

## Asteroid Mining

People have been mining on Earth for thousands of years. Yet someday in the near future, scientists might go to space to mine in our solar system!

This is a **future technology**. Scientists and engineers are still just imagining how they will mine asteroids. Children in school today will be the workers who develop these technologies! Now is your chance to get a head start - how would you design a machine that can mine materials on an asteroid?

### Supplies:

- Asteroid Drawing sheets (printable)
- Markers or colored pencils
- Challenge Cards (printable)

### Instructions:

**Your mission: travel to a distant asteroid to mine for minerals and other resources.**

1. Use your imagination to design a mining machine. How does it work? What special instruments or tools does it need? Does your machine need to communicate back to Earth? How would it get power to operate?
2. Draw a picture of your mining machine on the asteroid drawing worksheet. If you need inspiration for your design, or would like an extra challenge, choose a challenge card. Imagine you are the person on the card. How does this change your thinking about mining asteroids?
3. Consider the following questions, or if you have a partner or caregiver available, start a discussion using these questions: Why would you mine an asteroid? What does the asteroid look like after mining? How do you think life on Earth would be different after mining?
4. Great job on your design. You are helping to imagine the humans' future of working and living in space!

## What is Mining?

On Earth, the mining process takes minerals and other resources out of the ground to make new products. Mining can happen underground or on the surface, it uses many different kinds of machines and technologies, and it involves lots of different steps. These steps include:

## What is an Asteroid?

Asteroids are space objects that orbit the Sun but are much smaller than planets. They are leftover bits and pieces from the formation of the solar system. Scientists have counted about 800,000 asteroids so far – out of millions in our solar system – and found many different shapes and sizes. While asteroids are mostly made of rock, they can also contain metals and water ice. Most asteroids in the solar system can be found between Mars and Jupiter in a region called the asteroid belt.

## Why Asteroid Mining?

It's exciting to imagine what our lives might be like in a future filled with more space exploration – and it's also important. It's still too expensive and difficult to mine asteroids today. But in the future, asteroids and dwarf planets in our solar system could become new sources for materials used in manufacturing, energy production, or supporting humans living in space. When you imagine your asteroid mining machine, you're doing a little bit of science. Before scientists and engineers can start mining, they need to come up with ideas for how their mining machines might work. Our society will also need to consider how mining asteroids might change our lives, now and into the future.

**Design your own**

# ASTEROID MINING MACHINE

**What materials will your machine look for?**

**What tools will it need?**

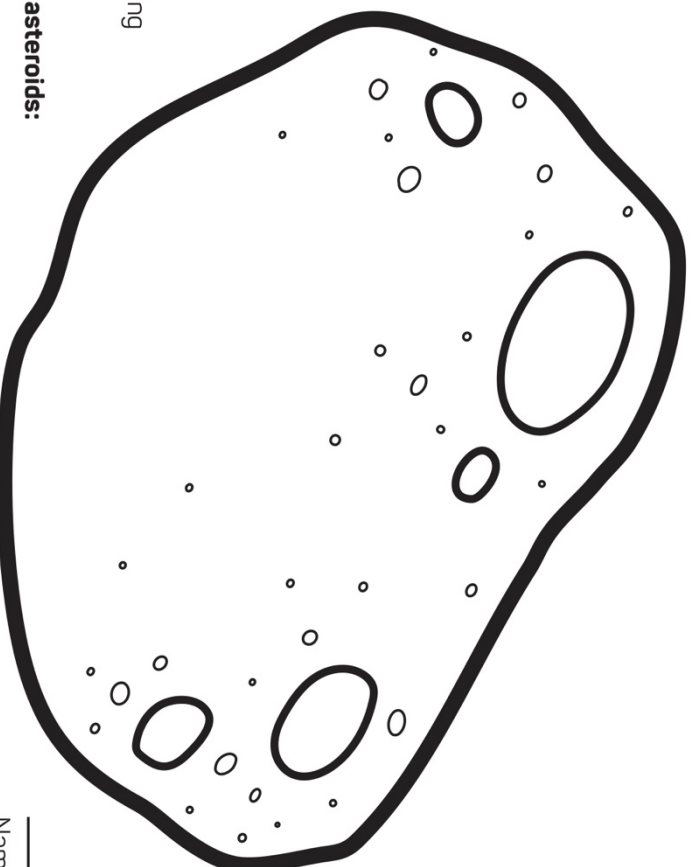
**How does it get the power it needs to run?**

**How does your machine communicate back to Earth?**

**It's exciting to imagine what our lives might be like in the future—it's also important.**

When you imagine your asteroid mining machine, you're doing a little bit of science. Well before scientists and engineers can start mining, they think up ideas for machines and consider how mining asteroids might change our future.

