Design Technology in Engineering education for English Learners: Project DTEEL

NSF DRK-12 #1503428

University of Texas, Austin

Second Grade
Lesson Plans
Units 1-8

DTEEL Second Grade Lessons

Unit 1 (Materials):
Special Properties of Materials

Concept
Materials have properties that can be observed; elasticity is stretching and returning to original shape; shear strength is resistance to tearing; tensile strength is the ability to resist pulling forces; compressive strength is the ability to resist pushing forces.

Content Objective
Students classify materials according to properties of elasticity, shear strength, and tensile and compressive strength; teams name positive ways to communicate.

Language Objective
Explain material properties *using target vocabulary*: property, shear strength, elastic, compression, tension.
Write a description of materials using target academic vocabulary.
Contrast material properties using *transitions* that signal difference: *but, while, whereas, however.*

Standards
- **NGSS:**
  - **2-PS1-1.** Plan and investigate kinds of materials and their observable properties.
  - **2-PS1-2.** Analyze data from materials to determine which have best properties for an intended purpose.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS:**
  - **2E** communicate observations and justify explanations using student-generated data from simple descriptive investigations (justify explanations of own data)
  - **2F** compare results of investigations with what students and scientists know about the world (compare with other findings)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **5A** classify matter by physical properties, including shape, relative mass, relative temperature, texture, flexibility, and whether material is a solid or liquid (phy prop: shape, mass, temp, texture, flexibility, solid v. liquid)
  - **5C** demonstrate that things can be done to materials to change their physical properties such as cutting, folding, sanding, and melting (phy changes in materials)

- **ELPS:**
    - **1E** internalize new basic and academic language by using and reusing it in meaningful ways in speaking and writing activities that build concept and language attainment (internalize vocabulary through meaningful use)
    - **3E** share information in cooperative learning interactions (share information in cooperative learning)
    - **5B** write using newly acquired basic vocabulary and content-based grade-level vocabulary (write using content-based vocabulary)
    - **5F** write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired (write using a variety of patterns, connecting words, clauses)

Materials:
Stuffed animal; Cloth samples; recycleds (esp. wood, plastic, rubber); cooked and raw spaghetti and rice noodles; clay; paper clips; balloons; Nerf™ ball; styrofoam pellets or peanuts; rubber band

Suggested Literature Connections
"Properties of Matter" by Katie Dicker
"Properties of Matter" by Rebecca E. Hirsh

Day 1: Engage/Explore Materials-Special Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Using a stuffed animal, pretend to bend it, stretch it, and squeeze it. Have students think of hand motions to represent these three forces. With students standing at a safe distance from each other, perform the motions and repeat the words: *bend, stretch, squeeze*. Use handout (**2.1.1**) as a reference. 2. Explain that each group of four students will receive a bag of materials (recycled materials, clay, bread, rubberbands, marbles, etc.). Have students think of ways to sort the items according to the different forces (bend, stretch, squeeze). As the students work, ask questions like: ▪ *"Why can some things be squeezed and others can't?"* ▪ *"Are there items that could fit into more than one group?"* 3. Using handout (**2.1.2**), introduce the idea of materials—that materials are used to make things, and that things often have special properties, like squeezability—because of their materials. You may show the following video of materials as well: https://www.youtube.com/watch?v=xOKr462HLc0 4. Explain that all materials have properties, *propiedades*, and that in this context, properties means something different from 'belongings' (As in, "Hey, that's my property!"). Here, properties are characteristics, *características*, meaning how a material is and how it reacts. 5. Remind students of the hand motions for bend, stretch, and squeeze.	Students create hand motions and perform them while practicing the words: bend, stretch, and squeeze. Students work in groups to sort objects. Students perform hand motions for bend, stretch, and squeeze.	Vocabulary: Bend, Stretch, Squeeze

6. Pass out Properties of Materials Chart handout (**2.1.3**) and tell your class that you will fill it out as a classroom and will be using it for the next couple of days. Let them know that today they will focus on thinking of other properties aside from *bend, stretch,* and *squeeze*. 7. Introduce a new property: elasticity, and tell your students that elasticity is the ability to stretch or be squeezed and return to its original size and shape. Demonstrate the elasticity of a rubber band. Also, add elasticity to handout (**2.1.3**). (This is done on the first row). 8. Have students discuss with a partner what other properties they might add to the chart and add them as a class. They may use handout (**2.1.2**) as it also contains some examples of properties. Possible additions include: o *Rough* o *Waterproof* o *Moldable* o *Flexible* 9. Recall the properties that were introduced with their corresponding gestures as well as the ones added to the chart by the students.	Student pairs discuss additions to the attribute chart. Students draw pictures on the attribute chart.	Vocabulary: Elasticity We would add _____ as a property because _____ _____ __.

Day 2: Explore/Explain Materials-Special Properties of Materials

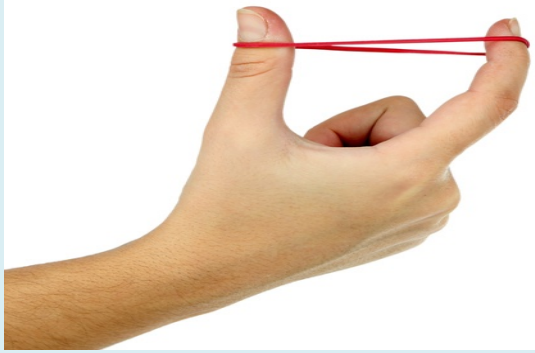
Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students the materials available and tell them that they will look through the materials and find examples of things that have properties like the ones they identified the day before. The students should collect items from around the room, then come together after fifteen minutes and share what they have found. 2. Have the students form teams of two. Remind the teams that partners are responsible for good teamwork, and that they must talk to each other and plan together in order to be a good team. As the students are working, note groups that have identified the following properties and encourage them to share later in the lesson: • Elastic- the ability to stretch or be squeezed and return to its original size and shape • Shear Strenght-resistance to tearing or shearing • Compressible- the act of applying pressure • Withstand tension- the act of stretching something tight 3. Call the students back to the whole group and explain that you will continue filling out the attribute chart (**2.1.3**) together. Use a document camera (doc cam) or projector and fill out the attribute chart as students fill out their own paper copies. Model how to complete the chart with one item, using check marks ✓to show properties of the material, and ✗'s to show properties that the material does not have. 4. Have the teams present one object that they found. Be sure to have at least one team demonstrate: • One item that is elastic and why they think it is made to be that way; • One item that has shear strength and why;	Student pairs sort objects provided and found around the room. Students record their observations on the attribute chart. Students describe the properties of an object.	The _____ is _____ so that_____. This is a_____. It is _____ because it needs to_____.

• An item that can be compressed, and; • One that withstands tension forces. As the groups present, encourage them to use the sentence frames. 5. Introduce the new vocabulary words using handout (**2.1.4**): compression, tension, shear strength when the groups discuss these properties. Have students repeat these words and record them on the attribute chart (**2.1.1**).		

Day 3: Elaborate/Evaluate Materials-Special Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. *Review the hand motions for bend, stretch, and squeeze. Have students create additional motions for elasticity and shear strength. Ask about the difference between elasticity (can stretch and return to its original state) and stretchability (can stretch but does not return to its original state).* 2. *Show the video on structures and forces: https://www.youtube.com/watch?v=8IN544ZKzmQ* 3. *Ask how the students' hand motions compare to the animation in the video. Introduce the difference transitions: but, while, whereas, however. Tell students that they can use these words when talking about two different properties.* 4. *Tell students that they will now think about a place that they know well (i.e. their room, kitchen, a park, playground, supermarket, etc.). They will work with a friend to draw different properties of materials found in that place using handout (**2.1.5**).*	*Students perform original hand motions and create new ones for the new vocabulary words.* *Student pairs discuss similarities and differences between their hand motions and the video.* *Students draw and write about materials in a familiar setting.*	*Vocabulary words: but, while, whereas, however* *The _____is/has _____ but the _____ is/has _____.* *The _____is _____. However, the _____ is _____.* *While the_____is/has _____, the _____ is/has_____.*

To bend. To stretch. To squeeze.

Bend	Stretch	Squeeze
		
movement that causes the formation of a curve	the act of physically reaching or extending out	the act of gripping and pressing firmly

Different types of Materials

Wool  Sheep Sweater Warm	**Metal**  Hard Shiny Waterproof	**Glass**  Transparent Waterproof Brittle	**Stone**  Hard Natural Rough
Wood  Natural Tree Brown	**Fabric**  Soft Clothes Wear	**Plastic**  Moldable Colorful Manmade	**Sand**  Grain Beach Yellow
Gold  Jewelry Metal Shiny	**Rubber**  Flexible Durable Tire	**Cotton**  Thread Plant Sew	**Paper**  Tree Write Flexible

Name: _____ Date: _____

Properties of Materials Chart

		Properties						
		Bend	Squeeze	Stretch	_____	_____	_____	_____
Materials								

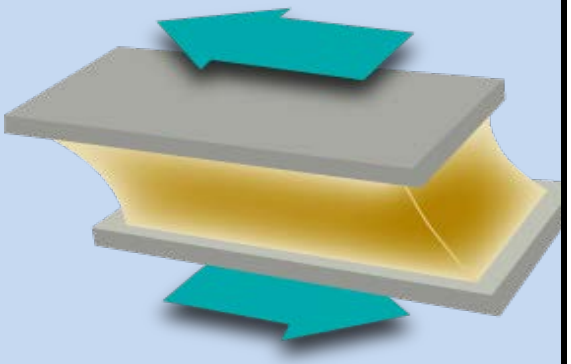
(Teacher Example)

Properties of Materials Chart*

		Properties						
		Bend	Squeeze	Stretch	waterproof	soft	rough	comestible
Materials	Bubble gum	✓	✓	✓	✓	✓	✘	✓
	Teddy Bear	✘	✓	✘	✘	✓	✘	✘
	Stapler	✘	✘	✘	✓	✘	✘	✘
	Journal	✓	✘	✘	✘	✘	✘	✘
	Crayons	✘	✘	✘	✓	✘	✘	✘
	Rubber Band	✘	✘	✓	✓	✘	✘	✘
	Lego	✘	✘	✘	✓	✘	✘	✘
	Napkin	✓	✓	✘	✘	✓	✘	✘

*Note that this is just an example and is likely that your class will produce different charts with different materials and properties. Don't focus too much on accuracy of their labeling but rather on concept understanding-materials are around us and they all have various properties.

Additional properties

Compression	Tension	Shear Strength
		
the act of applying pressure	the act of stretching something tight	resistance to tearing or shearing

Name: _____ Date: _____

Living with Materials and Properties!

The place that my partner and I chose is _____.

Some of the materials located at that place are_____, _____, and _____.

Several properties of those materials are _____, _____, and _____.

(Draw your place with materials and properties here)

Unit 2 (Materials):
Designing Experiments for Properties of Materials

Concept
Tests can be devised to determine properties of materials.

Content Objective
Teams use a design brief as they begin a design portfolio, and design a test to find materials that have certain properties.

Language Objective
Verbally describe a familiar test from home.
Evaluate the appropriateness of materials in writing using *coherent sentences* (evaluation and evidence match).
Sequence steps in design brief using sequencing words: *first, second, after that, next, then, last, finally.*

Standards
- **NGSS:**
  - **2-PS1-1.** Plan and investigate kinds of materials and their observable properties.
  - **2-PS1-2.** Analyze data from materials to determine which have best properties for an intended purpose.
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.
- **TEKS:**
  - **2C** collect data from observations using simple equipment such as hand lenses, primary balances, thermometers, and non-standard measurement tools (collect data with tools)
  - **2D** record and organize data using pictures, numbers, and words (organize data)
  - **2E** communicate observations and justify explanations using student-generated data from simple descriptive investigations (justify explanations of own data)
  - **2F** compare results of investigations with what students and scientists know about the world (compare with other findings)
  - **3A** identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat (explain prob and solution)
  - **3C** identify what a scientist is and explore what different scientists do (connect to adult scientists)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **5A** classify matter by physical properties, including shape, relative mass, relative temperature, texture, flexibility, and whether material is a solid or liquid (phy prop: shape, mass, temp, texture, flexibility, solid v. liquid)

- **5C** demonstrate that things can be done to materials to change their physical properties such as cutting, folding, sanding, and melting (phy changes in materials)

- **ELPS:**
  - **1A** use prior knowledge and experiences to understand meanings in English (prior knowledge)
  - **3G** express opinions, ideas, and feelings ranging from communicating single words and short phrases to participating in extended discussions on a variety of social and grade-appropriate academic topics (express opinions)
  - **4C** develop basic sight vocabulary, derive meaning of environmental print, and comprehend English vocabulary and language structures used routinely in written classroom materials (comprehend English vocabulary and structures in written materials)
  - **5F** write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired(write using a variety of patterns, connecting words, clauses)
  - **5G** narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired (narrate, describe, and explain)

Materials:
materials to be tested from recycleds and from around the room ; noodles ; paper; wood; plastic; Styrofoam; cloth ; manila folders or pocket folders for team portfolios ; butcher paper ; markers; copy of design brief on chart

Suggested Literature Connections
“First Day Jitters” by Julie Dannberg
“Iggy Peck Arcitect” by Andrea Beaty

Day 1: Engage Materials-Designing Experiments for Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Have students discuss how they get ready for school each morning using the sequence sentence stems in handout (**2.2.1**).	Student pairs discuss their morning routines at home.	Vocabulary: Design brief, product, material
2. Choose one student from each pair to share with the class, and record what s/he dictates. Number the steps and check the order with the student and class. Model the use of sequencing words like first, second, then, after that, etc.		first, second, after that, next, then, last, finally
3. Tell the students that a plan like this is a map for following directions, in engineering, we call these plans *design briefs*. *Design briefs* are very important for engineers, as they help them get their ideas together before they begin design work.	Student pairs discuss design brief.	
4. Remind students of the ways different materials stretched and compressed (Unit 1). Ask them how a design brief would help someone else repeat their test.		
5. Tell students different materials have different properties that make them better for a certain job or use. For the activity, each pair will receive copies of the material and product images from the handout (Materials Match **2.2.2**). [Note: Materials are represented in pictures. Products are written in words. You may want to review each material to be sure students know what each is.]	In pairs, students play the Materials Match activity using the sentence frames. Students chorally read sentence frames.	The product(s)_____ (can / cannot) be made with the material _____ because_____.
6. Model one or two matches and how to use of the sentence frames with the Materials Match cards.		
7. Observe students' language use and understanding while they play the Materials Match activity in pairs, and complete the sentence stems.		

