Invent-a-Wheel (Grades K-1)

Unit Overview

This unit develops energy concepts through children's attempts to get something to slide, and eventually, roll down a ramp. The key concepts, which are largely implicit, are gravitational energy and its enemy, friction.

Students begin by exploring ways to get an object to move, perhaps by pushing, pulling or blowing on it. The next challenge is to find a way to get it to move by itself – without touching it. An obvious solution is to make a ramp. In Lesson 3, students use small cardboard rectangles as sleds, and investigate how the height of a ramp affects whether a sled will go down. The following lesson focuses on how different surfaces affect sliding. Surface materials available for testing include cardboard, cardstock, wax paper, aluminum foil and sand paper. Next, students improve the "slipperiness" of a sled by putting rollers underneath. However, these rollers separate easily from the sled, and do not follow it beyond the bottom of the ramp. To solve this problem, students attach the rollers to the sled – thereby inventing the wheel! A sled with wheels is a car. In Lesson 8 they test their cars against one another's' cars. Lessons 9 and 10 require students to draw and write about their cars – first by showing the assembled car with parts labeled, and then by creating a How-to Book explaining how to make one. In Lesson 11 they improve on their designs, mechanically and esthetically, and in the final lesson present their cars to an audience. Table 1 provides a summary of the lessons.

Table 1: Summary of Invent-a-Wheel Curriculum

Lesson #	Title	Summary
1	**How Can You Get It To Move?**	Exploring ways of getting a flat object to move
2	**Playground**	Exploring slides in the playground
3	**Ramps and Sleds**	Trying to get a sled to go down a ramp, and exploring the effect of ramp height
4	**Surfaces and Friction**	Looking at how different ramp surfaces affect the movement of the sled
5	**Sled Re-design**	Re-design sleds to slide on a variety of surfaces
6	**Let's Roll**	Using rollers to make the sled move more easily
7	**Make a Car**	Inventing the wheel and the car by adding rollers to a sled
8	**A Test Drive**	Testing cars against each other
9	**Car Facts**	Students drawing and writing about the cars they have made
10	**Write a How-to-Book**	Making a How-to Book showing someone how to make a car
11	**Improve Your Ride**	Redesigning cars to make them work better and look better
12	**The Auto Show**	Presenting cars to an audience

Materials for Invent-a-Wheel

Item	Detail	Qty	Lessons used in
Cardboard sheets (ramps), slit to accommodate stand	8 ½ x 11 ″	30	1, 3, 4, 5, 6, 7
Cardboard rectangles	4 ¼ ″ x 5½ ″	100	
Templates for ramp stands	Printed on cardstock	40	3, 4, 5, 6, 7, 8, 11
Reclosable storage bag	2 gallon	25	5-12
Blank cardstock	8 ½″ x 11″ assorted colors	50	
Felt	8″ x 10″ sheet	25	
Wax paper	Roll	1	4, 5, 11
Aluminum foil	Roll	1	
Sand paper	8″ x 10″ sheet	25	
Masking tape	2 rolls		4, 5, 6, 7, 11
Jumbo paper clips	Box of 100, smooth	1	
Wooden barbecue skewers	6″ & 8″, 150 of each	300	
Wire stripper (for cutting skewers)		1	4, 5, 7, 11
Plastic coffee stirrers	5″	100	
Straws	Box of 100, ¼ in. diam.	2	
Rubber bands	¼ lb. bag, assorted #511378	1	
Wheels w/ 3 mm. holes	Pitsco black plastic	100	7, 11
Foam blocks (LDPE)	Cut into 4 ″ x 3 ″ x 2 ″ blocks	25	11
Steel washers	½ ″, box of 50	1	
Plastic spoons	6 ″	50	5

Craft supplies			
Tissue paper	13″ x 20″ sheet, assorted colors	6	11-12
Cellophane	5″ x 25″ roll, assorted colors	2	
Google eyes	Small bagful, assorted sizes	1	
Feathers	Small bagful, assorted shapes & colors	1	
Yarn	24 ft., assorted colors	1	
Felt	9″ x 12″ sheet, assorted colors	5	
Construction paper	9″ x 12″ sheet, assorted colors	40	
Foam stickers	Small bagful, assorted shapes & colors	1	
Craft sticks	Assorted colors	30	
Ribbon	Roll	1	
Pipe cleaner	Assorted colors	30	
Cocktail umbrella	Assorted colors, 4″ diam.	30	

Provided by School		
Blocks, boxes, bags and other found objects	These can be any objects that have flat sides, i.e., that can't roll.	1
Glue	School glue or glue stick	3, 5, 11
Clay, putty or Play Doh	Small quantities for keeping wheels for falling off	7
Art supplies	Markers, crayons, etc. (whatever is available) for decorating cars	11
Bins or boxes	Large enough for storing students' cars between lessons	5-12
Materials for playground	rubber mats, balls	2

Lesson 1: How Can You Get It To Move?

Overview

Students try to get things to move, first without a ramp, then with a piece of cardboard that can be used as a ramp.

Materials

- Variety of small objects that cannot roll: books, wooden or plastic blocks, small boxes, bags, pieces of paper or cardboard, etc.
- Cardboard sheets (for making ramps)

Procedure

1. How can you get it to move? (Part #1) Give students a variety of objects. Ask the students to try different ways of moving them.
2. Class Meeting: Gather the class to discuss the ways they came up with. They have probably thought of pushing and pulling, possibly blowing, pushing with a stick, etc. Chart with the students how they were able to get the objects to move. (Movement can be sorted into two categories, pushing and pulling.
3. How can you get it to move? (Part #2) Provide the large sheets of cardboard, but do not suggest how they might be used (as ramps) – some students will probably come up with this idea on their own. Students may also use the cardboard in a see saw motion (essentially creating two ramps).
4. Class meeting: Gather the class to discuss the ways they came up with. If anyone has thought of using the cardboard sheet as a ramp, ask students:
   - How this is different from moving it by pushing or pulling directly?

   If nobody has come up with this idea, ask:
   - How can you get it to move "by itself" – while you are not touching it?

Science Notebook: Draw and write about what you did to make something move. List the materials you used.

