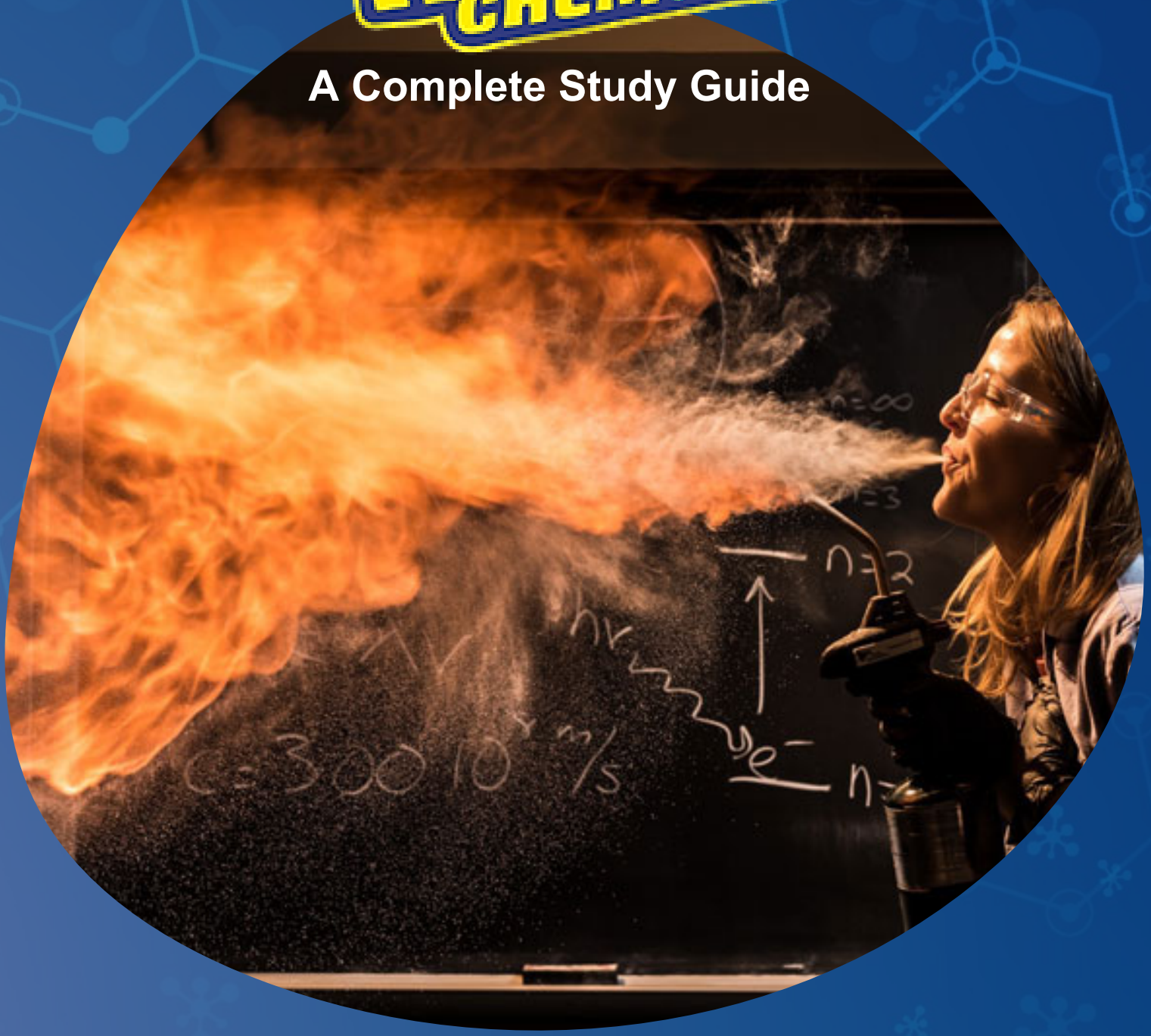
Great Lakes Center for the Arts Presents:

Kate the Chemist

A Complete Study Guide



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ABOUT

Dr. Kate Biberdorf

Dr. Kate Biberdorf is a Michigan born chemist, science entertainer, and professor at The University of Texas. Through her theatrical and hands-on approach to teaching, Dr. Biberdorf is breaking down the image of the stereotypical scientist, while reaching students who might otherwise be intimidated by science. Students' emotional responses, rather than rote memorization of facts, are key to Biberdorf's dynamic approach to her program, as well as science in general. Her exciting and engaging program leaves audiences with a positive, memorable impression of science—all while diminishing the stigma around women in science. She has appeared on The Today Show, The Kelly Clarkson Show, NBC Nightly News, the Wendy Williams Show, the Rachael Ray Show, the Nick Cannon Show and Late Night with Stephen Colbert.

