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

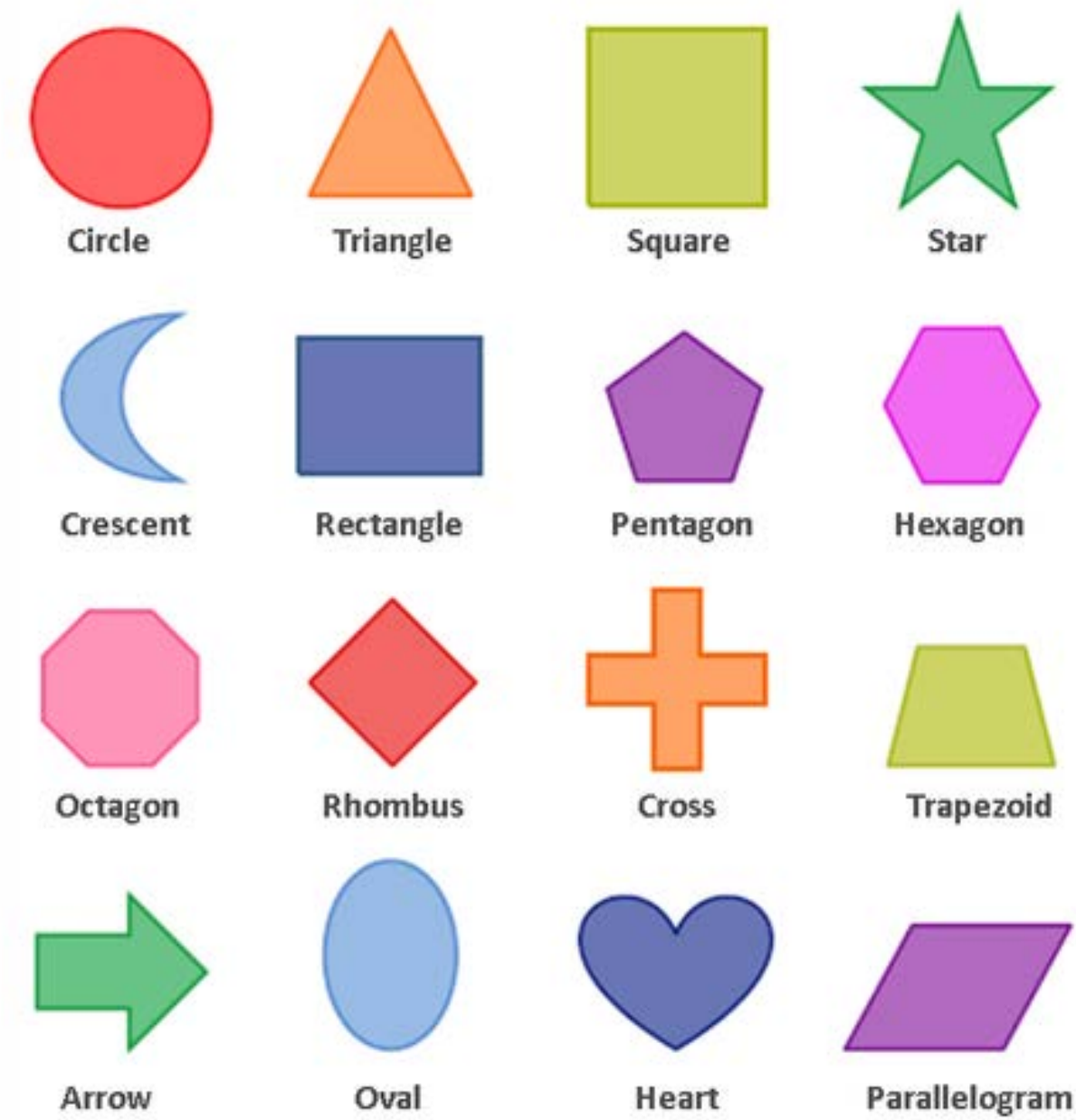
Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students your model of a cam and lever on posterboard. (See handout **2.4.7** as a reference). 2. Ask teams to analyze the model with you, observing what happens to the lever when the cam is turned. Let them suggest changes to your 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.