Outcomes

- Students explore methods of initiating motion of an object, and recognize that something "extra" is needed to make it go.
- The "extra" needed to make something move could come from a person, in the form of a push or pull. It could also be made to move by putting it in a place where it "wants" to move, such as at the top of a ramp or slide.

Lesson 2: Playground

Overview

Time and weather permitting, students explore slides in the playground. Students are encouraged to slide themselves in a variety of way and use a number of objects and surfaces to explore.

Materials

- Balls
- Rubber mats and cardboard for sitting on the slide

Procedure

1. Escort the Students to the Playground: Introduce the students to the playground and ask them what they see. Ask students which part of the playground they think the class will be using. Lead students to think about the slide and make comparisons to the slide and the ramps used in the previous lesson.
2. Ground Rules for the Slides: Gather the class to discuss safe ground rules for using the slide.
3. Using the Slide: Allow each student to use the slide.
    - Does this suggest a way to get something to move by itself?

    Have them try a few variations such as:

    a) starting only a little way up,

    b) trying to slide on a rubber mat or piece of cardboard

    c) letting a ball roll down.

    We will revisit these three variations in Lessons 3, 4, 5, and 6, so the playground visit could happen any time between the lessons, or even more than once. If you are not able to take them outside, ask them to recall what happens when they go on the slide.
4. Class Meeting: In the classroom review what happened on the slides and chart the students' responses. Using an OWL chart write down what the students Observed and what they Want to Know More About. Later in the unit you can revisit this chart and fill in what the students Learned.

Science Notebook: Draw and write about what you did on the slide.

Outcomes

- Students explore a variety of things that might alter how things slide.

Lesson 3: Ramps and Sleds

Overview

Students explore how putting an object on a ramp can get it to move "by itself," how to prop up the ramp with a stand, and how ramp height affects whether or not it will move. The lesson ends with an experiment: predict and then test to find the smallest ramp height that will make the sled go down.

Materials (one per student)

- Small cardboard rectangle (sled)
- Cardboard sheets for making rampsRamp Stand Template
- Objects to prop up a ramp (blocks, books, etc.)

Procedure

1. Class meeting. Ask students if they have ever been on a sled, or seen one on TV:
   - What is a sled? What does it do?
   - What makes it go downhill?

   Bring in an example of a sled, read a book, or show a video with sleds. Revisit the discussion of Lesson 1: how can you get something to move "by itself," without touching it as it is moving? Pushing, pulling, blowing are ways to get something to move.
2. Make a sled. Provide large cardboard sheets without slits and small rectangles. Ask students:
   - Find a way to make the small piece work like a sled.
3. Propping up the ramp: By now, students should have figured out how to use the ramp to make the sled go down. However, they may be holding up one end of the ramp themselves. Ask:
   - Find a way to make the ramp stand up without touching it.

   Encourage students to find objects they could use to prop it up.

   In discussion, the term "gravity" may come up. If not and after getting students' language to describe gravity, say we call that "gravity." Describe gravity as a force that pulls things down (toward the ground).
4. The ramp stand. The objects students are using to prop up the ramp may not be stable. Also they are all different, making it hard to tell how high the ramp is. Provide each student with a ramp stand template and a ramp with slits. Show students how to fold the stand and assemble it with the ramp. (Directions for making a ramp are included in Lesson 10 as an example of a "How-to Book") Ask:
   - What do you see that is printed on each stand?
   - How could we use these numbers to decide how high the ramp is?

- What will make the sled go down?

The numbers on the template refer to distances along the stand in inches. Demonstrate a ramp that is adjusted to a height of 1 ″ on the stand. Ask students if they think the sled will slide down. Then demonstrate that it doesn't:

- Why won't it go down? Maybe because the ramp's not high enough?
- What would you need to do to the ramp to make the sled go down?

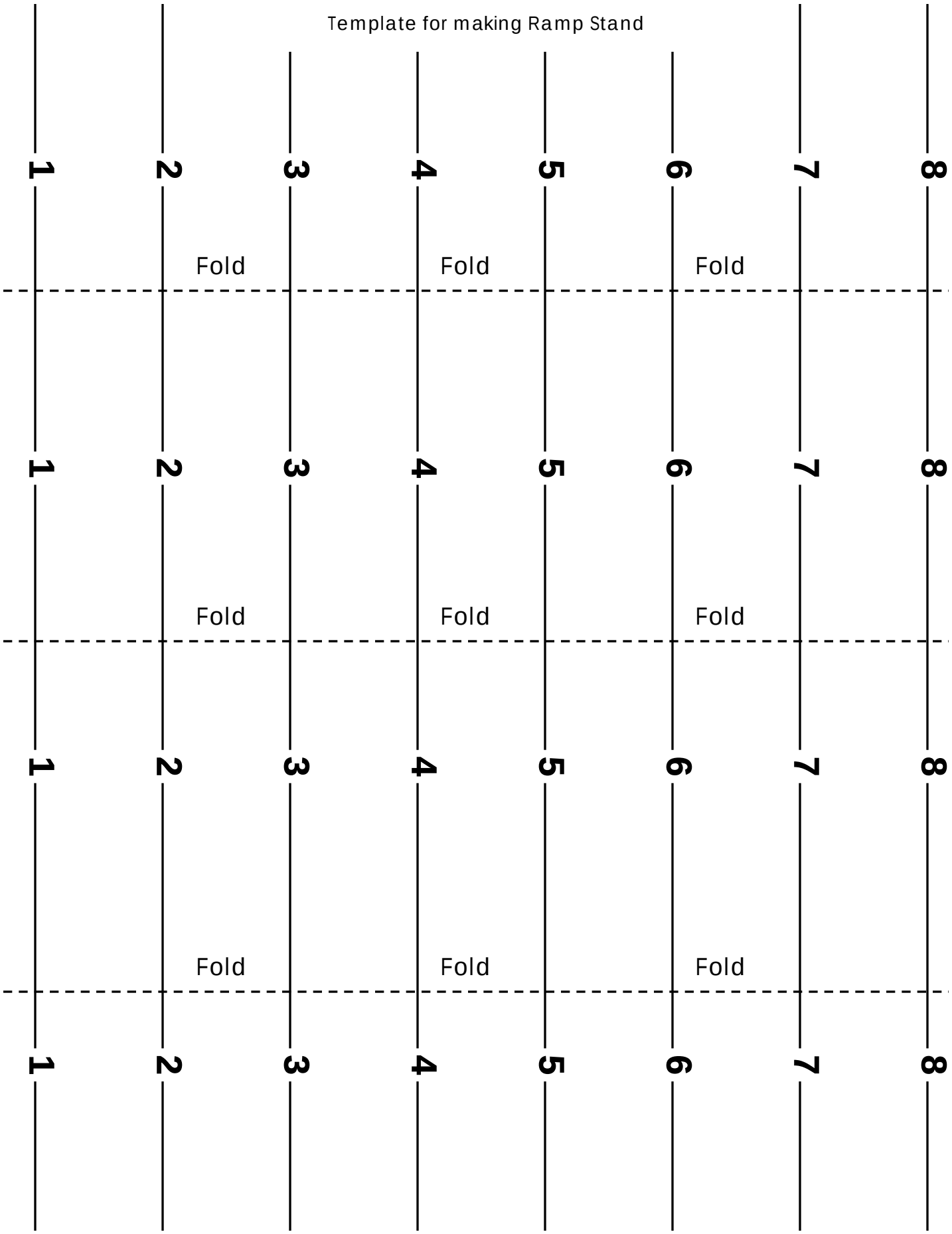
Remind them of the playground experiment or other prior experiences in which they started part way up a slide, and couldn't slide down. Students will likely come up with the idea of making the ramp higher.