Day 2: Explore/Explain Materials-Designing Experiments for Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Show students the different design problems in handout (**2.2.3**). Let each team pick the problem they want to work on. 2. Teams work independently to create a design brief for the test they've chosen, then discuss and try out the materials test. Have each team name their test and write down the steps they use during their tests using the sentence frames on the same handout (**2.2.3**). 3. While the students are working, use the **collaborative dialogue template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives. 4. When teams are done, bring them together to talk about what "tests" or *pruebas* are. The children know about math and reading tests, but did they know that scientists and engineers are always doing tests as part of their jobs? 5. Ask students to explain if they have seen their parents (or anyone else) ever test something. For example, when a company wants to make a new type of chewing gum, they have to find ways to test it to make sure that people will buy it. They need to find out if it's chewy and if it tastes good, properties they want the gum to have.	Student pairs discuss which challenge they will complete. Students write down the steps of their tests and perform the tests. Student pairs discuss how their parents test things out.	Vocabulary: first, second, after that, next, then, last, finally

Day 3: Elaborate/Evaluate Materials-Designing Experiments for Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Tell the students they will now exchange design briefs with the other teams to see if the other team can repeat the test. 2. Using the doc cam or projector, model the processing of filling out the feedback sheet (**2.2.4**). Emphasize the importance of respectful and constructive comments that help the team improve their plans. 3. Have the students exchange plans and circulate around the room while they are working to perform another team's test. 4. When the teams are ready, have each one share a 'glow' (a positive aspect) and 'grow' (something to improve) about the other team's design brief, and return feedback forms to the team. 5. Tell the students that they will have a chance in the next class to make changes to their plans based on their peers' feedback. 6. Ask students to discuss in pairs what makes a good design brief. 7. Allow student pairs to contribute ideas to the whole group, record the students' ideas about the criteria for quality design briefs. Tell them that you will use their ideas to develop the rubric for their final design briefs. Possible criteria include: • Includes appropriate sequence of steps • Uses of sequence words • Is easy to follow • Works to test the specific property	Student teams read another team's design brief and perform the test. Students write feedback using the sentence stems. Student pairs discuss qualities of a good design brief.	One thing that we liked was _____ __. One thing that you could improve is _____.

Day 4: Evaluate Materials-Designing Experiments for Properties of Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Before the lesson, modify the unit rubric based on the students' ideas from the previous session. 2. Have students work in teams to revise their design briefs based on peer feedback. In addition to the map, have students use sentence stems from handout (**2.2.5**) to answer the following questions: • *What materials and objects did you find that passed your test?* • *What materials were especially interesting?* • *Could you build a structure like a house out of your material?* 3. When the students are ready, have them share one important thing that they learned from the unit.	Student teams create a revised design brief and write their responses to the evaluation questions.	Vocabulary: first, second, after that, next, then, last, finally The _____ passed our test. We were especially interested in the _____ because _____. One important thing that we learned was _____.

Name: _____ Date: _____

Getting ready for school.

I want to explain _____.

First, _____

_____.

Second, _____

_____.

Then, _____

_____.

After that, _____

_____.

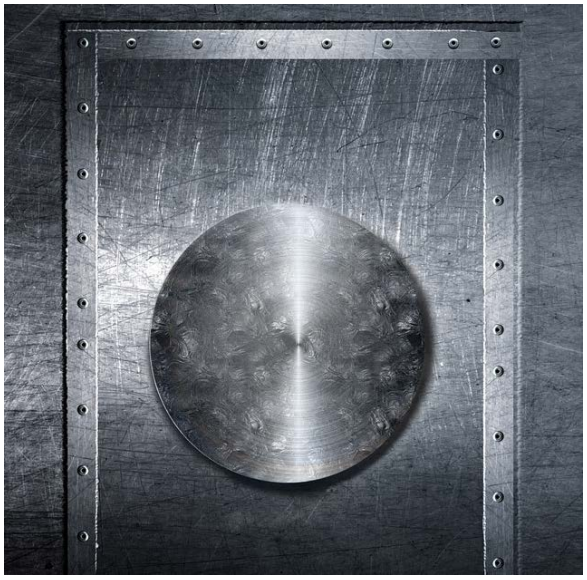
Finally, _____

_____.

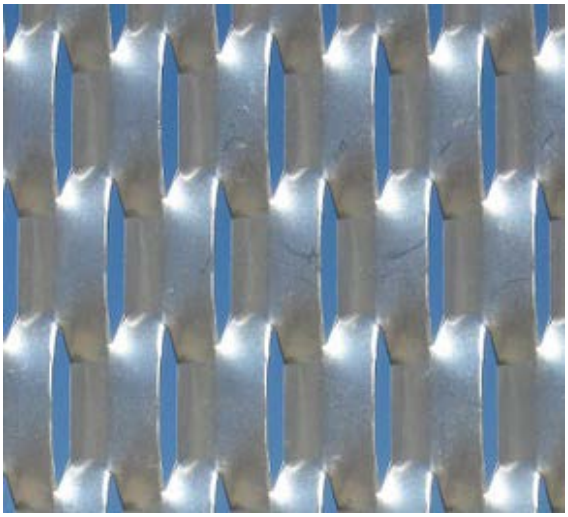
Name: _____ Date: _____

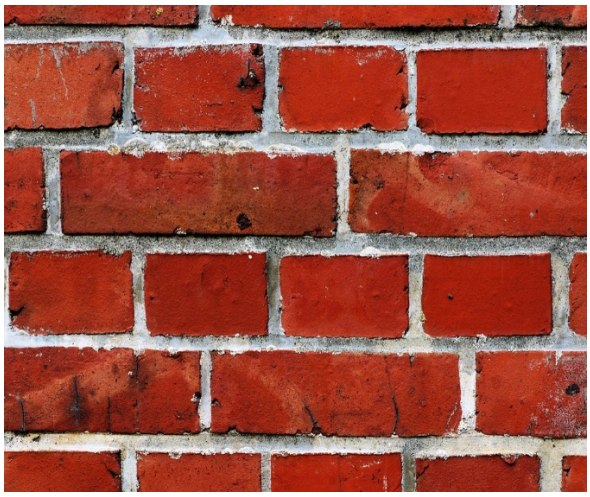
Name: _____ Date: _____

Materials Match



Name: _____ Date: _____





Name: _____ Date: _____

House or apartment building	**Car**
Teddy bear	**Soccer ball**
Straw	**Jeans**

Name: _____ Date: _____

Swimming suit	**Playground equipment**
Roads	**School building**
Pillow	**Spoon**

Name: _____ Date: _____

Can I use *this* to make *that*?

The product(s) _____ (can / cannot) be made with the material _____ because _____.

The product(s) _____ (can / cannot) be made with the material _____ because _____.

The product(s) _____ (can / cannot) be made with the material _____ because _____.

Name: _____ Date: _____

Name: _____ Date: _____

Design Brief: Experiments for Properties of Materials

Design Problem	Words to Remember/ Palabras para recordar
Design a way to find a material that is the most elastic. [OR] **Design a way to find a material that has the most shear strength.** [OR] **Design a way to find the best material that can be compressed without breaking.** [OR] **Design a way to find the best material that can be stretched without breaking.**	

Drawing or Model of Our Plan (You can use the back of the page, too!):

Steps	
Task	**Person Responsible**

Name: _____ Date: _____

Testing properties of materials.

For this experiment, we want to test _____.

To do this, we first need to_____

_____.

Second, _____

_____.

Then, _____

_____.

After that, _____

_____.

Finally, _____

_____.

Feedback Sheet

For Group: _____

From Group: _____

Instructions: Use this sheet to give respectful and helpful feedback about another team's design brief. Make an "*X*" on each line in the place showing how much you agree or disagree with each sentence.

1) We knew what we were supposed to test.

Strongly Disagree **Neutral** **Strongly Agree**

2) It was easy to follow your test.

Strongly Disagree **Neutral** **Strongly Agree**

3) We understood the different steps.

Strongly Disagree **Neutral** **Strongly Agree**

4) We got different results each time we tried your test.

Strongly Disagree **Neutral** **Strongly Agree**

5) One thing that we really liked was _____.

6) One thing that you could improve is _____.

Name: _____ Date: _____

Last remarks

The _____ (passed / did not pass) our test.

We were especially interested in the material _____

because _____.

One important thing that we learned about testing materials

was _____.

Unit 3 (Structures):
Making a Strong Frame

Concept
We can build a frame as a basic strong structure with wood and cardboard right triangles. The frames can be expanded into a box shape.

Teacher Preparation
Copy the design problem onto colored paper. Make a sample frame (see Figure 12, Teacher Handbook, p. 22).

Content Objective
Students use cardboard right triangles and adhesive to construct two basic wood frames the same size. The students add on to their wooden (flat) frames to make a wood box frame.

Language Objective
Use drawings and sentences to strategically demonstrate understanding of structures, using adjectives (e.g., *strength, weakness*).
Describe actions using *present progressive tense (verb+ing).*
Summarize the box construction using *past tense verbs*.

Standards
- **NGSS:**
  - **2-PS1-1.** Plan and investigate kinds of materials and their observable properties.
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.
- **TEKS:**
  - **2E** communicate observations and justify explanations using student-generated data from simple descriptive investigations (justify explanations of own data)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **5A** classify matter by physical properties, including shape, relative mass, relative temperature, texture, flexibility, and whether material is a solid or liquid (phy prop: shape, mass, temp, texture, flexibility, solid v. liquid)
  - **5D** combine materials that when put together can do things that they cannot do by themselves such as building a tower or a bridge and justify the selection of those materials based on their physical properties (combine materials for purpose)

- **ELPS:**
  - **1C** use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary (strategic learning techniques such as concept mapping and drawing)
  - **3C** speak using a variety of grammatical structures, sentence lengths, sentence types, and connecting words with increasing accuracy and ease as more English is acquired (speak using a variety of grammatical structures)
  - **5E** employ increasingly complex grammatical structures in content area writing commensurate with grade-level expectations, such as using correct verbs, tenses, and probnouns/antecedents, using possessive case correctly, and using negatives and contractions correctly (employ increasingly complex grammatical structures including, i. tenses)
  - **5G** narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired (narrate, describe, explain through writing)

Materials:
Wood strips; craft or popsicle sticks; low temp glue gun; glue sticks; wood glue; right triangle corners, cut paper shapes for triangle blueprints; newspaper to protect gluing table surface; crayons and paper; sample frame and one box frame sample; other construction materials such as cardboard, posterboard, construction paper; fan or hair dryer to test

Suggested Literature Connections
"Buildings and Structures" by Andrew Solway
"Building the Empire State Building: An Interactive Engineering Adventure" by Allison Lassieur

Day 1: Engage/Explore Structures-Making a Frame and Box

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask students to share their recollection of the story of the *The Three Little Pigs*. Discuss the structures of the three houses the pigs made. Distribute handout (**2.3.1**) with questions to student pairs and ask them to think of answers to each of the following questions: • *Why was the wolf able to blow down the house that was made of straw?* • *What makes a material strong?* • *Why did they get blown over?* • *Which way was the force of the wolf breath pushing on the structure?* 2. Give a few minutes for discussions, and then have student pairs share their ideas with the rest of the class. 3. Explain how strength is important in structures we build and how that strength allows the structures to hold different shapes. 4. Show the Zoom video on *Finding the Strongest Columns*: http://www.pbslearningmedia.org/asset/phy03_vid_zcolumnsi/ Ask what happened to the rectangular column. Emphasize the importance of materials and shape in making a strong structure. 5. For demonstration, consider using different paper shapes to compare the way they hold weight (i.e. a 2D rectangle vs. a 3D prism). Discuss strength in the little pigs' houses, school buildings, etc. 6. Tell your students that triangles can be used to make a type of frame that can be used to reinforce structures.	Students discuss the questions in pairs. Student pairs discuss what happened in the video.	The wold was able to blow down the house that was made of straw because _____. The strength of his blow breath was pushing _____. A material is strong when _____. The wold was not able to blow down the house made out of bricks because _____. Vocabulary: structure, predict, even, edges, frame

7. Show the video that highlights the importance of using triangles in bridges: https://www.youtube.com/watch?v=oVOnRPefcno 8. Show the students a sample frame you have made, and point out the triangles in the corners. See handout (**2.3.2**) as reference. 9. As a class, construct a similar frame, using adhesive to hold the right triangle corners onto the junction of each pair of rectangular pieces. You may want to create a paper blueprint for the construction of the triangles and/or frames. Model the use of active language as you work (making, gluing, pressing, etc.). 10. In pairs, ask your students to think of similar frames that they have seen in the "real world." Use handout (**2.3.3**).	Students draw three examples of frames from their house or the school.	

Day 2: Explain/Elaborate Structures-Making a Frame and Box

Teacher Says/Does	Student Says/Does	Language requirements
1. Tell your students that they will now be engineers themselves and design and construct houses (similar to *The Three Little Pigs*) using different types of frames like the ones they constructed. Their houses can either be rectangular or not. The purpose is for students to explore the strength of frames and how these can be assembled to create a structure. Do not give too much importance on the ahestetics of the house. 2. To recall previous knowledge, ask the students to think and share what a stable house needs. 3. Consider the following additional requirements: • The pig house stand in the same place after a wind (hairdryer or fan) has blown on it. • The pig house must resist some sort of weight (stapler, wooden blocks, etc). 4. To maintain fairness, tell your students that the same amount of time and distance will be used for the fan or hairdryer (wind test), and the same weight will be applied for the same amount of time to all the houses (resistance test). 5. *Optional.* You may wish to add a constraint that the houses are about the same size. You can do this by saying that the "footprint" of the house be not bigger than 6" by 6" (15 cm x 15 cm). This means that the base of the house will fit exactly onto a square that size. You may also wish to have a height limitation. 6. Organize students in pairs or groups as convenient and give them the following design brief:	Student pairs discuss. Student teams complete their design briefs. Student groups start work on their boxes. Students take notes on their vocabulary sheets.	Vocabulary: structure, predict, even, edges, frame

Design Brief: Design and construct a “house” that can withstand wind and weight 7. Give each pair/group a copy of handout (**2.3.4**), and talk with partners or within their groups to resolve any meanings, and plan who will do the different jobs. 8. Have teams start creating a plan for their model. Tell them to make several preliminary sketches, select one, and make a labeled sketch that can be used to present to the class. 9. Finally, let teams work on their houses. 10. Encourage your students to construct their houses using frames made of any materials that they want (paper, cardboard, straws, tape, etc). 11. Discuss additional uses/forms of the vocabulary words, such as: prediction, predicting, framing, ‘even’ in math different from ‘even’ here meaning ‘level’ and ‘smooth.’		