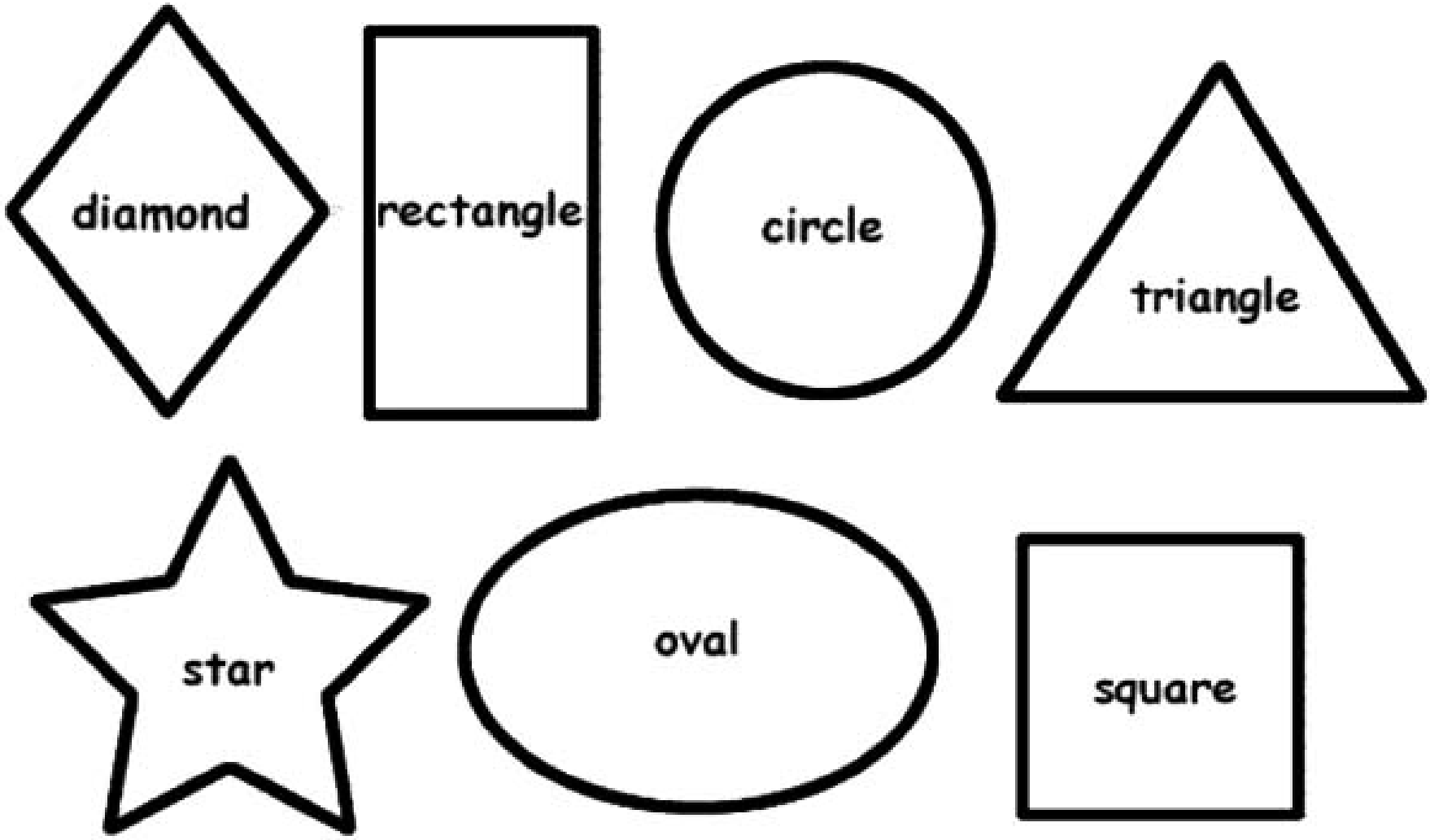
1) The _____was _____ than the _____.

