

# SYSTEM ALERT!

Tomorrow is almost here.



## The summertime Rube Goldberg challenge

How will you spend your summer? In 2020, an 11th grader who goes by Creezy on YouTube became a viral sensation. He created an elaborate machine named The Swish. The machine's last step is to make a trick basketball shot.

But getting there? That involves a model train, lawn chairs, skateboards, a square box rolling down a slope of paint cans, rocks and sticks, tennis balls, Ping-Pong balls, billiard balls, Wiffle balls, rubber balls, a football, toy cars, hinges and ramps, wooden tracks, wire tracks, baseball bat tracks, trampolines, traffic cones, flowerpots, and a LOT of string and tape.

Contraptions like this are called Rube Goldberg machines, named after the newspaper comic artist who drew countless numbers of them. The machines are more about fun than functionality. But they *are* functional, and they require a lot of engineering work to get them in proper working order.

### YOUR GOAL:

Use the items you gather to make an invention that:

- Is fun to watch.
- Does a simple task in an overly complicated way.

Here are some ideas for the final task:

- Water a plant.
- Brush your teeth.
- Feed the fish.
- Put a hat on your head.
- Make some toast.
- Anything else you can think of!

In this issue, you'll receive a head start in making your own Rube Goldberg machine. And, if you make a working machine and photograph or film it, we'll show off your hard work! (Send an image of your original machine to [cwhite@pitsco.com](mailto:cwhite@pitsco.com).) ⚠️

### RULES:

You don't have to be constrained to the objects in the scavenger hunt. This was just a way to get started.

If you can't find the right piece, you can make it.

Alter the pieces as you like (if you have permission, of course).

### GETTING STARTED

Rube Goldberg machines use familiar objects in new ways. Use this scavenger hunt to get started and look at your possessions with fresh eyes. Find these things:

- Balls of different sizes
- Something that rolls that is not a ball
- Objects that can tip over in sequence like dominoes do
- A ramp
- A track
- Something with a hole in it
- Something that balances on a point
- Something that can wind or unwind
- String
- Tape



## INVENTION EXPLORE-A-PAK

If you can dream it up, you can invent it with Pitsco's Invention Explore-A-Pak! We have included a wide variety of materials – rubber bands, straws, basswood, dowel rods, Skill Sticks, balloons, wheels, glue, plastic spools, and more.



## TIPS:

- Watch several Rube Goldberg machines in action before you try to make your own.
- Sketch out your idea on a piece of paper.
- Test each step of the machine separately.
- It is going to take a lot of trial and error to get your timing and placement right. You might use tape to mark your placement when you have it figured out.
- Be willing to change your ideas. Failure is part of the process. And it makes success is that much sweeter!

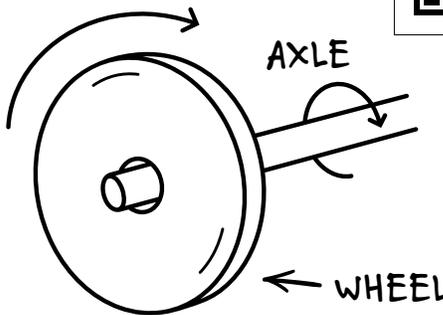
Energy is defined as the ability to do work. **Potential energy** is the energy stored within an object or system, even when sitting motionless. A lithium-ion battery has chemical potential energy. Other objects have gravitational potential energy due to their placement, such as a wheel at the top of a hill or a coffee cup on the edge of a table. Could you use string to harness work from a falling coffee cup? ⚠

# Simple machines are the key to complex machines

Very basic mechanisms that change the direction of work or multiply the amount of force are called **simple machines**. Simple machines are extremely common in Rube Goldberg machines. In addition to the three particularly relevant machines described here, scientists also recognize three other simple machines: the pulley, the screw, and the wedge.