Day 3: Evaluate Structures-Making a Frame and Box

Teacher Says/Does	Student Says/Does	Language requirements
1. Before testing, model the process of summarizing the steps of the project of an individual pig house. Use handout (**2.3.5**) as a reference. Draw attention to the regular and irregular past tense verb forms like: • *Glued* • *Built* • *Stuck* • *Looked* • *Connected* • *Worked*	Student pairs first discuss their answers, and then share in the whole group.	Vocabulary: stable, wind resistance, sturdy, weak
2. When they are finished, have them evaluate their houses with you, using some of the questions such as: • *What shapes do the faces of your house makes?* • *Did you use triangles to make your frames stronger?* • *What materials is your house made from? (wood, paper, glue)* • *What kinds of fasteners did you use to hold pieces together? Would these fasteners work on a real house?* • *What were some obstacles the team had to figure out before they could finish the house?*	With the assistance of the teacher, students test their structures. Students participate in a discussion about stability.	Regular and irregular past tense verb forms
3. It is time to test the houses! Go ahead and handle the air supply and weight and test each team pig house for stability.		
4. At the end of the tests, ask your students questions like: • *Which structures are more stable? Why?* • *Which frames were the most stable? The ones with triangles? Tape? Other materials?*		

• *Which shapes (triangles, squares, circles) seem to make structures that are best balanced—that is, they do not easily fall over?* 5. Have student pairs write a summary of their projects using the flow chart (handout **2.3.6**). Have student groups present their unique process to the rest of the class.	Student teams write a summary in the flow chart using past tense verbs.	

Name: _____ Date: _____

Strong vs weak materials

The wolf was able to blow down the house that was made of straw because _____

_____.

The strength of his breath was pushing _____

_____.

A material is strong when _____

_____.

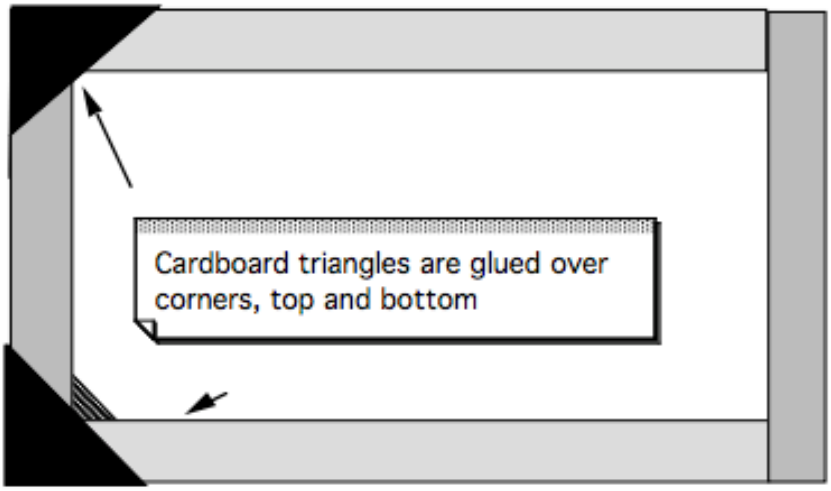
The wolf was not able to blow down the house made out of bricks because _____

_____.

(Teacher Reference)

Basic Wood Frame with Cardboard Triangle Corners

HOW TO MAKE SOME



MODELS

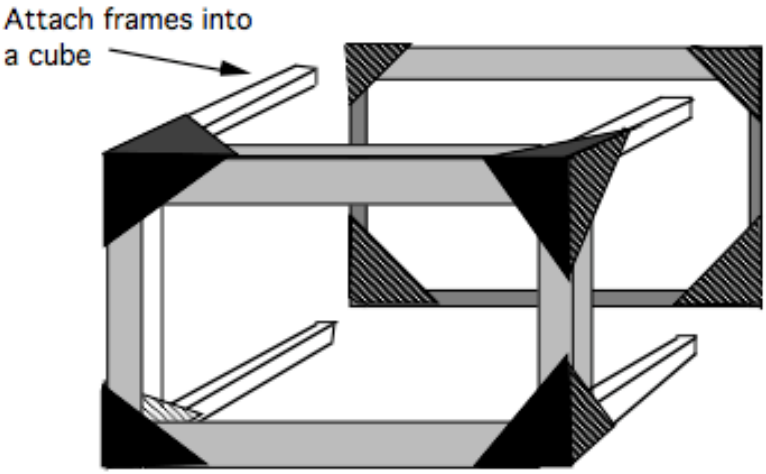


FIGURE 12. CONSTRUCTING A FRAME

Name: _____ Date: _____

Examples of Frames

Instructions: Draw 3 examples of frames using triangles that you can remember seeing in the past.

Drawing of example 1

Drawing of example 2

Drawing of example 3

Name: _____ Date: _____

Design Brief: Making a strong structure

Design Problem	Words to Remember/ Palabras para recordar
Design and construct a "house" that can withstand wind and weight.	• Structure • Predict • Even • Edges • Frame • Resist

Drawing or Model of Our Plan (You can use the back of the page, too!)

Steps	
Task	**Person Responsible**

Name: _____ Date: _____

Creating a strong structure

For this design brief, we wanted to create _____.

To do this, we first need to_____

_____.

Second, _____

_____.

Then, _____

_____.

After that, _____

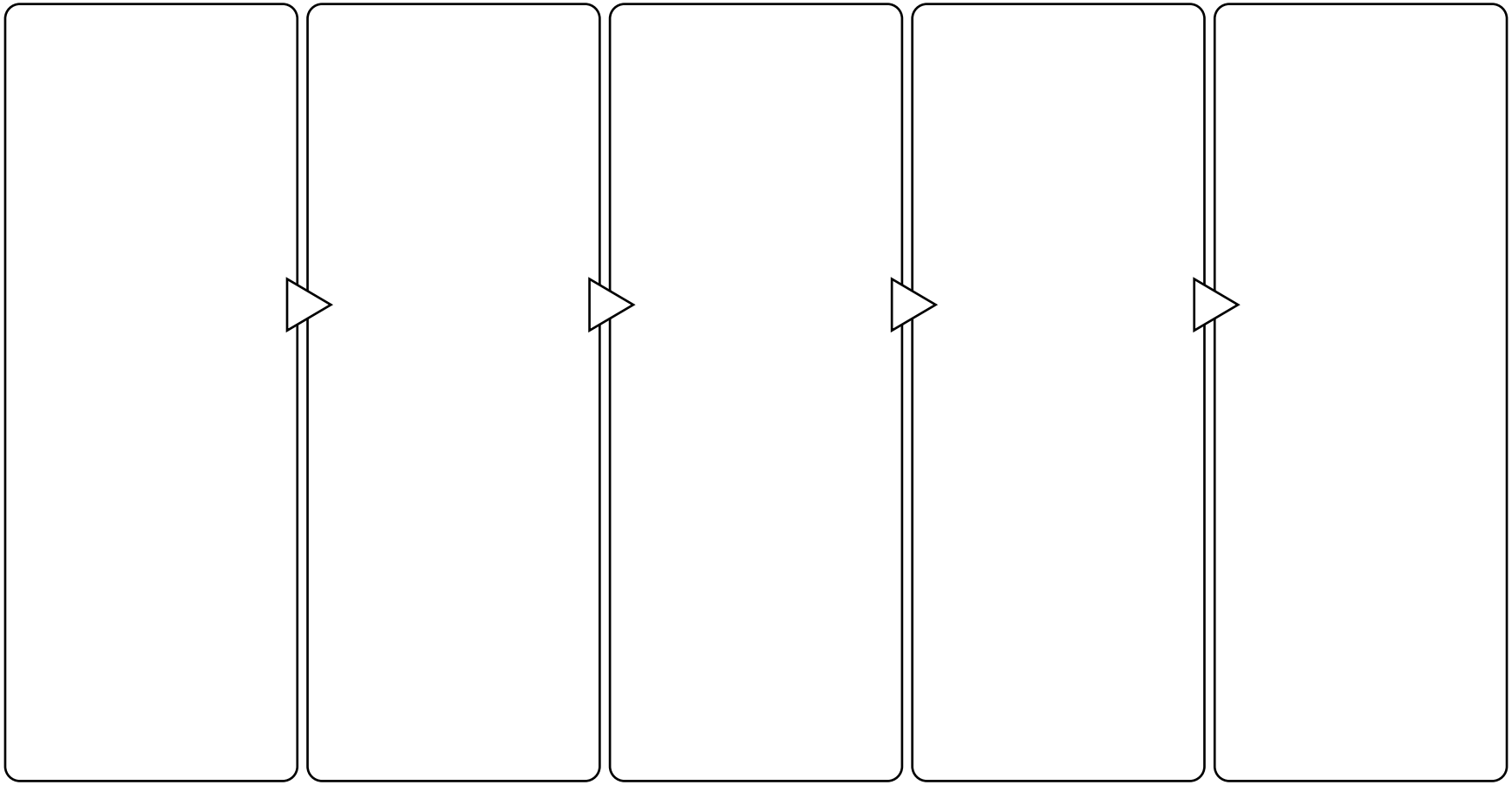
_____.

Finally, _____

_____.

Name: _____ Date: _____

Instructions: Summarize your process of creating your "house" by thinking about EVERYTHING you did and writing only the most important parts in order.



Unit 4 (Mechanisms):
Weird Wheels and their Axles

Concept
Various shapes of wheels and placements of axles cause the motion from mechanisms to differ.

Content Objective
Using cardboard disks as wheels, teams explore different places of connection with axles and describe the motion that results.

Language Objective
Compare features of wheels and shapes using comparatives (-er and -ier).
Describe actions using target vocabulary: *axle, cam, center, off-center, edge,*
Students will also be able to use mortar words: *Distinguish, observe*, *model, adaptations*
Describe spatial relationships using prepositions and prepositional phrases in writing, e.g., *through, around, near*

Standards

- **NGSS:**
  - **2-PS1-1.** Plan and investigate kinds of materials and their observable properties.
  - **2-PS1-2.** Analyze data from materials to determine which have best properties for an intended purpose.
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.

- **TEKS:**
  - **3A** identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat (explain prob and solution)
  - **6C** trace the changes in the position of an object over time such as a cup rolling on the floor and a car rolling down a ramp (trace changes in position)
  - **6D** compare patterns of movement of objects such as sliding, rolling, and spinning (compare patterns of movement)

- **ELPS:**
  - **2A** distinguish sounds and intonation patterns of English with increasing ease (distinguish sounds and intonations)
  - **3B** expand and internalize initial English vocabulary by learning and using high-frequency English words necessary for identifying and describing people, places, and objects, by retelling simple stories and basic information represented or supported by pictures, and by learning and using routine language needed for classroom communication (expand and internalize English vocabulary)
  - **3E** share information in cooperative learning interactions [Communicative Competence]

- **5F** write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired(write using a variety of patterns, connecting words, clauses)

Materials:
Paper fasteners, posterboard; assorted 2D geometric shapes from handout (**2.4.2**): hexagon, oval, square, circle, triangle, with holes in the center and off-center; also, model of cam and lever on posterboard from handout (**2.4.7**).

Suggested Literature Connections
"Wheels" by Lisa Owings
"Simple Machines" by Deborah Hodge

Day 1: Engage/Explore Mechanisms-Weird Wheels and their Axles

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask students to describe what wheels look like. *In what ways do wheels move? In what ways are wheels attached to objects?* Ask them to describe the wheels and axles they have seen. 2. Walk around the neighborhood or school grounds and look at the ways that wheels differ and are the same. *What are some other ways vehicles move?* 3. Back inside, show the students the geometric shapes handout (**2.4.1**). Ask them how they could figure out which shapes are wheels and would let objects roll. 4. Consider showing the following videos: • Simple Machines-Wheel & Axles: http://www.teachertube.com/video/simple-machines-wheel-axle-2229# • The Axle and The Wheel: https://www.youtube.com/watch?v=XlZYPFDjTJM 5. Explain the exit slip (handout **2.4.2**) to the students.	Students turn and talk to their classmates. Students observe their surroundings and draw their observations on the field notes sheet. Students write comparative sentences about wheels that they saw on the walk.	Vocabulary: Rougher, smoother, thicker, thinner, bigger, smaller, wider, narrower, skinnier. The _____is _____ than the _____.

Day 2: Explore/Explain Mechanisms-Weird Wheels and their Axles

Teacher Says/Does	Student Says/Does	Language requirements
1. In groups of 2, give your students the handout (**2.4.3**) and explain to them that they will have to cut the 2D geometric figures and that they will explore what geometric figures make the best wheels. 2. Once the figures are cut, ask them to try pushing a pencil through the shapes and find out how the shape would travel if the pencil were the axle. (If possible, try to print these handouts in cardstock paper so that it doesn't tear that easily when punctured). 3. Encourage your students to puncture the geometric figures (especially the non-round ones) on places besides the center-points to explore if this improves the movement of the "wheel". 4. Bring the class together to discuss their findings. Sort the posterboard shapes into "rolls" and "doesn't roll" categories. 5. Discuss what the motion of the shape looks like when the axle is placed in the center and then off-center.	Student pairs try to make different shapes roll. Students sort the different shapes.	

Day 3: Explore/Explain Mechanisms-Weird Wheels and their Axles

Teacher Says/Does	Student Says/Does	Language requirements
1. Write the word “cam” on the chart. Explain to your students the difference between a “wheel” and a “cam”. A wheel is a circle whose axle is located in the center-point. A cam is a wheel-like mechanism that also rotates on an axis, but the motion is uneven either because the axle is placed off-center or because the cam is not round Look at handout (**2.4.4**) for a more detailed explanation. 2. To demonstrate, place a pencil point through an oval shape. Rotate the oval, and let students see the uneven motion of the turning as the wide and narrow part of the shape go around. Then, place the pencil point through an off-center hole in a circle shape, and let the children look at the motion. Again, the shape turns unevenly. 3. Show the following animated image to further elaborate on what a cam is • https://s-media-cache-ak0.pinimg.com/originals/37/f3/10/37f3102c49f8443dde235e2032356c16.gif • http://www.technologystudent.com/cams/pear_cam3.gif • Toy using cam: http://3.bp.blogspot.com/_W0KVcM-07hE/R4BdgePjS-I/AAAAAAAAABw/M3cdloa0uis/s200/edty18.gif 4. Ask students to distinguish between what is a cam and what is not a cam by using handout (**2.4.5**). 5. Explain the exit slip (**2.4.6**) about an example and non-example.	Students repeat word and mimic movements with body. Student pairs discuss. Students write a summary sentence for the exit slip.	Vocabulary: Close = near / far Edge/ center A cam is _____.

