ArtsNow®
Teaching and Learning Across the Curriculum

Grade 5 STEAM Module

Chemical & Physical Changes

States of Matter • Reversible Change • Irreversible Change

STEAM MODULE DESCRIPTION

In this series of STEAM activities, students will engage in a variety of art forms exploring both physical and chemical changes. One activity will require that students use their bodies and movement to personify and dramatize physical or chemical changes. They will create a 2-part moving picture and dialogue to support their dramatization. Another activity in this module will use the visual arts process of indigo dyeing to help students apply their understanding of chemical and physical changes as they go through the various steps of dyeing fabric.

www.artsnowlearning.org

Modules provide differentiated ideas and activities aligned to a sampling of standards.
The modules do not necessarily imply mastery of standards, but are intended to inspire and equip educators.

Description	Learning Targets
In this series of STEAM activities, students will engage in a variety of art forms exploring both physical and chemical changes. One activity will require that students use their bodies and movement to personify and dramatize physical or chemical changes. They will create a 2-part moving picture and dialogue to support their dramatization. Another activity in this module will use the visual arts process of indigo dyeing to help students apply their understanding of chemical and physical changes as they go through the various steps of dyeing fabric.	"I Can…" ● Use my body and movement to dramatize the changes of an object involved in chemical or physical change ● Create a 2-part tableau and incorporate dialogue that helps communicate the story and my understanding of chemical and physical changes ● Use art materials to engage in the artistic process of indigo dyeing ● Differentiate between which steps in the visual arts process were physical changes versus chemical changes ● Justify my artistic choices using my knowledge of both physical and chemical changes

ESSENTIAL QUESTION(S)

- How can theatre and visual arts strategies be used to create works of art that assess students' understanding of what constitutes a physical change versus a chemical change?
- How can moving through two tableaux be used to dramatize materials as they undergo physical or chemical changes?
- How can the artistic process of indigo dyeing be used to model and classify both physical and chemical changes?

STANDARDS

Curriculum Standards	Arts Standards
<u>GA Performance Standards:</u> **S5P2. Students will explain the difference between a physical change and a chemical change.** **a.** Investigate physical changes by separating mixtures and manipulating (cutting, tearing, folding) paper to demonstrate examples of physical change. **b.** Recognize that the changes in state of water (water vapor/steam, liquid, ice) are due to temperature differences and are examples of physical change. **c.** Investigate the properties of a substance before, during, and after a chemical reaction to find evidence of change. <u>National Standards:</u> **NS.5-8.2 PHYSICAL SCIENCE** As a result of their activities in grades 5-8, all students should develop an understanding of properties and changes of properties in matter.	<u>GA Performance Standards:</u> **TAES5.3 Acting by developing, communicating, and sustaining roles within a variety of situations and environments.** **VA5PR.1 Creates artworks based on personal experience and selected themes.** **f.** Produces artworks emphasizing one or more elements of art (e.g. color, line shape form, texture). **g.** Combines materials in new and inventive ways to make a finished work of art. <u>National Standards:</u> Theatre Arts **Standard 2:** Acting, assuming roles and interacting in improvisations. **Standard 5:** Researching by finding information to support classroom dramatizations. Visual Arts

	Standard 1: Generate and conceptualize artistic ideas and works.

KEY VOCABULARY

Content Vocabulary
• **Physical change:** A change from one state of matter to another without a change in chemical composition • **Chemical change:** A change that produces one or more new substances and may release energy • **State of matter:** The distinct forms that different phases of matter take on: solid, liquid, gas and plasma • **Substance:** A type of matter that has a unique set of properties • **Material:** Relating to, derived from or consisting of matter • **Heat:** The movement of thermal energy from one place to another • **Reversible change:** A change that can be undone; often called a physical or temporary change • **Irreversible change:** A process that is not reversible
Arts Vocabulary
Theatre Arts • **Tableau:** A "living picture" in which actors pose and freeze in the manner of a picture or a photograph • **Dialogue:** A conversation between two or more persons • **Scenario:** The outline of action in a play • **Thought-tracking:** Drama technique in which individuals participating in tableau, or members of the class observing a tableau, are invited to speak the thoughts or feelings of a portrayed character aloud **Visual Arts** • **Indigo dye:** An organic compound with a distinctive blue color. Historically, indigo was a natural dye extracted from plants, and this process was important economically because blue dyes were once rare. A large percentage of indigo dye produced today – several thousand tons each year – is synthetic. It is the blue often associated with blue jeans. • **Indican:** The compound that yields indigo blue, is a glycoside: a sugar (in this case a form of glucose) bound to another molecule, indoxyl. When the glycosidic bond is broken, the indoxyl is freed. When the indoxyl compound is oxidised, it becomes blue: indigo blue. • **Shibori**: A Japanese manual resist dyeing technique, which produces patterns on fabric.

