Mystery science

# Anchor Layer Teacher Guide

A curriculum companion for Anchor Layer users

## Grade 2

# Material Properties

Unit Web Link • Pacing Guide • Other Units

## Unit Summary

In this unit, students explore the properties of materials and matter! They describe and classify different types of materials by properties like hardness, flexibility, and absorbency, and they investigate how those properties are useful in meeting basic human needs (such as clothing and cooking). They also investigate how heating and cooling affect the properties of materials. The anchor phenomenon for this unit can be found inside of a special type factory called a Foundry. Foundries are places where people melt solid metal into a liquid that can be poured into new shapes. Foundries can be dangerous places to work, so how do the people that work in foundries stay safe? Assessments

| Performance Expectations | Science & Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|---|
| • 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.<br>• 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.<br>• 2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.<br>• 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.<br>• K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.<br>• K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.<br>• K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. | • Asking Questions and Defining Problems<br>• Planning and Carrying Out Investigations<br>• Constructing Explanations and Designing Solutions<br>• Analyzing and Interpreting Data<br>• Developing and Using Models | • PS1.A: Structure and Properties of Matter<br>• PS1.B: Chemical Reactions<br>• ETS1.A: Defining and Delimiting Engineering Problems<br>• ETS1.B: Developing Possible Solutions<br>• ETS1.C: Optimizing the Design Solution | • Structure and Function<br>• Cause and Effect<br>• Energy and Matter<br>• Patterns |

***Unit Lesson Flow on Next Page***

## Material Properties Lesson Flow

## Anchor Phenomenon Background

How can people stay safe in a place like a foundry?

Foundries are an amazing type of factory. Foundries are places where people melt solid metal into a liquid, and then pour that liquid metal into new shapes. When the liquid metal cools, it turns back into a solid object. Many things we see in our lives are made in foundries, from cast iron pans in the kitchen, to large bells in clock towers, to some of the parts in cars and trucks.

Unfortunately, melting metal down and pouring it into new shapes can be very dangerous. Incredibly high heat is required to melt metal down, and heavy, powerful equipment is required to move objects around inside of a foundry. These dangerous conditions mean that people working in foundries need to wear special protective clothing to keep them safe. In this unit, students will learn how an understanding of different material properties allows people to work in foundries while they protect different parts of their bodies from different risks.

The main risk in a foundry is the potential for burns caused by high heat. Workers wear insulating clothing from head to toe. This reduces the chances of being burned by sparks, splashes of liquid metal, or even just being too close to something very hot. The clothing has to be flexible, however, so that workers are able to move as they work.

Workers also run the risk of hitting their heads on things, and this is solved by using a rigid hard hat instead of flexible clothing. These hard hats are similar to the ones worn by construction workers, but they must also resist the high heat from the process of melting metal.

Finally, people in foundries must shield their faces from heat and from being hit by sparks or splashes of metal. However, these shields must allow people to see what they are doing. For this reason, face shields must be made of a material that is heat resistant, impact resistant, and transparent. Plastic works perfectly for this!