She is the author of the bestseller The Big Book of Experiments, a full-color non-fiction book featuring 25 fun, kid-friendly experiments kids can do in their own kitchens. Readers learn how to make slime, fake tattoos, edible snot, glitter volcanoes and more! It was such a hit with kids across the country that Amazon selected it as one of their Best Books of 2020! Dr. Biberdorf's much anticipated follow-up book, The Awesome Book of Edible Experiments, is packed with 25 edible science experiment recipes kids can do in their own kitchen. Kids can make their own chocolate-covered pretzels, ice cream, and pretzel bites, all while learning the science behind their cooking.

The fun doesn't stop there! She is also the author of the Kate the Chemist fiction series that features a 10-year-old Kate the Chemist who, along with her friends and little brother Liam, solves problems in her community with the help of science! This five-book series shows kids that science truly is everywhere. The School Library Journal commented that the series "proves that science and fun go together like molecules in a polymer."

In addition to the fiction series, Dr. Biberdorf released her first nonfiction book for adults: It's Elemental; The Hidden Chemistry in Everything. This page-turner is about the ways we experience chemistry in our every day life. In It's Elemental, Kate demystifies the fundamental principles of the science that may have eluded you in high school and shows how chemistry comes alive in everything we do. In a glowing starred review, Publishers Weekly raves "Readers will come away with an appreciation of how crucial—and how cool—chemistry actually is."

Dr. Biberdorf lives in Austin Texas with her husband, two dogs, and one very grumpy cat.

To learn more visit her website:https://www.katethechemist.com/

WOMEN IN STEM

STEM is an acronym meaning Science, Technology, Engineering, and Mathematics. Women make up only 28% of the workforce in science, technology, engineering and math (STEM), and men vastly outnumber women majoring in most STEM fields in college. The gender gaps are particularly high in some of the fastest-growing and highest-paid jobs of the future, like computer science and engineering.

HOW CAN WE CLOSE THE GAP?

- Give girls, women, and everyone the skills and confidence to succeed in math and science.
- Improve STEM education and support for girls and others starting in early education and through K-12.
- Work to attract, recruit and retain women into STEM majors and fields in colleges and universities.
- Improve job hiring, retention and promotion pathways and intentionally inclusive cultures.

STEM IS AND SHOULD BE INCLUSIVE TO ALL.

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A FEW OF MANY FAMOUS WOMEN IN STEM

Mae C. Jemison

Mae C. Jemison was the first ever Black American woman to travel to space. She was a doctor for the Peace Corps for two years after graduating with a medical degree from Cornell University but in 1987 joined NASA's astronaut corps.

Mae orbited the earth from September 12th to 20th in 1992 with the STS-47 missions. She then, a year later, founded a tech research company and established a non-profit educational foundation that began the 100 Year Starship program funded by DARPA (Defense Advanced Research Projects Agency).

Chang Xu

Born and raised in Shanghai, China, Xu is a producer and cultural advisor for WDI, helping to foster a deep understanding of what audiences enjoy across Asia. She's been a "go-to" resource for Imagineers creating Shanghai Disney Resort—organizing events that promote cultural awareness as well as ensuring that creative concepts are developed with sensitivity. She joined WDI after earning her graduate school degree at Southern Illinois University at Carbondale

Rosario Costa

Rosario Costa from Sao Joao da Madeira, Portugal is a senior design director at LEGO and an absolute legend, one of the key drivers behind the LEGO Friends project in 2008. More recently, she's been on the LEGO Dots team. She has worked there since 1997 starting off as a designer.

Gladys West

Gladys West, née Gladys Mae Brown, (born October 27, 1930, Sutherland, Virginia), American mathematician known for her work contributing to the development of the Global Positioning System (GPS). We can thank her for not having to use paper maps!

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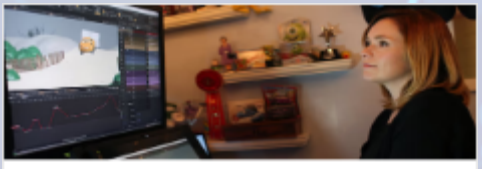
CAREERS IN STEM

Science, technology, engineering, and mathematics (STEM) programs open the door to many different careers, including opportunities in engineering, science, and research. STEM professionals can explore diverse fields like aeronautics and biochemistry. Some STEM students also apply their technical knowledge in law, politics, and education.