## WHEEL AND AXLE

An axle is a shaft that goes through the center of a wheel. Because the two objects are attached in this way, they turn together. However, the outer edge of the wheel travels a greater distance with each turn because it is further from the center. Meanwhile, the axle turns with greater rotational force, or torque. Imagine attaching a string to the axle. What happens to the string if you keep turning the wheel?



## ROLLER COASTER BALLS

These are incredibly helpful for making Rube Goldberg machines. Each pack includes two each of 3/4" metal, 1" wooden, and 1" acetal balls.



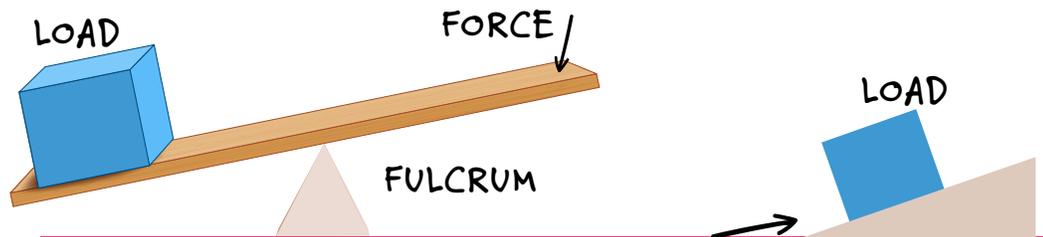
## TORSION CATAPULT

With just a little modification, imagine how you could use a catapult in your device to cause an incredible airborne chain reaction! With the torsion catapult you can launch small projectiles by twisting the strings holding the launch arm. Learn how to apply torque, potential and kinetic energy, projectile motion, and more.

## LEVER



One of the most familiar types of lever is a seesaw. A lever is a beam that pivots at a point called a fulcrum. If the fulcrum is at the center, the two halves of the lever are balanced, like a scale. In this case, even a small force applied to one side can make the lever tip. But the fulcrum doesn't have to be in the center. Imagine pushing down on the shorter side. Does it require more or less force to make the other side tip upward?