5. An experiment: How high does the ramp need to be? Introduce what it means to do an **experiment**. Before we do the experiment, we make a **prediction:** we say what we think will happen. Then we **test** the prediction to see if we were right. After we did the experiment, we write down what happened.
   - **Before**: Predict how high you think the ramp will need to be to make the sled start to slide. Circle this height in blue on the worksheet or use blue stickers.
   - Tally individual predictions on a class chart, keeping track of who predicted each height
   - Then make the ramp the height you predicted. Does it work? Does it slide at all?
   - **After**: Adjust the ramp so the sled just starts to slide. Mark this height in red.
   - **What did you notice**? Fill in the blanks on the worksheet. Possible statements will refer to how fast or how far down the sled went.

Outcomes

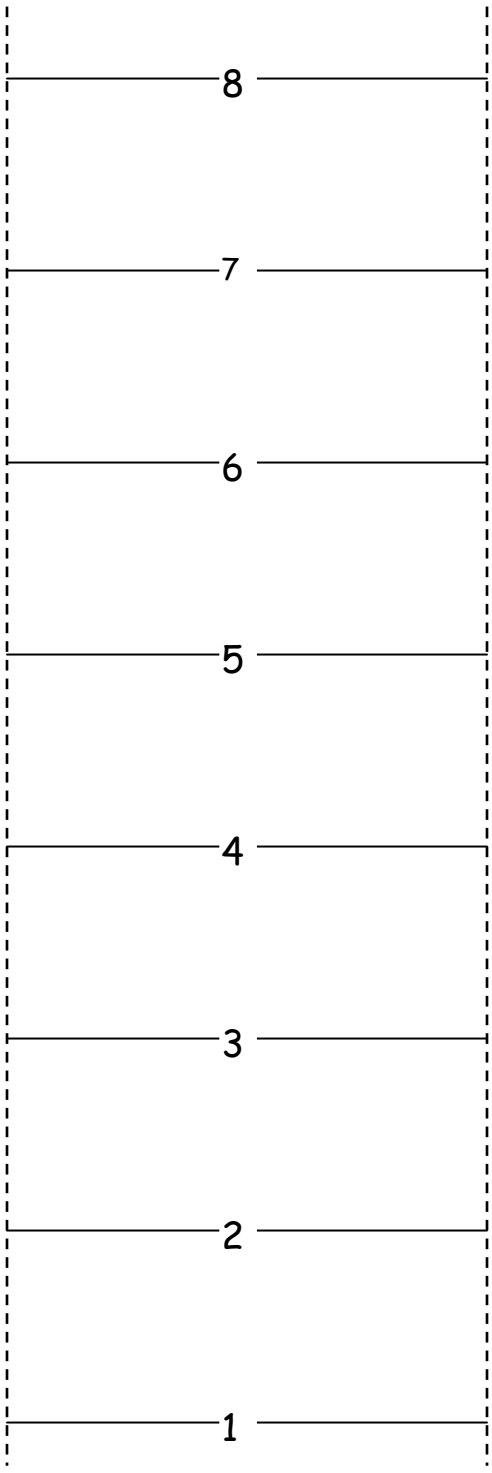
- Students learn to make and use a ramp, as a way to get the sled to go down by itself.
- Students explore how ramp height affects whether the sled will go down.
- Students learn to do an experiment. First they predict the minimum ramp height that will make the sled go down, and then they test their predictions.

Template for making Ramp Stand



Name: _____ Date: _____

Lesson 3: How I got the sled to go down



Before

Use BLUE to show where you think the ramp will be when the sled starts to slide

After

Use RED to show where the ramp really was when the sled started to slide

What I noticed

_____

_____

_____

_____

_____

Troubleshooting (for Teachers)

Children usually report conflicting results as to the height at which the sled will move on the ramp. There are various reasons for this. Whether the sled will begin to slide down the ramp may depend on factors other than just the height of the slide Here are some other issues that could affect the outcome:

- Dropping the sled, rather than placing it gently: If the sled is dropped on the ramp it may begin to move, whereas if it is carefully set down and given no initial push the sled may remain stationary.
- Knocking the ramp after placing the sled on it: If the slide is tapped or bumped, it may cause the sled to begin to move.
- Putting the sled at different places on the ramp. There are inconsistencies in the cardboard surface. These may result in the sled moving at some places and not at other places.

Lesson 4: Exploring Surfaces and Friction

Overview

Students begin with ramps that are at the height that would make the sled move in Lesson 3. They vary the surface of the slide. What effects do these different surfaces have?

