**Change Matters**

**Overview:**

In this inquiry activity, students will explore the properties of matter and investigate physical and chemical changes. The inquiry will focus on changes to matter in their kitchen, in transportation, or an area of personal interest.

**Grade Level:** 5

**Strand and Topic: Understanding Matter and Energy:** Properties of and Changes in Matter

**Inquiry Focus:**

*How does the constant changing of matter into new products affect society and our environment?*

The time required depends on students’ background knowledge, skills set, level of interest, and any additional time required for completion of student work.

**Big Ideas**:

* There are three states of matter.
* Matter that changes state is still the same matter.
* Physical change refers to the fact that a substance can be changed from one form to another. Chemical change implies the formation of a new substance.
* The properties of materials determine their use and may have an effect on society and the environment.

Teacher Tip: There are four states of matter (solid, liquid, gas, and plasma) commonly seen on Earth. In fact, 98% of the matter on Earth is in the plasma phase. Lightning, the aurora borealis, and the gas inside fluorescent tubes are all made of gas which has been given enough energy to cause it to become plasma.

Teacher Tip: Some websites teach three STATES of matter, some teach three PHASES of matter. The idea of phases tends to support the fact that more than one form often occurs at the same time. For example, the water in the classroom aquarium is at the liquid phase, but there is humid air above the tank which is at the gas (water vapour) phase even though I am not boiling the poor little fish.

**Overall Expectations:**

**Science and Technology**

1. Evaluate the social and environmental impacts of processes used to make everyday products;
2. Conduct investigations that explore the properties of matter and changes in matter;
3. Demonstrate an understanding of the properties of matter, changes of state, and physical and chemical change.

**Specific Expectations:**

**Science and Technology**

* 1.1 evaluate the environmental impacts of processes that change one product into another product through physical or chemical changes
* 1.2 assess the social and environmental impact of using processes that rely on chemical changes to produce consumer products, taking different perspectives into account (e.g., the perspectives of food manufacturers, consumers, landfill operators, people concerned about the environment), and make a case for maintaining the current level of use of the product or for reducing it
* 2.1 follow established safety procedures for working with heating appliances and hot materials (e.g., switch hot plates off immediately after use)
* 2.2 measure temperature and mass, using appropriate instruments (e.g., a thermometer, a single-pan balance)
* 2.3 use scientific inquiry/experimentation skills (see page 12) to investigate changes of state and changes in matter
* 2.4 use scientific inquiry/experimentation skills (see page 12 of the curriculum document) to determine how the physical properties of materials make them useful for particular tasks
* 2.5 use appropriate science and technology vocabulary, including mass, volume, properties, matter, physical/reversible changes, and chemical/irreversible changes, in oral and written communication
* 2.6 use a variety of forms to communicate with different audiences and for a variety of purposes
* 3.1 identify matter as everything that has mass and occupies space
* 3.2 identify properties of solids, liquids, and gases and state examples of each
* 3.3 explain changes of state in matter and give examples of each
* 3.4 describe physical changes in matter as changes that are reversible
* 3.5 describe chemical changes in matter as changes that are irreversible
* 3.6 explain how changes of state involve the release of heat or the absorption of heat
* 3.7 identify indicators of a chemical change
* 3.8 distinguish between a physical change and a chemical change

**Language: Oral Communication**

* 1.6 extend understanding of oral texts by connecting the ideas in them to their own knowledge, experience, and insights; to other texts, including print and visual texts; and to the world around them
* 2.2 demonstrate an understanding of appropriate speaking behaviour in a variety of situations, including paired sharing, dialogue, and small- and large group discussions
* 2.3 communicate orally in a clear, coherent manner, presenting ideas, opinions, and information in a readily understandable form
* 2.4 use appropriate words and phrases from the full range of their vocabulary, including inclusive and non-discriminatory language, and stylistic devices suited to the purpose, to communicate their meaning accurately and engage the interest of their audience
* 2.7 use a variety of appropriate visual aids (e.g., posters, charts, maps, globes, computer-generated organizers) to support or enhance oral presentations

**Language: Reading**

* 1.1 read a variety of texts from diverse cultures, including literary texts, graphic texts, and informational texts
* 1.4 demonstrate understanding of a variety of texts by summarizing important ideas and citing supporting details
* 1.6 extend understanding of texts by connecting the ideas in them to their own knowledge, experience, and insights, to other familiar texts, and to the world around them

