. Replace the cap and shake to mix.
* Then add the 30% hydrogen peroxide from the labeled vial to the first vial. Replace the lid on the vial and shake to mix.
* Observe and record your results.
* Clean your station. Place the fluorescing vial in the appropriately marked bin. Replace the cap on the hydrogen peroxide vial and place in the appropriate bin. Take a glowstick with you!

From “Make Glow Sticks – The Science” by NurdRage. Retrieved 06/28/2013 from <http://www.youtube.com/watch?v=tItOOpyJP5k>

**Magic Sand**

**Materials:**

500 g sand

baking tray

aluminum foil (optional)

oven

Scotch-Gard® spray

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. ***Caution: do this either under a fume hood or outside for adequate ventilation.***

**Procedure**:

* Line the baking tray with the aluminum foil (if desired) or place sand directly on tray.
* Place tray in the oven for 30 minutes at 400 F. (This is to remove any moisture from the sand.)
* Remove sand from oven and allow to cool.
* When cool, spray Scotch-Gard® over the surface of the sand using a back and forth motion to coat the sand evenly.
* Allow to dry.
* Gently shake the sand to mix up.
* Repeat the spray procedure.
* Allow to dry and then shake to mix up.
* Repeat the spray process one more time to ensure that all the sand has been coated with the spray.
* Allow to dry.
* Pour into bowl of water.
* Observe and record your results.
* Clean your station. Place your magic sand into one of the containers provided and take it with you.

From “Magic Sand/Mystic Sand” by David A. Katz. Retrieved 06/28/2013 from <http://www.chymist.com/Magic%20sand.pdf>

**Disappearing Ink**

**Materials:**

thymolphthalein

ethyl alcohol

3 M solution of sodium hydroxide

gloves

transfer pipette

dropper bottle to store ink

25 mL graduated cylinder

50 mL graduated cylinder

analytical balance

weigh boat

cup for mixing

autopipette

stir stick

squares of cotton cloth

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure**:

* Use the analytical balance to measure out 50 mg of thymolphthalein into the weigh boat.
* Pour the thymolphthalein into the 5 oz plastic cup.
* Use the graduated cylinder to measure out 5 mL of ethyl alcohol.
* Add to the plastic cup and stir to dissolve the solid.
* Add 45 mL water and stir. The solution will be milky white.
* Use the auto pipette to add 0.5 mL of 3 M sodium hydroxide solution. The solution will turn blue.
* Use a transfer pipette to put a few drops of the disappearing ink onto a piece of cloth.
* Observe and record your results.

From “Disappearing Ink” by David A. Katz. Retrieved 06/28/2013 from <http://www.chymist.com/Disappearing%20Ink.pdf>

**Dissolving Alien**

**Materials:**

baking soda

water

cornstarch

1000 mL beaker

500 mL graduated cylinder

spoon

hot plate

balance

citric acid

weigh boat

glass jar

alien toy

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. **Caution: hot plates are hot.**

**Procedure**:

* Use the balance to measure out 66.5 g of baking soda into the weigh boat. Dump into 1000 mL beaker.
* Use the balance to measure out 17.9 g of corn starch into the weigh boat. Dump into 1000 mL beaker.
* Use the graduated cylinder to measure out 37 mL of water.
* Slowly pour the water into the beaker while stirring with the spoon.
* Place the beaker on the hot plate and turn the hot plate on to a medium heat.
* Continue to stir as it heats. It will thicken up pretty quickly.
* Once it’s almost the same thickness as play dough, remove from heat and dump onto the table until cool.
* Once cool, knead the dough until smooth.
* Encase your alien toy in a ‘skin’ of the dough you just made.
* Thoroughly wash beaker.

**To dissolve the alien’s ‘flesh’**

* Use the balance to measure out 2.5 g of citric acid into a weigh boat. Pour the citric acid into the glass jar.
* Add 1000 mL of water to the beaker. Stir to dissolve the citric acid.
* Place your ‘alien’ into the citric acid solution.
* Observe and record your results.
* Clean your station. Rinse all glassware and wipe table. Take your alien toy with you.