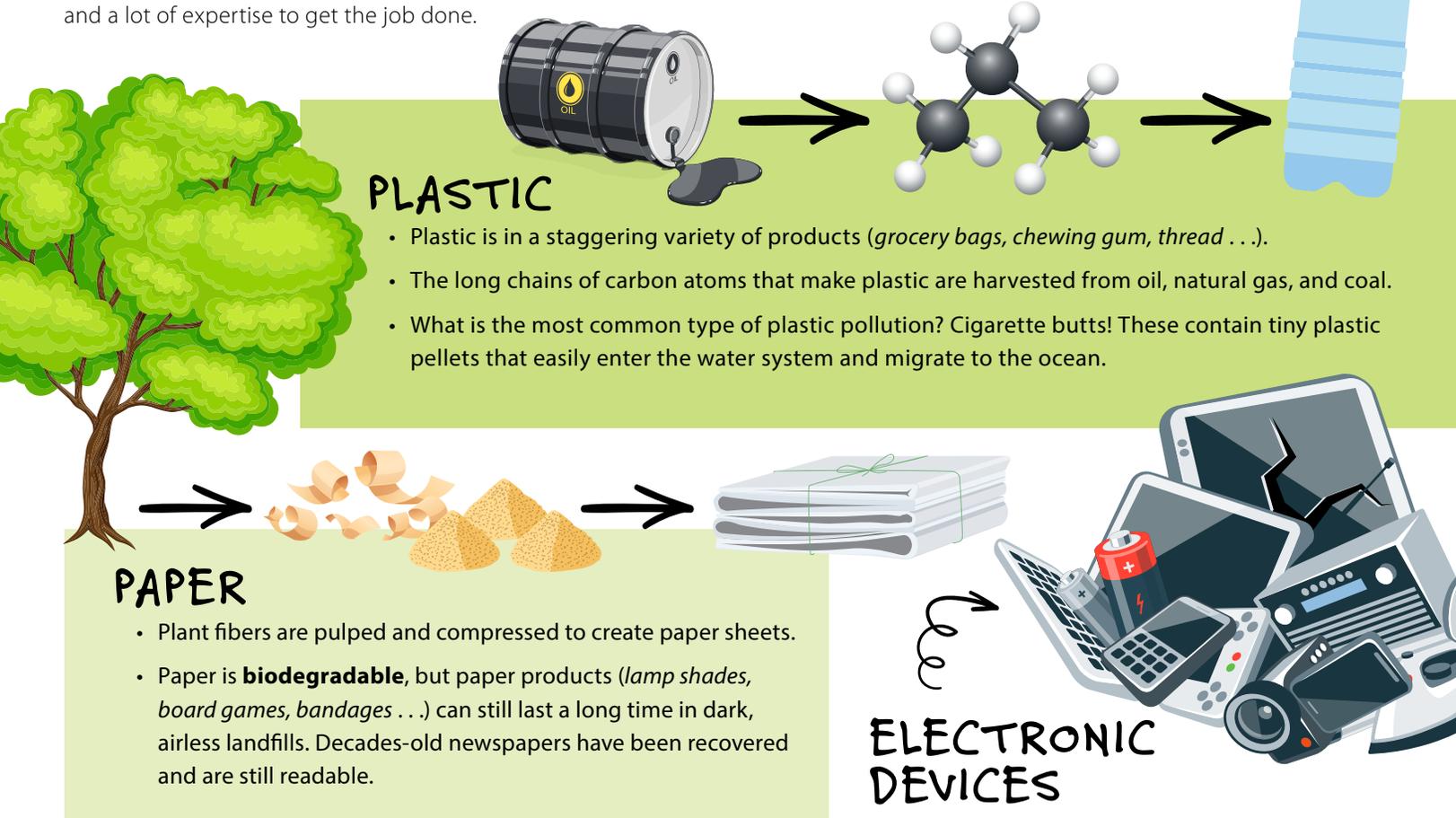


## INCLINED PLANE

Essentially, an inclined plane is a ramp. It can be used to raise an object at an angle, which requires less force than lifting it straight up. That is why heavy objects are often rolled into place up a ramp.

# Talking trash <<<

Our planet passed a milestone in 2020. For the first time, the combined mass of manufactured items (*soda cans, armchairs, radio towers . . .*) outweighed all life on Earth (*ostriches, redwood trees, bacteria . . .*). Humans make a lot of stuff. Dealing with discarded products (*paper plates, mattresses, flat tires . . .*) is a big challenge. It takes a lot of cooperation and a lot of expertise to get the job done.



## PLASTIC

- Plastic is in a staggering variety of products (*grocery bags, chewing gum, thread . . .*).
- The long chains of carbon atoms that make plastic are harvested from oil, natural gas, and coal.
- What is the most common type of plastic pollution? Cigarette butts! These contain tiny plastic pellets that easily enter the water system and migrate to the ocean.

## PAPER

- Plant fibers are pulped and compressed to create paper sheets.
- Paper is **biodegradable**, but paper products (*lamp shades, board games, bandages . . .*) can still last a long time in dark, airless landfills. Decades-old newspapers have been recovered and are still readable.

Biodegradable refers to things that are easily broken down by microorganisms in the environment.

## ELECTRONIC DEVICES

- Discarded electronic devices (*cell phones, electric toothbrushes, blenders . . .*) can contain harmful materials such as mercury and barium.



# Where does it all go? Let's visit the landfill.

When you throw away a plastic bottle (or an apple core, a bag of chips, a cracked cell phone case . . .) it might never cross your mind again. But its journey is just starting. Let's hop a ride to the city landfill.

**1** The route complete, the sanitation worker drives the garbage truck back to the landfill. First stop: the weigh station. The average garbage truck can haul upwards of 12 tons.