**Language: Writing**

* 1.3 gather information to support ideas for writing, using a variety of strategies and a range of print and electronic resources
* 1.5 identify and order main ideas and supporting details and group them into units that could be used to develop several linked paragraphs, using a variety of strategies and organizational patterns
* 1.6 determine whether the ideas and information they have gathered are relevant, appropriate, and adequate for the purpose, and do more research if necessary
* 2.1 write longer and more complex texts using a variety of forms
* 2.4 vary sentence types and structures, with a focus on using conjunctions to connect ideas, and pronouns to make links within and between sentences
* 2.7 make revisions to improve the content, clarity, and interest of their written work, using a variety of strategies
* 3.6 proofread and correct their writing using guidelines developed with peers and the teacher
* 3.7 use a range of appropriate elements of effective presentation in the finished product, including print, script, different fonts, graphics, and layout
* 3.8 produce pieces of published work to meet identified criteria based on the expectations related to content, organization, style, use of conventions, and use of presentation strategies

**Mathematics: Measurement**

* 1.1 estimate, measure (i.e., using an analogue clock), and represent time intervals to the nearest second
* 1.3 measure and record temperatures to determine and represent temperature changes over time
* 2.1 select and justify the most appropriate standard unit (i.e., millimetre, centimetre, decimetre, metre, kilometre) to measure length, height, width, and distance, and to measure the perimeter of various polygons
* 2.9 select and justify the most appropriate standard unit to measure mass (i.e., milligram, gram, kilogram, tonne)

**Mathematics: Data Management and Probability**

* 1.1 distinguish between discrete data and continuous data
* 1.2 collect data by conducting a survey or an experiment to do with themselves, their environment, issues in their school or community, or content from another subject, and record observations or measurements
* 1.3 collect and organize discrete or continuous primary data and secondary data and display the data in charts, tables, and graphs that have appropriate titles, labels (e.g., appropriate units marked on the axes), and scales that suit the range and distribution of the data, using a variety of tools
* 2.1 read, interpret, and draw conclusions from primary data and from secondary data, presented in charts, tables, and graphs (including broken-line graphs)

**Key Concepts**:

Molecular dynamics, energy and change, properties of matter, environmental stewardship

**Prior Skill Sets:**

* use of inquiry tools: electronic balance, ruler, thermometer, grid paper/isometric paper
* giving appropriate credit to sources of information
* technological design process
* safe use of hand tools: mini glue gun, scissors, mini hacksaws
* finding the answer to questions using a variety of sources and modalities

**Prior Knowledge:**

**Science and Technology**

**Grade 2:** Understanding Matter and Energy

* 2.2 investigate the properties of liquids and solids
* 2.4 use scientific inquiry/experimentation skills to investigate liquids and solids in terms of their capacity for buoyancy and/or absorption
* 3.1 identify objects in the natural and built environment as solids (e.g., sand, ice, rocks, tables, sidewalks, walls) or liquids (e.g., water, tree sap, milk, gasoline)
* 3.2 describe the properties of solids and liquids
* 3.3 describe the characteristics of liquid water and solid water, and identify the conditions that cause changes from one to the other
* 3.4 identify conditions in which the states of liquids and solids remain constant and conditions that can cause their states to change

**Grade 2:** Understanding Earth and Space Systems

* 2.3 investigate, through experimentation, the characteristics of water and its uses
* 2.4 investigate the stages of the water cycle, including evaporation, condensation, precipitation, and collection

**Materials and Equipment:**

* projector and internet access
* books, movies, images of matter in different states
* graduated cylinders
* beakers
* thermometers
* electronic balances
* resealable bag
* aluminum foil
* paper towel
* eyedroppers
* stopwatches
* vinegar
* baking soda
* Epsom salt
* calcium chloride
* talc
* corn starch
* salt
* washing soda, sugar
* flour
* yeast
* whipping cream
* food products for decomposition experiment: processed and unprocessed examples of similar items

**Safety:**

**Please consult the STAO Resource: Safety in Elementary Science and Technology** [**http://stao.ca/res2/unifElemSafety/**](http://stao.ca/res2/unifElemSafety/)

* Be aware of safe usage of tools.
* Follow established safety procedures for using tools and handling materials, including wearing safety goggles and having access to an eyewash station and a sink.
* Inspect laboratory equipment prior to its use.
* Do not use any glassware which is chipped or cracked.
* Use a stirring rod to stir liquids in a beaker or a test tube; do not use a thermometer.
* Perform food-based experiments, especially those involving food which will be tasted, in another classroom, kitchen, or life skills classroom to reinforce the concept that products are not to be tasted in a science laboratory.

