mystery science

Anchor Layer Teacher Guide

A curriculum companion for Anchor Layer users

Grade 4

Energy & Energy Transfer

Unit Web Link • Pacing Guide • Other Units

Unit Summary

In this unit, students explore energy! Students investigate how energy is stored, how it can make objects move, and how collisions transfer energy between objects. Students also construct chain reaction machines to explore the many different ways that energy can be transferred. Assessments

Performance Expectations	Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. • 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. • 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. • 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. • 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	• Analyzing and Interpreting Data • Developing and Using Models • Constructing Explanations and Designing Solutions • Asking Questions and Defining Problems	• PS3.A: Definitions of Energy • PS3.B: Conservation of Energy and Energy Transfer • PS3.C: Relationship Between Energy and Forces • ETS1.A: Defining and Delimiting Engineering Problems • ETS1.B: Developing Possible Solutions • ETS1.C: Optimizing the Design Solution	• Energy and Matter • Systems and System Models

Anchor Phenomenon

Energy & Modeling
Rube Goldberg Machine

Lesson 1

Speed & Energy
How is your body similar to a car?

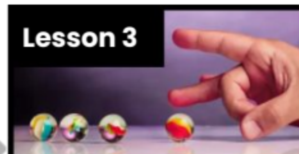
Anchor Connection

Lesson 2

Gravitational Energy, Speed, & Collisions
What makes roller coasters go so fast?

Anchor Connection

Lesson 3



Collisions & Energy Transfer
How can marbles save the world?

Anchor Connection

Lesson 4

Energy Transfer & Engineering Could you knock down a building using only dominoes?

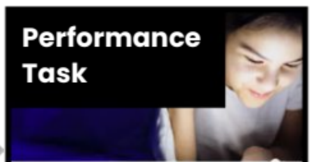
Anchor Connection

Lesson 5

Energy Transfer & Engineering
Can you build a chain reaction machine?

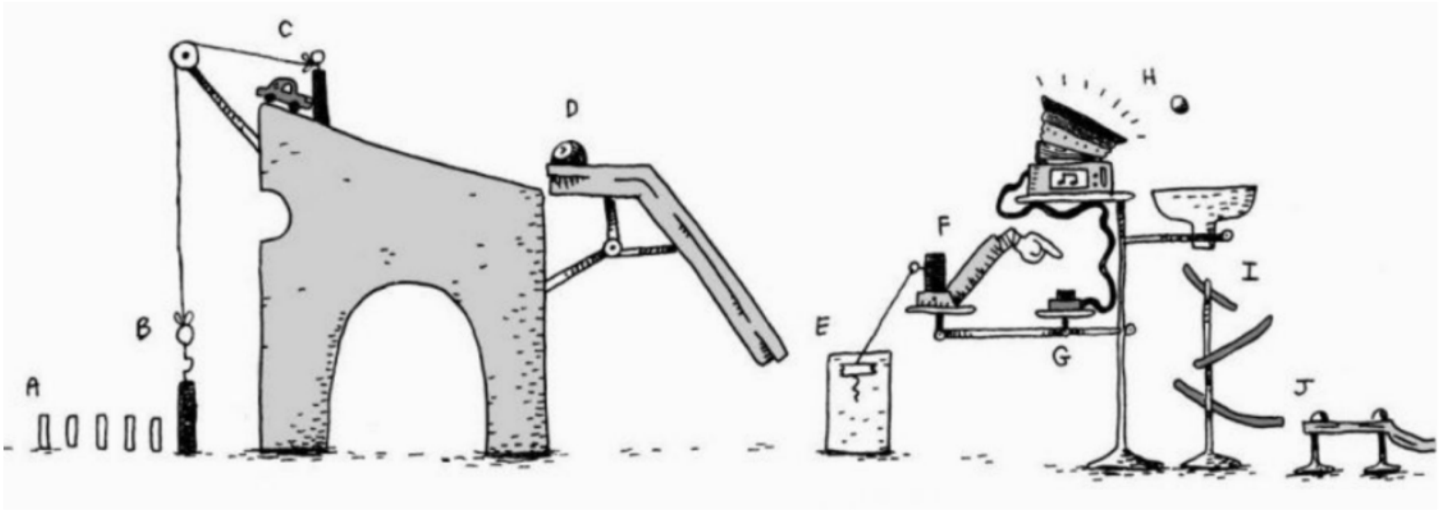
Anchor Connection

Performance Task



Energy & Engineering
How can you make something move without touching it?

