LESSON 9:

SPACE ARM PROBE

SUPPLIES

LESSON KIT #9

- Paper Clips - 10 per group of 3, 50 total
- Rubber Bands - 5 per group of 3, 25 total
- String - 2 rolls

HANDOUTS FOLDER

- Paper - 10 sheets / group of 3)

MAIN BIN

- Masking Tape

PENCIL BOX

- Ping Pong Balls - 7
- Pencils
- Rulers
- Scissors
- Tape Measure
- Clear tape (teacher holds onto)

OBJECTIVES

- [x] To engineer a creative way to pick up materials without our hands
- [x] To understand why we might need to grab objects without our hands, and how this is helpful

HOOK

3-5 min

Ask students:

- What are some situations where you have to grab something without using your hands?

Potential answers:

- Picking up trash from the side of the road
- Retrieving keys from a sewer grate
- Retrieving something that fell under your couch
- Holding something very hot (like a glass blower) or very cold (like a cryoclaw).

INTRODUCTION

3-5 min

The Earth is like a treasure trove of precious minerals, Humans have always mined for these treasures for a variety of reasons. Space is infinitely vast and unending. can you imagine what kinds of endless treasures exist out there?

Lets imagine a future where humans are able to successfully travel through space and collect resources from space rocks! These rocks floating through space are typically referred to as asteroids. Today we going to create our own engineering masterpieces to simulate what a tool would work like to collect asteroids and snatch them out of space!

LET'S LEARN ABOUT ASTEROIDS

An asteroid is a chunk of rock and minerals that floats in space and orbits (travels around) the Sun. Think of them as the leftover building blocks from when our solar system formed about 4.6 billion years ago!

Most asteroids hang out in a giant cosmic highway between the planets Mars and Jupiter. There are millions of them bumping around in this belt, but because space is so huge, they are actually very far apart.



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DISCUSSION

3-5 min

Tell the students that today we are going to design grabbers.

Tools like grabbers are mechanical and help humans in a variety of ways. In order to be effective tools, grabbers must have the following features:

- Lightweight
  - Light enough to be easily moved around
- Strong
  - Strong enough to carry an object without bending or breaking
- Secure
  - Be able to secure the object so that it doesn't fall while being moved



IDENTIFY & BRAINSTORM

15-20 min

1. Divide students into groups of 3 and pass out materials. Each group should receive:
   - 10 sheets of paper
   - 10 paper clips
   - 5 rubber bands
   - 1 roll of masking tape
   - 1 ping pong ball

   The students will have to share two rolls of string between all the groups. If they are having trouble sharing, the teacher can hang onto the string and cut pieces for students.

2. On the next page, there are three versions of the Ping Pong Pick Up challenge. You can choose the version of the challenge that best fits your students' ability levels. Explain the rules.

3. Give students 10-15 minutes to complete the challenge, with regular reminders of the time.

4. When time is up, test each group's grabber. Use masking tape on the floor to mark a start and end point. Each group can send a representative to try and move a ping pong ball between the start and end point using their grabber.

Bonus!

Grabbers rely on levers working together to move the claw. To picture this, think about scissors. Scissors are made from two levers. They are joined at the center by a fulcrum. When force from your hand is placed on the top lever, it pushes the bottom of the two levers together. When you release the scissors, the force is no longer applied and then bottom of the leaves go back apart.

This is the same mechanics in a grabber.

Many grabbers also have a coating of rubber on the claws. This helps to grip objects it is picking up.

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SPACE ARM PROBE

CHALLENGE #1
For very young students

Create a tool that can move a ping pong ball 1 foot.

Rules:

- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved

CHALLENGE #2
For younger students

Create a tool that can move a ping pong ball 2 feet.