A small selection of STEM careers

- **Medical Illustrator**
- **Astronaut**
- **Data Scientist**
- **Robotics Engineer**
- **Civil Engineer**
- **Legoland Designer**
- **K-12 STEM Educator**
- **Cartographer**
- **Agriculture/Food Scientist**
- **Disney Imagineer**
- **Computer Programmer**
- **Biomedical Engineer**
- **ESPN Statistician**
- **Marine engineer**

To explore more careers visit this list complied by James Madison University:



STEM Careers List

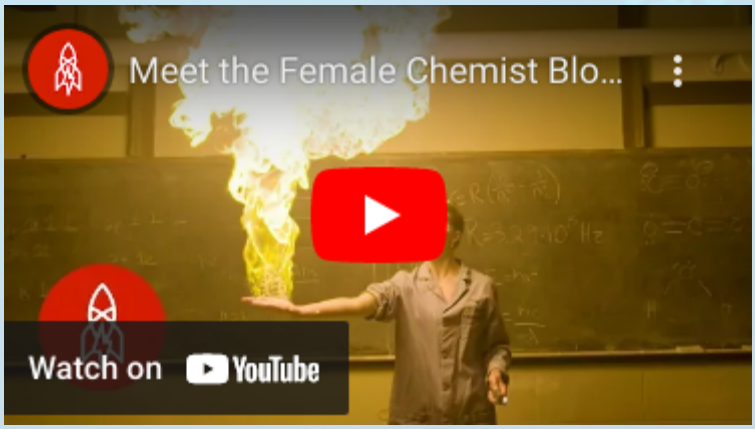
jmu.edu / Jan 4

EXTRA RESOURCES

Here is a small collection of informational videos all relating to either Kate the Chemist or the field of STEM. (Email Format only)

Kate the Chemist and Colbert Breathe Fire

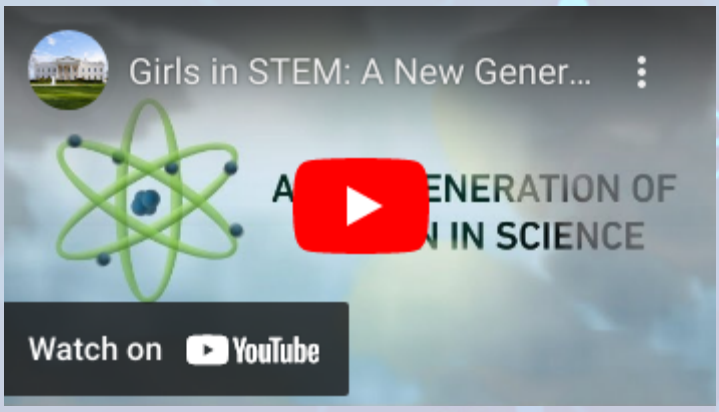
Experiments with Kate the Chemist: Daily Planet



Meet the Female Chemist Blowing Up Stereotypes

How These Women Changed Science Forever!