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:

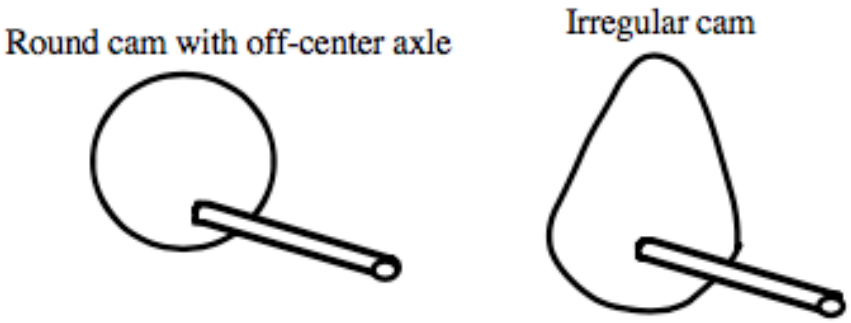


FIGURE 7. ROUND AND IRREGULAR CAMS

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).

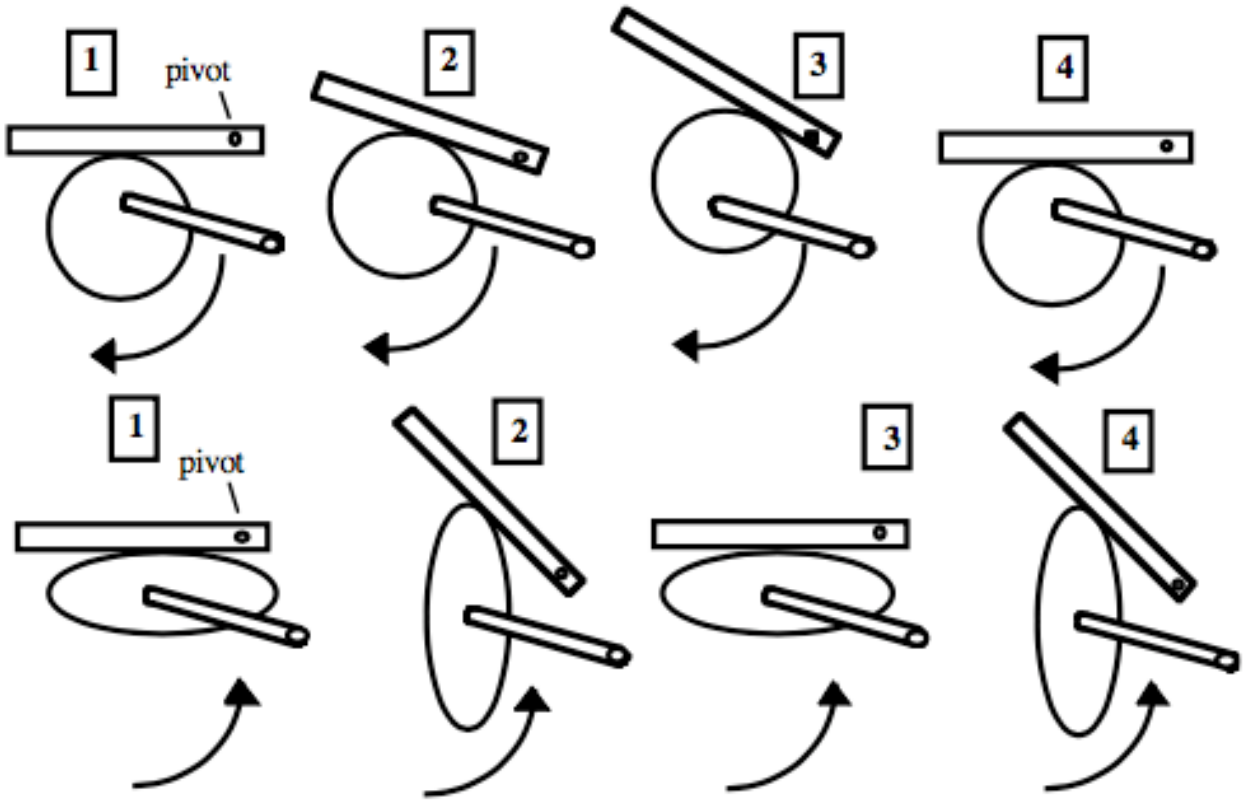


FIGURE 8. THE CYCLES OF TWO CAMS

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

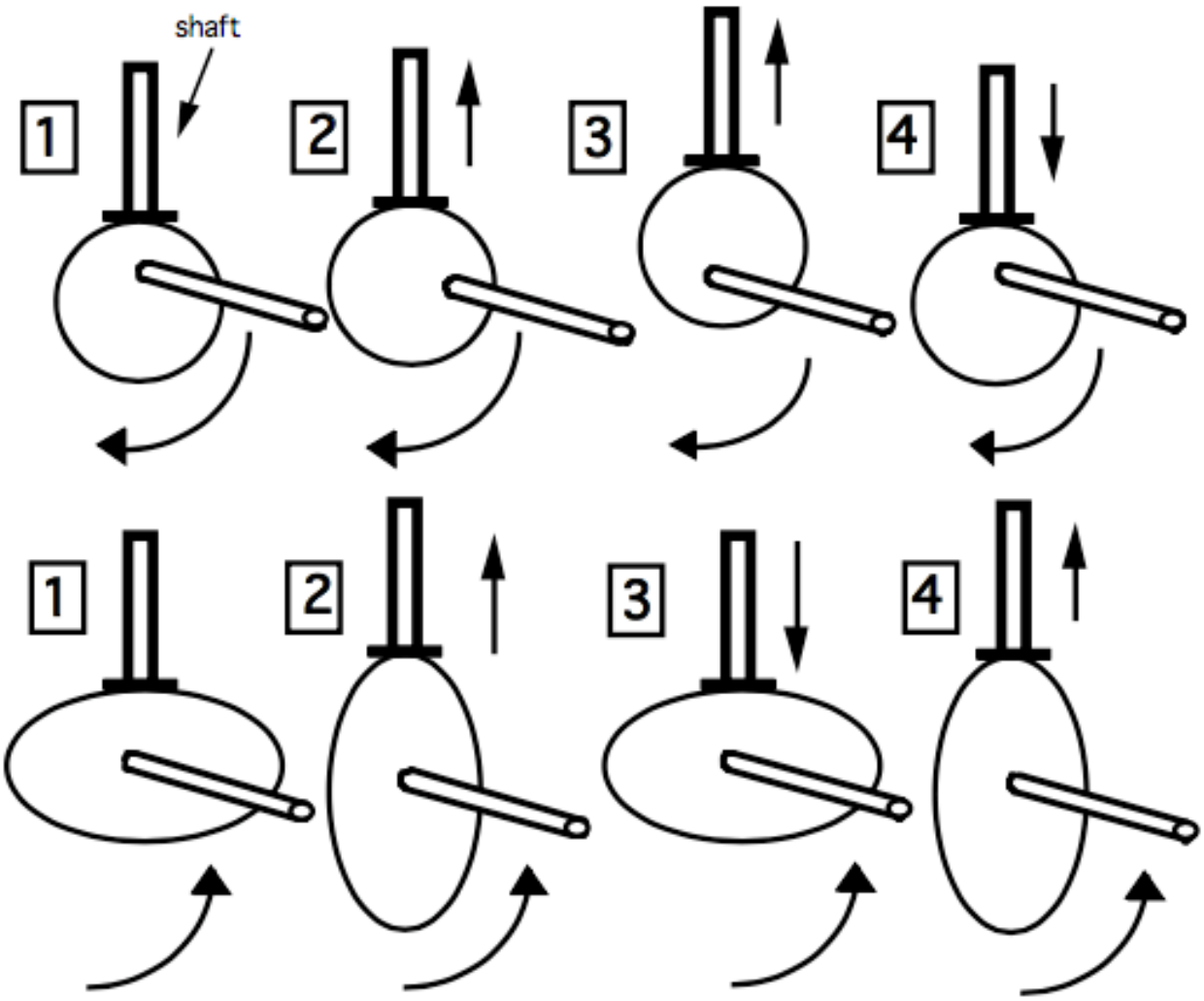
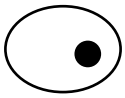
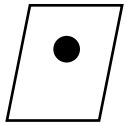
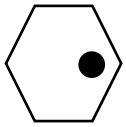
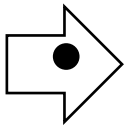
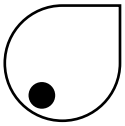
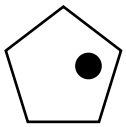
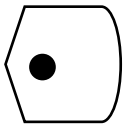
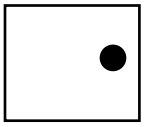
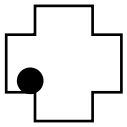
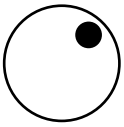
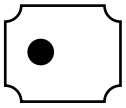
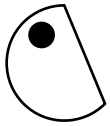
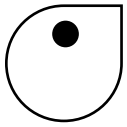