**Instructional Planning and Delivery:**

**Engage -> Explore -> Explain -> Extend -> Evaluate**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Structured or Directed** | **Guided** | **Coupled** | **Open or Full** |
| **Participant** | Teacher Initiated and Performed | Teacher Initiated, Students Performed | Teacher Initiated | Student Initiated |

**Teacher Directed Student Directed**

**Path to Inquiry**

**Engage (I SEE)**

**Activity 1**

Formative assessment of presumptions, states of matter

“What’s in the Bubbles?” from *Uncovering Student Ideas in Science Volume 2* (Available from the STAO store ) <http://static.nsta.org/files/PB193X2web.pdf>

Teacher Tip: Students tend to think that matter only evaporates when it is actually boiling. A glass of ice water can be used to illustrate three of the states of matter. The ice in the glass is a solid (how do we know?), the water filling the glass is a liquid, and the humid air above the liquid contains water vapour, a gas.

Introduce the students to the different states of matter using text-based resources or online sources such as: <http://www.e-learningforkids.org/science/lesson/bermuda-triangle-particles-matter/>

**Option 1: Teacher-Directed, Student Investigation**

Perform the experiment at <http://www.inquiryinaction.org/classroomactivities/activity.php?id=32>

Read the student activity page together first and have the students predict what they will see. After the students have conducted the experiment, ask them to explain why the hot bag caused the water to evaporate faster. Using a knowledge circle, discuss the energy involved to change state and apply it to energy changes they have seen: drying clothes in a spin dryer compared to letting them dry on a rack, drying hair naturally compared to using a hair dryer, humid shower air condensing on the mirror, water boiling in a kettle, and so on.

Other quick experiment options with water if you prefer to split them into focus groups:

* How does the surface area affect rate of evaporation?
* How do dissolved solids affect evaporation?
* How does providing an air current affect evaporation?

**Option 2: Teacher-Directed, Text-Based Exploration**

Use text based resources or online sources such as <http://www.district196.org/schools/shms/STAFF/SIEFKES_T/tebweb/sci_units/Unit4/phases.html> to compare the different states of matter. Assign students into three (or four if you want to include plasma) groups and give them chart paper on which to include facts about the state of matter they are exploring, a diagram, and some common examples.

In a knowledge circle, compare the states of matter.

* How could you distinguish between the different states?
* How could you order them from lowest to highest energy level?
* What has to happen for a substance to travel to the state of matter above it?
* Which changes would release energy?
* Which changes would absorb energy?

Review sheet on the phases of matter: <http://www.district196.org/schools/shms/STAFF/SIEFKES_T/tebweb/sci_units/Unit4/PDF/Matter_pdf/Amazing_Matter.pdf>

The northern lights are an earthly example of plasma and an interesting discussion on native lore: <http://www.ctvnews.ca/sci-tech/strong-blast-of-plasma-from-sun-smacks-earth-may-pull-northern-lights-show-south-1.2283880>

<http://www.auroraborealisyukon.com/faq/>

<http://www.indigenouspeople.net/aurora.htm>

Knowledge Share:

Once the students seem to understand the transfer of energy in changing states of matter, try discussing these questions:

* Frost happens when water in the air freezes. Why would a farmer spray his strawberry crops with water if he sees frost in the forecast? (When water freezes, it releases heat energy which prevents the surface of the strawberry from freezing in light frosts.)
* Why do eyeglasses fog up when entering a warm school on a cold day? (Water molecules in the school’s air lose energy when they come in contact with the cold glass on the eyeglasses and condense into liquid water.)
* How does sweat cool us down? (Sweat [water] uses heat energy from our skin to turn into water vapour.)

Water can be used as an example for three of the states of matter: solid, liquid, and gas. Have students draw the cycle in their lab notebooks and invent a way to remember the meaning of vocabulary: evaporation, condensation, sublimation, freezing, and melting. Some ideas which might work: drama/dance (activating the motor cortex helps memory), a game (label parts of the room with the different states, call out “add energy” or “remove energy”, and the students chant the phase change as they move from one state to the other), painting a phase diagram, computer presentations such as Prezi, poems, raps, or stories.

How does what we have seen with the cycling of matter and the water cycle relate to what we know about the Seven Sacred Teachings, specifically respect for all things and humility for our place in the natural order of things? In the knowledge circle, relate the water cycle and pollutants to both respect and humility. How does the way we treat waste in our water affect our animals in the lakes and streams? If we dispose of liquids which are not part of the normal water cycle, the contaminants are left when the water evaporates. The contaminants can then collect and become more toxic, especially in times of drought. Contaminants, such as those found in smoke, can collect in clouds and return to earth in rainwater which will damage our soils and waterways. How could we show respect and humility while we use resources in our daily lives?

**Activity 2**

Give the general definition that a physical property is a quantitative or qualitative observation, whereas a chemical property is how the molecules react with other molecules.