Materials

- Ramps, ramp stands and sleds from Lesson 3 (six per group)
- Materials for making new surfaces: approximately 8″ x 10″ sheets of aluminum foil, wax paper, sand paper, cardstock and felt (one sheet per group)
- Bull dog clips or masking tape for attaching materials to ramps
- Scissors for cutting out samples of surfaces, and glue for attaching these to worksheet (as alternative to writing their names)

Procedure

1. Setting up six surfaces. Set up or help students set up six ramps per group, adjusted to the minimum height to make the sled go down, which students have discovered in Lesson 3. Attach a different surface to each ramp, except one, which should be left bare. The six ramps should have the following surfaces:

    - Aluminum foil
    - Felt
    - Sand paper
    - Wax paper (crumpled)
    - Card stock
    - Plain cardboard

    Review the names of these materials and make a large chart showing a sample of each one and its name. Conduct a discussion about how they are different. How does each surface **feel** when you touch it? Help students develop their words for describing the various textures, such as “hard,” “soft,” “rough,” “smooth,” “crinkly,” “scratchy,” etc.

2. Predicting what each surface will do. Ask students to predict:

    - Will the sled be able to go down each one?
    - On which ones will it get stuck?

    Conduct a class discussion about what will happen when they let the sleds go. You could relate this question to the previous playground experiment or other prior experiences in being slowed down on a slide by a heavy coat or blanket.

    - Why does the sled get stuck?

- Which of the surfaces will act like the heavy coat or blanket?
- Which one is most like a bare slide?

Introduce the word **friction** as a word scientists use to describe how things that want to move might get stuck, and kept from moving.

3. Doing the experiment and recording data. Ask students to test each ramp, and record the results on the worksheet. Students can identify each surface by writing its name, or by gluing a small sample of each one onto the worksheet.
4. Class chart: Create a chart with the class that lists all the surfaces the students tried. Beside each surface record the lowest height that the slider was able to slide on.

Outcomes

- Students explore surface and textures and develop vocabulary for describing each one.
- Students investigate how different kinds of surfaces make it easier or harder for something to slide down, relating this to their own experiences on playground slides.
- Students classify surfaces according to their types, and record what the sled did on each surface.

Name: _____ Date: _____

Lesson 4: Surfaces I Tried

Surfaces	What I predict at ____ inches	What happened	How high does the ramp need to be?
	_____ _____	_____ _____	_____
	_____ _____	_____ _____	_____
	_____ _____	_____ _____	_____
	_____ _____	_____ _____	_____
	_____ _____	_____ _____	_____

Lesson 5: Sled Re-design (Let's Slide)

Overview

Students revisit the sled that won't go down the ramp, and invent a new way to "help" it move by modifying the sled.

Materials

- Ramps, stands and sleds, one per pair of students
- Felt or sandpaper sheets, and bulldog clips to attach them to ramps
- Card stock, weights, paper plates, spoons, washers, lids, aluminum foil, wax paper, paper fasteners, masking tape, paper clips. [Note: do not provide materials that can roll.]
- Reclosable storage bags for keeping students' work

Procedure

1. Review of the sled problem: Set up a ramp per pair of students. Use either the plain cardboard ramp, or attach felt or sandpaper to increase the friction. Make sure the sled cannot initially slide down, due to the combination of surface and slope. Review what happened when the surface was too rough and/or the slope wasn't steep enough to make the sled move on its own:
   - What is happening here? Use the word "friction to describe what is holding the sled back.
   - Why doesn't the sled go down?
2. A new way to get it to move. Provide card stock, weights, paper plates, spoons, washers, lids, aluminum foil, wax paper, paper fasteners, tape, paper clips. Ask:
   - How could you use these to help the sled move down the ramp?

   Provide time for students to experiment with the materials. Some students will probably come up with the idea of attaching materials to the sled. If not, help by asking:
   - Which of these would work to help the sled go down?
3. Class meeting: Lead a discussion of the methods students used, and which ones worked. Introduce the words **design, re-design** and **troubleshooting**.
4. Further experimenting and recording results: If students haven't tried a variety of ideas, provide time for them to test their ideas, as well as others that students have come up with. Then ask students to record their findings on the worksheet.
5. Class chart: Make a class chart to describe what happened as a group.
6. Storage: Provide two-gallon plastic bags for storing students' sleds. Make sure each child's name is written on his or her bag or sled.

Outcomes

- Students explore how re-design of the sleds can reduce friction and allow an object to move down a ramp.

Name: _____ Date: _____

Lesson 5: How did I get it to slide?

Draw your idea	What Happened
	_____ _____ _____
	_____ _____ _____
	_____ _____ _____

Lesson 6: Let's Roll

Overview

Students revisit the sled that won't go down the ramp, and invent a new way to "help" it move by putting rollers under it.

Materials

- Ramps and stands, one per pair of students; attach a surface (the surface used in Lesson 4 that had the most friction, such as felt or sandpaper).
- Redesigned sleds from Lesson 5
- Plain cardboard sleds
- Wooden skewers, straws, stirrers, pencils, crayons, paper clips, paper fasteners, masking tape

Procedure

1. Review of the sled problem: Set up a ramp per pair of students; make sure the sled cannot initially slide down, due to the combination of surface and slope. Students may use plain cardboard sleds or the sleds they redesigned in Lesson 5. Review what happened when the surface was too rough and/or the slop wasn't steep enough to make the sled move on its own:
   - What is happening here? Use the word "friction to describe what is holding the sled back.
   - Why doesn't the sled want to go down?
2. A new way to get it to move. Provide skewers, straws, stirrers, pencils, crayons, paper clips, paper fasteners, masking tape. Ask:
   - How could you use these to help the sled move down the ramp?

   Provide time for students to experiment with the materials. Some students will probably come up with the idea of placing straws, skewers, crayons or stirrers under a sled, to allow it to roll down. If not, help by asking:
   - What would happen if I put this (indicating a straw) under the sled?
   - Which of these would work to help the sled go down?
3. Class meeting: Lead a discussion of the methods students used, and which ones worked. Introduce the words **roll** and **roller**.
4. Further experimenting and recording results: If students haven't all tried rollers, provide time for them to test this idea, as well as others that students have come up with. Then ask students to record their findings on the worksheet
5. Class chart: Make a class chart to describe what happened as a group.
6. Storage: Students should keep their materials in the storage bags for use in the next lesson.

Outcomes

- Student discover how rollers can reduce friction and allow an object to move down a ramp.

Name: _____ Date: _____

Lesson 6: How did I get it to roll?