Day 4: Elaborate Mechanisms-Weird Wheels and their Axles

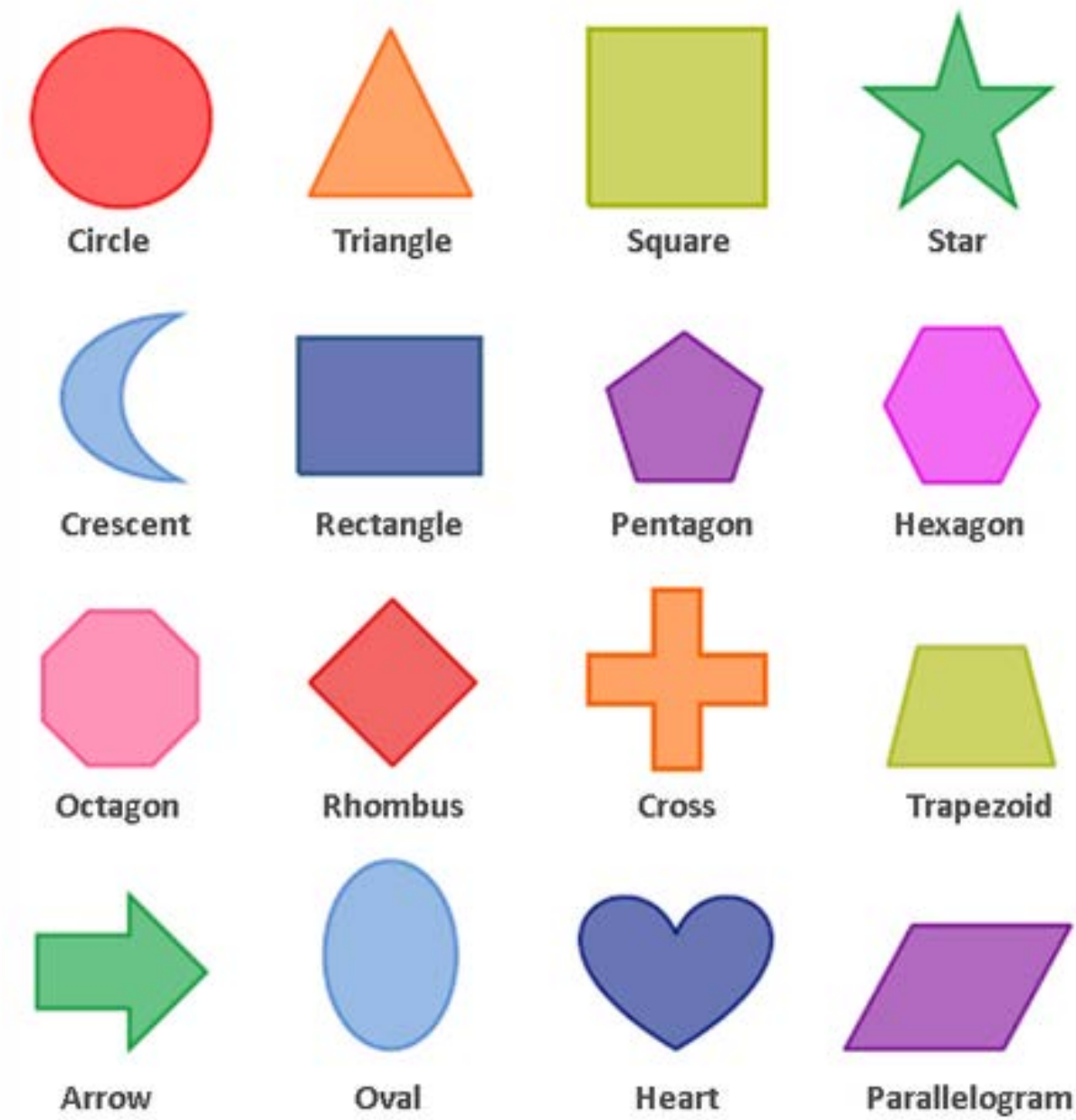
Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students your model of a cam and lever on posterboard. (See handout **2.4.7** as a reference). 2. Ask teams to analyze the model with you, observing what happens to the lever when the cam is turned. Let them suggest changes to your model, and try their suggestions. For example, they may want to lengthen your lever (substitute a longer strip of tagboard), or may want to try a camshaft type of device. 3. If you wish, ask the teams now to make a model like yours. 4. Discuss additional uses of cams.	Students do a think-pair-share. Student pairs make changes to the cam and observe the resulting changes in movement. Students take notes on their vocabulary sheets. Direct students to look for ***cam and lever models*** in their homes, with their parents or famiies.	Vocabulary: Close = near / far Edge/ center

Day 5: Evaluate Mechanisms-Weird Wheels and their Axles

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask a student to describe the changes in motion produced by working the cam. 2. Model completing a section of the cause/effect graphic organizer and assign one to your students as their exit slip. (Handout **2.4.8**).	Student pairs complete the cause/effect graphic organizer.	Vocabulary: Rougher, smoother, thicker, thinner, bigger, smaller, wider, narrower, skinnier. Close = near / far Edge/ center When the axle is _____, the wheel _____.

Different Geometric Figures

Which of these geometrical figures could be used as wheels?



Exit Slip

Name _____ Date _____

Write comparative sentences about wheels that you saw on the walk.

1) The _____was _____ than the _____.

2) The _____was _____ than the _____.

3) The _____was _____ than the _____.

Exit Slip

Name _____ Date _____

Write comparative sentences about wheels that you saw on the walk.

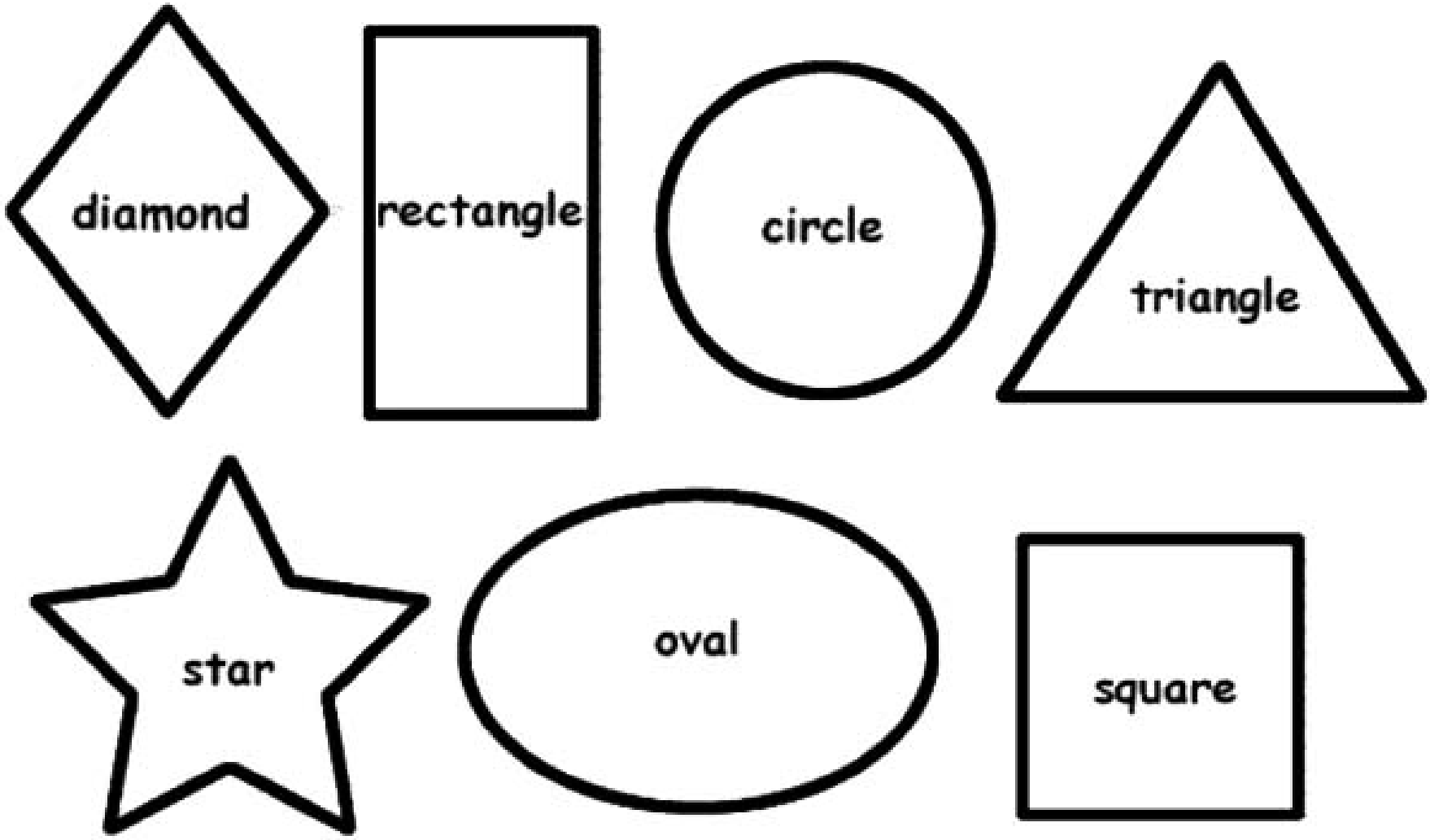
1) The _____was _____ than the _____.

2) The _____was _____ than the _____.

3) The _____was _____ than the _____.

Different types of 2D Geometric Figures

Cut the 2D geometric figures below and try poking them with a pencil to create wheels out of them. Think of the following questions: Which figures serve best as wheels? What if you poke them in different places?



(Teacher Guide)

Cams

Cams are "eccentric wheels," mechanisms that rotate about an axis like a wheel, but the motion is uneven either because the axle is placed off-center or because the cam is not round. Look at these examples:

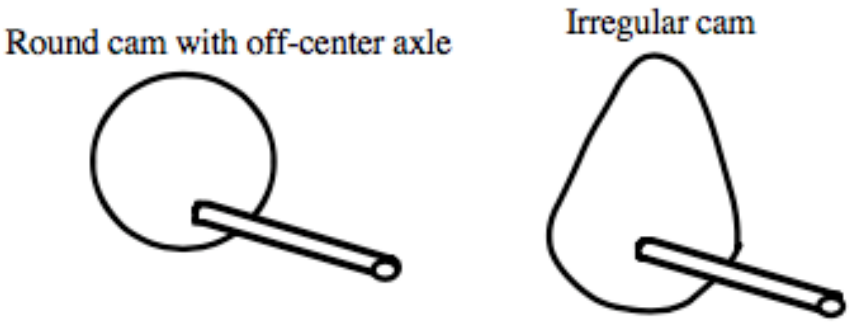


FIGURE 7. ROUND AND IRREGULAR CAMS

Cams are paired with "followers," levers or shafts that move in a rocking or up-and-down fashion as the cam turns. Figure 8 shows sequential steps of a cycle of two cams—round and irregular—and its follower (in this case the follower is a lever).

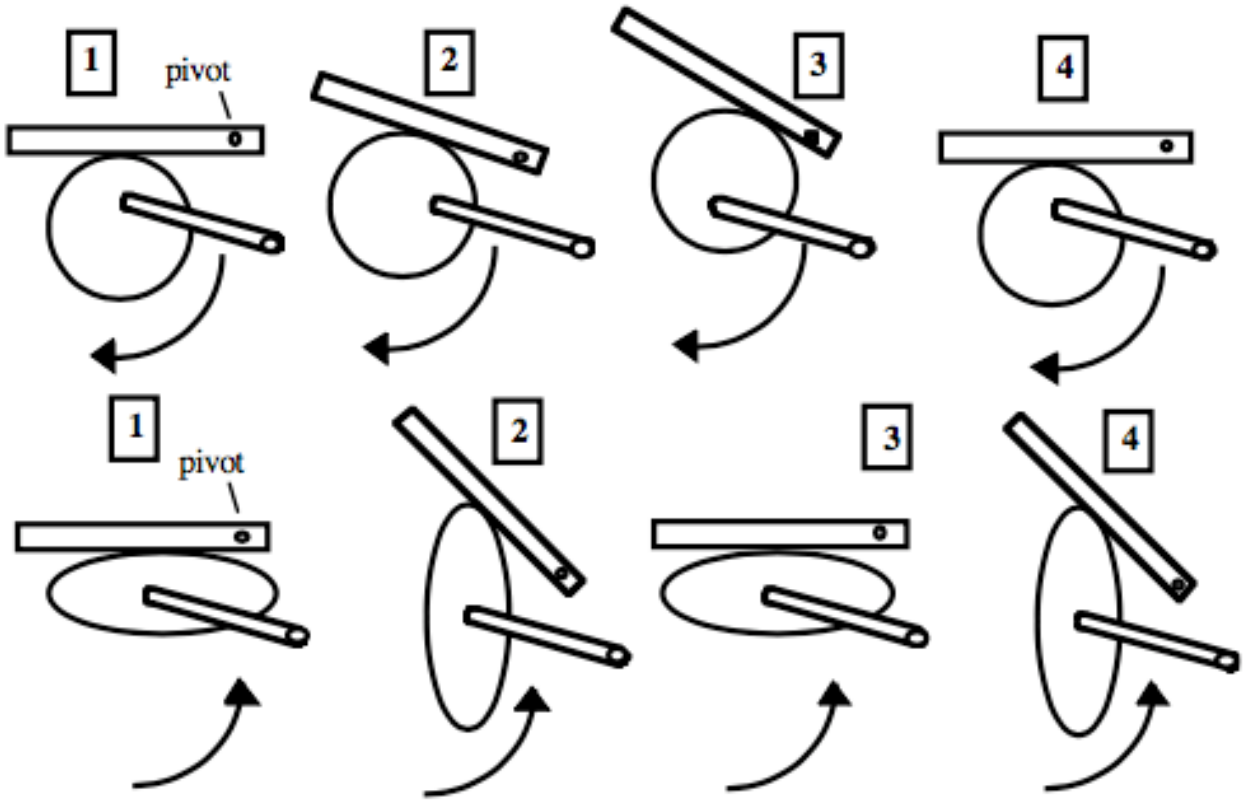


FIGURE 8. THE CYCLES OF TWO CAMS

Figure 9 shows the same cams with shafts rather than levers as followers.