How to Engage More Girls in STEM



Girls in STEM: A New Generation of Women in Science

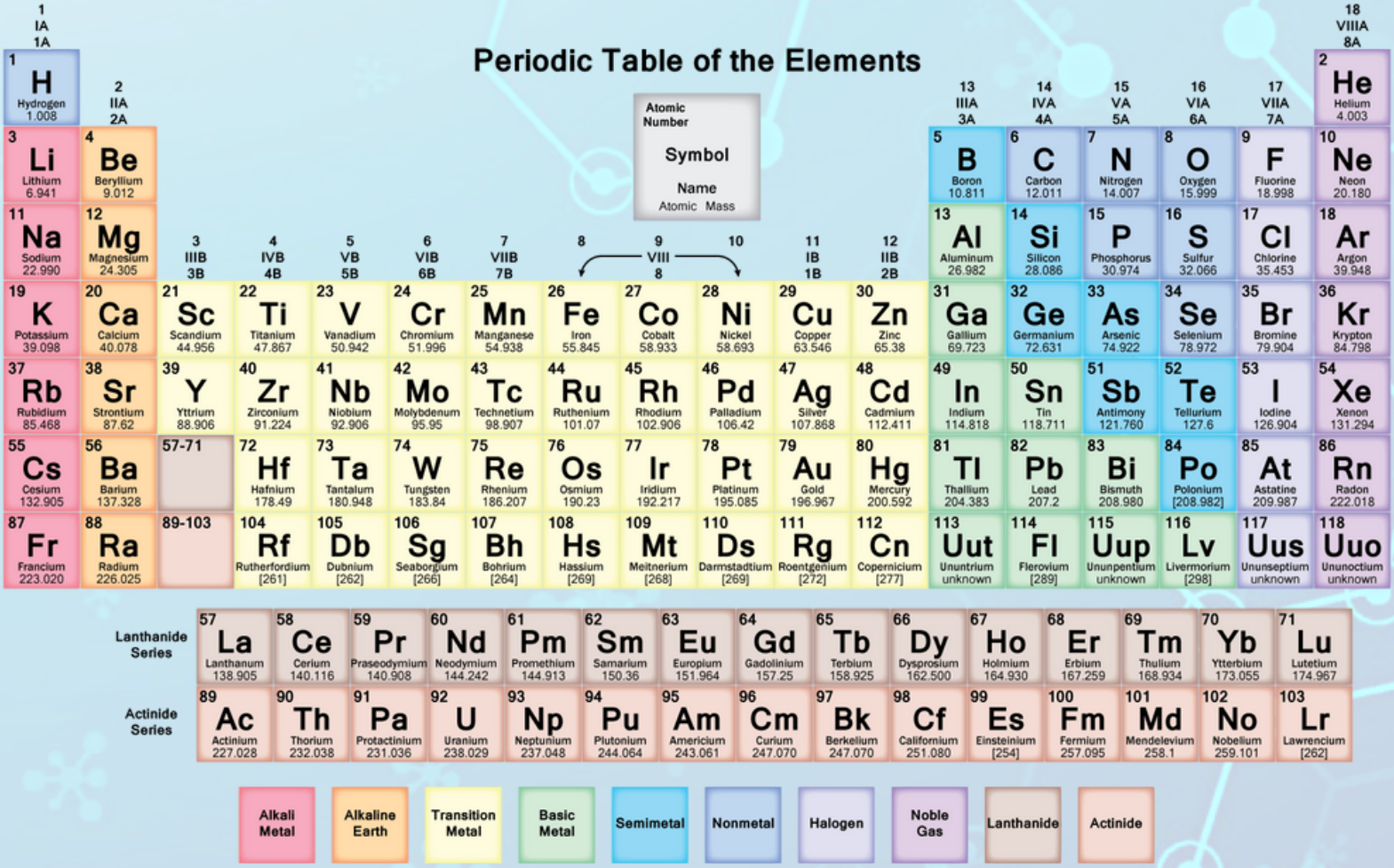
CONTENT FOR THE CLASSROOM

The next section will provide you with worksheets and an outline of Kate's performance. The performance talks alot about Chemical and Physical changes so along with the outline there will be a glossary of terms! Also included will be some curriculum from Midland Center For The Arts. The curriculum covers some science experiments with major "awe" factor.

GLOSSARY OF TERMS TO KNOW

Electrochemistry	The study of chemical processes that cause electrons to move.
Cryogenics	The branch of physics that deals with the production and effects of very low temperatures.
Physical change	Involves a change in physical properties.
Chemical Change	Occurs when a substance combines with another to form a new substance, called chemical synthesis.
Sublimation	The process in which a solid transforms into a gas phase without first melting to form a liquid phase.
Endothermic	Heat is absorbed by the system from the surroundings.
Exothermic	Releases heat, causing the temperature of the immediate surroundings to rise.
Combustion Reaction	Substance reacts with oxygen to make heat and light.
Chemistry	Chemistry is the branch of science that deals with the properties, composition, and structure of elements and compounds, how they can change, and the energy that is released or absorbed when they change.

CRASH COURSE TO THE PERIODIC TABLE OF ELEMENTS



The Periodic Table is a way of listing the elements. Elements are listed in the table by the structure of their atoms. This includes how many protons they have as well as how many electrons they have in their outer shell. From left to right and top to bottom, the elements are listed in the order of their atomic number, which is the number of protons in each atom.

Each element has its own name and abbreviation in the periodic table. Some of the abbreviations are easy to remember, like H for hydrogen. Some are a bit harder like Fe for iron or Au for gold. For gold the "Au" comes from the Latin word for gold "aurum".