**Option 1: Teacher-Directed, Students Observe**

Create a series of samples which could be used to fit a task. For example, you may wish to have a container to take hot soup to school. Containers could be made from paper, aluminum foil, different grades of plastic, glass, wood, clay, and so on. Students rotate to all the different choices and record the physical properties of the different containers: size, shape, volume, heat transference (put ice cubes in the container and feel the outside), malleability, and any other physical characteristics which will fit the task (for example, conductivity might be an issue if you plan to microwave the soup).

In a knowledge circle, discuss how the physical properties of the product affect how useful the product is for the task. Chemical properties, such as how it reacts to acids (like tomato salsa) and whether it will combust, could also be a factor in decision making. As a class, decide on a definition for “physical property” and “chemical property”.

Physical properties of materials game: <http://www.abpischools.org.uk/activescience/module15/home.html>

**Option 2: Teacher-Directed, Student Investigation**

Provide samples of white powders: salt, sugar, baking soda, talc, cornstarch, washing soda

Have students measure out 5 grams of one of the powders. They will create a chart in their lab notebook and record the physical and chemical properties of the powder:

* colour
* crystal size
* transparency
* luster
* shape (if you have access to a magnifying device)
* solubility in 5mL of water (at 20 degrees C, sugar is 10g/5mL water, salt 2g/5mL water, baking soda [roughly] 0.5g/5mL, talc is insoluble, cornstarch is insoluble [it makes a suspension, but let it rest a while and the cornstarch will collect at the bottom], 1g/5mL washing soda
* reaction with vinegar (baking soda and washing soda release carbon dioxide gas)
* reaction with iodine (cornstarch will turn the iodine dark)
* (Note: solubility is a bit of a grey area. Much depends on the compound itself. Dissolving sugar in water is a physical change, but dissolving salt in water is not as the salt dissociates [splits into sodium and chlorine ions] in water <http://www.chemtutor.com/react.htm#examp> )

Provide a mystery powder (a mixture of two powders) and ask the students to use their deductive reasoning skills to identify it.

In a knowledge circle, discuss the physical properties of the substances and how they determine the use of the product.

**Activity 3**

Explore physical and chemical changes.

Teacher Tip: The idea that something feels cold because heat is being transferred from your skin is interesting to students. A demonstration of heat transfer could be done with a drop of isopropyl (rubbing) alcohol on the back of a student’s hand. As it evaporates, the skin will feel cold.

This video shows demonstrations of several physical and chemical changes; the narrator defines the difference between the two types, but doesn’t talk about which demonstrations show physical change and which show chemical change until the end. After each example, pause the video and ask the students to write down what they observed and explain why each one is a physical or chemical change. <https://www.youtube.com/watch?v=NHmt0xa6qCg>

**Option 1: Teacher-Directed, Medium Technology**

Watch the video on how bread is made: <http://www.youtube.com/watch?v=3UjUWfwWAC4>

Divide the students into focus groups for each part of the process. As they watch the video, they can use the guiding questions at the end of <http://aitc.mb.ca/images/uploads/documents/FromWheattoBread.docx> to explain each stage of the process.

In a knowledge circle, talk about the steps of the process and share information. With two different colours of pencil crayon or highlighter, identify which stages of the process are chemical changes and which are physical changes.

If you have access to an oven, consider the following handout on how to make bread and butter: <http://aitc.mb.ca/images/uploads/documents/BreadinaBag-ButterinaJar.pdf> The students can see first-hand some of the signs of a chemical change. Be sure to follow safe food handling practices by washing hands and tools, providing gloves, and tying hair back.

First Nations Link: One of the original “Three Sisters” crops is corn which is now used to make tortillas, chips, oil, cornstarch, animal feed, corn syrup, cornmeal, and corn on the cob. <https://www.youtube.com/watch?v=QT0_YBrloqI> gives an overview of canned corn production and <https://www.youtube.com/watch?v=-DtpYcxnS4M> shows how the corn is made into corn flakes. The history of corn production for the Oneida peoples (this tribe is from Wisconsin, USA. There is also an Oneida tribe in southwestern Ontario near London) is explored here: <https://www.youtube.com/watch?v=LB75og48YpI> and a news broadcast from the white corn harvest is here (discusses physical properties of the corn which make it good for seed): <https://www.youtube.com/watch?v=6hSWyqQq-Ls>

Discussion Questions:

* What are the benefits of processing corn in large batches with machines?
* What are the impacts to the environment of processing corn in this way?
* What social impacts can you see with small batch processing of corn such as that done by the Oneida people?
* What are the benefits of processing corn locally in small batches?
* If you had a choice, would you choose corn on the cob from a local farmers’ market or from a grocery store?