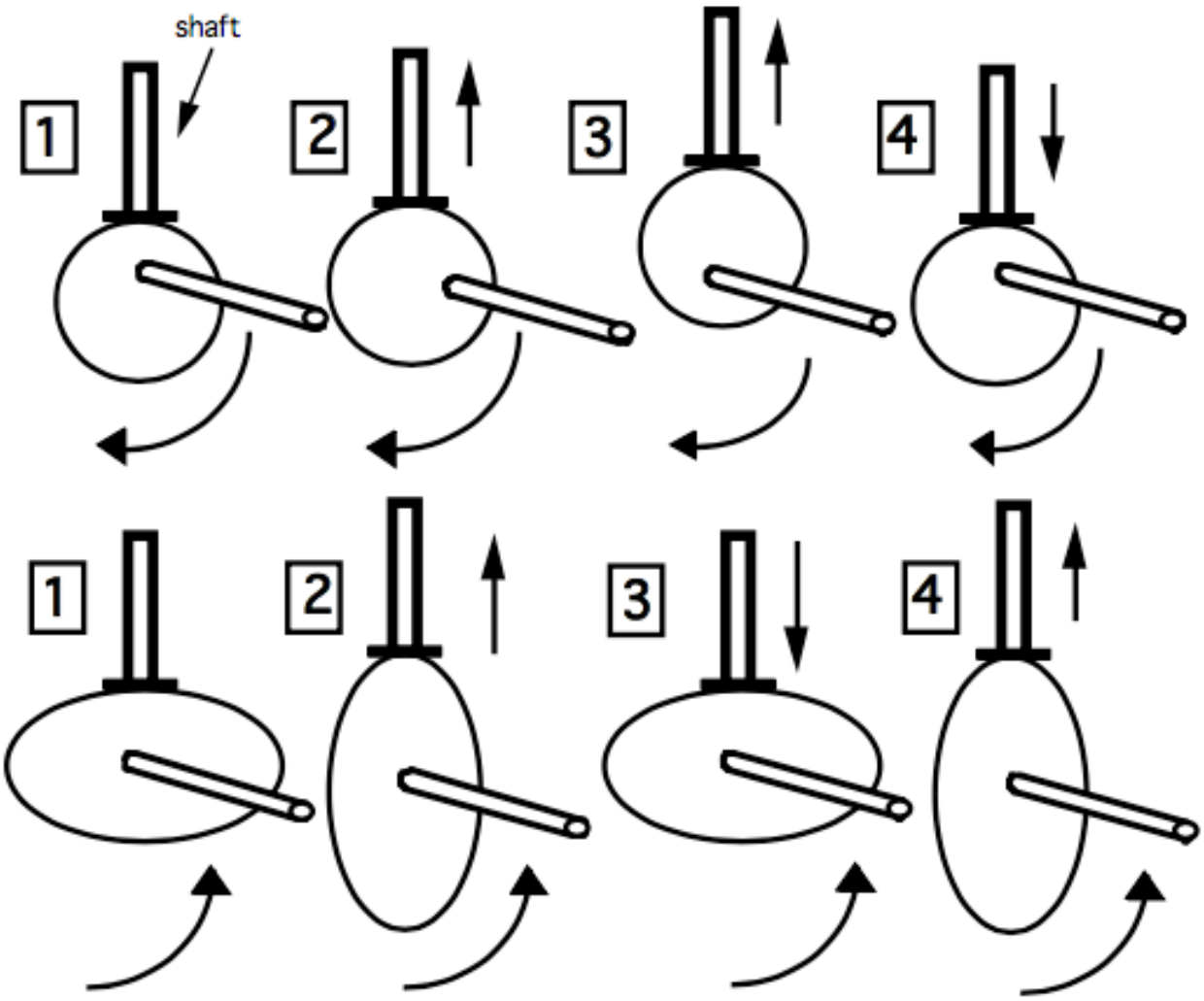
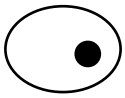
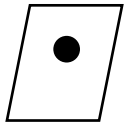
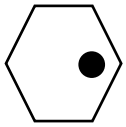
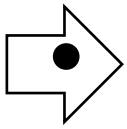
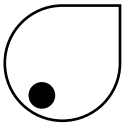
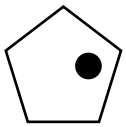
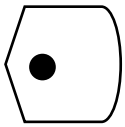
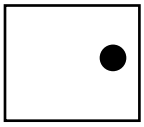
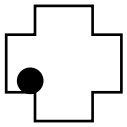
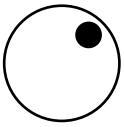
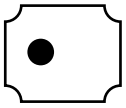
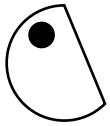
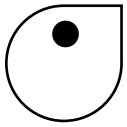


FIGURE 9. Cams with camshafts as followers

Name _____ Date _____

Directions: Look at the figures below, and separate them according to whether they are a cam or not. The black dot represents where the axle would be located.

Cam			Not a Cam		
					
					
					

Define a Cam:

A cam is a …

_____

_____

_____

_____

_____

Cam Uses:

A cam can be used in …

_____

_____

_____

_____

_____

Exit Slip

Name _____ Date _____

Draw an example and a non-example of a cam.

Example	Non-example

Exit Slip

Name _____ Date _____

Draw an example and a non-example of a cam.

Example	Non-example

(Teacher Guide)

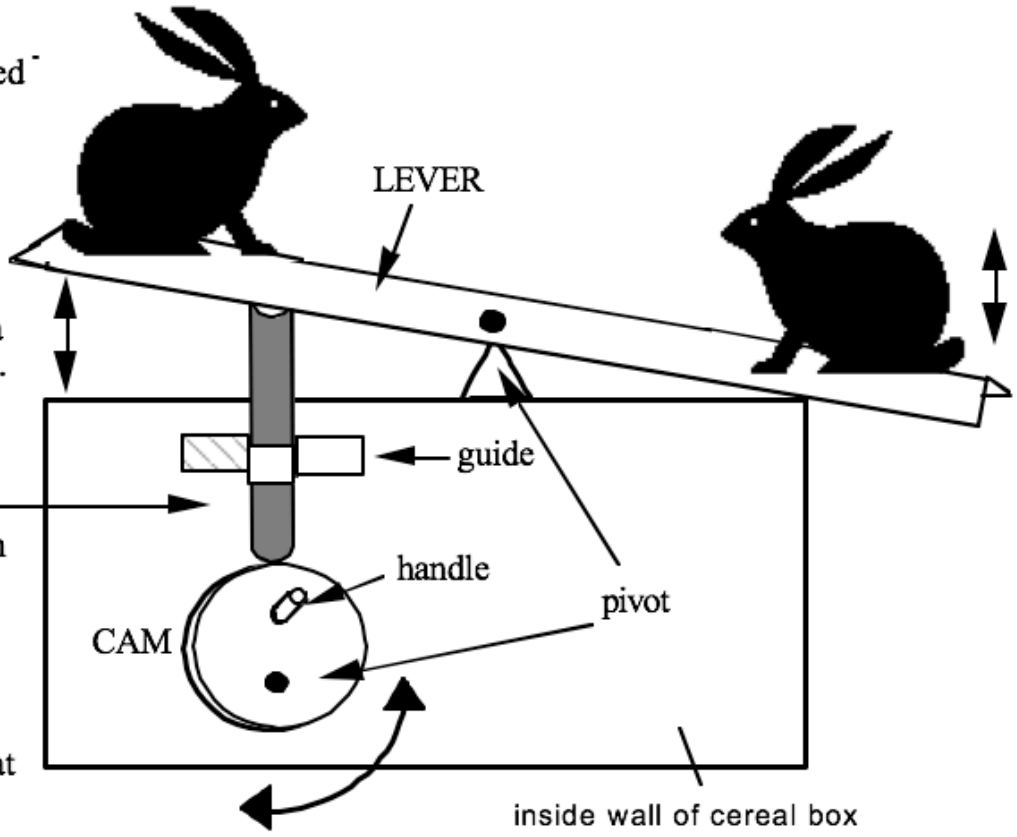
Turn the handle and the rabbits go up and down!

LEVER:
Make this from folded posterboard.

CAM:
This is a thick cardboard wheel or container lid, with off-center hole, and a handle to turn it with.

CAMSHAFT, OR FOLLOWER:
Made from a toilet paper tube, it rests on the cam and goes up and down.

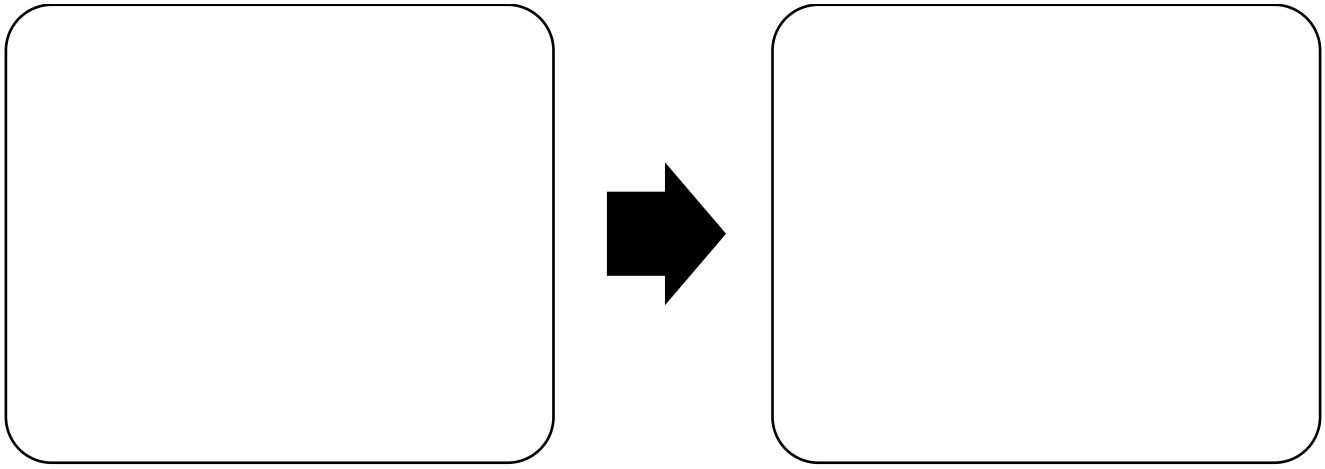
GUIDE:
This is a strip of tagboard or paper that keeps the camshaft going in a straight path



Cause/Effect Graphic Organizer

Name _____ Date _____

Describe the changes in motion produced by working the cam.



When the axle is _____,

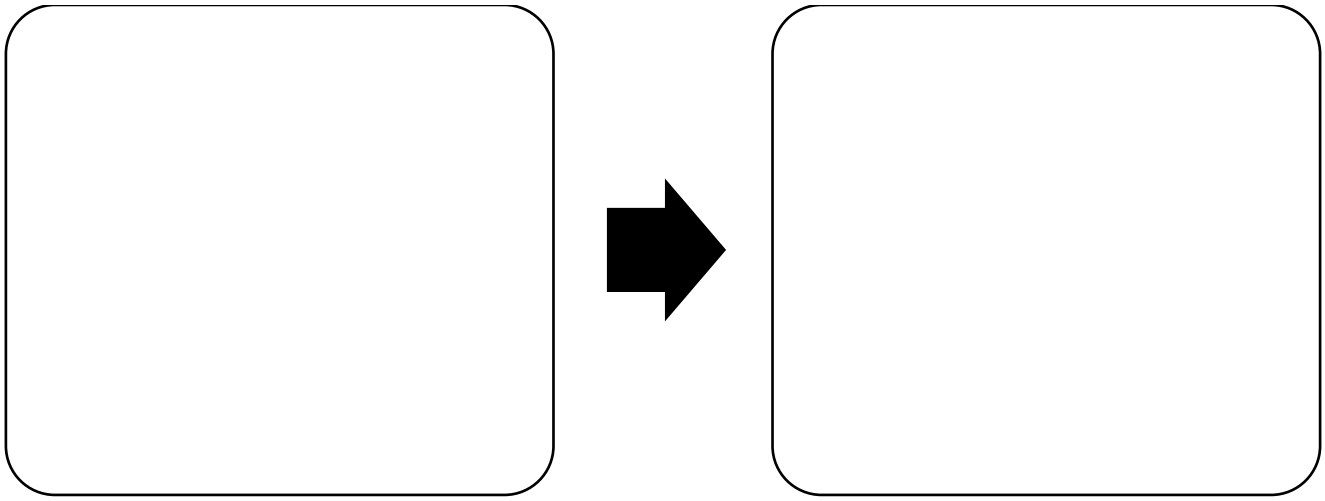
the wheel _____.

When the axle is _____,

the wheel _____.

Name _____ Date _____

Describe the changes in motion produced by working the cam.



When the axle is _____,

the wheel _____.

When the axle is _____,

the wheel _____.

Unit 5 (Work & Energy):
Black Box Thinking

Concept
A system is a group of parts working together as a whole; a system has input and output.

Content Objective
Teams identify input and output components of everyday situations and make side-view sketches of simple work systems. “Black box thinking” is used to analyze folders from other teams in which an event/system is inferred by its input and output.

Language Objective
Collaborate with peers and ask for clarification when needed.
Explain systems using *target vocabulary*: input, output, system, cause, effect.
Predict the output of a system using *future tense*.

Standards
- **NGSS:** No NGSS standards apply directly to this lesson.

- **TEKS:**
  - **3A** identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat (explain prob and solution)
  - **3B** make predictions based on observable patterns (predict from patterns)
  - **3C** identify what a scientist is and explore what different scientists do (connect to adult scientists)

- **ELPS:**
  - **1C** use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary (use strategic learning techniques such as concept mapping, drawing, etc.)
  - **2I** demonstrate listening comprehension of increasingly complex spoken English by following directions, retelling or summarizing spoken messages, responding to questions and requests, collaborating with peers, and taking notes commensurate with content and grade-level needs (follow directions, summarize, collaborate with peers)
  - **3D** speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency (use vocabulary)
  - **3H** narrate, describe, and explain with increasing specificity and detail as more English is acquired (narrative, describe, explain while speaking)
  - **5G** narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired (narrative, describe, explain while writing)

Materials:
manila folders (1 per team), construction paper, crayons and markers, glass or cup of water

Suggested Literature Connections
“Pushes and Pulls” by Anna Claybourne
“Push and Pull: The Way Things Move” by Lola Binding

Day 1: Engage Work & Energy- Black Box Thinking

Teacher Says/Does	Student Says/Does	Language requirements
1. To have a better sense of the concept that will be covered in this unit, review handout (**2.5.1**) prior to beginning lesson. 2. Without your students seeing, place a small puddle of water on the floor and lay a cup or glass down on its side next to the puddle. Then, when you have the students' attention, ask them what they would think if they came home and found a scene like this: a spilled cup of water. [Note: This will be later called the OUTPUT]. Let them tell their ideas. 3. Tell the students that many different things could have happened to make that spill. Ask your students, *What do you think <u>happened during</u> the event that lead to the spill?* [Note: This will later be called SYSTEM]. Take one of the children's ideas and draw roughly the event she or he feels could have led to the spill, such as the family cat getting startled and bumping into the cup of water. Ask the children, *What <u>started</u> the event?* [Note: this will later be called the INPUT] then circle the picture that shows that, or draw another. Dog could have entered the kitchen, thus startinling the cat, for example. Then ask, *What was the <u>result</u> of those events?* [Note: as mentioned earlier, this will be called the OUTPUT]. The water is spilled, and the floor is wet. 4. Let them know that this kind of thinking is called “Black Box Thinking” typically implemented by engineers / scientists in which they know what they want to put into a SYSTEM they are designing [INPUT] and what they want to produce out of it [OUTCOME] but the SYSTEM itself is yet to be designed / created. They then get toghether and go through several rounds of experimentation and hypothesizing until the SYSTEM is formulated / created.	Student pairs think-pair-share about their inferences for the spill. Student pairs think-pair-share	Vocabulary: infer, work, system, input, output Terminology: INPUT: What goes into a SYSTEM SYSTEM: A series of events / mechanisms with the goal of producing an outcome. OUTPUT: What is produced by the SYSTEM Black Box Thinking: Hypothesizing on what the SYSTEM is composed of.