Each element also has an atomic number representing the number of protons in the atom. Along with the name and symbol, each element has a weight. This is the total weight of the atom. They are measured in atomic mass units also known as daltons

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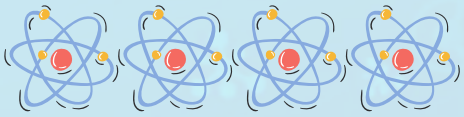
Kate the Chemist Presents

PHYSICAL VS. CHEMICAL CHANGE

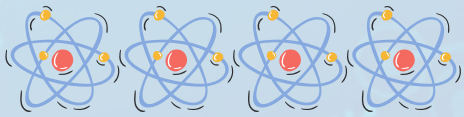
The presentation will begin with a short introduction to Dr. Kate Biberdorf. She will share her story about becoming a chemistry professor + science entertainer and will explain how she has used her platform to build a STEM army. The students will be invited to join the STEM army by participating in a discussion on the difference between a chemical and physical change. After a brief lecture on these scientific principles, Dr. Biberdorf will invite students on stage (one at a time) to participate in the below demonstrations.



Each demonstration will have the following format:

1. Student Volunteer assists Dr.Biberdorf with the experiment.
2. Audience members discuss the experiment with their peers for 30-60 seconds.
3. As a group, the audience votes on whether they believe the experiment was a physical or chemical change.
4. Dr.Biberdorf provides the audience with the answer, while providing a detailed explanation of the fundamental scientific properties.

NOTE: All voulunteers MUST wear goggles and gloves, in order to participate in the experiment.



1 COLORED WATER OVER DRY ICE

MATERIALS:

- One empty beaker
- Two beakers half full of water
- Dry ice
- Food coloring

PROCEDURE:

- Add three handfuls of dry ice to the empty beaker
- Add food coloring to the two beakers with water
- Pour the beakers of water into the beaker of dry ice

TYPE OF CHANGE:

Sublimation
Endothermic

EXPLANATION

The dry ice absorbs the thermal energy from the water. This causes the solid carbon dioxide to sublime into gaseous carbon dioxide. This is an endothermic physical change.

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2 UNIVERSAL INDICATOR

MATERIALS:

- Two graduated cylinders
- Water
- NaOH
- Universal indicator
- Dry ice

PROCEDURE:

- Fill each graduated cylinder 3/4 of the way full with water
- Add 1mL of universal indicator for every 400 mL of water to each graduated cylinder
- Add 1 mL of base for every 400 mL of water to one graduated cylinder
- Add 2 mL of base for every 400 mL of water to the other graduated cylinder Stir the solutions
- Add a small handful of dry ice to each graduated cylinder

TYPE OF CHANGE:

Physical change (solid CO2 to Gas CO2)
Sublimation
Endothermic
Chemical Change (color change)
Acid/Base chemistry
Exothermic

EXPLANATION

The dry ice absorbs the thermal energy from the water. This causes the solid carbon dioxide to sublime into gaseous carbon dioxide. This is an endothermic physical change.

The dry ice converts into carbonic acid in the presence of water. The acid and base perform a neutralization chemical reaction, resulting in an exothermic process.

3 DRY ICE BUBBLES

MATERIALS:

- 3L empty soda bottle
- Tube-funnel apparatus
- Water
- NaOH
- Universal indicator
- Dry ice
- Bowl
- Bubble Bath Solution

PROCEDURE:

- Fill the soda bottle half full with water
- Add 1mL of universal indicator to the soda bottle
- Add 1 mL of base to the soda bottle
- Pour the bubble bath solution into the bowl
- Add a small handful of dry ice to the soda bottle
- Use the tube-funnel to route the gas to the bubble bath solution Collect the dry ice bubbles on your hand

TYPE OF CHANGE:

Physical change (solid CO2 to Gas CO2)
Sublimation
Endothermic
Chemical Change (color change)
Acid/Base chemistry
Exothermic

EXPLANATION

The dry ice absorbs the thermal energy from the water. This causes the solid carbon dioxide to sublime into gaseous carbon dioxide. This is an endothermic physical change.

The dry ice converts into carbonic acid in the presence of water. The acid and base perform a neutralization chemical reaction, resulting in an exothermic process (and the color changes).