FIGURE 9. Cams with camshafts as followers

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)

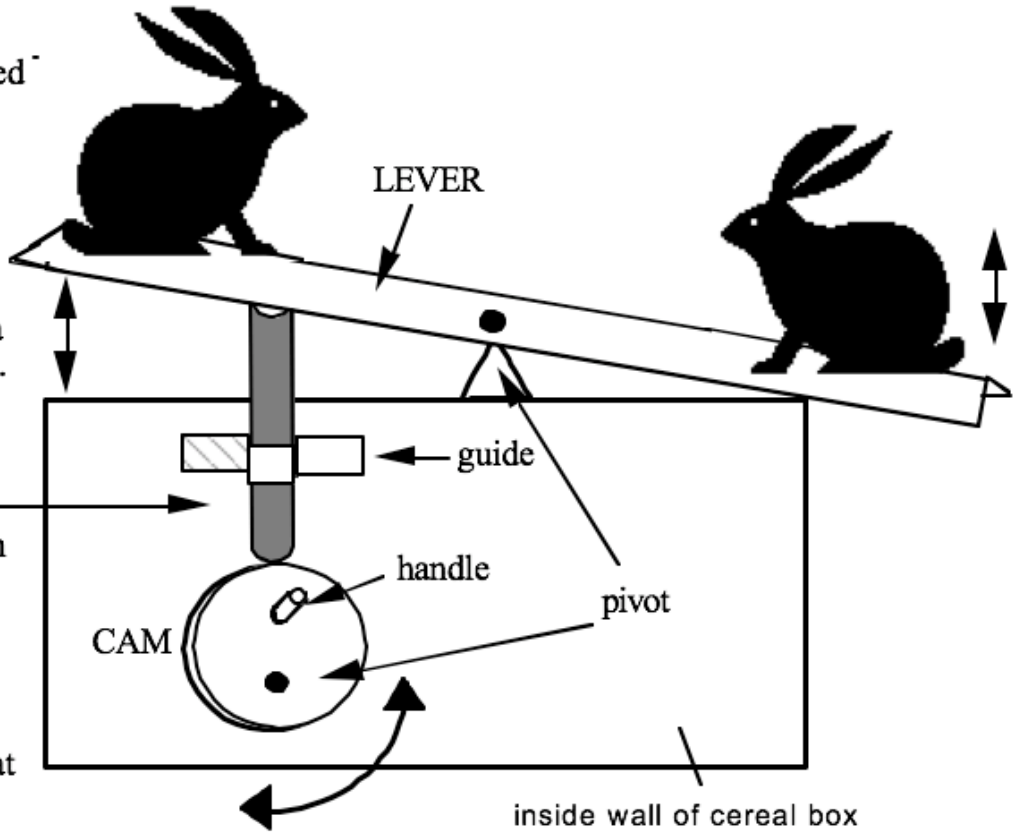
Turn the handle and the rabbits go up and down!

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.