Rules:

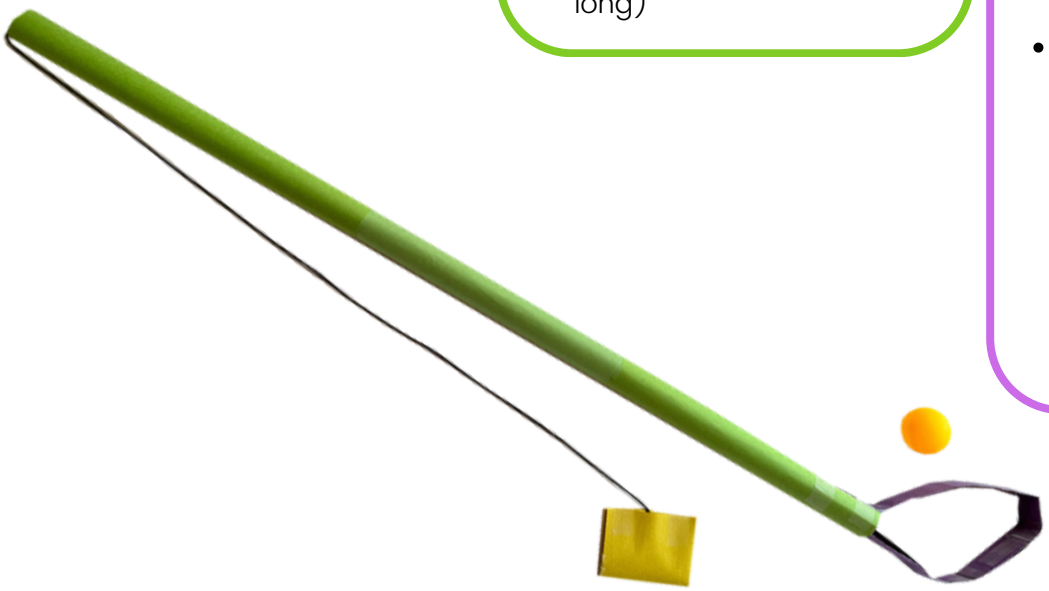
- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved
- Your hands must remain 1 foot or further from the ball while it is being moved (meaning the grabber tool must be at least 1 foot long)

CHALLENGE #3
For older students

Create a tool that can move a ping pong ball 10 feet.

Rules:

- You cannot touch the ping pong ball with your hands
- The ball cannot be secured to the tool using tape
- Neither the tool nor the ping pong ball can touch the ground while it is being moved
- Your hands must remain 1 foot or further from the ball while it is being moved (meaning the grabber tool must be at least 1 foot long)
- The tool must include a mechanical element (like a hook that can be opened and closed or a loop that can be tightened) that can be controlled from the far end of the grabber



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EVALUATE & REDESIGN

10-15 min

After they've tested their grabbers, tell students to reflect on the features you discussed earlier in class.

- Was the grabber lightweight enough for you to move it easily?
- Was the grabber strong enough to pick up the ping pong ball without breaking?
- Once the ping pong ball was picked up, did it stay secure?

If students struggled with this activity, give them another 5-10 minutes to adjust their designs and help the groups who are struggling.

If all groups completed the challenge, have them complete a harder version of the challenge or do the extension activity.

OBSERVE & EXPLAIN

5-10 min

Discuss the following ideas as a class. Refer to the next page for examples of grabber designs and how they connect to different engineering concepts.

- Did most groups make similar designs, or were the tools fairly different?
  - If they were different, which designs were most successful and why?
  - If they were similar, why? What made that approach successful or unsuccessful?
- Did your tool use a mechanical mechanism (a moving part you could control using a level, switch, string, etc.)? If so, how did it work?
- What principles from other lessons did you use in this lesson?
- Is your current design versatile, or could it only be used for this task?
  - Could it easily pick up larger/smaller objects?
  - Could it be used at different angles (picking something out of a tree instead of off the floor)?
- What are other tasks grabbers could be used for? How would your design change if it was being used for one of those other tasks?

EXTENSION

Set up two rectangles of masking tape five feet apart. You can choose to increase or decrease this distance if you wish.

In the starting rectangle, lay out multiple ping pong balls. You can add other classroom objects as well, such as balled up paper, glue sticks, pencils, books, water bottles, etc. If an object is particularly heavy, you can assign bonus points to it.

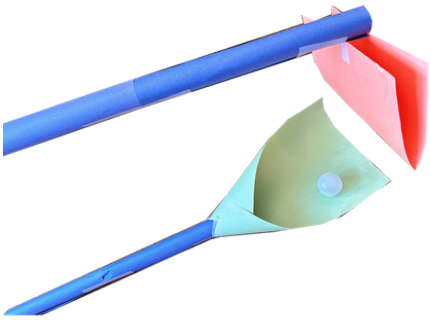
Have each group send a representative to compete. One by one, give each representative one minute to move as many objects between the two rectangles as possible using their grabber.