Anchor Phenomenon Background



How do all of the parts of a Rube Goldberg machine do so many different things without stopping?

Rube Goldberg Machines, like the one above, were first drawn in the early 1900s. A cartoonist named Rube Goldberg imagined overly complex machines that completed a very simple task, such as pouring water into a glass or closing a door.

While these machines were invented by Rube Goldberg and were initially only ever drawn, many people have gone on to actually build working versions of these types of devices. One such example is in the music video that serves as the anchor phenomenon for this lesson.

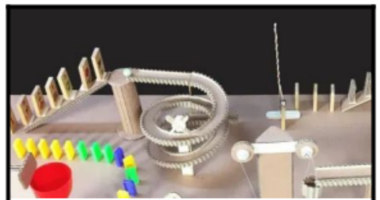
Rube Goldberg machines are more than just entertaining to imagine. They can also help us to understand energy. Energy is what causes things to change in the world around us. Everyone has seen a moving object, like a rolling ball, hit a stationary object and cause that second object to start moving, too.

Examples of this can be seen throughout the anchor phenomenon at the start of this unit, and in the world around us every day. Whenever one object hits another and causes it to move, energy has been transferred. The transfer of energy causes things to start moving, stop moving, speed up, slow down, and get hotter and colder. The list goes on and on.

Energy can also be stored, and then transferred at a later time. For example, whenever an object is lifted to a high place and held there, energy is stored within it. When it is allowed to fall or roll down, the energy is released. There are other ways to store energy, such as within a coiled spring, or within the food we eat. Students will explore all of these aspects of energy over the course of this unit.

Anchor Phenomenon: Rube Goldberg Machine

Energy & Modeling



Anchor Phenomenon
8 mins

Guided Inquiry
20 mins

Hands-On Activity
30 mins

Wrap-Up
2 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 the first six lessons in this unit in order. The performance task can be completed at any time after the sixth lesson.

The anchor phenomenon for this unit is an intricate Rube Goldberg machine. Students generate observations and questions about the phenomenon and create an initial conceptual model to explain what is happening.

Student Work Samples & Notes

IIt is important to encourage students to recognize that this activity is about making predictions to explain the phenomenon. They are going to learn a lot throughout the unit and have an opportunity to change or add to their initial ideas and observations.

See-Think-Wonder Chart Name: ____________________ mystery science

See What did you observe?	Think How can you explain what is happening?	Wonder What questions do you have?
There is always something moving Some things move faster and some things move slower If one thing messed up, it would mess it all up It's all normal stuff It's like a chain reaction	Things push other things and it makes them start moving Heavier things move faster There are different types of movement When something hits something it stops moving	Who made this? How long did it take to make this? Why doesn't it stop moving? How did it start moving?

Lesson 1: How is your body similar to a car? (pg 1 of 2)
Speed & Energy

Exploration
16 mins

Hands-On Activity
40 mins

Wrap-up
4 mins

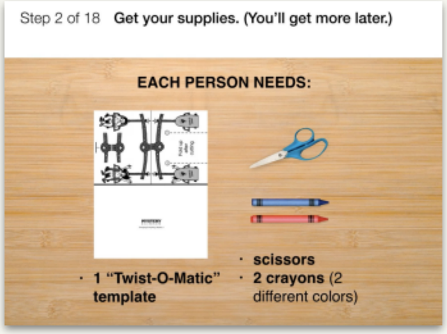
Anchor Connection
10 mins

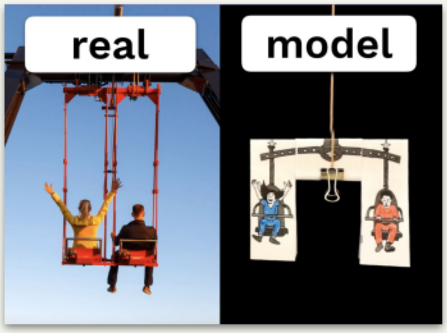
Assessment
25 mins

Overview

In this lesson, students learn that we use the energy from food to make our bodies move just like cars use the energy from gasoline to move.