<http://www.sixnationsfarmersmarket.com/gardening_three_sisters_gardens.php> gives instructions for planting an outdoor “Three Sisters Garden”.

**Option 2: Teacher-Initiated, High Technology**

Watch a video on physical and chemical changes such as:

* <http://www.learnalberta.ca/content/secsu/html/matter_and_chemical_change/ChemicalAndPhysicalChange/> has videos in the Guide. Following each video, click on the animated clipboard and record the signs of a chemical or physical change. As a class, decide on how they might decide if something has undergone a chemical or a physical change. Include the concept that a physical change is reversible and a chemical change is irreversible (as some energy is often lost in the process).
* A (flash animation) quiz on chemical and physical changes: <http://vital.cs.ohiou.edu/steamwebsite/downloads/ChangeLab.swf>

**Option 3: Teacher-Initiated, Low Technology**

Hook: “Tomato versus Twinkie” <https://www.youtube.com/watch?v=588hZ-kU10U>

Invitation to inquiry:

* What does this video tell us?
* What is it about the Twinkie that made it slow to decompose?
* What questions do you have?

There are many physical and chemical changes which take place during decomposition. The discussion should prompt many questions about processed foods and decomposition (there is also a YouTube video about a decomposing fast food sandwich).

As a class, design an experiment to test one of their questions about processed and unprocessed foods. Use shallow pans of soil (or use plastic containers or tart plates). For example, the students might choose samples which are less processed, such as whole grain bread, and compare them to more processed samples, such as white bread. The packaging would also allow for a discussion of the environmental effects of processing foods. Record the physical characteristics of small samples (mass, colour, size, and shape) and place them in damp soil (Teacher hint: dirt from an established garden would provide bacteria which would give a more naturalized and faster, result). Place the buried samples in a warm place and keep the soil damp. Every two days, unearth the samples and record the physical characteristics again.

Knowledge circle discussion: Adding preservatives to products can make them last longer on shelves which results in less food wasted and fewer illnesses due to bacteria and mould, but reduces the nutritional value of products like bread and uses more energy to manufacture. What are some of the environmental or social consequences seen in the products which make up your school lunch?

**Questioning (I WONDER)**

The overall inquiry task is to show the use of physical and chemical changes in an everyday activity. This strand is unique in the Grade Five Science curriculum because it does not have an expectation which begins with “use technological problem solving skills to…”. In keeping with the scope of the unit, most of the inquiry questions tend to be experiment-based and the final showcase of learning evolves into a sharing of models based on the results of experimental inquiries, such as baking cookies in student-created outdoor ovens, or using insulation technology to stop ice from melting in a glass of water.

The questioning stage may take longer than normal as we can become so familiar with change that we do not notice it happening, or that it can be made to happen differently. You may want to initiate the questioning before the first two events listed below, but allow the students to add questions daily as they participate in the activities and start to notice the changes around them more. Many students are not familiar with kitchen chemistry, such as baking or preserving. They are naturally curious about questions such as why some cookies are chewy and others are crunchy. To begin with, ask students to think of questions to answer in this unit.

* Where do they see physical changes happening?
* What do they wish would dry faster/slower?
* What would they like to melt or freeze faster/slower?
* What would they like to preserve?
* How were foods preserved by indigenous people?
* What chemical or physical changes occur as the foods and treats they eat are processed?
* What would you like to be able to make for yourself?

The focus is on rich questions. The definition of a “rich” question may change depending on the students’ experience with inquiry. As a start, we define a rich question as one which will require combining information from more than one source and which helps us to understand the topic.

|  |  |
| --- | --- |
| Teacher-led | Student-led |
| What is plasma? What other states of matter are there?  How do preservatives in food affect the rate of decomposition in compost?  How does the way an item is processed affect its environmental/social impact?  How do the physical properties of electronic and plastic gadgets impact the environment once they are destroyed?  What are the components of the products students use every day?  How does your choice of clothing/pencil/notebook/bicycle impact the environment? How does it impact social conditions in Canada or other countries? | What are the physical and chemical reactions in cookie baking? How could I adjust one ingredient to make a chewier/crunchier/bigger/thicker/moister/healthier cookie?  How could we make a better \_\_\_\_\_\_\_\_\_\_\_?  How do fireworks work?  How do plasma TVs work?  How could we make \_\_\_\_\_\_\_\_\_\_ less harmful to the environment, but just as good at \_\_\_\_\_\_\_\_?  How could I make a solar oven?  How does drying of food preserve its nutrients?  How did the First Nations process of food preservation work?  How do microwaves cook food? |

**Explore / Inquiry activity: (I DO)**

Review the vocabulary used so far: physical change, chemical change, physical property, chemical property, evaporation, condensation, sublimation, melting, freezing, molecule, energy, heat, temperature

**Option 1: Teacher-Directed**

In pairs or small groups, choose an everyday item to investigate. Using websites such as <https://manufacturing.stanford.edu/> or <http://www.teachers.cr.k12.de.us/~galgano/howmade.htm> , learn about how the product is made. Create a presentation to teach others about the steps and resources involved. Which steps are chemical changes and which are physical changes? Be sure to consider the social and environmental impacts involved in the manufacture of the product.

