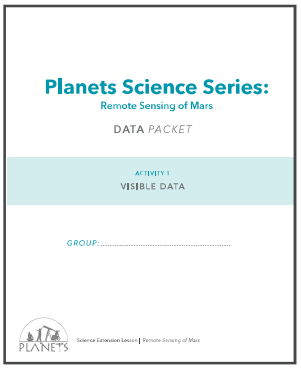
Activity 1: Introducing Mars and Remote Sensing (60 min)

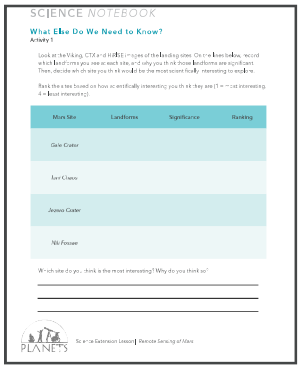
Overview

What do scientists want to learn about Mars? Youth brainstorm questions about Mars and the evidence needed to answer them. They learn NASA's questions about Mars, and how NASA remote sensing data are used to choose landing sites.

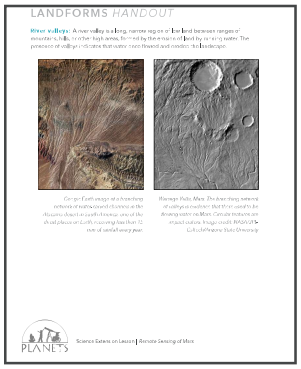
In this activity:



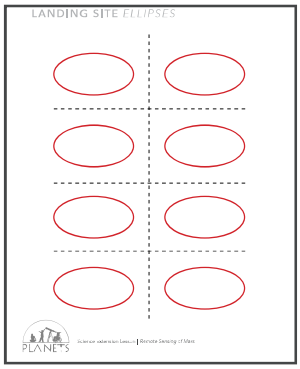
Visible Data Packet (CTX & HiRISE images)
1 per group



Science Notebook
1 per youth

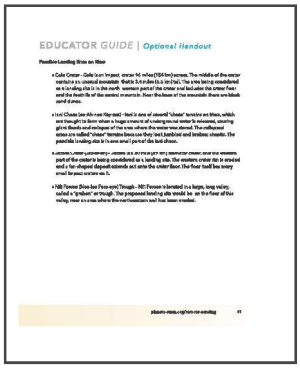


Landforms Handout
1 per group



Ellipses Sheet
Cut out 1 ellipse per group

Optional:



Optional Handout
1 per group

Introduction (5 min)

1. Let youth know that today, they will use real remote sensing data collected by NASA scientists to help decide where to land a spacecraft on Mars.

2. Review what youth already know about remote sensing and post the following definition so they can reference it throughout the activity: "Remote sensing is the science of obtaining information about objects or areas from a distance." Examples of devices that collect these data include cameras, video cameras, telescopes, microscopes, and the human eye. These devices are often mounted on aircraft, satellites, and spacecraft to collect remote sensing data.

3. Ask youth to share what they know about Mars. Be sure to correct any misconceptions that appear.

Common Misconceptions About Mars

Misconception	Truth
Astronauts have been to Mars	Earth's moon is the only planetary body that astronauts have visited so far.
We have already collected samples from Mars	Nothing we have sent to Mars has ever been intended to return to Earth. We don't have any samples from Mars yet (except meteorites).
There is a lot of liquid water flowing on Mars	It is too cold and the atmosphere is too thin for there to be significant amounts of liquid water on present-day Mars.
There is no water at all on Mars	Mars does have water, it is just mostly in the form of ice at the poles or trapped in minerals and the ground.

Formulating Science Questions (5 min)

1. Once youth have had a chance to share their prior knowledge about Mars, ask them: "What questions do you still have about Mars?" Have students take a minute to write down questions in their Science Notebooks.

2. Have youth volunteer to share a few of their questions.

3. Have youth discuss with their group and brainstorm ways they think scientists might try to answer those questions in the table on p. 2 in their Science Notebooks. What evidence or observations of Mars would they need to answer their questions? Encourage them to think about how landing a rover on the surface might help find answers.

4. Explain to youth that they will play the role of scientists answering these questions for the first time. It's their job to use remote sensing technologies to find out more about what the surface of Mars is like.

5. Acknowledge all questions youth have as important science questions, and then tell youth about NASA's main question about Mars:

   » NASA is most interested in learning about habitability: What evidence can we find to indicate that Mars could have supported Earth-like life in the distant past?

   » One of the key requirements for life as we know it is liquid water, so evidence for liquid water on Mars is what planetary scientists are interested in.

Tip: If youth are not familiar with rovers, take some time to learn more about what rovers do:

Resources for educators:
planets-stem.org/remote-sensing

NASA's main Mars page:
mars.nasa.gov

Perseverance Rover:
mars.nasa.gov/mars2020/

Introduce the Challenge (5 min)

1. Let youth know:
   - » NASA needs help to decide where to land its next rover on Mars!
   - » The ideal landing site should be safe to land on, with minerals and landforms that indicate evidence for past water.
   - » You will have the chance to examine different types of real NASA data from four possible landing sites and decide which site to recommend to NASA.

