ULTIMATE RECYCLING MACHINE (URM)

MIDDLE SCHOOL LEVEL 2

The Ultimate Recycling Machine is an interactive learning experience that teaches principles of engineering. The aim is to get kids thinking about structures and devices they can build to meet the goal, three points of contact, and the bottle ending in the bin.

EDUCATIONAL STANDARDS:

NGSS CONNECTION:

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

COMMON CORE CONNECTION:

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-PS3-1)

6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. (MS-PS3-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-1)

8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)

8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. (MS-PS3-1)

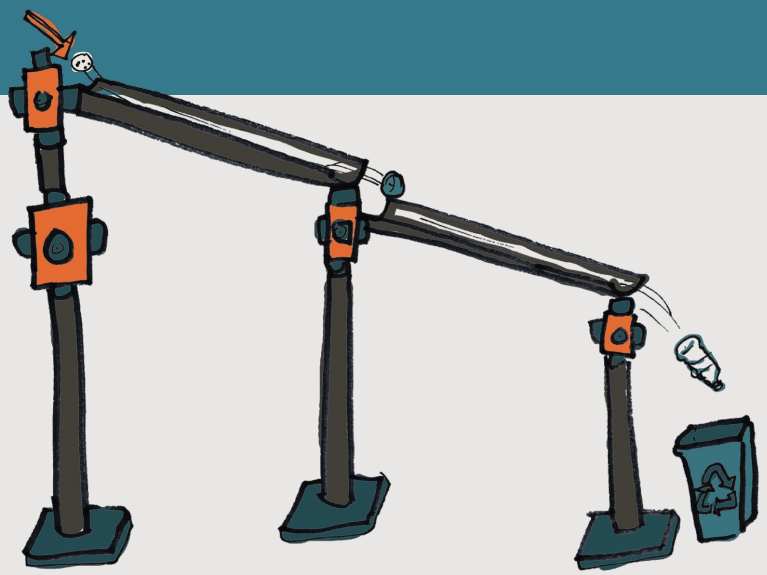
8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.

DOK:

Level 2: Concept
Level 3: Strategic Thinking
Level 4: Extended Thinking

MATERIALS NEEDED FOR BINS:

- ❏ Cardboard tubes
- ❏ Rubber tubes
- ❏ Cardboard half-tubes
- ❏ Connection pieces (same as the STEAM Lab connectors)
- ❏ Plastic stands



MATERIALS NEEDED FOR CART:

- ❏ Metal clips
- ❏ Metal clamps
- ❏ Rubber bands
- ❏ Golf balls
- ❏ Tennis balls
- ❏ Rope
- ❏ Velcro strips
- ❏ Stretchy fabric with velcro
- ❏ Belt ends

PREPARATION:

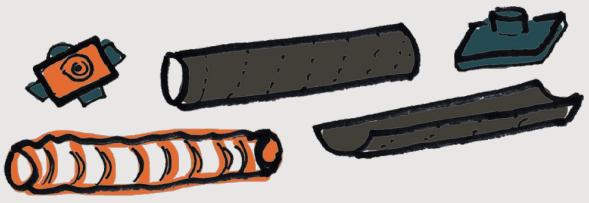
Before beginning, fill the large rubber trash bins with each of the materials listed above. Set up the cart with the materials listed separated into small plastic containers such as Akro bins. Put recycle bins at one end of the room for the water bottles to land in.Separate students into groups of 4-5.

The goal is to build a machine that knocks a water bottle into a recycling bin, with three points of contact where energy is transferred from one object to another along the way. Give the students paper and pencil and ask them to plan their construction. Once they have a plan and have gotten approval from the teacher, time to build.

Pendulums, pulleys, tubes, and tracks, all's fair in building and construction. Binder clips are great for holding pieces together, different-sized tubes connect to make tunnels. The cart is full of materials to be tied and fastened to make your structure. Golf balls positioned along the track are great way to transfer energy, one into the next, knocking each other down in a domino effect.