5. Going back to the classroom example, you can tell your students that in your particular example, the water spilled is the OUTPUT of your SYSTEM, the dog entering the kitchen is the INPUT of your SYSTEM, and that your SYSTEM itself is composed of the events that occurred that lead to the water getting spilled. Use the following diagram as a teacher reference: **[INPUT] → system of events → [OUTPUT]** **[INPUT]** dog enters kitchen 1. dog sees cat 2. dog runs toward cat 3. cat jumps up on counter 4. cat bumps into cup of water **[OUTPUT]** cup tips over **System (Version 1)** 6. Make sure to fully elaborate the new terminology so that there is no confusion as to what INPUT, SYSTEM, and OUTPUT is. 7. Cover up the events other than the input and output events [or SYSTEM], and ask the children for another sequence of events [or SYSTEM] could have resulted in the same output. Look below for a different example: **[INPUT] → system of events → [OUTPUT]** **[INPUT]** dog enters kitchen 1. dog barks at cat 2. barking scares little brother 3. little brother drops cup **[OUTPUT]** cup tips over **System (Version 2)**	Student pairs collaborate on a drawing storyboard with labels and captions. They ask each other and teacher for clarification when needed. Student pairs conversate and hypothesize on different types of SYSTEMS for their classroom example. They ask each other and teacher for clarification when needed.	Question Stems: Could you please repeat that? What did you mean by _____? So you think that _____?

8. Remind your students that in a broader sense, the system of events or mechanisms is typically blank or unknown, but that the INPUT and OUTPUT can be described in terms of “work” that is done. Tell the students that when you are talking about work here, you mean using energy, such as moving something or making something new.		

Day 2: Explore/Explain Work & Energy- Black Box Thinking

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask your students to consider a funny story from their lives or someone they know, and to continue using the following way of thinking: INPUT → SYSTEM → OUTPUT	Student pairs share a funny story for their lives.	
2. To do this, the students will be assigned the following design brief: **Design Brief: Creating a Black Box Model** Create a Black Box Model using a funny story that occurred to you or someone you know.		
3. Hand your students the handout (**2.5.2**) in which they will be guided in writing their funny story and separating it into the INPUT, SYSTEM, and OUTPUT sections for the Black Box Model. Students can work individually or in pairs, but encourage them NOT to share their stories with other classmates and to wait until the very end to do so.	Students draw and write captions using vocabulary.	
4. After doing so, the Black Box Model foldables can be created with handout (**2.5.3**), which also includes instructions on how to assemble.	Student teams discuss their design briefs.	
5. Let the teams work on making their foldables in which they will write down their story's INPUT and OUTPUT, and they will write their SYSTEM behind the folded paper so that it is hidden. Encourage them to sketch and color a picture that can go with their SYSTEM from a scene they wish to illustrate. When they are done, they should be ready to discuss the input and output from their system and share their design briefs.	Student hypothesize different SYSTEMS based on their peers' Black Box Model presentations	Vocabulary: infer, work, system, input, output

6. Once complete, ask a couple of your students to share their Black Box Model foldables with the SYSTEM section closed, and ask the rest of the class to guess what were those events (or SYSTEM) that occurred between the INPUT and the OUTCOME of the story. You may like to laminate a teacher-example handout so that you can draw and then wipe-off different examples of events inside a black box system. 7. Tell your students that they will get an opportunity to write down their predictions later. 8. While the students are working, use the **collaborative dialogue template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives.		

Day 3: Elaborate/Evaluate Work & Energy- Black Box Thinking

Teacher Says/Does	Student Says/Does	Language requirements
1. Review vocabulary from the unit. 2. After the teams have had a chance to complete their Black Box foldables, number the foldables and post them around the room. 3. Explain how the students should move around the room and now write their predictions about what will happen to produce the output. (Use handout **2.5.4**). 4. While the students are completing their predictions, ask questions like the following: • *What work is going into your SYSTEM? (INPUT)* • *What work is coming out of your SYSTEM? (OUTPUT)* • *How well does your prediction match the actual SYSTEM of your peer?* • *How is your foldable like/unlike those of others?* 5. Ask the rest of the class what questions they have for the team that is presenting.	Students use vocabulary words in a sentence. Student teams fill out the graphic organizer for the new guessing folder.	Vocabulary: Infer, work, system, input, output I predict that _____ will _____.

(Teacher Guide)

Black Box Modeling

"Black Box Thinking" is a strategy for modeling and predicting used by scientists and engineers who are trying to design systems of various types. This strategy involves thinking about "what will go into the system" (input) and "what will come out of the system" (output). Thinking in terms of input and output helps them identify the things that must happen within the system.

You use this strategy when you are problem solving every day, though you may not use the terminology. For example, you arrive in the library for a staff meeting and discover that you don't have your glasses. You go back to your room and they are not on your desk. So you think:

" I had them at lunch in the teachers' lounge."

" They weren't on my desk after school."

Working from these two knowns, you begin to concentrate your thinking on what happened in between the times when you were aware of having and not having your glasses.

That "unknown" space, between lunch and after school, is like a Black Box: you can't see into it, you can only construct guesses as to what's in it.

Black Box Thinking and Black Box Modeling are introduced to students because of its value as a strategy during the invention process. It is not important whether all of your students comprehend and use the term Black Box Thinking, but they should be able to use "input" and "output," and they should be able to understand and enjoy the Black Box folders that build understanding of this problem solving strategy.

The basic Black Box Model and two examples are given:

$$\textbf{input} \Rightarrow \{X\} \Rightarrow \textbf{output}$$

Where $\{X\}$ is the Black box: the unknown system.

FIGURE 14. Basic black box model

Black Box Model Example 1

input ⇒ {X} ⇒ output

girl walks into room ⇒ {X} ⇒ music is playing

{X}= A series of events: Perhaps she is walking to the radio, turning it on, adjusting the station and adjusting the volume.

Black Box Model Example 2

input ⇒ {X} ⇒ output

back-and-forth linear motion ⇒ {X} ⇒ rotary motion

{X}= A series of mechanisms: Possibly there is a system of levers linked to a wheel and pulley

Name: _____ Date: _____

DESIGN BRIEF: Creating a Black Box Model
Create a Black Box Model using a funny story that occurred to you or someone you know.

Brain Storm: What funny story will you use for your Black Box Model?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Considering what you wrote above, what event caused everything in your story to happen? In another words, what "triggered" the events in your story? **This will be your story's <u>INPUT</u>.**

_____

_____

_____

What happened at the very end of your story? In another words, what was your story's "punchline"? **This will be your story's <u>OUTCOME</u>.**

_____

_____

_____

Now, think of the series of events that occurred between your story's beginning [**INPUT**] and ending [**OUTPUT**] and number them in the order in which these occurred. Remember that you do not need to include your story's INPUT nor OUTPUT, just what happened in-between. You may use as many numbers as you need. **These numbered events will compromise your story's <u>SYSTEM</u>.**

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

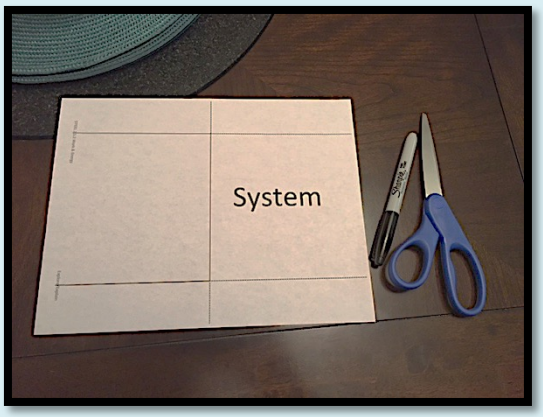
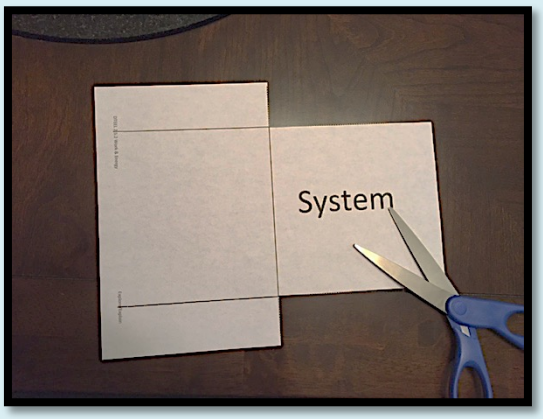
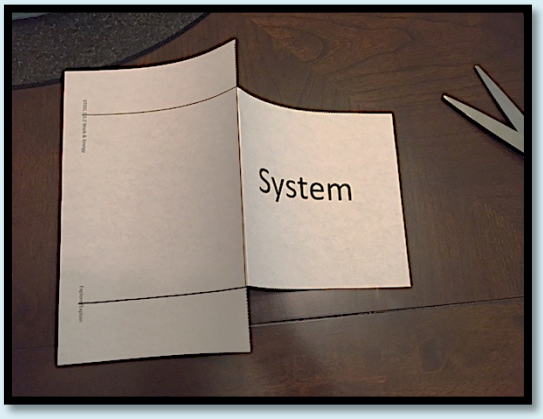
DTEEL 2.5.3 Work & Energy

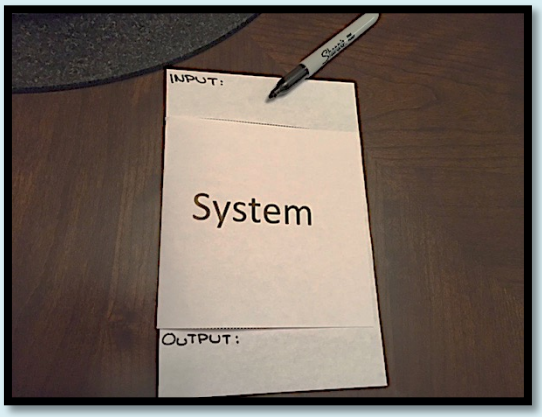
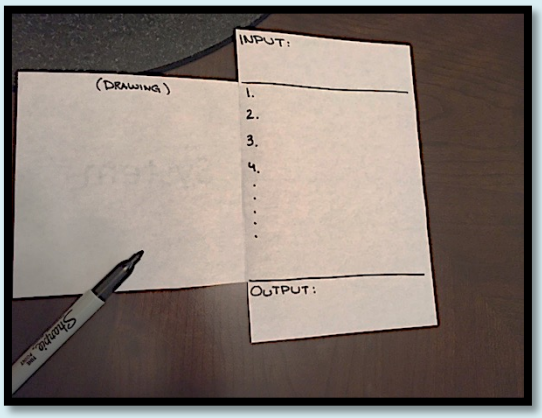
System

Explore/Explain

Name: _____ Date: _____

Creating my "Black Box Model" foldable

1. Make sure to gather all the materials needed (printout, scissors, pencil or marker).	
2. Cut the dotted lines only. This will remove 2 rectangles from your foldable.	
3. Fold your foldable in half or in a "hamburger" style, following the solid line.	

4. Once folded, label the top rectangle as your “INPUT” section. It is here where you will write the INPUT or beginning of your story. Label the bottom rectangle as your “OUTPUT” section. Here you will write the OUTPUT or ending of your story.	
5. Open the “SYSTEM” section. Number and record the events that happened between the beginning (INPUT) and ending (OUTPUT) of your story. Draw a specific event from your SYSTEM on the left hand side.	

Graphic Organizer for Black Box Thinking

Name _____ Date _____

Use words and/or pictures to summarize the input and output of each guessing folder. Write your predictions about the inside of the story system in the middle box.

Folder # _____

Input		**Output**
	I predict that _____ will _____ _____ _____ _____.	

Folder # _____

Input		**Output**
	I predict that _____ will _____ _____ _____ _____.	

Folder # _____

Input		Output
	I predict that _____ will _____ _____ _____ _____.	

Folder # _____

Input		Output
	I predict that _____ will _____ _____ _____ _____.	

Unit 6 (Mechanisms):
A See-Saw Playground

Concept
Black box thinking can help us determine mechanisms that are in systems; movement of a lever depends on location of the pivot point.

Content Objective
Teams analyze input/output of a hidden lever system in terms of work and motion and use inference to determine the placement of the pivot point(s).

Language Objective
Listen to and comprehend a variety of media, including video.
Use and internalize academic vocabulary through repeated exposure and meaningful activities: *infer, predict, depend, pivot, lever*
Infer using complex sentences and future tense verbs.

Standards

- **NGSS:**
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.

- **TEKS:**
  - **3B** make predictions based on observable patterns (predict from patterns)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6C** trace the changes in the position of an object over time such as a cup rolling on the floor and a car rolling down a ramp (trace changes in position)
  - **6D** compare patterns of movement of objects such as sliding, rolling, and spinning (compare patterns of movement)

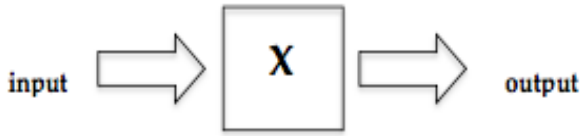
- **ELPS:**
  - **1E** internalize new basic and academic language by using and reusing it in meaningful ways in speaking and writing activities that build concept and language attainment (internalize vocabulary through meaningful use)
  - **2F** listen to and derive meaning from a variety of media such as audio tape, video, DVD, and CD ROM to build and reinforce concept and language attainment (understand a variety of media)
  - **3E** share information in cooperative learning interactions (share information in cooperative learning)

- **5E** employ increasingly complex grammatical structures in content area writing commensurate with grade-level expectations, such as using correct verbs, tenses, and probnouns/antecedents, using possessive case correctly, and using negatives and contractions correctly (employ increasingly complex grammatical structures)

Materials:
Pieces of posterboard, strips about 14" x 1", tongue depressors drilled with holes, manila folders, paper fasteners, hole punch, construction paper, A wooden shelf or other plank, or an actual see-saw.