The group who successfully moves the most objects wins!

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SPACE ARM PROBE

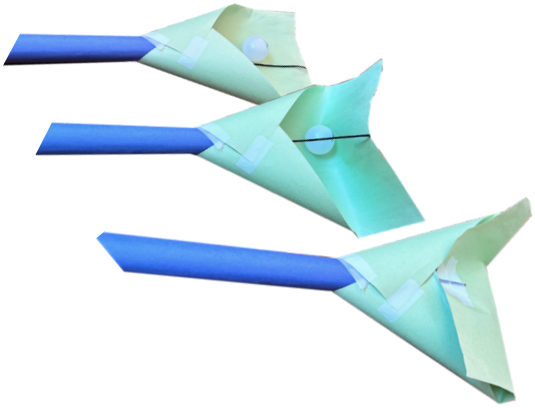
PING PONG GRABBER EXAMPLES



Dustpan Grabber

Engineering Concepts:

- Gravity - once the ball is in the dustpan, this version uses gravity to keep it secure. This wouldn't work if the grabber had to be used at different angles
- Materials - the dustpan is made of a single sheet of paper. It can support a ping pong ball, but would not work for heavier objects



Mechanical Dustpan Grabber

Engineering Concepts:

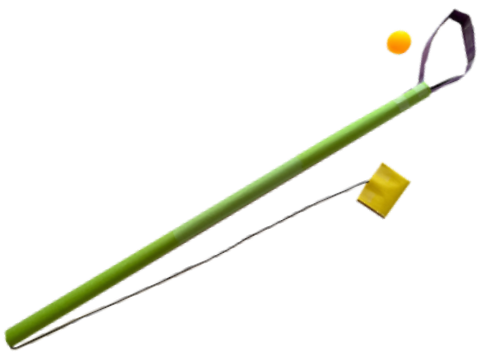
- Mechanics - this tool uses a string to close over the ping pong ball
- Tension - the tension from pulling on the string closes the lid, but when you let go of the string, the tension of the paper causes it to unfurl. This grabber can open and close, unlike the mechanical loop grabber, which cannot open easily
- Materials - the dustpan is made of a single sheet of paper. It can support a ping pong ball, but would not work for heavier objects



Loop Grabber

Engineering Concepts:

- Size - the loop is designed to fit the exact size of the ball. If your class has already done the marble sorting experiment, connect this to concepts in that lesson
- Friction - this grabber uses friction to keep the ball in place. It would not work with a differently sized object



Mechanical Loop Grabber

Engineering Concepts:

- Mechanics - this tool uses a loop, which can be tightened using a string, to grab the ping pong ball
- Size - this tool can be used to grab objects of various sizes
- Materials - the way the paper handle is rolled and the paper loop is folded makes this grabber very strong. If your class has done the paper tower or paper bridge experiment, connect this to concepts in those lessons

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SPACE ARM PROBE

CONCLUSION

3-5 min

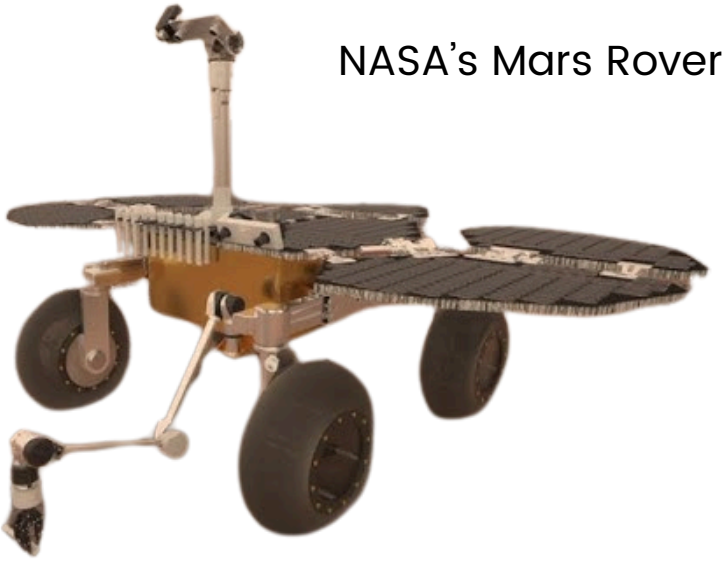
Materials in space are extremely valuable for research purposes. In order to collect these materials we need lots of different tools and extraction methods. This is due to the extreme conditions space, and other planets' atmospheres' create. For example, Outer Space has a resting temperature of around -458ºF, for reference Antarctica is around -45ºF. Knowing this, we definitely can't just put our hands out there and grab things.

