Linkages

Cardboard levers and pivots that make creatures move.

GRADES K THROUGH 8 | AGES 5 TO 14 | ABOUT 45 MIN

These are the standards listed in the Linkages educator guide. Under each one is where you will see it in the activity.

Next Generation Science Standards (NGSS)

CODE	WHAT IT COVERS
K-PS2-1	Motion and Stability: Forces and Interactions
	WHERE YOU'LL SEE IT (GRADES K-2): Learners **explore how pushing and pulling one end of their Linkages system causes the other end to move** in a predictable direction - observing firsthand that a push force transfers through the connected levers and around the fixed pivot to create motion at the far end of the mechanism.
K-2-ETS1-2	Engineering Design: Develop a simple sketch, drawing, or physical model
	WHERE YOU'LL SEE IT (GRADES K-2): Learners **sketch their creature or machine on the printable design sheet before building it** - drawing where the levers will go, labeling the pivots, and planning how the linkage will be disguised inside the character - then iterate on the design when the first build does not move as expected.
3-PS2-1	Forces and Interactions: Cause and Effect
	WHERE YOU'LL SEE IT (GRADES 3-5): Learners **investigate how the force of pushing on a reverse-motion linkage causes the opposite end to travel in the reverse direction**, testing different push strengths and observing how harder pushes move the mechanism farther - establishing a cause-and-effect relationship between applied force and lever motion.
3-5-ETS1-3	Plan and carry out fair tests to identify failure points
	WHERE YOU'LL SEE IT (GRADES 3-5): Learners **systematically troubleshoot a stuck Linkages system** by checking one variable at a time - is the brad too tight, is the fixed pivot floppy, is there a lever traffic jam, is the backing board too flexible - isolating the failure point before making a fix.
MS-PS3-5	Construct an argument that a change in kinetic energy means energy was transferred
	WHERE YOU'LL SEE IT (GRADES 6-8): Learners **argue that the creature's motion at the far end is evidence of energy transferred along the linkage** - the output lever starts at rest with zero kinetic energy, and a push at the input end sets it moving. Tracing the push through each brad and fixed pivot shows where the energy went, and why the far end cannot move unless something is pushed at the near end.
MS-ETS1-2	Engineering Design: Evaluate competing design solutions
	WHERE YOU'LL SEE IT (GRADES 6-8): Learners **compare which linkage type best solves a design challenge** - reverse motion for side-to-side motion, bell crank for right-angle transfer, parallel motion for tilting-and-sliding scenes, scissor for reach and extension - evaluating trade-offs in simplicity, distance traveled, and visual effect before committing to a final design.

Common Core State Standards (Math and ELA)

CODE	WHAT IT COVERS
RI.K-2.7	Use illustrations and words in a text to describe key ideas
	WHERE YOU'LL SEE IT (GRADES K-2): Learners **refer to the printed Linkages visual guide** in their kit to identify which piece is a lever, which is a brad, and how the pivot holes line up - using both the printed illustrations and the educator's spoken vocabulary to understand the system before assembling their first free pivot.
SL.K-2.1	Participate in collaborative conversations
	WHERE YOU'LL SEE IT (GRADES K-2): Learners **describe to a partner what happens when they push on one end of their reverse-motion linkage**, using the vocabulary "lever," "pivot," and "fixed pivot" to explain why the opposite end moves in the other direction.
RI.3-5.3	Explain relationships between concepts in a text
	WHERE YOU'LL SEE IT (GRADES 3-5): Learners **explain the cause-and-effect chain in their bell-crank linkage** - how pulling the vertical lever causes the angled crank to rotate, which in turn pulls the horizontal hammer toward the imaginary bell - tracing the path of force through the connected levers.
W.3-5.3	Write narratives to develop real or imagined experiences
	WHERE YOU'LL SEE IT (GRADES 3-5): Learners **write a short story for the creature or machine they designed on their Linkages design sheet**, naming their invention, describing what problem it solves or what it does, and explaining how their chosen linkage type powers the moving part of the story.

CODE	WHAT IT COVERS
RST.6-8.3	Follow a multistep procedure when carrying out experiments
WHERE YOU'LL SEE IT (GRADES 6-8): Learners **follow the Linkages build sequence precisely** - preparing levers and brads, creating a free pivot, anchoring a fixed pivot with a pencil-poked starter hole, and adding guides before testing the system - understanding that each step depends on the previous one or the linkage will jam.	
SL.6-8.1	Engage in collaborative discussions with diverse partners
WHERE YOU'LL SEE IT (GRADES 6-8): Learners **debate which linkage type is the best fit for a partner's design challenge** during the Problem-Solving with Linkages extension - comparing the trade-offs between reverse motion, bell crank, parallel motion, and scissor linkages and defending their choice with evidence from the mechanism's motion.	
K.MD.A.1	Describe measurable attributes of objects
WHERE YOU'LL SEE IT (GRADES K-2): Learners **compare the lengths of the long levers and short levers** in the Linkages kit and describe how a longer lever travels a greater distance when it rotates around the same pivot - connecting the observable attribute of length to the distance the mechanism moves.	
K.G.A.1	Describe objects using names of shapes and relative positions
WHERE YOU'LL SEE IT (GRADES K-2): Learners **identify the parallelogram shape formed by a parallel-motion linkage**, naming the four sides and describing positional relationships - the top bar stays parallel to the bottom bar, the side bars tilt together - using shape and position vocabulary as they tilt the assembled linkage on the backing board.	
3.MD.B.4	Generate measurement data by measuring lengths
WHERE YOU'LL SEE IT (GRADES 3-5): Learners **measure how far the end of their reverse-motion linkage travels** when they push the opposite end a fixed distance, generating data about the ratio between input and output motion and comparing results across different lever lengths on the same backing board.	
4.OA.C.5	Generate and analyze patterns
WHERE YOU'LL SEE IT (GRADES 3-5): Learners **observe the push-pull pattern of their reverse-motion linkage** - when one lever moves right, the other moves left, over and over - and identify this as a consistent, repeating inverse relationship that they can predict before every push.	
6.RP.A.1	Understand ratio concepts and use ratio reasoning
WHERE YOU'LL SEE IT (GRADES 6-8): Learners **explore the lever-arm ratio in their bell-crank linkage** - a short input lever paired with a long output lever moves a shorter input distance into a longer output distance - and describe the ratio of input-to-output travel in simple terms, discussing how changing the lever lengths would change the ratio.	
7.G.A.2	Draw geometric shapes with given conditions
WHERE YOU'LL SEE IT (GRADES 6-8): Learners **draw the parallelogram formed by a four-bar parallel-motion linkage** on their design sheet, labeling the two pairs of equal-length sides and the fixed pivots - then predict how the parallelogram will tilt when one side is pushed, verifying the prediction by building and testing the linkage.	

LEARNERS EXPLORE

mechanical linkages (reverse motion, bell crank, parallel motion, scissor); levers and pivots; force and motion transfer; the engineering design process; storytelling through mechanism design