**Learn more about how NASA is studying asteroids:**  
[science.nasa.gov/solar-system](https://science.nasa.gov/solar-system)



Name your asteroid mining machine: \_\_\_\_\_

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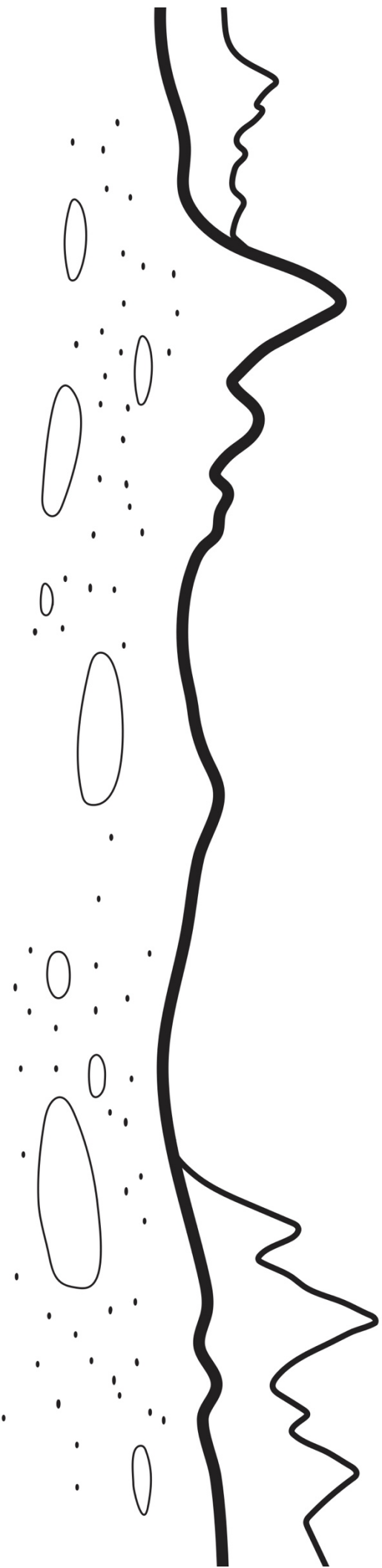
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Name your asteroid mining machine:





## DEEP SPACE EXPLORER

You are thinking about exploring distant regions of our solar system. To do this, you will need to refuel your spacecraft while out in space. Ice mined from asteroids can be processed into fuel, which could be used to refuel your spacecraft for exploration and travel to the far reaches of space.



## SPACE LAWYER

You are working on making laws that govern how asteroids can be mined. You are trying to answer questions like: who gets to own things in space, and who decides that? How are laws in space enforced? Your work makes sure that asteroids are mined responsibly, ethically, and equitably.



### NASA'S GALILEO SPACECRAFT

took the first-ever close-up asteroid photos of



### GASPRA

when it flew by in 1991.

### CHALLENGE!

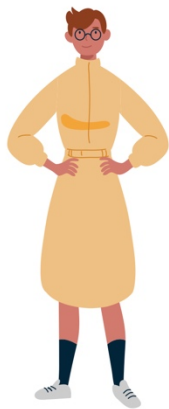
Design a machine that can mine and process ice into fuel for your spacecraft.



Even a house-sized asteroid could contain  
**METALS WORTH MILLIONS**  
of dollars.

### CHALLENGE!

Imagine some laws you could create to govern mining and ownership on asteroids. Draw what this looks like and how they are enforced.



## MISSION CONTROL OPERATOR

You and your team are designing a way to mine a small and fast-moving asteroid. Your goal is to fly alongside or orbit the asteroid, so you don't change its path. Your mining machine will need to gather valuable minerals from above the surface of the asteroid.

Scientists have counted about  
**800,000**  
**ASTEROIDS**  
of the millions in our solar system.



### CHALLENGE!

Design a machine that can orbit or fly above an asteroid and mine it without landing there.



## SPACE HYDROLOGIST

You study water ice found in space and are part of a team planning a future mission to collect ice from asteroids. You will need remotely controlled lab equipment that can collect water ice samples, analyze it, and send the data back to Earth.

### CHALLENGE!

Imagine what the lab equipment could look like. How will it collect water ice? How will it analyze the water ice?



NASA spacecraft and telescopes have already detected  
**THE PRESENCE OF WATER**  
on some asteroids.



## NASA ENGINEER

Your team is planning a future mission to the asteroid belt to drill into an asteroid and collect and analyze a sample of its core. As the chief engineer, you and your team need to design a device that you will remotely control from Earth.



Most asteroids are  
**IRREGULARLY SHAPED**



Though a few are nearly  
**SPHERICAL**



### CHALLENGE!

Imagine what the drilling machine might look like. How will it collect the core sample? Where will the sample be stored?



## ASTRO-BIOLOGIST

You are interested in the search for signs of life in our solar system. But Earth contains a lot of life forms, and some of the smallest—*microorganisms*—can hitch a ride on spacecraft or just about anywhere.



### CHALLENGE!

Design a mining machine that's unlikely to contaminate an asteroid with microorganisms from Earth.

In 2005, the Japanese spacecraft  
**HAYABUSA**  
landed on the asteroid **ITOKAWA**



Hayabusa collected  
**DUST SAMPLES**  
that it brought  
back to Earth in 2010.