Another example is the surface of Venus can get up to 864ºF. This is extremely hot, and impossible for humans to walk around in even with modern space suits. So, just like in this lesson, we have developed many different ways to collect materials outside of our own atmosphere.

Space shuttles come equipped with robotic arms, much like our grabbers, to help assist in collecting materials, repairing the ship, and other miscellaneous needs of the ship. Rovers and robots that land on the surface of moons and planets also come equipped with a "grabber like arm to collect samples! See some example here:



Robotic arm for gathering samples



NASA's Mars Rover

Exit Ticket

Ask each student one of the following questions as they walk out the door.

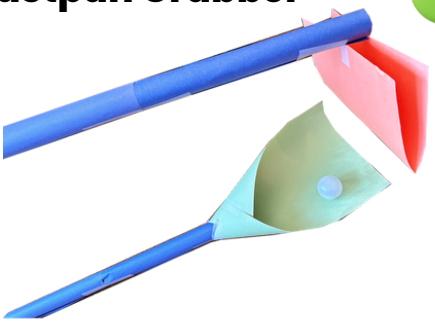
- What is one important features to have in a grabber?
  - Potential Answers: lightweight, strong, secure
- How did you structure your materials to make them stronger?
  - Potential Answers: rolling the paper, folding the paper
- What is a real-life example of a time someone would need. a grabber tool?
- What are some engineering or physics concepts your grabber used?
  - Potential Answers: friction, gravity, tension, strong shapes (cylinders)



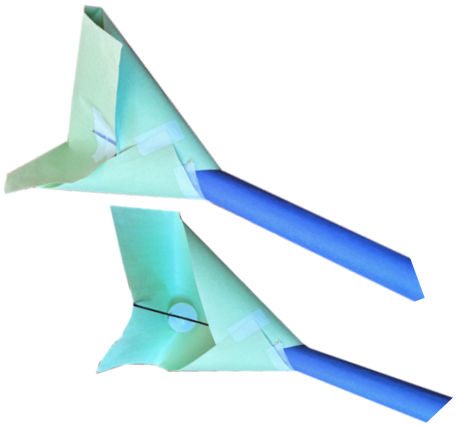
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SPACE ARM PROBE: STUDENT EXAMPLES

1. **Dustpan Grabber**



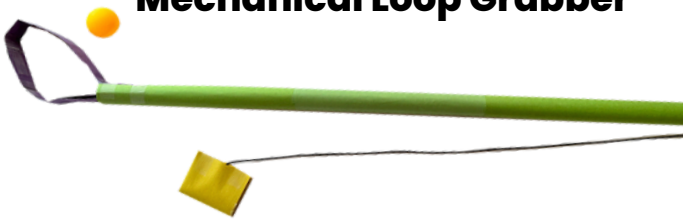
2. **Mechanical Dustpan Grabber**



3. **Loop Grabber**

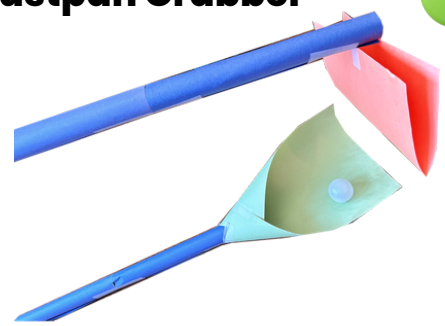


4. **Mechanical Loop Grabber**

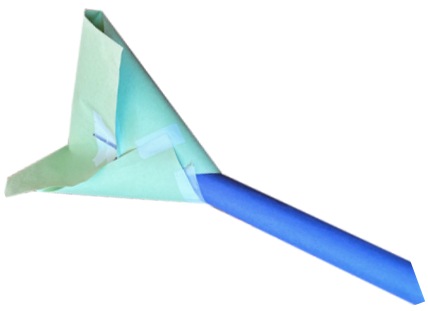


SPACE ARM PROBE: STUDENT EXAMPLES

1. **Dustpan Grabber**



2. **Mechanical Dustpan Grabber**



3. **Loop Grabber**



4. **Mechanical Loop Grabber**