In the activity, Twist-o-matic Tester, students build paper models of an amusement park ride called the Twist-o-Matic. The ride stores energy in rubber bands and spins around when the energy is released. Students compare the speed of the spins when they use a thin rubber band versus a thick rubber band.





Activity Notes

We suggest students work in pairs. Students can work on their own, but they will need to make two models so that they can compare and contrast what happens when using the thin versus thick rubber band.

Student pairs will need to set up two Twist-O-Matic models next to each other for easier comparison between the thin and thick rubber bands. Each model takes up the space of about one student desk, so it is easiest if student pairs are sitting next to one another.

Anchor Connection on Next Page

Lesson 1: How is your body similar to a car? (pg 2 of 2)
Speed & Energy

Exploration
16 mins

Hands-On Activity
40 mins

Wrap-up
4 mins

Anchor Connection
10 mins

Assessment
25 mins

Anchor Connection

Energy makes things move. There are many different ways to store energy (batteries, food, etc.).

Students revisit their explanations and/or drawings that they worked on during the Anchor Phenomenon. They should understand that there are many places where energy is stored and released in a Rube Goldberg machine.

Connecting Storyline Question

Where is energy stored in the chain reaction machine?

Lesson 2: What makes roller coasters go so fast? (pg 1 of 2)

Gravitational Energy, Speed, & Collisions

Exploration
12 mins

Hands-On Activity
45 mins

Wrap-up
3 mins

Anchor Connection
20 mins

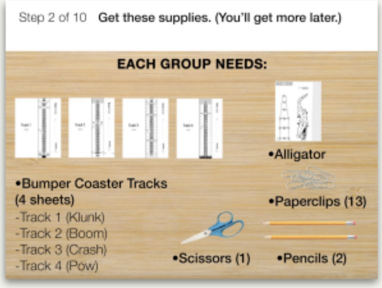
Assessment
25 mins

Overview

In this lesson, students explore how energy can be stored as height.

In the activity, Bumper Coasters (Part I), students build paper roller coasters. Students release marbles down the roller coaster track to understand height energy and energy transfer.

This entire lesson with the activity will take about an hour or slightly more. There are two natural stopping points during the activity — the first one when students finish building their roller coaster tracks and a second one after they complete their first set of experiments. If you are pressed for time or have a short class period, we recommend splitting this lesson into shorter sessions that might work better for you.



Activity Notes

If you will be teaching Bumper Coasters Part II (Lesson 3), then you must save the tracks and the alligator that each group makes in this lesson.

This activity works best when students work in groups of 4. Students can work on their own, but will need to build all four pieces of their roller coaster track.

Each roller coaster extends about 1.2 meters (a little over 4 feet) from the box, stack of books, wall, or other surface that it's attached to. For storage tips, troubleshooting ideas, and more detailed prep instructions, see our lesson page.

Anchor Connection on Next Page

Lesson 2: What makes roller coasters go so fast? (pg 2 of 2)
Gravitational Energy, Speed, & Collisions

Exploration
12 mins

Hands-On Activity
45 mins

Wrap-up
3 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Height gives energy. The higher the drop, the more energy a falling object will have. The more energy something has, the faster it will go.

Students revisit their explanations and/or drawings that they worked on during the Anchor Phenomenon. They should understand that in the Rube Goldberg machine, objects that start higher have more energy. They can move faster/farther/longer.

Students can update their explanations and/or drawings by:

- Labeling the places in which energy is stored and released in the drawing
- Labeling the places with a high starting point

Connecting Storyline Question

How is energy transferred from one step of the chain reaction machine to the next?