ASSESSMENTS

Formative	**Summative**
• **Tableau Preparation Sheet** (see Appendix) • **Indigo Dyeing Chart** (see Appendix) • Observations of students in the artistic process (rehearsing, performing, visual arts process)	• Final performance of Chemical/ Physical Change with movement and dialogue • **Indigo Dyeing Chart** (see Appendix)

MATERIALS

<u>**Theatre Arts:**</u> **Anchor Charts: Chemical/Physical Changes** (see appendix) **Tableau Preparation Sheet** (see appendix) **Suggested Prompts for Dramatization of Chemical & Physical Changes** (see appendix) Markers Index Cards Pencils <u>**Visual Arts:**</u> **Chemistry of Indigo** (see appendix) **Indigo Dyeing Chart** (see appendix) Rubber gloves Buckets Water Plastic table cloth liner Paint stirrer Cotton fabric cut into squares for dyeing (a sheet works well) Indigo Dye kit: http://www.dharmatrading.com/kits/starter/sets/indigo-dye-kit.html Rubber bands Various size clothes pins

THEATRE ARTS:

Activating Strategy

- Introduce the art form of Tableau with a warm-up: Silent Tableau
- Students will form small groups. Groups will be asked to form various shapes within their groups silently. (Ex: circle, crescent moon, diamond)
- Go over the Principles of Tableau (see Appendix: **Anchor Charts-Chemical & Physical Changes**)
- Groups will then be asked to form various scenarios within their groups silently. Dialogue will be added into the silent scenes through thought-tracking. Groups will practice forming 2-part tableaux of a particular scenario.
    - Examples: On a picnic and it begins to rain; students are playing with a ball in the living room until someone hits a lamp and it breaks; group of friends wait to yell “surprise” for a surprise birthday party

Main Activity

- Review the Science Concept: Physical vs. Chemical Changes
    - Model by tearing up a piece of paper. Ask class if this was a physical or a chemical change. As a class, create an anchor chart that lists the characteristics that classify a physical vs. a chemical change. (see Appendix: **Anchor Charts-Chemical & Physical Changes**, slide #2)
- Divide class into small groups and assign a particular chemical or physical change on an index card. (see Appendix: **Suggested Prompts for Dramatization of Chemical & Physical Changes**)
- Groups will discuss their change and determine together whether it is physical or chemical.
- Then they will form a 2-part dramatization of the scenario undergoing the change. The two tableaux will dramatize how the change occurred and the cause and effect of the change.
- Direct students to use the **Tableau Preparation Sheet** (see Appendix) to help with the next step.

- In each scenario, students will create dialogue that helps support the type of change that occurred.
- After the groups have had time to rehearse, groups share out their tableaux in a non-formal class performance. The goal is for the audience to be able to determine the materials that changed and whether it was a physical or chemical change based on the performance.

Classroom Tips:

- *Use cueing methods when directing tableaux in your classroom: "3-2-1- Freeze" and "Actor's Neutral."*
- *Make your expectations for the tableau science task explicit and go over these before the group work begins. Write them up so that students can refer back to them if they need to during their group working time.*

VISUAL ARTS:

Activating Strategy (5-10 min)

- Review physical and chemical changes.
- Introduce students to the Art of Shibori with images.
- Shibori is a technique that results in both physical and chemical changes.

Main Activity

This activity can be done in small groups or as a whole class.
Hand out the physical and chemical changes checklist. Students may complete this individually or in pairs. Students will complete the checklist during the process.

- Fill a bucket with 4 gallons of water.
- Add the thiox and soda ash to the water while stirring.
- Add the reduced indigo.
- Stir in a clockwise motion until indigo is dissolved, reverse the direction and place the lid on the bucket.
- Let indigo sit for 20 minutes.
- Demonstrate shibori folding techniques. Students should fold their cloth and bind to create a resist.
- Remove lid from the indigo vat and remove the frothy bloom. The bloom is the result of oxygen leaving the vat.
- Now the vat is ready for dyeing.
- Put on rubber gloves.
- Dip our fabric bundle into clean water and wring out.
- Hold your bundle under the surface of the indigo vat, massaging the dye into the fabric for 1 minute.
- Remove your bundle, notice the physical characteristics of the bundle.
- It should be a yellow color that changes from green to blue as it oxidises.
- The bundle may be dipped multiple times to obtain a deep blue color.
- Allow the bundle to sit for 10 minutes.
- Rinse under water.
- Unbind your bundle and admire your design.
- Hang to dry.