4 BALLOON ANIMAL IN LIQUID NITROGEN

MATERIALS:

- Two balloon animals
- Liquid nitrogen
- Container for liquid nitrogen

PROCEDURE:

- Put liquid nitrogen in container
- Put balloon animals in container

TYPE OF CHANGE:

Physical Change

Exothermic (big to small balloon)

Endothermic (small to big balloon)

EXPLANATION

The liquid nitrogen absorbs the thermal energy from the balloon, resulting in the compression of the air molecules in the balloon.

This is a physical, exothermic process. When the balloon animal begins to warm up, the gasses decompress, resulting in a physical, endothermic process. (NOTE: In this example, the balloon is the system).

5 HELIUM BALLOON ANIMAL

MATERIALS:

- Balloon animal with large helium balloon attached
- Container for liquid nitrogen
- Liquid nitrogen

PROCEDURE:

- Put balloon animal in liquid nitrogen
- Let go of balloon animal as it warms up

TYPE OF CHANGE:

Physical Change

Exothermic (big to small balloon)

Endothermic (small to big balloon)

EXPLANATION

The liquid nitrogen absorbs the thermal energy from the balloon, resulting in the compression of the air molecules in the balloon. This is a physical,
exothermic process. When the balloon animal begins to warm up, the gasses decompress, resulting in a physical, endothermic process. Helium is less dense than air; the balloon floats to the ceiling
.

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6 MARSHMALLOWS

MATERIALS:

- Ten marshmallows
- Styrofoam cup
- Spoon
- Liquid nitrogen

PROCEDURE:

- Put marshmallows into Styrofoam cup
- Add liquid nitrogen to cup
- Let sit for a few minutes
- Have the student put their hands out
- Put 1-2 marshmallows in the students' hand TWO BLOWS on the marshmallows
- Put the marshmallow into your mouth

TYPE OF CHANGE:

Marshmallows in liquid nitrogen

Physical change

Exothermic Marshmallows in body

Chemical Change

Exothermic

EXPLANATION

The liquid nitrogen absorbs the thermal energy from the marshmallows. This is a physical, exothermic process.

The stomach acid reacts with the marshmallow. This is an exothermic chemical change.

7 BUBBLE SNAKE

MATERIALS:

- Precut plastic water bottle
- Rubber band
- Towel/rag
- Food coloring
- 1/2 cup water
- 1/4 cup dish soap
- Bowl

PROCEDURE:

- Use the rubber band to secure the towel to the precut water bottle
- Add the water and dish soap to the bowl, and stir
- Use the food coloring to design a pattern on the towel
- Dip the bottle-towel apparatus into the soapy water
- Blow into the water bottle mouthpiece to create a buttle snake

TYPE OF CHANGE:

Physical Change

Exothermic

EXPLANATION

The gas molecules in a person's exhale are pushed into the soap solution that is caught within the towel fibers. The gas molecules are trapped, and form a bubble inside of the soap's interior.

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8 FIRE BREATHING DRAGON

MATERIALS:

- Propane torch
- Corn starch
- Cup
- Spoon
- Bottled Water

PROCEDURE:

- Put scoop of corn starch into mouth
- Blow corn starch over propane torch
- Use water to wash out mouth

TYPE OF CHANGE:

Chemical Change (Combustion Reaction)

Exothermic

EXPLANATION

This is a simple combustion reaction. It is an exothermic chemical reaction.

9 BUBBLE SNAKE

MATERIALS:

- 3 giant empty, dry, plastic water jugs
- 20 mL of methanol, ethanol, propanol
- Propane Torch

PROCEDURE:

- Add each alcohol to a separate container
- Quickly cover the top of the jug with the palm of your gloved hand
- Shake the jug for at least 30 seconds
- Use the torch to ignite the flame

TYPE OF CHANGE:

Physical Change

Exothermic

EXPLANATION

We use alcohol as a fuel source for the exothermic chemical reaction.

10 THUNDER CLOUD

MATERIALS:

- Liquid nitrogen
- Hot water
- Bucket
- Tarps for floor

PROCEDURE:

- Put liquid nitrogen in bucket
- Add hot water to the bucket
- Observe giant nitrogen cloud

TYPE OF CHANGE:

Physical Change

Endothermic

EXPLANATION

The liquid nitrogen absorbs the thermal energy from the hot water. The liquid nitrogen vaporizes into gaseous nitrogen in an endothermic physical change.