Lesson 3: How can marbles save the world? (pg 1 of 2)
Collisions & Energy Transfer

Exploration
15 mins

Hands-On Activity
40 mins

Wrap-up
15 mins

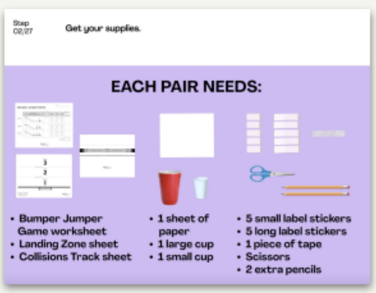
Anchor Connection
10 mins

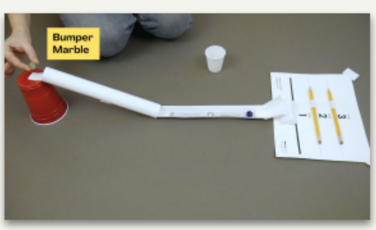
Overview

In this lesson, students investigate how energy transfers when objects collide.

In the activity, Bumper Jumper, students ask questions and make predictions about how far a marble will launch over a jump after colliding with other objects.

This entire lesson with the activity will likely take more than an hour. There are two natural stopping points during the activity — the first one when students finish building their Bumper Jumper apparatus (after step 11) and a second one after they complete their first set of experiments (after step 22). If you are pressed for time or have a short class period, we recommend splitting this lesson into shorter sessions that might work better for you.





Activity Notes

We suggest students work in pairs. We suggest doing this activity on the floor. If Bumper Jumper is played on a table the marbles may roll far away if they fall off the table.

We suggest building the Bumper Jumper apparatus where it will be used. Moving the apparatus can affect the connections and how marbles travel. If the Bumper Jumper must be moved after assembly, do so carefully.

All marbles used by a group must be the same size/weight. If two different size/weight marbles are used, the results of the Bumper Jumper game will be significantly altered. See the lesson page for more detailed prep instructions.

Anchor Connection on Next Page

Lesson 3: How can marbles save the world? (pg 2 of 2)
Collisions & Energy Transfer

Exploration
15 mins

Hands-On Activity
40 mins

Wrap-up
15 mins

Anchor Connection
10 mins

Anchor Connection

Objects have more energy when they move faster. When objects collide, some of energy is transferred. When objects in the Rube Goldberg machine collide, the first object transfers some of its energy causing the other object to move.

Students gain a deeper understanding of how energy is transferred in collisions. They observe how the speed of a moving object affects the speed of the object it hits.

Connecting Storyline Question

How can the chain reaction machine store enough energy to get through all the steps?

Lesson 4: Could you knock down a building using only dominoes?

Energy Transfer & Engineering (pg 1 of 2)

Exploration
28 mins

Hands-On Activity
30 mins

Wrap-up
2 mins

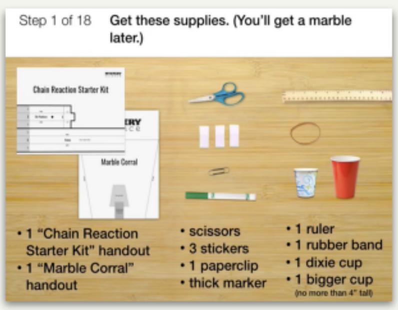
Anchor Connection
20 mins

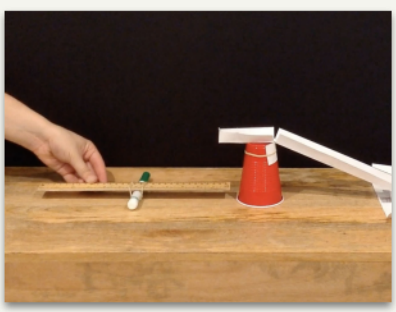
Assessment
25 mins

Overview

In this lesson, students construct an explanation of how energy is stored, released, and transferred in chain reactions, such as falling dominoes.

In the activity, Build a Chain Reaction (Part I), students are presented with an engineering design challenge to create their own chain reaction machine--a project they will continue in Lesson 5. Students experiment with a “Chain-Reaction Starter Kit.” This kit includes a lever and a ramp, which serve as the first two steps of a chain-reaction machine.