Draw your idea	What Happened
	_____ _____ _____
	_____ _____ _____
	_____ _____ _____

Lesson 7: Make a Car

Overview

Students look at issues with using rollers: the sled gets to the bottom of the ramp, but won't keep going. Also, the rollers separate from the sled and may keep going after sled stops. To solve these problems, students invent ways to attach things that roll to the sled – thereby inventing the **wheel**! A sled with wheels is a **car**.

Materials

- Ramps, ramp stands, sleds and rollers from Lesson 6
- Wooden skewers, straws, and stirrers (for making axles)
- Plastic wheels, beads
- Masking tape, rubber bands, bulldog clips, clay (for keeping wheels on axles)
- Two-gallon bags for storage of students' cars; markers for putting a name on each one

Procedure

1. The problems with rollers: Set up one ramp with rollers, and review what happened with them:
   - What happened when we used these rollers?
   - What problems do you see with using them?
   - Create a class chart listing the positives (what's good) and the negatives (what's bad) about using the rollers.

   Help students notice that the rollers don't stay with the sled. At the bottom of the ramp they might even go off in different directions, and the sled stops.
   - What are some solutions for fixing the problems?
2. The solutions: Have students try their solutions. These might include attaching the rollers to the sled in some manner using masking tape, glue etc.
   - How well did each solution work?
   - What else could we attach to the sled that would allow it to roll?
3. The wheel: After students have worked with the rollers, show them the plastic wheels:
   - What are these for? What should we call them?
   - How could you put these on the sled so it will have its own rollers, and won't lose them at the bottom of the ramp?

   If students have difficulty, call attention to their own experiences with rolling things.
   - What have you seen go up and down a ramp easily?

Students will probably come up with examples such as a shopping cart, wheel chair, wagon, rolling suitcase, tricycle, toy car, etc. Use this example in the next question:

- What does a _____ have that makes it easy to go up and down?
- How could you use the same idea to make your sled go down easily, and keep going when it hits the bottom?

4. Making cars: Provide students time to experiment with the materials. Their problem is to come up with a way of attaching two skewers or stirrers (axles) to the sled, and then adding a wheel on each side of each axle. The axles can be taped, pushed through the corrugations or held with rubber bands. The wheels can be slid on from either end. At first, the wheels will tend to fall off, but students will probably come up with the idea of adding tape, rubber bands, clay, or putty to the ends of the axles to keep the wheels on. If students get stuck, encourage them to be creative, and see what other children are doing.
5. Class meeting: While students are making cars stop periodically to give students an opportunity to share and discuss how they are making their cars.
6. Writing: On chart paper, make a list of each of the materials, with a sample of each one. On the worksheet, each student should draw and write the name of the car parts they used. Introduce functional names for the parts:
   - You are using this stick to hold a wheel. Something that holds a wheel is called an **axle**.

   A piece of tape, rubber band or clay used to keep the wheel from falling off can be called a **stop**. They should also record how many of each part they used.
7. Clean-up: Make sure each student's name is written on his or her car. Provide each student with a plastic bag for storage. Collect unused materials and save them for future lessons.

Outcomes

- Students design and make a car that has its own wheels
- Students discover and solve design problems, such as wheels that fall off
- They identify and record the names and numbers of each part using names that describe their functions

Name: _____ Date: _____

Lesson 7: Materials I used for my Car

Drawing	Name	How many?
	_____ _____	_____
	_____ _____	_____
	_____ _____	_____
	_____ _____	_____

Troubleshooting (for Teachers)

The barbecue skewers do not all have exactly the same diameter. Thus, wheels slide easily onto some skewers and turn easily on them. On other skewers wheels fit tightly so that both the skewer and wheel must turn together.

If the wheels turn easily on the skewer, the main problem is that the wheels may fall off, which is addressed above. The other major problem is that a wheel may rub against the cardboard. Help the student find the place where rubbing is creating too much friction, and brainstorm ways to reduce it.

If the wheels fit tightly on a skewer, the skewer will need to be attached to the bottom of the car in a way that allows the skewer to turn freely. If the skewer is taped directly to the cardboard, it will not turn and then the wheels will not turn either. A simple solution is to place the skewer through a straw, and then tape the straw to the bottom of the cardboard. This leaves the skewer free to rotate inside the straw, and allows the skewer and wheels to turn easily.

Lesson 8: A Test Drive

Overview

Students compare their cars with one anothers' cars, by rolling them down ramps to see what happens. They develop vocabulary to describe what happens.

Materials

- Students' cars from Lesson 7
- Ramps, ramp stands and sleds from Lesson 4 (three ramps per group, each with a surface and slope, such as felt or sandpaper)

Procedure

1. How did it work? Review what has happened so far: students have had ramps that a sled wouldn't go down. They helped the sled go down by putting **rollers** underneath, but at the bottom of the ramp, the rollers broke loose, and the sled couldn't keep going. Finally, they invented wheels, by attaching the rollers to the sleds, which made the rollers into **wheels** and the sleds into **cars**. Ask:

   - What's an experiment we can do to see how our cars compare with each other?

   Model an experiment for them, by comparing the performances of two cars made in Lesson 7:

   - Which car will go furthest
   - Which one will go straightest?

   Use a class chart to record results. Generate more questions that could be tested. Then have students pick a partner and a question that they want to test. After doing the experiment with a partner, discuss briefly what happened.

2. Comparing cars. As the students are testing their cars against each other, help them develop language for comparing the results:

   - Some cars go **straight**, but other cars go in **curves.**
   - Some cars go **far**, but some **don't go as far**
   - Some cars **stay together**, but some **come apart**.

3. Storage: Make sure each car is labeled with stored in a plastic bag, as in Lesson 7.

Science Notebook:

- What was your question in your experiment with your partner?
- How did your car compare with other cars?
- What other questions do you have?

Outcomes

- Students design an experiment for comparing cars with each other.
- Students develop and use language for comparing the performances of their cars.

Lesson 9: Car facts

Overview

Students make detailed drawings of their cars, showing and labeling each part.

