## Unit 7 (Mechanisms): <br> Linear and Back and Forth Motion

Concept Mechanisms can change size and direction of motion; linear motion is movement in a line; back-and-forth linear motion is called reciprocating motion. Up-and-down motion about a pivot point is an arcing or oscillating motion.

## Content Teams explore linear and reciprocating motion with linkages and slider mechanisms.

$\begin{array}{ll}\text { Language } & \text { Students will recognize the meaning of the terms: linear, rotary and reciprocating, for types of movement } \\ \text { Objectives } & \text { Students will write sentences using the words: linear, rotary, or reciprocating to describe types of movement }\end{array}$ Students will deepen their knowledge of the meaning of: power, systems, input, lever and mechanisms

## 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
- 2A Plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world.
- 2F Communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.
- 3A Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing.
- 3C Represent the natural world using models and identify their limitations, including size, properties, and materials.
- 6B Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons.
- ELPS
- 1C Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
- 2E Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language [Context Clues]
- 3E Share information in cooperative learning interactions [Communicative Competence]

Tools
Materials

Poster board strips; hole punch; paper fasteners; scissors; construction paper; glue guns; glue sticks; design brief on chart; lever model (Model of slider-crank Mechanism Figure 12).


Handouts 3.7.1-3.7.6
$\begin{array}{ll}\text { Literature } & \text { Motion: Push and Pull, Fast and Slow by Darlene R. Stille } \\ \text { Conncetions } & \text { Oscar and the Cricket: A Book about Moving and Rolling by Geoff Waring } \\ & \text { Learning about the Way Things Move by Heidi Gold-Dwarkin }\end{array}$

| Teacher Says/Does | Student Says/Does | Language requirements |
| :---: | :---: | :---: |
| 1. Ask students what they think movement is, and to share their ideas. <br> 2. Explain to students that we will be exploring movement in several directions. Tell them that we will be looking at objects and machines that can move up and down, on a straight line, around a circle, and also in a repetitive way either up and down or back and forth. <br> 3. Describe simple everyday actions that involve linear, rotary and/or back and forth movement, e.g., brushing one's teeth (reciprocating motion). Have students share if they wish other examples. <br> 4. Show students the picture cards in handout 3.7 .1 with several examples of movement. Discuss with students one or two in terms of the type of movement. Then, give each pair or group an additional picture card from the handouts to discuss and identify if the movement is on a straight line, back and forth, repetitive back-and-forth or repetitive up-and-down. <br> 5. Present word cards: linear, rotary, reciprocating. (see p. 21 in Teacher Handbook for more clarification). Have the students say the word. Tell them that the movement that they worked with that was on a straight line can be called "linear"; that the movement that goes around the circle can be called "rotary" and the movement that goes in a repetitive way either up and down or back and forth can be called "reciprocating". <br> 6. Distribute the handout 3.7 .2 with descriptions of movement to each student pair and have them identify and write the type of movement it involves and have student pairs use the words: linear, rotary, or reciprocating in sentences. <br> 7. Have students form groups and choose one of the activities in the following exploratory centers: | Students share their ideas about movement <br> Students discuss different types of movement <br> Students identify and write about linear, rotary, and reciprocating types of movements | - linear movement <br> - rotary movement <br> - reciprocating movement |


| Teacher Says/Does | Student Says/Does | Language <br> requirements |
| :---: | :---: | :---: |
| Cut apart and mix up words, definitions and examples from 3.7.3. <br> Match them back up and glue to construction paper. |  |  |
| Look through books and note pages on which linear, rotary or <br> back and forth motions are shown. |  |  |
| o Illustrate a scene showing action of a person or object and draw <br> arrows to show the direction of movement (linear, rotary, back <br> and forth). |  |  |

Day 2: Engage/Explore

| Teacher Says/Does | Student Says/Does | Language requirements |
| :---: | :---: | :---: |
| 1. Review with students the concepts of: power, systems, input, lever and mechanisms. Group students evenly into the five concept teams. <br> 2. Use a Jigsaw procedure (3.7.4); have each team collaborate to construct drawings and sentences for their concept in relation to movement (power, systems, input, lever or mechanisms). Prompt students to complete the jigsaw handout before they leave their homogenous groupings. <br> 3. Regroup into teams, each of which has one representative from each of the five concept areas. Have groups share with one another, guided by their jigsaw handouts. <br> 4. Briefly review as a whole class the five concepts. <br> 5. Read and discuss the following sentence with the whole class: Mechanisms can send energy through a system and increase it; mechanisms can also change the direction of input energy. <br> 6. Have each group work on drawing the meaning of the sentence and sharing it with the class | Students investigate concepts of power, systems, input, lever and mechanisms <br> Students read and discuss a paragraph about mechanisms | Brick words: power <br> - systems <br> - input <br> - lever <br> - mechanisms |