Some ideas:

* a picture book
* a dance or dramatic presentation
* a slideshow
* a board game

**Option 2: Teacher-Initiated, Student Driven**

Choose an everyday object with different designs, such as a pen (ball point, gel, fountain, rollerball). Compare the design of the object types by exploring the components and how these components are made; don’t forget the packaging. Also compare their ability to perform the intended task (for example: how well does the pen write horizontally, at an angle, in cold environments, in warm environments, or for an extended length of time?).

Decide on a ranking system for your object which includes the environmental impact of that type of product and its effectiveness during testing. Mention alternatives which might have less impact with the same result and how the design of the better product could be changed to make it less costly for the environment.

**Option 3: Teacher-Initiated, Student Driven**

Choose an object which you use on a daily basis.

* What are the components of your object?
* How is the object manufactured?
* What are the environmental and social implications of making the object?
* What physical properties make it a successful design?

Conduct a survey to determine how the object could be improved. Create an improved model of your design which accomplishes the task with less social or environmental impact. Present your model to the class and explain how the physical properties of your design make it an improvement over the original design.

*Students use the Technological Design Process (p.13-15, Ontario Curriculum Science and Technology 2007 document) to choose and draw in their lab book their first original design.*

**Experimental Inquiry Activity**

Hook: demonstrate exothermic reactions using hydrogen peroxide, yeast, and dish soap: <http://www.education.com/activity/article/Foam_It_fifth/>

**Option 1: Teacher-Directed, Whole Class Experiment**

Ice cream in a bag: <http://www.teachnet.com/lesson/science/icecream051999.html>

At each stage of the experiment, ask students to measure and record the temperatures of the mixtures in the bags and the physical properties of the materials.

Sample guiding questions (from the curriculum document):

* What change of state happens during condensation?
* During solidification?
* Do the changes of state you are observing take place because of a release of heat or an absorption of heat? Explain.
* What physical changes in matter did you observe?
* What caused those changes to take place?
* What would have to happen to reverse those changes?

**Option 2: Teacher-Directed, Small Group Experiments**

Students choose from a selection of experiments exploring physical and chemical changes. They must show appropriate use of the classroom tools (thermometers, electronic balance, and graduated cylinders) during the procedure and as part of at least one of the measurements taken. Students should write the procedure they wish to undertake in their lab notebook and create a data table to record observations before they begin. Provide feedback orally, focussing on the properties they observe before, during, and after the change.

Some choices:

Endothermic change in temperature (baking soda in vinegar) <http://www.inquiryinaction.org/classroomactivities/activity.php?id=24>

Gas production in chemical change (using soap to make gas bubbles in the baking soda/vinegar reaction last longer) <http://www.inquiryinaction.org/classroomactivities/activity.php?id=25>

Exothermic change in temperature (baking soda in calcium chloride) <http://www.inquiryinaction.org/classroomactivities/activity.php?id=26>

Formation of a precipitate (soap scum in hard water) <http://www.inquiryinaction.org/classroomactivities/activity.php?id=30>

Physical properties- making butter (Note, this is not a physical change. The fat is suspended in the water and shaking it causes the fat molecules to stick together. It is an interesting discussion, though, because students will assume the shaking gave energy to the process and caused a physical change. Point out that giving energy to molecules in the liquid phase normally turns them into a gas, not a solid.) <http://www.theoldschool.com/motivate/tips/2013/turn-heavy-cream-into-butter-with-a-shake-of-the-hand>

Formation of a precipitate (polyurethane foam from Steve Spangler science) <http://www.stevespanglerscience.com/lab/experiments/erupting-foam>

Formation of a gas (The Diving Spudmarine) <http://makezine.com/2011/05/06/the-diving-spudmarine/>

Formation of a precipitate (casein in milk) <http://sciencebob.com/make-plastic-milk/> or <https://www.youtube.com/watch?v=akhs3wcSDGA>

Formation of a gas, exothermic reaction (yeast in water, carbon dioxide collected in a balloon) <https://www.exploratorium.edu/cooking/bread/activity-yeast.html>

Physical change- making sugar crystal candy <https://www.exploratorium.edu/cooking/candy/recipe-rockcandy.html>

or maple sugar candy (from maple syrup) <http://www.scientificamerican.com/article/maple-syrup-science-cooking-up-some-candy/>

Reflection:   
  
Post questions around the room (or use white board markers on the desks and take pictures when done for the website) the students travel around the room and write a comment or draw a diagram to show their understanding. If they agree with a statement already made, they can add to it, or use their initials to show support. If they have a question about a statement, they could show their opinion using a question mark.