Materials

- Students' cars from Lesson 7
- Two worksheets for each student

Procedure

1. Initial question: If we re-designed our cars and then changed our mind and wanted our original car back, what could we do to help us remember?
   Students will probably come up with the idea of making a drawing.
2. Why make a drawing? Later, we'll be changing our cars and it will be hard to remember what we did at first. To help us remember, today everybody will make a drawing showing how his or her car looks right now. Provide the worksheet "Drawing My Car" and have students draw their cars.
3. Gallery walk: Post all the students' diagrams of their cars, and allow students time to examine each of them. Raise these questions:
   - How are these diagrams different from one another?
   - Have students share what they liked about another student's drawing (what made it a good drawing)?

   Introduce the issue of **labeling**. If one diagram has labels, but another doesn't, show both to the class and ask (if not, expand on the first question):

   - Can you tell from this diagram what each part is?
   - What does this diagram have that makes it easier to understand?

   Ask about **viewpoint:**

   - Where would I have to be to see the car look like this?

   If the car is drawn from a birds-eye view, students should recognize that you would have to be above it. Then change your point of view, looking at it from the side or front.

   - Suppose I was looking at it from over here. What would I see?
   - How could you make a new diagram to make it look like it does now?
4. Class chart: Using the student's ideas or ideas from the attached sample diagrams, draw a large class diagram.
5. Redesigning diagrams: On a new worksheet, "How My Car Looks from Different Views," encourage students to add labels to their diagrams and to draw them from a specific point of view. If time permits, they could add new diagrams from additional

points of view or draw the car in an exploded view using the worksheet “My Car in Exploded View.”

Outcomes

- Students use diagrams to represent their own constructions.
- Students compare their diagrams, and add labels to their diagrams.
- Students compare how things look from different viewpoints, and represent different views of the same object.