REFLECTION

Reflection Questions
• *How did engaging in the arts support and build upon your understanding of chemical and physical changes?* • *How did this STEAM activity help you understand chemical and physical changes in the world around you?* • *If you were to go through this artistic process again, what would you do differently? Why?*

ADDITIONAL RESOURCES & EXTENSION ACTIVITIES

- Shibori: https://www.seamwork.com/issues/2015/08/shibori-dyeing

Extensions:

- Ask students to predict their shibori pattern based on their folding technique.
- Compare the predictions and final product.

Technology Extension

- During the student performances of the tableau, digital pictures or video should be taken for integration on a final group presentation of a Thinglink (https://www.thinglink.com/). The class will work in groups to create a Thinglink example of their physical or chemical change. They may link their digital pictures or videos to a place in the artwork. Other content to include on the Thinglink should be the definition of the physical or chemical change, other examples of the physical or chemical change, why the change is important, and a definition of a tableau.
- Technology Resources Thinglink https://www.thinglink.com (also available as an App for Android and iOS Devices)

APPENDIX

- **Anchor Charts-Chemical & Physical Changes**
- **Suggested Prompts for Dramatizing Chemical & Physical Changes**
- **Tableau Preparation Sheet**
- **Chemistry of Indigo**
- **Indigo Dyeing Chart**

Anchor Chart
Chemical & Physical Changes

Tableau
A frozen "living picture" in which actors pose and freeze in the manner of a picture or a photograph

Principles of Tableau
1.) Create levels with your body (high, medium, low)
2.) Use Facial Expression (show the character's feeling)
3.) Make sure your audience can see you
4.) Consider the characters' relationships with one another

! To cue students to make a tableau, use **"3-2-1-FREEZE!"**

ArtsNow® Teaching and Learning Across the Curriculum

Physical vs. Chemical Changes

- Physical properties may or may not change
- The change may be reversible
- A new substance is NOT produced

- Physical properties change
- Change is not reversible
- New substance is produced

ArtsNow® Teaching and Learning Across the Curriculum

Suggested Prompts for
Dramatizing Chemical & Physical Changes

- Melting chocolate candies
- Water freezing into ice
- Mixing paint to make a new paint color
- Lighting a match
- Frying an egg
- Light bulb getting hot
- Autumn leaves changing colors
- A nail rusting
- A flower vase breaking into various pieces
- Grilling a steak
- Baking a cake
- A banana peel rotting
- A bank statement being shredded
- Mixing cake batter
- Popsicles melting in the sun
- Burning cookies
- Tossing a salad

TABLEAU PREPARATION **Name:**________________________________

→

Describe what your group is doing in Tableau #1:

____

____

____

Describe what your group is doing in Tableau #2:

____

____

____

TABLEAU PREPARATION **Name:**____

What is your role in Tableau 1?____

I will say: "____**"**

What is your role in Tableau 2? ____

I will say: "____**"**

Are the Tableaux dramatizing a Physical OR Chemical Change?

____

Explain how you know this:

____

____

____

____

____

Chemistry of Indigo

Indigo is extracted from plants such as Woad (Isatis tinctoria, a member of the Cruciferae, related to cabbages) and Japanese Indigo (Polygonum or Persicaria tinctoria, a type of knotweed) in addition to “true” Indigo, Indigofera, a member of the Leguminosae (related to beans and peas) that has several species, including tinctoria and suffruticosa. In fact many plants will yield indigo, but only a few yield it in sufficient quantity to be of any use in dyeing.

Indican, the compound that yields indigo blue, is a glycoside: a sugar (in this case a form of glucose) bound to another molecule, indoxyl. When the glycosidic bond is broken, the indoxyl is freed. When the indoxyl compound is oxidised, it becomes blue: indigo blue.