Once your students know the goal, it's a cooperative effort to build structures and problem-solve issues along the way. Rather than answering questions with instruction, ask questions back of students to get them thinking.
If you're asked "How can I make these pieces connect?" Ask "What materials could you use to connect them?" or "Have you tried all of the materials available?"
This will help the students problem-solve structures and learn through trial and error as they improve and grow their machines.

The best part is how fun it is to succeed! The machines can grow into some wild and crazy contraptions, the crazier the better. You can expect lots of smiling faces at the end of the exercise, so much so, they don't realize they're learning. And isn't that the goal? To make learning fun?



LESSON 1: SIMPLE MACHINE STATIONS

SIMPLE MACHINE EXAMPLES

- Wheel and Axle
- Pulley
- Screws
- Pendulum
- Levers
- Wedge

OBJECTIVE

Students familiarize themselves with simple machines and other concepts in order to prepare for the Chain Reaction recycling project.

ENGAGE

1. Inform students that the point of Simple Machines Stations is to spark ideas and inspire creative connections for the Chain-Reaction Machine. They are going to take the ramps that they made and connect them into a whole-class Chain-Reaction Machine.

EXPLORE & EXPLAIN

1. Students rotate around stations and explore each concept
    a. Students identify the labeled station
    b. From their experience with the station or prior knowledge describe the concept
        i. What does it do?
        ii. How does it work?
    c. Students brainstorm ways in which this machine may assist with their recycling project.
2. Teacher facilitates student learning
    a. Monitors station timing
        i. Based on classroom dynamics—you know your students.
    b. Circles around classroom
        i. Asks guiding and supporting questions—deepen student understanding
        ii. Provides examples of the use of the machine in real-world scenarios
            1. Making real-world connections
            2. Students can provide real-world connections
        iii. Answers student questions

ELABORATE

3. Students “apply” simple machine
    a. Students sketch a possible transition to another ramp
        i. Students make connections from lab to project outcome
        ii. Students participate in engineering practices

*Students should be given the simple machines table hand-out to support this process.

LESSON 2: CHAIN-REACTION RECYCLING MACHINE

OBJECTIVE

Students connect ramps to create one continual recycling machine that sorts paper and plastic by knocking them into the correct container.

ENGAGE AND ELABORATE

1. Watch the OK GO “This Too Shall Pass” video, and/or Honda’s “Cog” commercial.
    a. Re-engage students in the Chain-Reaction Machine Process
    b. Provide ideas for students.
2. Students construct recycling machine
    a. Teacher may have to set supporting guidelines for classroom management
        i. Delegate roles, provide guidelines on which group communicates to who. The order of which group follows which needs to be clearly defined, so groups can decide how to transition between their elements
        ii. Support students at toolstation—safety
    b. Students take part in engineering practices
        i. Communicate amongst peers and plan
        ii. Construct and problem solve
        iii. Design, expand and elaborate on ideas
3. Students explain conservation of energy concepts
    a. Articulate in writing
        i. Work, gravitational potential energy, kinetic energy
        ii. Possibly elastic potential energy etc.
    b. Students effectively use academic language and concepts.
    c. Students sketch their connection
        i. Label points
        ii. Identify energy at that point
4. Students develop a procedure to collect and analyze data
    a. Identify energy at each point
    b. Calculate the respective energy using the correct formula
    c. Explain their data collection process
    d. Articulate areas of trouble to demonstrate deep understanding of content and its application.
5. 5. Students should record in a daily log
    a. Serves as reflection and collection of the evolution of their thinking process
    b. Students ought to think deeper about content and its application to engineering and real-world phenomenon.
    c. Teacher should scaffold the logs to make them appropriate to their class and can be used as a method of assessment (pre and post)
6. Teacher facilitates
    a. Probes students for conceptual understanding
    b. Models for students when necessary
    c. Evaluates and suggests
    d. Provides constructive feedback

Evaluate

7. Teacher evaluates student progress in each of the following areas (rubric created by instructor)
    a. Construction of transition
    b. Explanation and application of content
        i. Calculations and conceptual understanding
    c. Application of the scientific method in respect to the collecting and analyzing of da