Suggested Literature Connections
"Levers in Action" by Gillian Gosman
"Wheels, Levers and Pulley" by David Adler
"How Machines Work" by Nick Arnold

Day 1: Engage Mechanisms-A See-Saw Playground

Teacher Says/Does	Student Says/Does	Language requirements
1. Before class, create the Hidden Lever System Model Version 1 that is in handout (**2.6.1**). If you feel this might be too simple, you can create Version 2 which is also in handout (**2.6.1**). 2. Once in class, show the students the hidden lever card you have made. Ask them if they can infer what is inside that causes the end of the piece of posterboard to go up when you push the other end down. Tell them that 'infer' means to make a guess based on your observations and background knowledge. 3. Give them a few minutes to sketch what they think is inside the folder and let them share their inferences. Have them discuss their inferences with a partner. 4. Tell them there is a simple mechanical system inside the folder that is changing your motion of pushing down on the paper into motion of moving up and vice versa. Show them what is inside the folder. They can check their sketches and compare. 5. Sketch the Black Box Model (introduced in Unit 5) of what you have shown them:  Students show where work has gone into and come out of the system.	Student pairs discuss their inferences using the sentence frame and then sketch their ideas. Student pairs discuss their ideas comparing their sketches. Students create a drawing of a lever with labels for the pivot point, work, and lever.	I infer _____ because _____. Vocabulary: Depende de (cognate), pivot point, work, lever

6. Ask students to tell what they think would happen to the lever system if you moved the paper fastener to another place along the lever, in other words, if you changed the pivot point. After some have had a chance to say their ideas, punch another hole in the folder and lever for the paper fastener and move the pivot point. Have the children check and see if the lever in its new position moves differently than it did before. 7. Write on a chart the generalization that "Movement of one end of a lever depends on ____," and have students talk about the words that will complete the statement. They should begin to understand that the location of the pivot point makes a difference in the movement of a lever. 8. Explain how students should complete the exit slip sentence and drawing from handout (**2.6.2**).		Movement of one end of a lever depends on _____.

Day 2: Explore/Explain Mechanisms-A See-Saw Playground

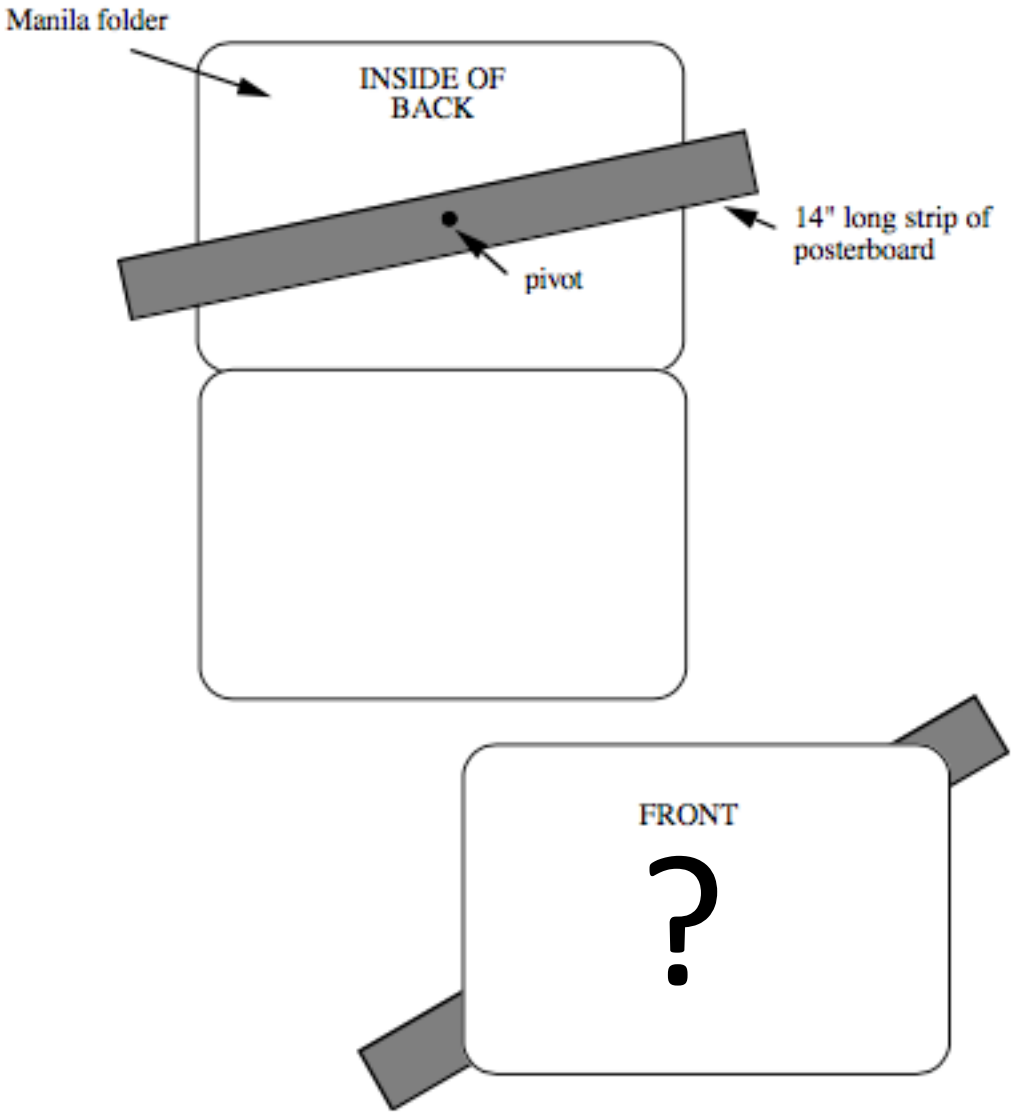
Teacher Says/Does	Student Says/Does	Language requirements
1. Review vocabulary by having students pronounce the words and then ask individual students to define the terms in their own words. Have students review their exit slips from the previous lesson. 2. Show the following video: *What is a Lever* https://www.youtube.com/watch?v=E8RA9Kw_IaE 3. Ask students to explain how humans use levers in everyday life. 4. Explain that mechanisms like levers can change the size of "input work". Have a student use your lever model to prove this is true (a small movement on the short end of a lever can cause a large movement on the long end of the lever). Similarly, a light weight on a lever can move a heavy weight if the pivot point is in the right place. 5. Demonstrate this with a wooden plank or shelf: Challenge the students to find a way to lift you, the teacher, as you stand on one end of the plank. Use a broomstick or other round solid (such as a solid cylinder from your geometric figures) as the pivot point. A lighter weight can lift a heavier weight with a lever, if the pivot point is closer to the heavy weight, so one child may be able to move you. 6. For additional teacher reference, watch the following: https://www.youtube.com/watch?v=IE6hUjjQVSc 7. Have students make predictions using the sentence stems.	Students revise their exit slip if necessary. Students turn and talk with their classmates. Student teams discuss how they might lift the teacher with the plank. Students make predictions using the sentence stems.	Vocabulary: Pivot point, work, lever Because _____, we infer that the _____ will _____. Since _____, we predict that _____ will _____.

Day 3: Elaborate/Evaluate Mechanisms-A See-Saw Playground

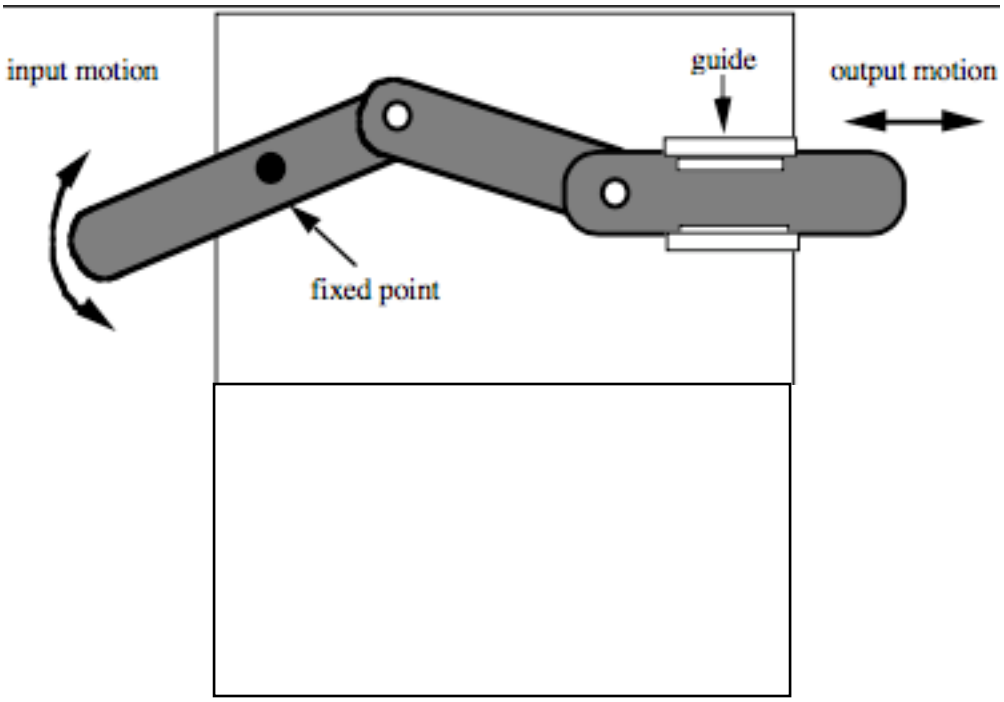
Teacher Says/Does	Student Says/Does	Language requirements
1. Tell the students that their teams will make "guessing folders" for other teams and for display. Using folders to hide the lever mechanisms, they will create a see-saw for a bulletin board playground. If they are not familiar with the see saw as playground equipment, show them some photos online. 2. Students create see-saws that extend from the sides of their folders and then add people (or animals) to the see-saws. Then other students can push their see-saw up and down and guess where the pivot point is. See handout (**2.6.3**) for a reference. 3. While the students are working, use the **collaborative dialogue template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives.	Student pairs make see-saw folders.	Because _____, we infer that the _____ will _____. Since _____, we predict that _____ will _____.

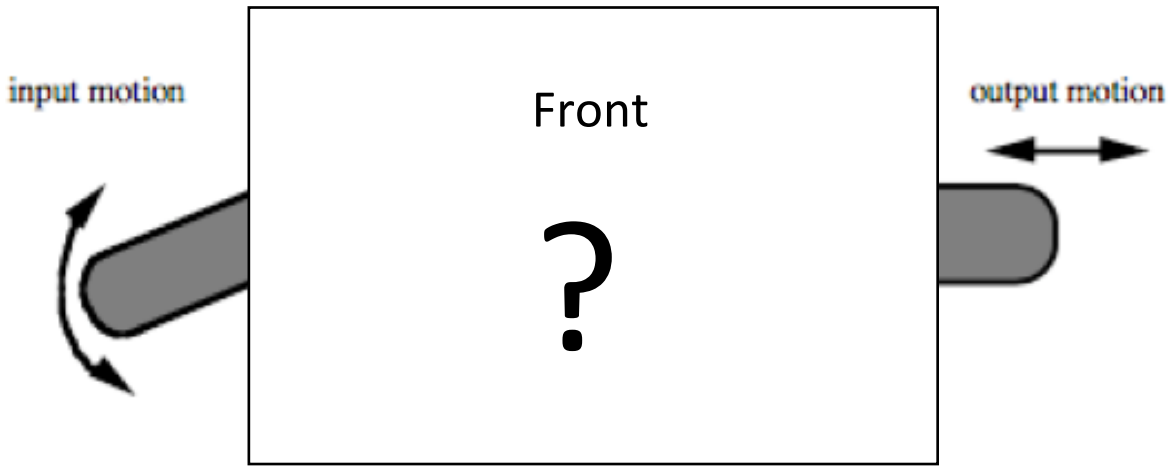
(Teacher Guide)

Hidden Lever System Model (Version 1)



Hidden Lever System Model (Version 2)





Exit Slip

Name _____ Date _____

Draw a lever. Label the pivot point, work, and lever.

Exit Slip

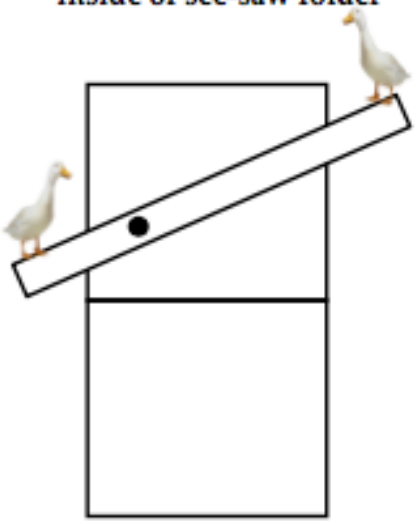
Name _____ Date _____

Draw a lever. Label the pivot point, work, and lever.

(Teacher Guide)

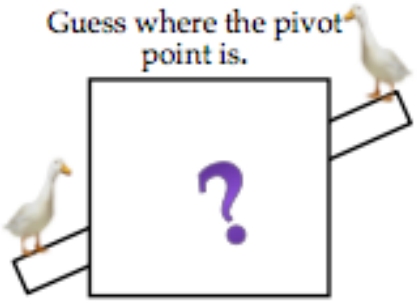
Hidden Lever System Model (Students)

inside of see-saw folder



outside of see-saw folder

Guess where the pivot point is.



(Hint: Compare the size of the input motion to the output motion.)

Unit 7 (Mechanisms):
Pop-Up Moving Scenes

Concept
Cams can be used to push levers that illustrate a scene.

Content Objective
Student teams make pop-up pictures that use cams, levers, or other simple machines to illustrate a scene.

Language Objective
Use prior knowledge of a story to discuss motion in the story.
Describe motion using adverbs.
Explain pop-up pictures using declarative sentences in a cohesive paragraph.