## Anchor Phenomenon: Melting Metal
Materials & Properties

**Anchor Phenomenon**
20 mins

**Guided Inquiry**
25 mins

**Hands-On Activity**
25 mins

### Anchor Phenomenon Lesson Overview

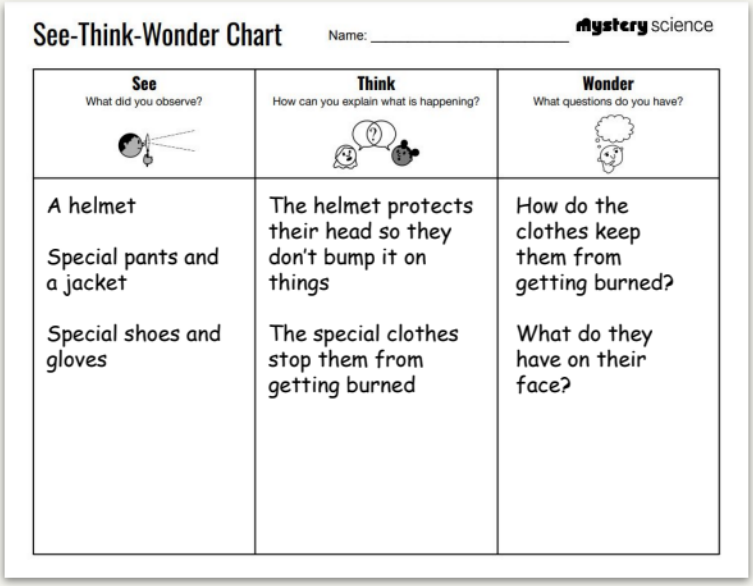
Note: This lesson is part of this unit's Anchor Layer. If you have the Anchor Layer turned on, we recommend teaching all lessons in the remainder of this unit in order.

The anchor phenomenon for this unit can be found inside of a special type factory called a Foundry. Foundries are places where people melt solid metal into a liquid that can be poured into new shapes. Foundries can be dangerous places to work, so how do the people that work in foundries stay safe?

During the introduction, students generate observations and questions about the phenomenon and create an initial conceptual model to explain the phenomenon. Students will use these initial ideas to track how their understanding grows throughout the unit.

### Student Work Samples & Notes

Students will gather clues during and after each lesson in this unit to help them improve their explanations. It is important to encourage students to recognize that even if they don't know the perfect answer yet, they are going to learn a lot throughout the unit and will have an opportunity to change or add to their first explanation.



See-Think-Wonder Chart

Name: _____

| See<br>What did you observe? | Think<br>How can you explain what is happening? | Wonder<br>What questions do you have? |
|---|---|---|
| A helmet<br><br>Special pants and a jacket<br><br>Special shoes and gloves | The helmet protects their head so they don't bump it on things<br><br>The special clothes stop them from getting burned | How do the clothes keep them from getting burned?<br><br>What do they have on their face? |

## **Lesson 1: Why do we wear clothes?** (pg 1 of 2)
Material Properties & Engineering

**Exploration**
20 mins

**Hands-On Activity**
35 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Overview

In this lesson, students explore the different properties of materials used for clothing, such as texture, flexibility, and absorbency.

In the activity, Mad Hatter, students use this information to design and build a hat that protects them from the Sun.



### Activity Notes

You will need access to water for this activity. Each student will make their own hat, but groups of four students will share a cup of water for the Sweat-Soaker test. For more detailed prep instructions, see our lesson page.

We created the Hat Inspiration printouts for students who are stumped and frustrated by the task of making a hat. We suggest letting students try building on their own first, then providing these Inspiration Sheets only to those who may need additional help.

***Anchor Connection on Next Page***

## **Lesson 1: Why do we wear clothes?** (pg 2 of 2)
Material Properties & Engineering

**Exploration**
20 mins

**Hands-On Activity**
35 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Anchor Connection

Different materials have different properties. Therefore, those materials will be better and worse in different uses. Rigid materials are great at protecting someone's face and head. If you covered your whole body in rigid materials, though, you would not be able to move. Therefore, workers in a foundry cover their bodies in flexible materials.

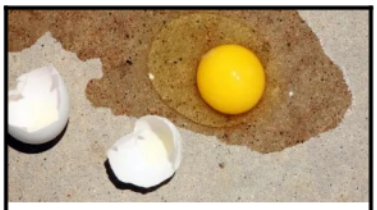
Students revisit the drawing that they worked on during the Anchor Phenomenon. They should understand that when designing protective clothing, sometimes rigid materials are needed, such as in the hard hat. Other times, flexible materials are needed.

Students can revise their thinking by drawing any protective clothing items that they were missing before, and/or by adding the terms "rigid" and "flexible" to their worksheets.

### Connecting Storyline Question

What other properties do different types of protective clothing need to have?