**Sanitation workers** transport trash to the landfill.

**Duties:** driving garbage trucks, lifting and loading heavy objects, maintaining the trucks

**Pay:** approximately \$32,000 per year

**Downside:** ranked as the fifth most dangerous job in America

**2** The truck is carefully driven to a tipping area. This is the place where, all day long, trucks have been tipping out their haul of garbage onto the ground. Dozers even out the mess. Mean-looking tractors with spiked wheels roll over the garbage, packing it down to save space. These machines are called compactors, and they can crush more than 1,000 pounds of trash into one cubic yard.

It doesn't exactly smell like a spring meadow, but this waste won't be left out in the open air for long. Soil is trucked in and spread over the trash. (Here we say goodnight to the plastic bottle. It will never see the light of day again.) This covering process is done every single day. The next day's load of trash will be deposited near this one.

Eventually, the landfill supervisor declares this area to be maxed out on trash fill. The area, called a cell, is permanently closed off and buried. Most landfills operate only one cell at a time before moving on to the next one.



## DOWN IN THE DEEP, DEEP DARK

Your plastic bottle will eventually decompose, but it will take hundreds of years. But don't plan on a visit to check in on its progress. Apart from the eternal darkness and the close quarters, its new home is downright toxic. As the materials in the waste products break down, the chemicals mix with rainwater to form a nasty liquid called **leachate**.

Keeping leachate from escaping the landfill and entering the water supply is a challenge. That is why landfills are built in layers. Below the trash there is often a layer of gravel run through with pipes. The gravel serves as a filter for the fluid, which is gathered by the pipes and taken to a wastewater treatment

plant. Below the gravel is a heavy-duty plastic layer called HDPE. And at the very bottom, compacted clay is the last barrier against the escaping toxins.

Sometimes people use the word *dump* interchangeably with the word *landfill*. But they are not the same! Sure, they're both big holes in the ground where trash gets deposited. But unlike a dump, a landfill is regulated by the government. It meets strict safety guidelines to protect the community and environmental health. A landfill is a highly engineered and strictly maintained operation. And you can be thankful for that! ⚠️

**Landfill engineers** are civil engineers that design and manage solid waste management facilities.

**Duties:** ensuring an environmentally sound design that meets the waste disposal needs of a community

**Pay:** approximately \$85,000 per year

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Student name: \_\_\_\_\_ Class/hour: \_\_\_\_\_

## ***SySTEM Alert!* Quiz (Volume 9, Number 3)**

This quiz covers the information in *SySTEM Alert!* Volume 9, Number 3. Circle the letter of the correct answer or write the letter by the question number.

1. Plastic is made from long chains of \_\_\_\_\_ atoms.
  - A. oxygen
  - B. hydrogen
  - C. lithium
  - D. carbon
2. As rainwater filters into a landfill, it mixes with chemicals and creates a liquid called \_\_\_\_\_.
  - A. leachate
  - B. prill
  - C. oobleck
  - D. acid rain
3. An axle turns with a rotational force called \_\_\_\_\_.
  - A. fulcrum
  - B. goldberg
  - C. torque
  - D. spin
4. Energy is defined as the ability to \_\_\_\_\_.
  - A. transmit a charge
  - B. change direction
  - C. do work
  - D. lift a weight
5. What is the pivot point of a lever called?
  - A. zero point
  - B. simple machine
  - C. axle
  - D. fulcrum
6. Sanitation worker is one of the five most dangerous jobs in America.
  - A. True
  - B. False



7. When a wheel turns, its outer edge travels a greater distance than the edge around its center.
  - A. True
  - B. False
  
8. The combined mass of all life on Earth weighs more than the combined mass of manufactured items.
  - A. True
  - B. False
  
9. A lithium-ion battery is designed to store gravitational potential energy.
  - A. True
  - B. False
  
10. A vacuum cleaner is a type of simple machine.
  - A. True
  - B. False