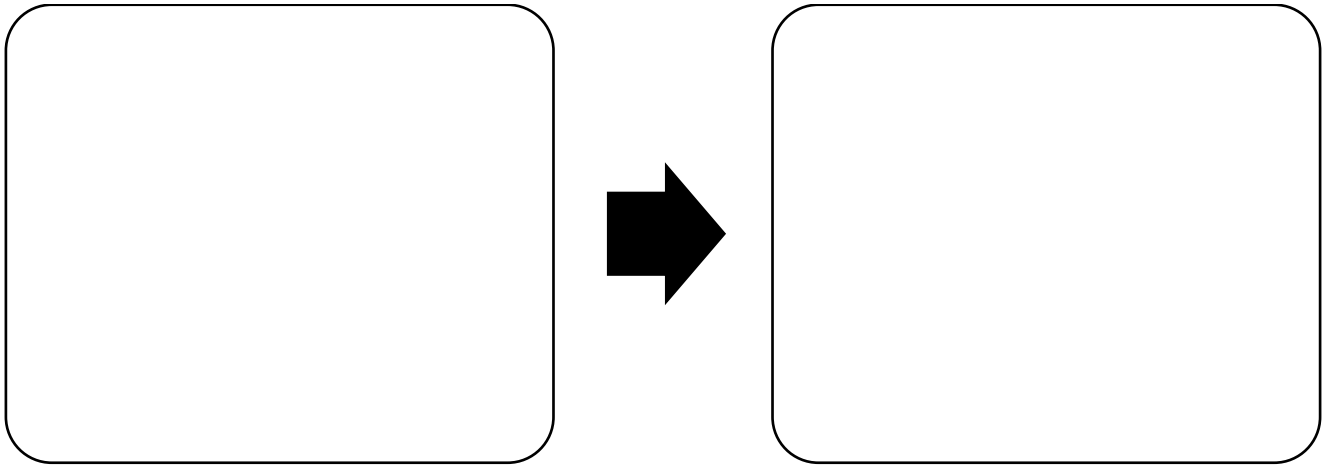
GUIDE:
This is a strip of tagboard or paper that keeps the camshaft going in a straight path



Cause/Effect Graphic Organizer

Name _____ Date _____

Describe the changes in motion produced by working the cam.



When the axle is _____,

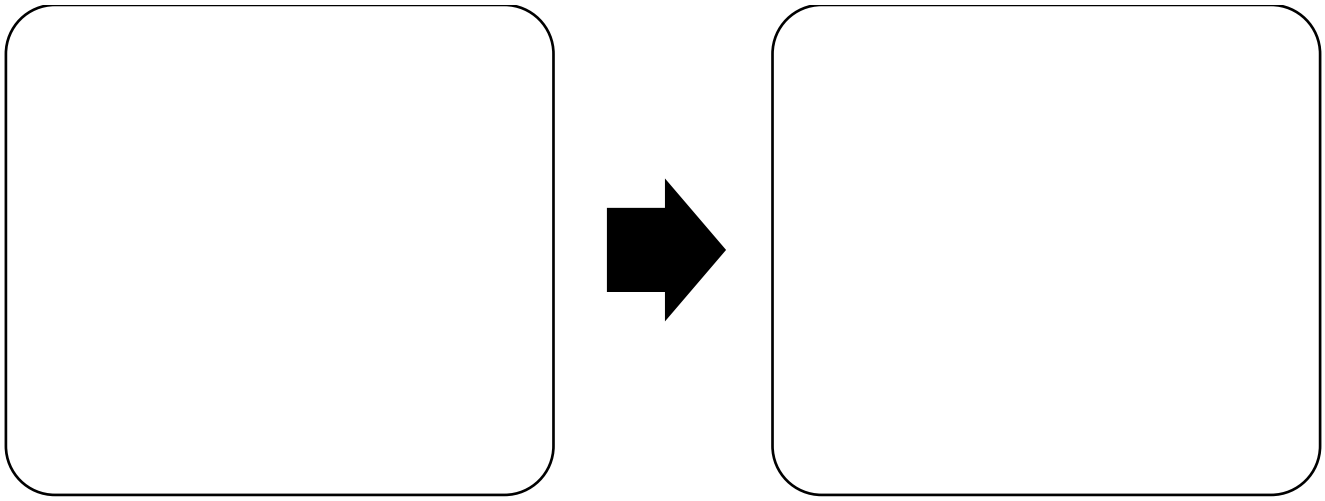
the wheel _____.

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 _____.