The indigo-bearing leaves are harvested. In Japan the Indigo leaves are dried in the sun and stored for later use. Elsewhere the leaves are then physically damaged – chopped, pounded or trampled – presumably to release larger quantities of indican. This is the point at which woad was traditionally made into balls of leaf matter and dried for easier storage and transport. In West Africa the pounded leaves might also be dried and stored at this stage. Alternatively (in West Africa and elsewhere) the mass of fresh leaf material might be fermented; in Japan the dried leaves are later moistened and fermented; in Europe the woad balls are moistened and fermented (a process known as couching). In other words, bacteria are encouraged to consume the glucose in the indican, leaving the indoxyl molecules as highly reactive free radicals. The bacterial breakdown of glucose may be an aerobic process in which the bacteria consume oxygen, creating the reducing (low oxygen) environment necessary for the next stage of the process, or an anaerobic process in which the bacteria release hydrogen that acts as a reducing agent in the next stage.

The indoxyl free radicals bind to each other to form indigo. If an alkali is present (pH is above neutral), this takes the form of water-soluble leuco-indigo (leuco means white), also known as white indigo or white indigotin. The “white” refers to the compound’s relative lack of color: the leuco-indigo solution is a clear yellow or yellow-green. This is the form in which indigo dyes, so at this point it is possible to convert the fermentation vat to a dye vat, or to continue the process to extract indigo from the solution. Extraction is simply a matter of converting the soluble leuco-indigo to its insoluble blue form by adding oxygen: straining the fluid off the leaves, then pouring it back and forth between two containers may be sufficient, after which the blue particles of indigo can then be filtered out of the liquid.

Chemistry of Indigo

How does indigo dye?

Water carries the soluble form, leuco-indigo, as it soaks through the material in the vat. When the material is exposed to the air (or another source of oxygen such as well-oxygenated water) the leuco-indigo oxidises to blue indigo particles that physically lodge in the material. Unlike many other dyes, the particles are not chemically bound to the material, just wedged into cracks and crevices. This means that dense, smooth materials or those that are not easy to wet will not hold a lot of dye or will not be easy to dye. Indigo is one of the most light-stable natural dyes, but the way in which it dyes means that materials dyed with indigo “fade” in two ways: as particles of indigo are dislodged and fall away from the material, and as the dyed material itself wears away to reveal undyed material. Taken together, these largely explain the classic fading of denim.

Making leuco-indigo: reducing the vat to remove oxygen:

Whether they’re based on synthetic or natural indigo (including plant material that contains indigo), all indigo vats work on the same basic principle: convert the blue indigo into soluble leuco-indigo, then allow that solution to penetrate the material to be dyed. As leuco-indigo only maintains that form in the absence of oxygen, the vat must be reduced (the oxygen removed) in some way. Traditional vats use bacterial fermentation: the vats contain organic matter on which bacteria feed, such as the nutrients in urine, rice bran, the plant material that contains the indigo compounds, or even the skin flakes, sweat and manure held in a sheep fleece. Chemical vats use raw chemistry - compounds, including sodium hydrosulphite or thiourea dioxide, or reducing sugars, such as fructose - to remove oxygen from the vat.

pH – the acidity or alkalinity of the vat – is important, as the conversion to leuco-indigo requires an alkaline environment. It’s easiest to predict and maintain in a chemical vat, with recipes calling for measured amounts of lye (sodium hydroxide) or washing soda/soda ash/soda crystals (sodium carbonate) or calc (calcium hydroxide, a.k.a. slaked lime). It’s just as important in a biological vat, but much trickier to maintain because the fermentation process produces byproducts, such as lactic acid, that lower the pH. Dyers in the past learned to manage their vats by tasting the fluid or feeling it between their fingers, trying for something that’s slippery (alkaline), but not too slippery.

Indigo Dyeing Chart

Action	Chemical	Physical	Observation
Add thiox, soda ash and reduced indigo to water.			
Stir in a clockwise motion to create a "bloom" removing oxygen.			
Cover the indigo vat with plastic wrap.			
Fold cloth to create a pattern.			
Bind cloth with string, rubberbands or clothespins.			
Dip the bound fabric in water.			
Wring excess water from fabric.			
Remove indigo bloom from vat.			
Submerge bound fabric in the vat. Keeping fabric under the surface of the dye.			
Massage the bound fabric under the surface for 60-90 seconds.			
Carefully remove the fabric from dye vat to minimize splashing.			
Allow fabric to fully oxidize.			
To achieve a darker shade of indigo, repeat the dipping process.			
Unfold the fabric to reveal the design.			