From “I Can Teach My Child” blog post “Baking Soda Modeling Clay”dated 11/03/2011. Retrieved 06/28/2013 <http://www.icanteachmychild.com/2011/11/baking-soda-modeling-clay/>

**Spy Paper**

**Materials:**

1 piece of spy paper

beaker of water

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing.

**Procedure**:

* Draw a design or write your message on the spy paper – OR – use a piece of printed paper.
* Place into beaker of water.
* Observe and record your results.
* Empty out beaker and add additional clean water for the next group.

**Memory Wire**

**Materials:**

one 15 cm length of nitinol wire

plastic forceps

600 mL beaker with water

hot plate

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. **Caution: hot water is hot.**

**Procedure**:

* Place beaker of water on hot plate.
* Turn on hot plate to heat water until boiling.
* While waiting for water to boil, bend the wire into any interesting shape.
* Use the forceps to dip the wire into the hot water.
* Observe and record your results.
* Remove wire from water. Turn off hot plate. Place beaker onto table.

**Sunprint Paper**

**Materials:**

Bottle of Solution A (ferric ammonium citrate solution)

Bottle of Solution B (potassium ferracyanide solution)

50 ml Erlenmeyer flask

clipboard

two 25 mL graduated cylinders

watercolor paper

glass stir rod

old newpapers

paper towels

**Safety:**

Observegeneral laboratory safety: Tie up long hair. Wear protective gloves when working with chemicals. Wear proper eye protection. Wear appropriate clothing for the lab; i.e. closed-toe shoes and non-loose-fitting clothing. ***Caution: this will stain clothing and skin – you must wear gloves!***

**Procedure**:

* Use the graduated cylinder to measure out 10 mL of solution A. Pour it into the 50 mL Erlenmeyer flask.
* Use another graduated cylinder to measure out 10 mL of solution B. Pour it into the 50 mL Erlenmeyer flask. Place the lid on the flask and swirl to mix.
* Clip a piece of water color paper to the clipboard.
* Wipe the stir rod clean with a paper towel.
* Lay the glass stir rod horizontally across the paper against the clip.
* Use a clean transfer pipette to obtain some of the newly mixed solution in the 200 mL beaker.
* Dispense 6 – 8 drops of the solution onto the paper right below the glass stir rod.
* Grasp the stir rod at both ends.
* Slowly pull the stir rod down the paper to help smear the solution onto the paper evenly.
* When the solution has evenly coated the paper, hang it up to dry out of direct light. (It should dry to be an opaque yellowish color.)
* When dry, place objects on the paper and place paper in direct sunlight.
* Allow to remain in direct sunlight for about 15 minutes.
* Remove objects and then rinse paper under running water until yellow residue is gone from unexposed areas (areas under the objects). The exposed areas should appear silvery blue and the color will intensify as the paper dries.
* Observe and record your results.
* Dispose of any remaining solution down the drain and rinse flask with water. Rinse out graduated cylinders. Take your sun print with you once it is dry.

From “The Cyanotype Process” from The Science Company. Retrieved 06/25/2013 from <http://www.sciencecompany.com/The-Cyanotype-Process-W164.aspx>

**Mrs. Magorium’s Wonder Emporium**

**Directions:** Place an ‘X’ in the box that you think represents the scientific principle behind each toy.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Toy** | **Chemical Reaction** | **Physical Change/Property** | **Polymer** | **Surface Tension** |
| **Disappearing Ink** |  |  |  |  |
| **Dissolving Alien** |  |  |  |  |
| **Fortune Teller Fish** |  |  |  |  |
| **Glow Stick Reaction** |  |  |  |  |
| **Happy/Unhappy Balls** |  |  |  |  |
| **Instant Snow** |  |  |  |  |
| **Latex Rubber Ball** |  |  |  |  |
| **Magic Sand** |  |  |  |  |
| **Memory Wire** |  |  |  |  |
| **Spy Paper** |  |  |  |  |
| **Sunprint Paper** |  |  |  |  |
| **Swimming Fish** |  |  |  |  |
| **Unpoppable Bubbles** |  |  |  |  |

**Questions:**

How do the physical properties of polymers enhance play?

Which toys involve a chemical reaction?

Which toys involve a physical reaction?