Sample guiding questions:

* What change of state happens during condensation?
* During solidification?
* Do the changes of state you are observing take place because of a release of heat or an absorption of heat? Explain.
* What physical changes in matter did you observe?
* What caused those changes to take place?
* What would have to happen to reverse those changes?
* What chemical changes in matter did you observe?
* What caused those changes to take place?
* What conclusions did you make about changes in matter?

If this is to be part of a summative mark for the student, they could write their results as a formal lab report. Otherwise, use a knowledge circle format to discuss the main points on the chart papers (or make a slide show of pictures taken of the comments for the discussion).

**Inquiry: Part Two**

Students use the knowledge gained from the inquiry activities done in class to explore answers to their personal inquiry questions. Provide a timeline and decide on success criteria as a class. You may need to solicit the help of parent or community volunteers for inquiries which require the use of less standard equipment, such as microwave ovens.

**Explain**

Students can explain their learning in a variety of forms. For example:

* Language : Autobiography of a chocolate chip in a cookie (Recount)

Video on how to make the perfect \_\_\_\_\_\_\_\_\_\_\_

Persuasive: letter persuading a company to improve the design of a product with suggestions

Report: a breakdown of the steps of making a product along with environmental/social impacts

* Art: three dimensional model of their design along with promotional posters
* Math: comparison of the performances of various designs shown in a graph
* Computer simulation game for choosing appropriate products to minimize social and environmental impact

**Student Support Resources:**

States of Matter

Chem4kids: <http://www.chem4kids.com/files/matter_states.html>

How fluorescent lights work (plasma): <http://www.chem4kids.com/files/matter_plasma.html>

eLearning activity on mass and volume: <http://www.e-learningforkids.org/science/lesson/iceland-mass-volume-matter/>

eLearning activity on particles in matter: <http://www.e-learningforkids.org/science/lesson/norway-matter-particles/>

Why buy local?: <http://www.ontario.ca/foodland/page/why-buy-local> and <http://greenlivingideas.com/2014/08/28/importance-of-buying-local/>

Experiment showing temperature and energy: <http://www.inquiryinaction.org/classroomactivities/activity.php?id=31>

eLearning activity on the water cycle: <http://www.e-learningforkids.org/science/lesson/atlantic-ocean-what-is-the-water-cycle/>

How it’s made: <http://www.sciencechannel.com/tv-shows/how-its-made/>

Corn production in Canada: <http://www.statcan.gc.ca/pub/96-325-x/2014001/article/11913-eng.htm>

Bread chemistry: <http://www.rsc.org/images/BreadChemistry_tcm18-163980.pdf>

Chemistry of cookie ingredients: <http://sugarkissed.net/cookie-chemistry/>

**Related Background Resources and/or Links:**

States of matter inquiry unit: <http://www.inquiryinaction.org/classroomactivities/>

<http://www.district196.org/schools/shms/STAFF/SIEFKES_T/tebweb/sci_units/Unit4/matter_index.html>

Physical and chemical changes: <http://chemwiki.ucdavis.edu/Analytical_Chemistry/Qualitative_Analysis/Chemical_Change_vs._Physical_Change>

Another experiment on testing for physical/chemical change: <http://www.inquiryinaction.org/classroomactivities/activity.php?id=22>

**Extend / Redesign**

Both the LEGO EV3 and NXT robot kits can be used to record temperature using an adapter. <https://spectrum-nasco.ca/product.htm?Product=732104&Source=Search> Students could program the robot to signal (with a beep) when water is about to boil, when body temperature is too high, or produce a graph showing change during an exothermic/endothermic reaction.

It is difficult to find a manufacturing or processing industry which does not rely on physical or chemical changes in the process. Experts from the parent population or industries local to the community can provide pictures or conversations to add to the dialogue about physical and chemical change.

The local business organisation is often very happy to discuss the importance of buying locally made products

Consider touring the produce or dry goods section of the grocery store nearby to survey the point of origin of the produce for sale. How much is available from local sources?

Survey the parents. Factory tours are often not permitted, but they may have the ability to take a video camera to parts of the production process to show the resources and materials used.