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Name: _____ Date: _____

PHYSICAL VS. CHEMICAL CHANGE

PART 1
Physical Change

1 What is the definition of a physical change?

2 Name the physical change that occurs when a solid transitions into a liquid.

3 Name the physical change that occurs when a liquid transitions into a gas.

4 Name the physical change that occurs when a solid transitions into a gas.

5 Name the physical change that occurs when a gas transitions into a liquid.

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Kate the Chemist

Name: _____ Date: _____

PHYSICAL VS. CHEMICAL CHANGE

PART 1
Physical Change

7 Name the physical change that occurs when a gas transitions into a solid

_____
_____
_____
_____

8 Does the chemical composition change during a physical change? Please be specific.

_____
_____
_____
_____

9 Is a physical change reversible? Please be specific.

_____
_____
_____
_____

10 Provide three examples of a physical change.

_____
_____
_____
_____

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Kate the Chemist

Name: _____ Date: _____

PHYSICAL VS. CHEMICAL CHANGE

PART 2
Chemical Change

1 What is the definition of a chemical change?

_____
_____
_____
_____

2 Does the chemical composition change during a chemical change? Please be specific.

_____
_____
_____
_____

3 Is chemical change reversible? Please be specific.

_____
_____
_____
_____

4 Provide Three examples of chemical change.

_____
_____
_____
_____

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Kate the Chemist

PHYSICAL VS. CHEMICAL CHANGE

PART 1
Physical Change

TEACHERS KEY

1	What is the definition of a physical change?	A reversible change in the physical properties of a substance (e.g. size, shape, phase)
2	Name the physical change that occurs when a solid transitions into a liquid.	Fusion
3	Name the physical change that occurs when a liquid transitions into a gas.	Vaporization
4	Name the physical change that occurs when a solid transitions into a gas.	Sublimation
5	Name the physical change that occurs when a gas transitions into a liquid.	Condensation

PHYSICAL VS. CHEMICAL CHANGE

PART 1
Physical Change

TEACHERS KEY

7 Name the physical change that occurs when a gas transitions into a solid

Deposition

8 Does the chemical composition change during a physical change? Please be specific.

No. The intermolecular bonds are broken during the physical change, but the intramolecular bonds will remain intact.

9 Is a physical change reversible? Please be specific.

yes, ice can melt and then we can freeze water

10 Provide three examples of a physical change.

sugar dissolving into water, crushing a can, breaking a glass, mixing sand and water.

PHYSICAL VS. CHEMICAL CHANGE

PART 2
Chemical Change

TEACHERS KEY

1 What is the definition of a chemical change?

An irreversible change involving the rearrangement of the atoms of one or more substances (e.g. cooking, fire, etc.)

2 Does the chemical composition change during a chemical change? Please be specific.

Yes, you cannot "unburn" a log of wood. Fuel + Oxygen → Water + Carbon Dioxide

3 Is chemical change reversible? Please be specific.

No, water and carbon dioxide are not starting materials for a combustion reaction.

4 Provide Three examples of chemical change.

Combustion, respiration, photosynthesis, oscillating clock reaction

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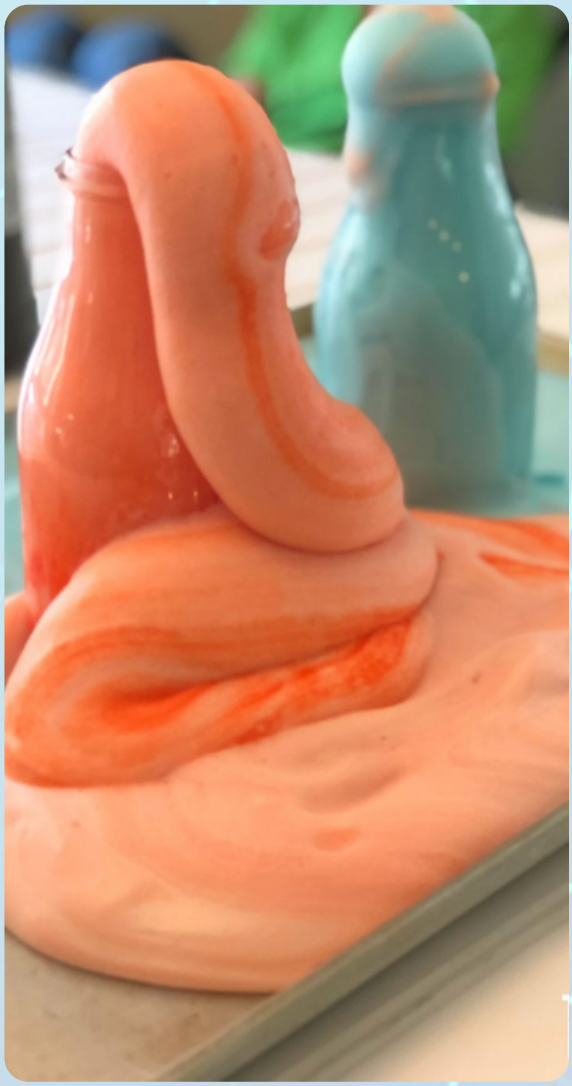
Kate the Chemist