Activity Notes

We suggest students work in pairs. Students can work on their own, but will need a partner to help with some steps.

We strongly recommend pairing this lesson with Lesson 5, “Can you build a chain reaction machine?” If you plan to do Lesson 5, don’t throw away the ramps that your students build in this lesson. Students will use these ramps when creating their very own chain reaction machine.

Marbles are very fun, but can be very distracting! We suggest waiting to distribute marbles to students until Step 17 of the activity.

Anchor Connection on Next Page

Lesson 4: Could you knock down a building using only dominoes?

Energy Transfer & Engineering (pg 2 of 2)

Exploration
28 mins

Hands-On Activity
30 mins

Wrap-up
2 mins

Anchor Connection
20 mins

Assessment
25 mins

Anchor Connection

Devices can convert stored energy into movement. Energy moves along a path and transfers to other objects.

Energy moves along a path in the Rube Goldberg Machine. Stored energy is released and becomes movement. Energy is transferred between objects along the path.

Students realize that each step of a chain reaction machine involves triggering the release of stored energy in the next step.

Students can update their explanations and/or drawings by:

- Labeling the objects that start to move due to a collision
- Labeling the path of energy throughout the drawing
- Labeling all of the places that an energy transfer occurs

Connecting Storyline Question

How many different ways can a chain reaction machine store and transfer energy?

Lesson 5: Can you build a chain reaction machine? (pg 1 of 2)
Energy Transfer & Engineering

Exploration
30 mins

Hands-On Activity
30 mins

Anchor Connection
10 mins

Assessment
25 mins

Overview

In this lesson, students learn about storing, releasing, and transferring energy.

In the activity, Build a Chain Reaction (Part II), students complete the chain-reaction machine they started building in the previous lesson.

Activity Notes

We suggest students work in pairs. Students can add a variety of materials to extend their chain-reaction machines. You can ask them to bring things in, or gather some basic materials to keep in the classroom. See the lesson page for items we recommend having on hand, more ideas, and an inspiration video.

Each Chain Reaction Machine will take up several feet. Each student or group of students will need a table or several desks pushed together as a work space.

Marbles are very fun, but can be very distracting! We suggest waiting to distribute marbles to students until Step 14 of the activity.

Anchor Connection on Next Page

Lesson 5: Can you build a chain reaction machine? (pg 2 of 2)
Energy Transfer & Engineering

Exploration
30 mins

Hands-On Activity
30 mins

Anchor Connection
10 mins

Assessment
25 mins

Anchor Connection

The anchor connection for this lesson continues the discussion from Lesson 4. Students consider how to add steps to an existing chain reaction machine, reasoning about how energy is stored and how that stored energy can be released.

Students can update their explanations and/or drawings by:

- Labeling the objects that start to move due to a collision
- Labeling the path of energy throughout the drawing
- Labeling all of the places that an energy transfer occurs

Connecting Storyline Question

Are there other forms of energy the chain reaction machine in the video could use?

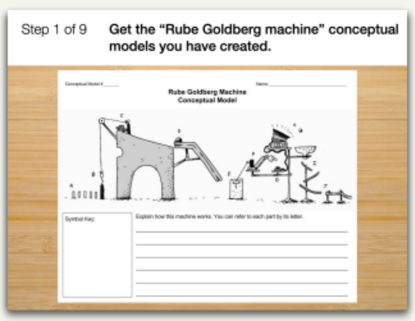
Performance Task: Can you design and build your own Rube Goldberg Machine?
Energy & Engineering

Unit Review
20 mins

Hands-On Activity
120 mins

Overview

In the Performance Task, students will design a Rube Goldberg machine that utilizes energy transfers and conversions to complete a simple task.



Performance Task Notes

In this performance task, students apply what they've learned about storing, releasing, and transferring energy by building their own Rube Goldberg machine. To complete the performance task, students will need the ramps, levers, and various classroom materials from Lessons 4 and 5.

Students may bring in materials and objects from home to use in their machines. See the lesson page for detailed supply suggestions and extension options.

Crosscutting Concepts

Systems: A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

A system can be described in terms of its components and their interactions.