Look at the media. Many advertisements profess a drink/clothing line, shoe, etc. will “cool you down”. For example, Omniwick clothing by Columbia claims to move sweat through the fabric to evaporate it faster and keep the wearer cool. Students may wish to try their own product testing using their new skills and write the manufacturer with their findings.

For students wishing to explore more in the area of indigenous scientific thought consider this resource:

Pearson’s book on indigenous scientific thought <http://catalogue.pearsoned.ca/educator/product/Bridging-Cultures-Indigenous-and-Scientific-Ways-of-Knowing-Nature/9780132105576.page>

**Evaluate (I REMEMBER)**

Things to look for in assessment pieces:

* can the student use the vocabulary appropriately?
* does the technological-design process show signs that new knowledge was used to improve on the design?
* can the student explain how the physical characteristics make the product a good choice for the task?
* can the student infer the environmental and social impacts of the design?
* can the student identify areas for improvement to the design or next steps for future products?

**Possibilities for Assessment As/For/Of Learning:**

**Assessment As Learning:**

Use anecdotals during knowledge circle to find common misconceptions and frame inquiries during the “I Explore” phase to dispel the misconceptions and build new understandings. Common misconceptions include:

* all liquids boil at the same temperature
* water does not evaporate unless it is boiling
* all liquids float when frozen
* glaciers melt and freeze every year
* baking cookies just involves drying the dough really fast

Take the time to review laboratory safety and proper measurement before the inquiry part of the process. Be sure to note that cracked or chipped glassware should not be used, how to dispose of liquids safely, and that thermometers are not used to stir liquids. A quick safety assessment at the beginning is a good review and often a confidence builder for junior scientists.

**Assessment For Learning:**

Exit passes, lab notes, graffiti wall, and daily physical quizzes

Examples of daily physical quizzes:

* True/False run: have one side of the class be “true”, the other be “false”. Call out statements; students walk quickly to the correct side.
* Quick spell: ask a question with a one-word answer. Students mime jumping rope as they spell the answer.
* Four corners-change edition: label the areas of the classroom with stages of physical change, and vocabulary words. Most of the students, except a calling-out student (who faces the wall) and a referee, move to one of the labelled areas as silently as possible. The student facing a wall calls out a change (for example, “water is heated in a kettle”). Students in that part of the classroom (evaporation/vaporization) state the name on the label enthusiastically and dance to their seats. The rest of the students silently glide to another spot of the classroom and wait for another type of change to be called out.

**Assessment Of Learning:**

Use Co-created success criteria to assess student projects.

Consider inviting community members, parents, or other grades to see the final projects. A mailbox for each student will provide a way for the students to get supportive feedback on their learning.

Sample assessment tool: expectation-based feedback form. The expectations would be selected by the class, with the exception of the last row which is completed by the student to reflect his/her personal inquiry. Once the student has selected the expectation and filled in the mastery criteria, the teacher initials the box to state it has been approved (and hasn’t already been mastered on a previous assignment).

Once the final inquiry project has been showcased, the teacher writes positive feedback in the “working at it” or “mastered” columns for each expectation. The student and/or the teacher add comments to the extensions/next steps. This last column allows for reflection on learning, connecting science concepts to other subjects, and an overall expectation that learning is continuous.

|  |  |  |  |
| --- | --- | --- | --- |
| Expectation | Working at It | Mastered | Extensions/Next Steps |
| I can conduct investigations that explore the properties of matter and changes in matter |  | Correctly measure and communicate mass, volume, and temperature  Display the results of the experiment /investigation using a chart and graph  Explain the purpose of your experiment/investigation  Explain the steps of your experiment/investigation so someone else would be able to repeat it |  |
| I can demonstrate an understanding of the properties of matter, changes of state, and physical and chemical change |  | Makes a connection between the observations and the presence of chemical or physical properties  Correctly describes two physical and/or chemical changes observed during the experiment/investigation  You have attempted and tested a change in the procedure which may affect the speed or quality of the physical/chemical change |  |
| Clearly communicates the results of the investigation |  | Graphs and charts are neatly labelled, show consistent scale on the axes, and use a legend to show different components of the data found in the experiment  Summary below the graph correctly explains what the graph is showing  A conclusion summarizes the results of the investigation/experiment and makes suggestions for further study and/or improvement to the design |  |
| Inquiry specific expectation  Teacher initials: \_\_\_\_\_\_ |  | How will you show mastery? |  |

**Technology Possibilities**

* 3D modelling software, e.g., 123D Design for iPad, [www.tinkercad.com](http://www.tinkercad.com) for PC
* creation of an online game with software such as flowlab.io
* use of moldable plastic (<https://www.instamorph.com/>) to make models
* 3D printing
* PowerPoint, Prezi, Google slides and other presentation tools