Standards

- **NGSS:**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS:**
  - **2E** communicate observations and justify explanations using student-generated data from simple descriptive investigations (justify explanations of own data)
  - **3A** identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat (explain prob and solution)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6D** compare patterns of movement of objects such as sliding, rolling, and spinning (compare patterns of movement)

- **ELPS:**
  - **1A** use prior knowledge and experiences to understand meanings in English (prior knowledge)
  - **2C** learn new language structures, expressions, and basic and academic vocabulary heard during classroom instruction and interactions (understand new language structures)

- **3B** expand and internalize initial English vocabulary by learning and using high-frequency English words necessary for identifying and describing people, places, and objects, by retelling simple stories and basic information represented or supported by pictures, and by learning and using routine language needed for classroom communication (expand and internalize English vocabulary, retell)
- **5B** write using newly acquired basic vocabulary and content-based grade-level vocabulary (write using content-based vocabulary)
- **5G** narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired (narrate, describe, explain in writing)

Materials:
Access to all construction and craft materials, glue gun and glue, Copy of the design problem on a chart

Suggested Literature Connections
"Mechanics" by Cari Melster

Day 1: Engage Mechanisms-Pop-Up Moving Scenes

Teacher Says/Does	Student Says/Does	Language requirements
1. Read aloud a book or talk about a story everyone knows. As you go through the story, ask the children to raise their hands whenever they know something described in the story is moving. Write their ideas on the chart tablet. 2. Ask the students if they could use cams and levers to make a picture from the story that moves like the story describes. Have them close their eyes and imagine what a pop-up scene like one on the list would look like, and what materials they would need. 3. Show the video: *Mi Primer Libro Pop-Up* https://www.youtube.com/watch?v=plFyQ0cHmvs or *How to Make a Pop-Up Book* https://www.youtube.com/watch?v=xeLKPgJ9Kos 4. Have students think of different adverbs to describe motion, and have them safely act out the motion behind their desks. 5. Explain to students how to complete the exit slip that is in handout (**2.7.1**).	Students listen and raise hands for movement. Students turn and talk to their classmates. Students act out the motion according to the adverb. Students draw three scenes and write a caption about the movement.	Abverbs: quickly, slowly, rapidly, lazily, quietly The _____ moves _____.

Day 2: Explore Mechanisms-Pop-Up Moving Scenes

Teacher Says/Does	Student Says/Does	Language requirements
1. Show students the design problem on the design brief sheet for the unit. **Design Brief**: Make a pop-up or movable scene from …[story of their choice] 2. Remind the student teams of how to go about solving the design problem. • Ask questions to be sure you understand the design problem. • Plan before you work (make blueprints). • Remember safety rules. 3. Using handout (**2.7.2**), let the student teams work on sketching, planning, selecting materials and making their models. 4. While the students are working, use the **collaborative dialogue template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives.	Students read the design brief aloud. Student teams discuss their plans and create models.	

Day 3: Explain/Elaborate Mechanisms-Pop-Up Moving Scenes

Teacher Says/Does	Student Says/Does	Language requirements
1. While students are working, look for groups that are discussing the ideas below; ask them to present their work to their classmates later in the class. 2. When they have finished, they should evaluate their teamwork, their designs, and whether they have met the specifications in the design problem. Also ask the following questions: • *Where have you used natural materials in your construction?* • *Where have you used synthetic materials?* • *Are natural materials easier to work with than synthetic materials?* • *Did you have to think about balance in your project?* • *Did you have a problem with the project not having stability? What did you do about it?* • *What types of mechanisms are present in your design? (wheels, axles, levers, cams, etc)* 3. Discuss additional uses and interesting features about the unit vocabulary, such as: 'Work' in this case doesn't mean a job, or employment. Instead it means using energy, like moving something, etc.	Student teams complete their models. Students orally present their work using simple past tense. Students take notes in their vocabulary notebooks.	For the _____, we used _____ materials.

Day 4: Evaluate Mechanisms-Pop-Up Moving Scenes

Teacher Says/Does	Student Says/Does	Language requirements
1. Model writing a paragraph explaining the process of making the models. The cohesive paragraph should describe the process, materials, and challenges that the students encountered. 2. Let the students use the graphic organizer on handout (**2.7.3**) to describe their scene. They should explain: • How the team planned together • Where the work and the forces are shown in operating their models	Students think-pair-share about important words from the project. Student teams write paragraphs using the graphic organizer.	Cohesive paragraph for art gallery display.

Exit Slip

Name _____ Date _____

Draw three scenes and write a caption about the movement in each scene.

The _____ moves _____ _____.	The _____ moves _____ _____.	The _____ moves _____ _____.

Exit Slip

Name _____ Date _____

Draw three scenes and write a caption about the movement in each scene.

The _____ moves _____ _____.	The _____ moves _____ _____.	The _____ moves _____ _____.

Name: _____ Date: _____

Design Brief: Experiments for Properties of Materials

Design Problem	Words to Remember/ Palabras para recordar
Make a pop-up or movable scene from …	

Drawing or Model of Our Plan (You can use the back of the page, too!):

Steps	
Task	**Person Responsible**

Graphic Organizer for Art Gallery Paragraph

Names _____ Date _____

Write a cohesive paragraph describing the process, materials, and challenges that you encountered while making your pop-up moving scene.

Topic Sentence:

Process:

Materials:

Challenges:

Closing Sentence:

Unit 8 (Work & Energy):
Technology Fair

Content Objective
Teams of students respond to a design problem to make a toy that is safe, pleasing to look at, and has at least one moving part.

Language Objective
Use academic vocabulary from DTEEL curriculum orally and in writing.
Collaborate with peers to summarize prior learning from the DTEEL curriculum.
Summarize design and construction process in a cohesive paragraph using complex sentences.

Standards

- **NGSS:**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS:**
  - **1A** identify and demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including wearing safety goggles, washing hands, and using materials appropriately (identify)
  - **3A** identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat (explain prob and solution)
  - **4A** collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6C** trace the changes in the position of an object over time such as a cup rolling on the floor and a car rolling down a ramp (trace changes in position)
  - **6D** compare patterns of movement of objects such as sliding, rolling, and spinning (compare patterns of movement)

- **ELPS:**
  - **2I** demonstrate listening comprehension of increasingly complex spoken English by following directions, retelling or summarizing spoken messages, responding to questions and requests, collaborating with peers, and taking notes commensurate with content and grade-level needs (follow directions, summarize, collaborate with peers)
  - **3G** express opinions, ideas, and feelings ranging from communicating single words and short phrases to participating in extended discussions on a variety of social and grade-appropriate academic topics (express opinions)

- **5B** write using newly acquired basic vocabulary and content-based grade-level vocabulary (write using content-based vocabulary)
- **5F** write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired(use a variety of patterns, connecting words, clauses)
- **5G** narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired (narrate, describe, explain in writing)

Materials:
Access to all construction materials and equipment, copy of the design problem on a chart

Suggested Literature Connections
"Forces and Motion at Work" by Shirley Smith
"Motion and Forces" by Rebecca Hirsh

Day 1: Engage Work & Energy-Technology Fair

Teacher Says/Does	Student Says/Does	Language requirements
1. Review with the students what they have learned about materials, structures, mechanisms and energy. They have looked at different materials' properties, equilibrium and stability of structures, mechanisms like levers and cams, and have experimented with energy, work and motion. Ask a few students to tell some things that they remember. 2. Explain the Table Points game (handout **2.8.1**) where you will ask a question and the student teams have 30-60 seconds to discuss the answer. Randomly select students so that all students are ready to answer the question. Teams can receive 'points' for correct answers. 3. Tell the students that there will be a Design Technology Fair in the school soon, and that their teams will be entering toy models that they invent. 4. Have the class decide what makes a toy different from other things, and ask them to think about models that could and couldn't be toys. Or pose a problem that could be solved with some sort of toy invention the teams create.	Students talk in groups as part of the game. Student teams brainstorm ideas for toys.	

Day 2: Explore Work & Energy-Technology Fair

Teacher Says/Does	Student Says/Does	Language requirements
1. Share with the students the design bref. **Design Brief:** Design and make a toy that is safe, pleasing to look at, and has one or more moving parts. 2. Remind the student teams how to begin working on the design problem for the Technology Fair. Talk about who will do what jobs, and how you will make sure both people have interesting jobs to do. Students should be encouraged to have more than one moving part in their toy, in other words, to have two different mechanisms for movement. This is up to the teacher, however, and may depend on available time. 3. Review what has been discussed about materials, structures, mechanisms and energy, so children will remember to draw from all they have studied in making this last project. 4. Using handout (**2.8.2**), teams should work on the planning, sketching, gathering materials and creating a toy. During that time, evaluate with them on their teamwork and plans. Ask them to identify the moving parts and the energy. 5. While the students are working, use the **collaborative dialogue template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives.	Students plan and create toys. Student teams discuss the design brief and write their steps in complete sentences.	

Day 3: Elaborate/Evaluate Work & Energy-Technology Fair

Teacher Says/Does	Student Says/Does	Language requirements
1. When the teams have finished their toys, provide them with examples of toy packaging. Ask critical questions about gender stereotypes, etc. Explain that the students will design their own packaging for the toys they made. 2. Explain how students will now design packaging for their toy that contains the following features in detail: • how the toy works, • what materials it is made of, • and what makes it fun and/or interesting. 3. Students will write a cohesive paragraph describing their packaging using the paragraph graphic organizer (**2.8.3**). 4. Using the Word Splash handout (**2.8.4**) as a reference, review some of the words below so that students implement them during the writing of their cohesive paragraph: • *Natural and synthetic materials* • *combinations of materials* • *durability, strength,* • *stability and flexibility* • *structures and stability* • *structures and balance* • *models* • *levers and pivot points* • *levers and motion* • *cams and levers* • *cams and shafts* • *how it is pleasing to look at* • *how it is safe to play with* • *what the mechanisms are for movement*	Students turn and talk with their classmates. Student teams write and revise cohesive paragraphs for their toy packages. Students use the word splash to say complex sentences using unit vocabulary.	Vocabulary: • Natural and synthetic materials • combinations of materials • durability, strength, • stability and flexibility • structures and stability • structures and balance • models • levers and pivot points • levers and motion • cams and levers • cams and shafts

5. Lastly, have students present their toy models at the Technology Fair (or simply in front of the classroom) as well as their manufacturing process and package design process.		

Table Points Teacher Questions

Ask these questions and/or create your own as you lead a game of Table Points.

- What is something that has natural and synthetic materials?
- What does durable mean?
- What is the difference between durability and strength?
- Give an example of a flexible material. Why would you want it to be flexible?
- Why might engineers want something to be stable? Why might they want something to be unstable?
- Think of an example of a system. Describe its input and output.
- What did the triangles do for the frames and boxes that we made?
- Why do engineers create plans and blueprints?
- Draw a lever and a pivot point.
- What happens with a lever as the pivot point moves?
- What is an example of a lever? Why do we use them?
- What is a cam? How are they used?
- How is a cam different from a wheel?

Name: _____ Date: _____

Design Brief: Experiments for Properties of Materials

Design Problem	Words to Remember/ Palabras para recordar
Design and make a toy that is safe, pleasing to look at, and has one or more moving parts.	

Drawing or Model of Our Plan (You can use the back of the page, too!):

Steps	
Task	**Person Responsible**

Graphic Organizer for Toy Packaging Paragraph

Names _____ Date _____

Write a cohesive paragraph describing the process, materials, and challenges that you encountered when designing your team's toy packaging.

Topic Sentence:

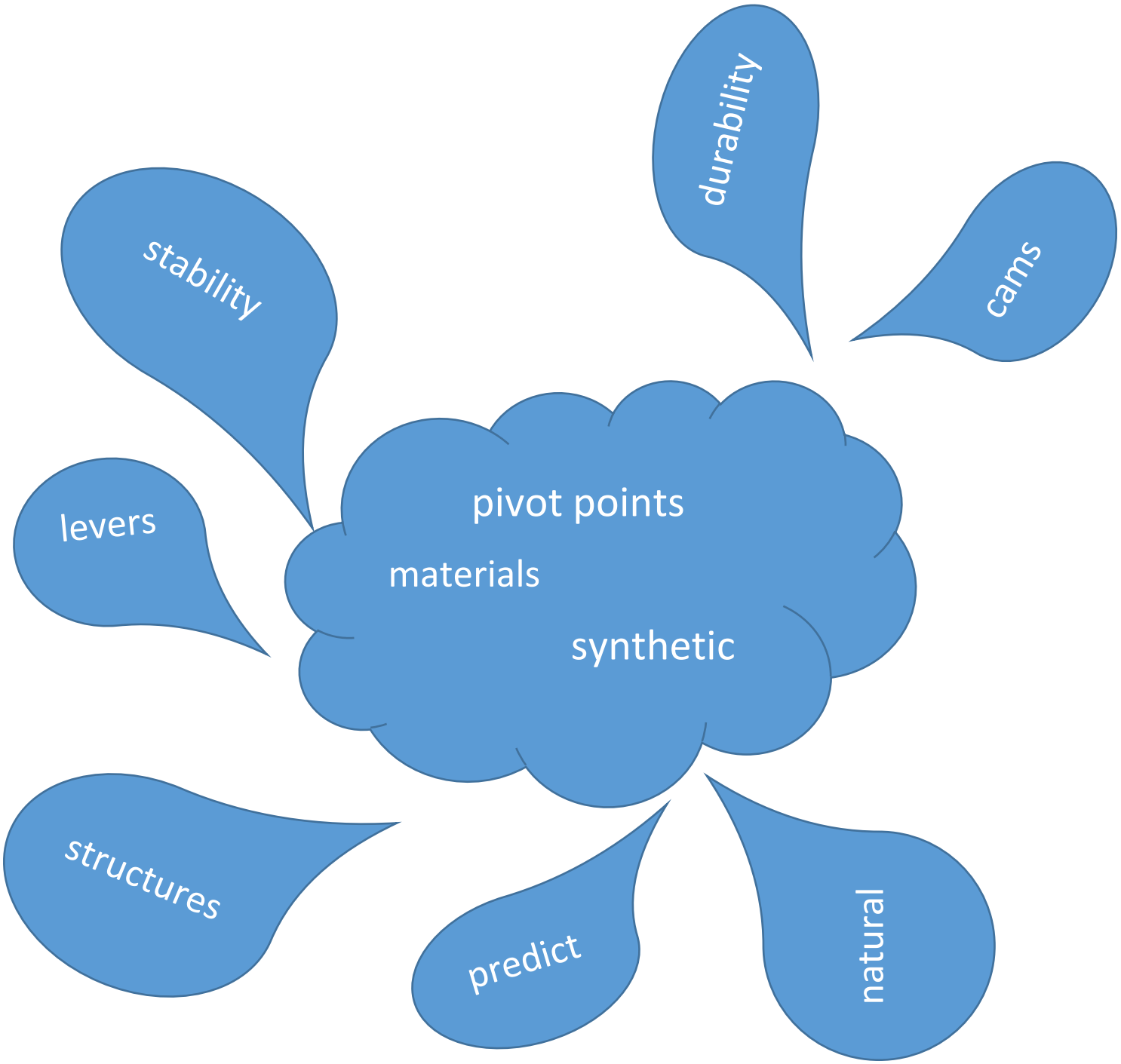
Process:

Materials:

Challenges:

Closing Sentence:

Word Splash


durability
cams
stability
levers
pivot points
materials
synthetic
structures
predict
natural