## Lesson 2: Can you really fry an egg on a hot sidewalk?
Classify Materials: Insulators (pg 1 of 2)



**Exploration**
12 mins

**Hands-On Activity**
35 mins

**Wrap-Up**
3 mins

**Anchor Connection**
20 mins

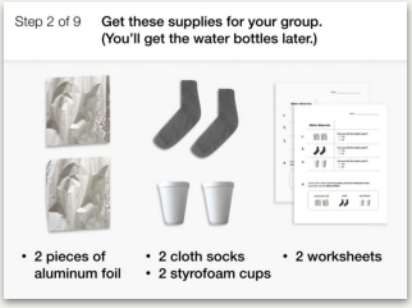
**Assessment**
20 mins

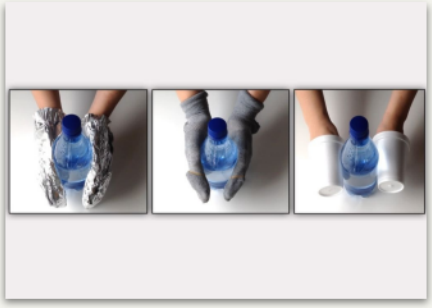
### Overview
In this lesson, students consider the insulating and conducting properties of different materials.

In the activity, Feel the Heat, students test different materials and determine which would make the best oven mitts.

### Activity Notes
We suggest students work in pairs and share water bottles in table groups of four. For more detailed prep instructions, see our lesson page.

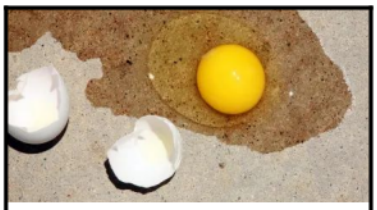
You will need access to hot water for this activity. You can fill bottles an hour or two ahead of class if you have a cooler (or a cardboard box and a bath towel) to keep the water bottles hot.



***Anchor Connection on Next Page***

## Lesson 2: Can you really fry an egg on a hot sidewalk?
Classify Materials: Insulators (pg 2 of 2)



**Exploration**
12 mins

**Hands-On Activity**
35 mins

**Wrap-Up**
3 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Anchor Connection

Continuing with the idea that different materials have different properties, students will apply what they have learned about insulators and conductors to the foundry workers' protective clothing. Heat is the biggest danger in a foundry. Therefore, all of the items that workers wear are made of materials that will insulate them from heat.

Students revisit the drawing that they worked on during the Anchor Phenomenon. They should understand that heat is the biggest danger in a foundry, so all of the protective clothing must be insulating.

Students can revise their thinking by drawing any protective clothing items that they were missing before, and/or by adding the term "insulating" to their worksheets.

### Connecting Storyline Question

Can protective clothing melt?

## Lesson 3: Why are so many toys made out of plastic?
Heating, Cooling, & States of Matter (pg 1 of 2)

**Exploration**
20 mins

**Hands-On Activity**
35 mins

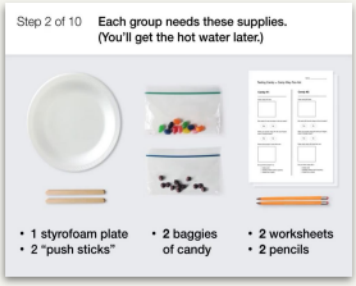
**Anchor Connection**
20 mins

**Assessment**
20 mins

### Overview

In this lesson, students learn about melting, about the solid and liquid states of matter, and then discover why plastic was invented.

In the activity, Candy Melt, students conduct an investigation to determine which types of candy melt in hot water. Using their observations, they decide which candy is the best choice to bring to a hot summer camp.





### Activity Notes

We suggest students work in pairs for this activity.

You will need a source of hot water for this activity and a way to keep the containers of hot water warm. You can either use a cooler or create your own insulator using a cardboard box and bath towels.

You need to fill the Ziploc bags with candy, prepare the hot water bottles, and results charts before class. This will take about 20 minutes. For more lesson prep details, see our lesson page.