Name: _____ Date: _____

Lesson 9: Drawing My Car

Name: _____ Date: _____

Lesson 9: How my car looks from different views

What it looks like
Top View
Bottom View
Side View

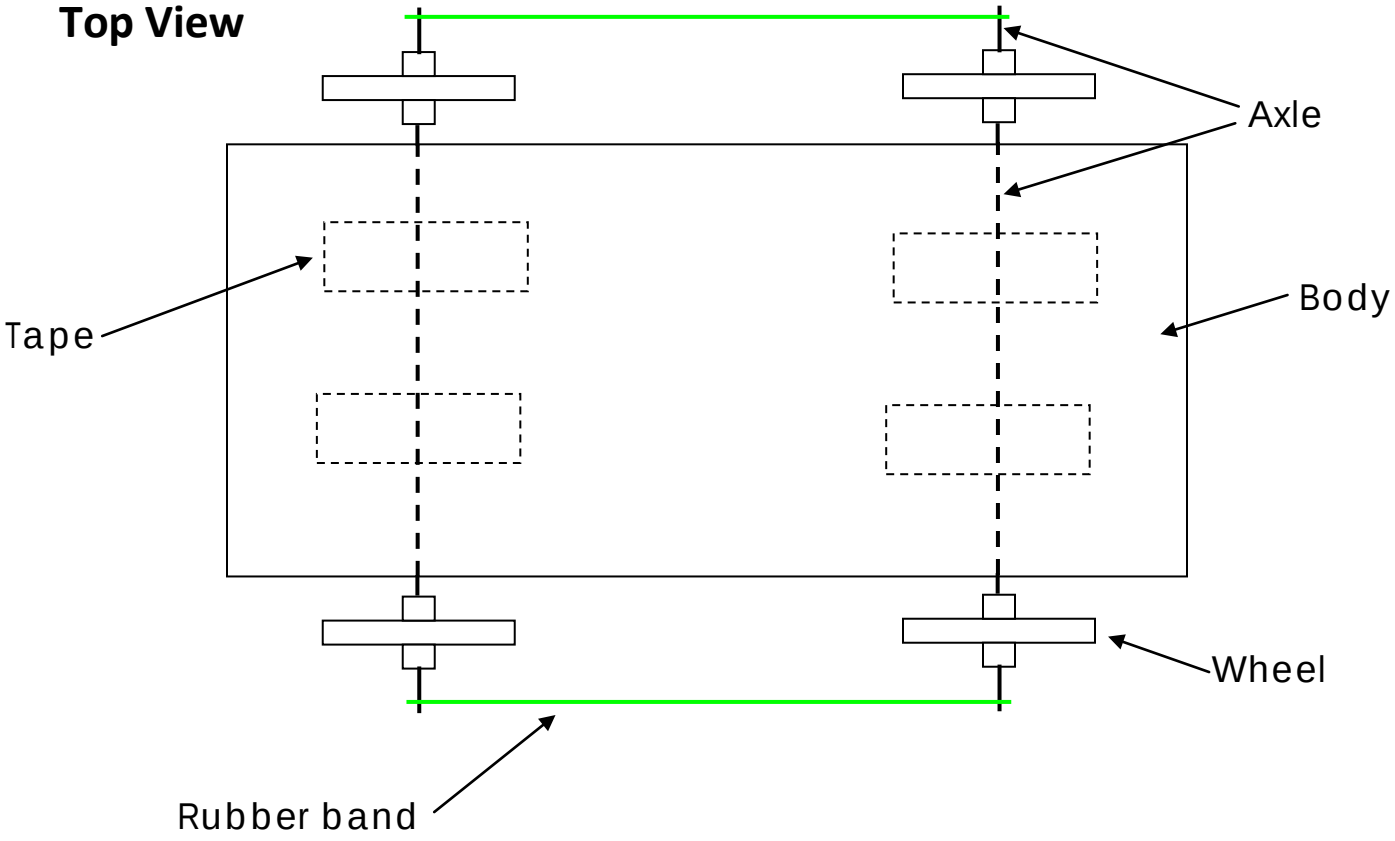
Name: _____ Date: _____

Lesson 9: My Car in Exploded View

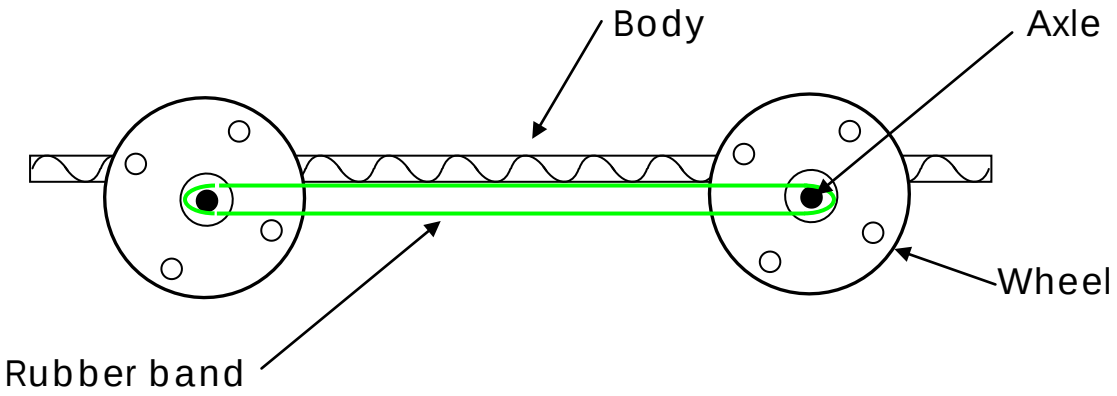
What it looks like

Sample Diagramming

Top View



Side View

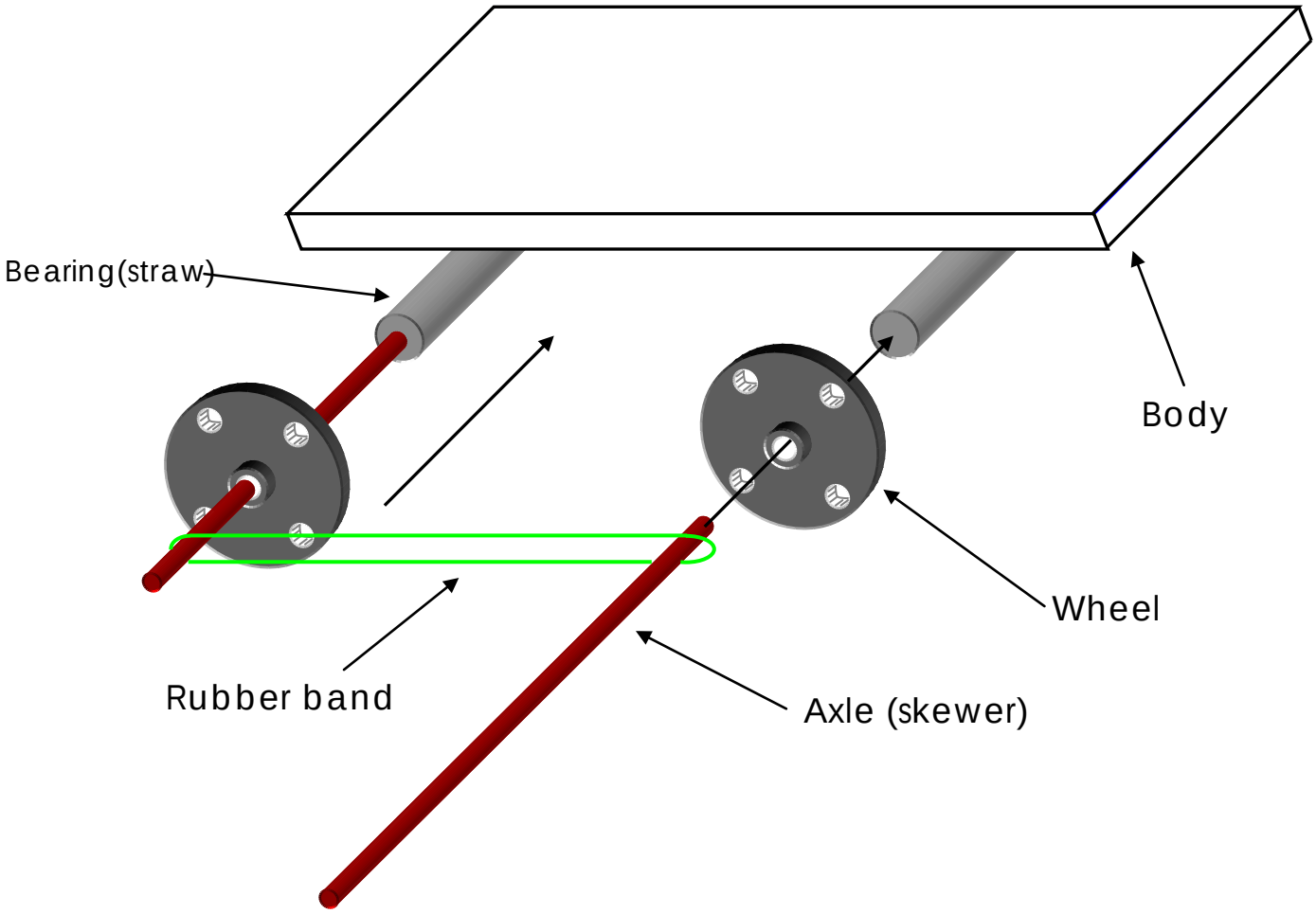


Notes:

1. Dashed lines represent objects that are hidden from view.
2. Drawing the rubber band in a separate color makes the drawing less confusing to look at.

Exploded View

This drawing of an exploded view also shows another way in which to make a car. The car has bearings (straws) in which the axles (skewers) slide into.



Lesson 10: Write a How-to-Book

Overview

Students review the purpose of a **How-to-Book** and reconstruct the steps they took to make a car. They then each write a book, "How to Make a Car."

Materials

- Students' cars from Lesson 7
- Materials list from lesson 7
- Examples of instruction sheets familiar to students, such as Lego Construction Guides (if available)
- Example of how to make a ramp and stand

Procedure

1. How-to Books: Ask students if they have Legos™ or other construction toys. Ask:
   - When you open up a toy that you have to put together yourself, how do you know what to do?

   Help students recall that there is usually an instruction sheet (or **How-to-Book**) that tells you what to do. Show students any examples you have.
   - How does a How-to-Book show you what to do?

   Develop the idea that it shows you how to make something in **steps**. Each step means adding something new. The How-to-Book shows you what it will look like after each step. Today we will be making How-to-Books showing how you made your cars.
2. What steps did you take to make a car? Using their own cars as reminders, help students walk through the steps they followed when they made their cars. For example:
   a) Tape the axles to the body.
   b) Put two wheels on each axle.
   c) Put a stop on the ends of the axles.
3. How to Make a Car: Provide worksheets. Ask each student to write a How-to-Book showing how he or she made a car. Provide students with additional sheets as needed.
4. Share and build: Collect all the student's cars. Have students share their "how to book" with another student. Tell the students that they are now going to build their classmate's car based on their "how to book".
5. Share: Give the student's their original cars back. Have students share and compare with their partner. Ask students to discuss what issues came up.