BONUS CURRICULUM: ELEPHANT TOOTHPASTE

This is a kid-friendly version of the popular Elephant's Toothpaste demonstration. A child with a great adult helper can safely do it on their own and the results are wonderful.



MATERIALS

- 16 oz. empty plastic soda bottle (preferably with a narrow neck such as those made by Coca-Cola)
- 1/2 cup 20-volume hydrogen peroxide (20-volume is 6% solution, purchased from a beauty supply store)
- Squirt of Dawn dish detergent
- 3-4 drops of food coloring
- 1 teaspoon yeast dissolved in ~2 tablespoons very warm water
- Funnel
- Foil cake pan with 2-inch sides
- Lab goggles
- Lab smock

PROCEDURE

1. At each student's place: cake pan, plastic bottle, Dawn in small cup, food coloring, funnel, goggles and smock, 1/2 cup peroxide, dissolved yeast mixture.
2. Stand up bottle in the center of the cake pan. Put funnel in opening. Add 3-4 drops of food coloring to the peroxide and pour the peroxide through the funnel into the bottle. Show a water molecule diagram and a peroxide molecule diagram, pointing to the extra oxygen that will be set free.
3. Add the Dawn detergent to the peroxide in the bottle.
4. Pour the yeast mixture into the bottle and quickly remove the funnel.
5. The students can touch the bottle to feel any changes that take place.

OBSERVATIONS

The reaction creates foam that shoots up out of the bottle and pools in the pan. After a minute or so, it begins to come out in a moving stream that looks like toothpaste being squeezed our of a tube. The students can play with the foam as it is just soap and water with oxygen bubbles. The bottle will feel warm to the touch as this is an exothermic reaction.

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BONUS CURRICULUM: ROCK CANDY CRYSTALS

This activity is a beautiful science experiment and a yummy treat all in one. Students LOVE checking on their jars each day to see if the rock crystals had grown.

MATERIALS (Per Candy Color)

- 2-3 cups of sugar
- 1 cup of water
- Skewers
- A jar or glass
- A large saucepan
- Clothespins

Optional additions:

- Food coloring
- Candy flavoring

PROCEDURE

1. Combine equal parts of sugar and water in a saucepan and heat until all of the sugar is dissolved.
2. Then, slowly add more sugar and mix, slowly adding more sugar and mixing until the sugar will no longer dissolve in the water.
3. The water should start to look a little cloudy. That is when you know that no more sugar is dissolving and the perfect sugar-saturation has been reached.
4. The short version is that you are creating a saturated sugar solution, or a solution in which no more sugar can dissolve at a particular temperature.
5. The amount of sugar verses water used should be roughly 3:1. You can easily double & triple the recipe as long as you mantain a 3:1 ratio.
6. Add candy flavoring if desired, and then continue to heat the water until it comes to a simmer.
7. Remove the sugar-water from the heat and allow it to cool.
8. Cut the skewers to a desirable size for the jar(s) that you are using. Then, dip the sticks in water and roll them in sugar.
9. Set the sugar-coated sticks aside and allow them to dry.
10. Once your sugar-water is cool enough pour it into jars, using one jar for each color of rock candy that you wish to make.
11. Once the sticks are dry carefully place them into the jar(s).
12. You want to make sure that the sugar-coated sticks are completely dry before placing them in the jars.
13. The rock candy needs the sugar on the sticks to grow, and if the sugar isn't dry it will dissolve in the water.
14. It is also important to make sure that the sticks are not touching the bottom or sides of the jar.

- After a week your rock candy can be removed from the jars and enjoyed.
- You can extend the fun and grow your rock candy longer if desired.
- Once you and the kids are ready remove the candy sticks from the jar(s), and then place them on a clean surface to dry.
- Once dry you will have a yummy treat to enjoy!

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