## Day 3: Explore/ Explain

| Teacher Says/Does | Student Says/Does | Language <br> requirements |
| :--- | :--- | :--- |
| 1. Show the students the hidden lever model in a folder that you <br> made to match the example in the Hidden Figure Handout <br> 3.7.5. When your input work was to push down the lever the <br> other end went up. Show them a Black Box Model of the <br> lever in the handout. | Black Box model <br> Input |  |
| Output |  |  |

Day 4: Explore/ Explain

| Teacher Says/Does | Student Says/Does | Language <br> requirements |
| :--- | :--- | :--- |
| 1. Show students your model of a slider-crank mechanism <br> (Figure 12). Ask students to provide a definition of a lever, and <br> to give examples of levers they are familiar with. Explain that <br> levers in a series are called linkages, and that the last link, the <br> one that goes back-and- forth, is called a slider. | sliders <br> slider-cranks <br> levers <br> linkages |  |
| 2. Give students a picture of a model with a slider and linkages. | Students label parts of a <br> model that has sliders and <br> Have them label the sliders and the linkages. |  |
| 3. When the lever at one end of the folder is pushed down, the |  |  |
| slider is made to travel back and forth. |  |  |
| 4. Complete handout 3.7.6 to include a definition and illustration |  |  |
| of each. |  |  |
| 5. Go on a walk to find examples of sliders and slider-cranks. |  |  |
| Many kinds of bolts are sliders, especially those found on |  |  |
| bathroom stall doors and other enclosures. Many doors and |  |  |
| windows have slider-cranks and linkages. |  |  |


| Teacher Says/Does | Student Says/Does | Language requirements |
| :---: | :---: | :---: |
| 1. Remind them of how to work on a Design Brief: <br> a. Look at the Black Box (from Day 3) as their Design Brief. <br> b. Ask questions about what the words mean. <br> c. When you understand what the words in the Design Brief mean, talk with your partner and plan what you might like to make. <br> d. Make a plan for what you will make. Talk about who will do what jobs, and how you will make sure both people have interesting jobs to do. <br> e. Draw a side-view sketch of what you will do. <br> 2. Give the teams time to use trial-and-error to work with different types of mechanisms. They will find that a series of links connected together may create the input and output they want, but they will need to make some kind of guide for the slider so that it will be forced to go back and forth. Work with some teams to trouble- shoot during the process, and if several get frustrated, call the group back together to analyze what is being done in other groups that are having some success. <br> 3. When the teams have a completed folder to show, let them demonstrate it for the whole class, asking everyone to evaluate whether the product meets the Design Brief specifications. Ask the teams: <br> - What was the hardest thing about your Design Brief? <br> - Did you stick to your original plan? If not, why? <br> - What were some skills you and your partner used while you worked together? <br> - Where is linear motion demonstrated in your product? (One stroke of the lever, in one direction) Where is back-and-forth motion (reciprocating) motion shown? | Students explore different types of mechanisms <br> Students evaluate their design briefs <br> Students, with parents, will identify linear |  |


| Teacher Says/Does | Student Says/Does | Language <br> requirements |
| :---: | :---: | :---: |
| How might the same folder show how linear motion can <br> be transformed into rotational motion? (Push the slider <br> back and forth and the link at the other side goes up <br> and down in an arc.) |  |  |
| 6. Also, ask the rest of the class what questions they have for the <br> team that is presenting. |  |  |
| 7. When each team has completed its presentation, let them |  |  |
| display their folder in the Design Gallery along with their side- |  |  |
| view sketches of the inside of their folder and a written |  |  |
| explanation of how their product changed from their original |  |  |
| plan, if it did |  |  |



| Brushing your teeth | What kind <br> of movement | Why? |
| :--- | :--- | :--- |
| A car going on a highway |  |  |
| A child moving on a swing |  |  |
| A child moving on a swing |  |  |
| A sewing machine |  |  |
| Planets moving around |  |  |
| the sun |  |  |
| Opening a door knob |  |  |
| Clock handle moving |  |  |

## Concepts about Motion:

| Type of <br> motion | Definition | Example |
| :--- | :--- | :--- |
| Linear motion | Motion in <br> one direction | Pushing a lever <br> forward |
| Reciprocating <br> motion | Linear <br> motion that <br> goes back <br> and forth | Pushing and <br> pulling a lever <br> back and forth <br> the piston in an <br> engine moving up- <br> and-down |
| Rotary <br> motion | Motion in a <br> circle | The hands of a <br> clock moving, or a <br> wheel on an axle |
| Oscillating <br> motion | Circular or <br> arc-motion <br> back and <br> forth | The swing of a <br> pendulum or the <br> turning and <br> release of a <br> doorknob |



Jig Saw Activity


Examples

## HIDDEN LEVER SYSTEM MODEL



| Examples of reciprocating motion in the school |  | Describe the reciprocating <br> motion |
| :--- | :--- | :--- |
| Example |  |  |
|  |  |  |
| Example |  |  |
|  |  | Drawing |
|  |  | Describe the reciprocating <br> motion |


| Picture of a slider | Picture of a linkage |
| :--- | :--- |
|  |  |
| Picture of a lever |  |