6. Edit: Have student's edit their books based on issues that their partner had in reading/understanding them.

Outcomes

- Students review the meaning and purpose of How-to-Books.
- Students recall the steps they took to make a car.
- Students write How-to-Books that record a process they have invented themselves.

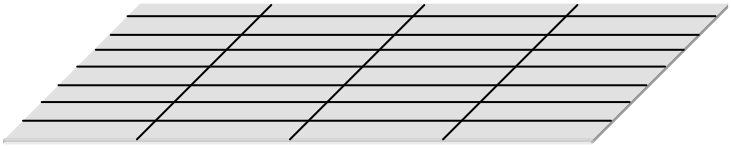
Name: _____ Date: _____

Lesson 10: How-to-Book for Making a Car

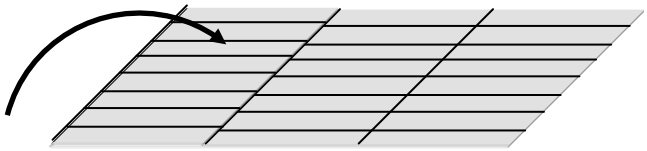
___	_____ _____ _____
___	_____ _____ _____
___	_____ _____ _____

How to Make a Ramp and Stand

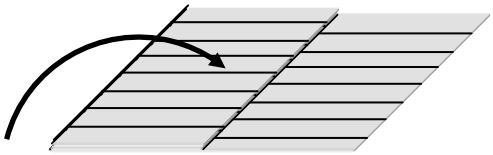
Step 1



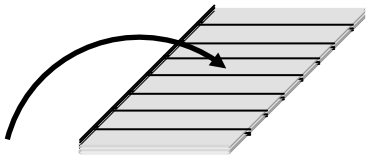
Step 2



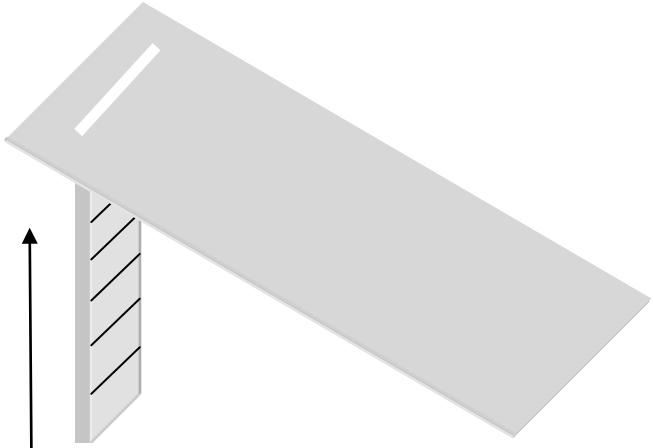
Step 3



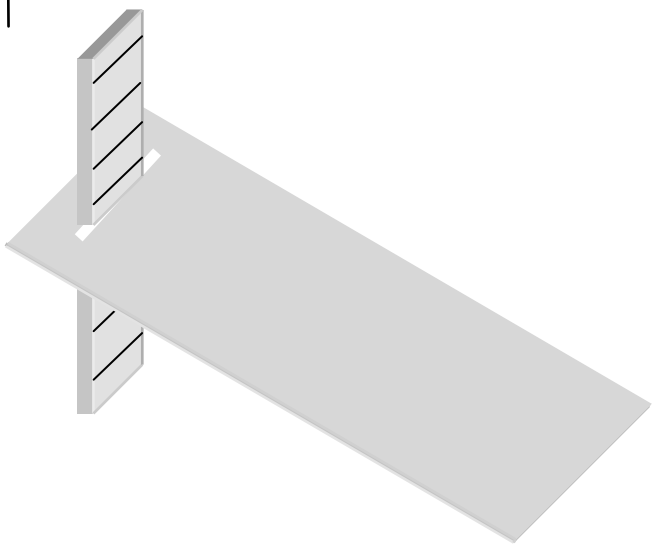
Step 4



Step 5



Step 6



Step 1 – Lay the stand flat.

Step 2 – fold the first line to the second line

Step 3 – Fold the second line to the third line.

Step 4 – Fold the third line to the end

Step 5 – Slide the stand through the slit in the ramp.

Lesson 11: Improve Your Ride

Overview

Students discuss ways they would like to make their cars work better, and/or look better, and then redesign their cars.

Materials

- Students' cars from Lesson 7
- Materials for making cars (as in Lesson 7)
- Foam blocks for car bodies
- Art supplies and craft materials for decorating cars

Procedure

1. Better cars: Meet with the class briefly to explore ways in which their cars could be improved. Introduce the word **redesign**: changing something you've already made so it will work better, or look better, or both. Ask for suggestions about why they might want to redesign their cars. They might want to make their cars…
   - … go straight, when previously they went in curves
   - … go further
   - … look better, etc.
2. Redesign your car: Provide car parts, foam blocks, art supplies and craft materials. Students will spend most of the period redoing their cars, or making new ones.

Science Notebook:
Draw and write about how you redesigned your car.
How was your new car different from your old one?

Outcomes

- Students identify things they would like to change.
- Students find ways to address problems they have identified.

Lesson 12: The Auto Show

Overview

Students present their cars to an audience.

Materials

- Redesigned cars from Lesson 11
- Worksheets and science notebooks that illustrate their design and redesign processes

Procedure

This is the culminating lesson, where students will present their final cars to an audience. The display could take one or more of several forms:

- **Formal presentation**: each student shows his or her car to an audience and explains what he or she did to make it.

  Describe the materials used, the steps taken to make the cars, and how the car works. Compare the Lesson 11 car to the original car from Lesson 7, holding them both up and testing them against each other. The cars should be signed and named.

- **Museum**: Students create a display on tables, where visitors can view the cars and learn about how they were made.
- **Car Fair**: Like a Science Fair, visitors come to view the cars and students explain their cars to them.

Outcomes

- Students gain recognition for their efforts and ingenuity.