***Anchor Connection on Next Page***

## Lesson 3: Why are so many toys made out of plastic?
Heating, Cooling, & States of Matter (pg 2 of 2)

**Exploration**
20 mins

**Hands-On Activity**
35 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Anchor Connection

Plastics are materials that can melt. This is very helpful for making toys. However, metal is the only thing that workers want to melt in a foundry.

The helmets and face shields that workers wear are made of special plastic that won't melt as long as the workers stay back from hot metal. Their clothing is made of materials that can't melt, even if hot, molten metal splashes onto it.

Students revisit the drawing that they worked on during the Anchor Phenomenon. They should understand that people in foundries wear helmets and face shields made of plastic, just like many toys. They have to stay back from the heat.

Students can revise their thinking by drawing any protective clothing items that they were missing before. They may also add the terms "could melt" to the helmet and face shield, and "won't melt" to the rest of the protective clothing.

### Connecting Storyline Question

How do the people working in foundries see what they are doing while their face is covered?

## Lesson 4: What materials might be invented in the future?
Inventions & Engineering

**Exploration**
20 mins

**Hands-On Activity**
35 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Overview
In this lesson, students learn how new materials are invented.

In the activity, Bouncy Glass Inventions, students come up with ideas for inventions that use an exciting futuristic material: glass that bounces and stretches like rubber!

**Activity Notes**
You will need access to a large dry-erase board or chalkboard where you can record student ideas. We encourage students to think "outside the box" and come up with wild ideas.To prepare yourself to lead the class discussion, we suggest you watch this short video of a creative team coming up with ideas.

### Anchor Connection
Bouncy glass is something that exists today, in the form of clear, impact-resistant plastic. This plastic is found in safety glasses and face shields. Impact-resistant plastic is rigid enough to protect workers' faces but flexible enough to not shatter when objects hit it. And, importantly, this plastic is transparent, so workers can see what they are doing while they stay safe.

Students revisit the drawing that they worked on during the Anchor Phenomenon. They should understand that face shields and safety glasses are made with a type of plastic that is transparent but impact-resistant.

Students may revise their drawing by adding any protective clothing items that they were missing before. Students may also add the term "transparent" to the description of the face shield on their worksheet.

### Connecting Storyline Question
How do people make things out of metal in foundries?

## **Lesson 5: Could you build a house out of paper?** (pg 1 of 2)
Materials, Properties, & Engineering

**Exploration**
12 mins

**Hands-On Activity**
30 mins

**Wrap-Up**
3 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Overview

In this lesson, students examine how large structures like houses are built from smaller pieces.

In the activity, Paper Towers, they design their own structures using an unconventional building material: paper! Students build towers using 3" x 5" index cards and paper clips. First, they build tall towers, then they are challenged to build towers strong enough to support a hardcover book.

### Activity Notes

Each student will create their own paper tower, but we suggest students work in pairs to share ideas.

Each student will need a flat, level area where they can build a tower without bumping into someone else's. Desktops and tables are great. Floor space works as long as you have a hard surface. We don't recommend building towers on a carpet.



***Anchor Connection on Next Page***

## **Lesson 5: Could you build a house out of paper?** (pg 2 of 2)
Materials, Properties, & Engineering

**Exploration**
12 mins

**Hands-On Activity**
30 mins

**Wrap-Up**
3 mins

**Anchor Connection**
20 mins

**Assessment**
20 mins

### Anchor Connection

Students have spent the unit focused on worker safety. Now, they are challenged to look at the building materials they have learned about, such as metal, plastic, and paper. Students are introduced to how metal is recycled, and this leads into the performance task for this unit.

Students will look back on the drawing that they worked on during the Anchor Phenomenon. They should understand that foundries can recycle metals into raw materials that can be used to make new objects.

There is no revision to the worksheet after this lesson. The content here is primarily to prepare students for the performance task.

### Connecting Storyline Question

Can we make buildings with different materials?

## Lesson 6: How do you build a city out of mud? (pg 1 of 2)
Soil Properties

**Exploration**
12 mins

**Hands-On Activity**
35 mins

**Wrap-Up**
8 mins

**Anchor Connection**
10 mins

**Assessment**
20 mins

### Overview

In this lesson, students learn about a unique building material: mud! The properties of mud depend on the properties of the soil it's made from.

In the activity, Mystery Mud, students use models of sand and clay soils to investigate how the properties of soils can differ. They use their observations as evidence to classify each soil model based on whether or not it would make mud that's good for building.

### Activity Notes

We suggest students work in pairs. You will need access to water for this activity. Prepare your Dixie cups and water cups in advance. For detailed prep instructions, see the lesson page.

Making a mud model is very fun, but it can also be distracting! We recommend waiting to distribute the cups of water and spoons until Step 5 of the activity, after students have explored the dry soil models.



***Anchor Connection on Next Page***

## **Lesson 6: How do you build a city out of mud?** (pg 2 of 2)
Soil Properties

**Exploration**
12 mins

**Hands-On Activity**
35 mins

**Wrap-Up**
8 mins

**Anchor Connection**
10 mins

**Assessment**
20 mins

### Anchor Connection

The properties of the materials you work with tell you which types of things to wear to stay safe. Metal is hot, so workers need to wear things to protect them from heat.

Students will look back on the drawing that they worked on during the Anchor Phenomenon. They should understand that people have to wear safety clothing in some situations and because of the properties of the materials they work with.

There is no revision to the worksheet after this lesson. The content here is primarily to prepare students for the performance task

### Connecting Storyline Question

Can foundries help us reuse things?

## **Performance Task: How do we recycle metal?** (pg 1 of 2)
Materials & Properties

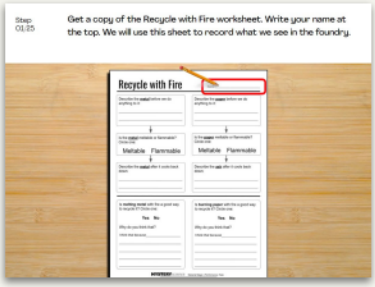
**Unit Review**
20 mins

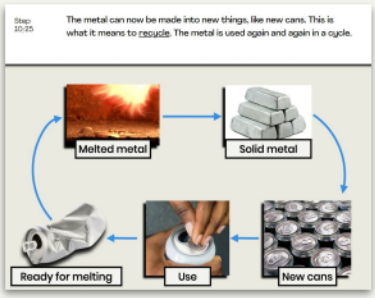
**Hands-On Activity**
50 mins

### Overview

In this performance task, students observe how fire can be used to recycle some materials, but not others. Some changes caused by fire, such as melting, are reversible. Other changes, such as burning, are not reversible.

After a review of the unit, students record observations of the changes that metal & paper experience when they are exposed to fire. Then, they use their observations of these changes to construct an argument about whether or not fire can be used to recycle each of those materials.




### Performance Task Notes

If you would like to break this performance task into smaller parts, you can break it apart like this:

1. Unit review, then stop after the comparison of reusing vs. recycling a metal can.
2. Teach the introduction to the foundry & how metal is recycled, then stop once the first three boxes about metal on the student worksheets are completed.
3. Teach the portion about burning paper & have students complete the final written answers.
4. Share any of the extension videos that are of interest.

***Crosscutting Concepts on Next Page***

## **Performance Task: How do we recycle metal?** (pg 2 of 2)
Materials & Properties

**Unit Review**
20 mins

**Hands-On Activity**
50 mins

**Crosscutting Concepts**

*Structure and Function*: When designing and building anything, each part of the structure should serve a certain function. This is true for the protective clothing the workers wear in the foundry. Each article of protective clothing should protect the wearer in at least one way.

*Energy and Matter*: In the performance task for this unit, students will see how different materials can be broken down into pieces and recycled in different ways. Some materials can be recycled by adding energy in the form of heat. This allows that material to be reused by molding it into a new form. Other materials are permanently changed when they are heated. Therefore, they cannot be recycled in this way.