Did you know? There are other requirements for habitability, such as an energy source, water chemistry that is safe for life, the presence of key nutrients, safe temperature range, not too much radiation, etc. but these are all very hard to detect using remote sensing – that's why NASA wants to send a rover!

Explore the Visual Data (15 min)

1. Divide youth into groups of four. Hand out the Data Packets containing CTX (Context Camera) and HiRISE (High Resolution Imaging Science Experiment) images, from instruments on the Mars Reconnaissance Orbiter, a satellite that has been orbiting Mars since 2006.

2. Let youth know:
   - » On the CTX images of the sites, there are small white boxes, labeled "A" and "B"
   - » These are locations where extremely high-resolution images (from the HiRISE camera show landforms in even better detail than CTX. For example box "A"on p. 2 corresponds with image 'A" on p. 3.
   - » Now we will examine these landform types and see what they can tell us about the geologic history of Mars.

Look for Evidence of Landforms on Mars (20 min)

1. Pass out one copy of the Landforms Handout to each group. Discuss with youth the landforms shown on the handout: river valleys, layered rocks, alluvial fans, river deltas, lava flows, sand dunes and yardangs.

- River valleys – Indicate that water once flowed and eroded the landscape
- Layered rocks – Some layered rocks are deposited in water but others are deposited by the wind. It can be hard to tell the difference without studying them up-close!
- Alluvial fans – An alluvial fan is a fan-shaped pile of sand and gravel that is deposited by water flowing into an open area like a crater.
- River delta – A delta is a fan-shaped feature made of layered rocks deposited when flowing water encountered standing water in a lake or sea. They require a lot of water to form.
- Lava flows – Areas that form a hard "cap" rock, often with lots of craters, might be lava flows which can be used to learn the ages of rocks on Mars.
- Sand dunes – These moving piles of sand can carry minerals.
- Yardangs - Wind erosion can sculpt soft rock into elongated, streamlined groups of ridges and hills called yardangs. These are most often found on the Earth in deserts.

2. Let youth know:
   - They can rearrange the pages in the handout into different categories, and group them by site or by data type.
   - Next, describe the four potential landing sites to youth (see optional handout at the end of this guide, p. 41).

     - Gale Crater - Gale is an impact crater 96 miles (154 km) across. The middle of the crater contains an unusual mountain that is 3.4 miles (5.5 km) tall. The area being considered as a landing site is in the north western part of the crater and includes the crater floor and the foothills of the central mountain. Near the base of the mountain there are black sand dunes.

     - Iani Chaos (ee-Ah-nee Kay-oss) – Iani is one of several "chaos" terrains on Mars, which are thought to form when a huge amount of underground water is released, causing giant floods and collapse of the area where the water was stored. The collapsed areas are called "chaos" terrains because they look jumbled and broken: chaotic. The possible landing site is in one small part of the Iani chaos.

- Jezero Crater (Jez-er-oh) – Jezero is a 30 mile (39 km) diameter crater, and the western part of the crater is being considered as a landing site. The western crater rim is eroded and a fan-shaped deposit extends out onto the crater floor. The floor itself has many small impact craters on it.

- Nili Fossae (Nee-lee Foss-eye) Trough – Nili Fossae is located in a large, long valley, called a "graben" or trough. The proposed landing site would be on the floor of this valley, near an area where the northwestern wall has been eroded.

3. Explain to youth that they will need to:

   » Study their data (CTX and HiRISE) of the four potential landing sites (Gale, Iani, Jezero, and Nili).
   » Look for an interesting place to land in the CTX image of each landing site and explain why they think that site is the best.

4. Pass out a landing site ellipse to each group. Tell youth:

   » Landing on Mars is difficult! We can be sure the rover will land in an area the size of this ellipse (16 km by 8 km; 10 miles by 5 miles), but we can't pinpoint the landing location any better than that.
   » Rovers can't drive very quickly or very far, so a scientifically interesting landing site should contain evidence for water within the ellipse or very nearby.
   » As a bonus challenge, groups can look for evidence of volcanic activity which is also scientifically interesting because it can tell scientists how old the rocks are and how geologically active the planet is.

5. Ask youth:

   » Within each CTX image, where would you put this landing site ellipse and why?
   » Decide with your group, and trace your chosen areas in the Gale, Iani, Jezero, and Nili CTX images. Reminder: Don't trace ellipses on the HiRISE images—the scale isn't the same.

6. Have youth record the landforms present at each site, the scientific significance of each landform, and rank the sites based on how scientifically interesting they are.

   » Guide youth to emphasize scientific significance in their ellipse placement, providing some time to update their initial landing locations if necessary.

Wrap Up (10 min)

1. Summarize by going through each site and leading a discussion about which images show geological features that indicate that water might have been there and why.

   » Describe why the areas you chose would be good landing sites –what's good or bad about each one?

   » What is the evidence for describing each area as "good" or "bad"?

2. Wrap up for the day by congratulating youth on their excellent scientific work. Let youth know that next time, they will use new data to learn more about the surface of Mars.

Site	Landforms (water-related landforms are underlined)
Gale	River valley, alluvial fan, layered rocks*, sand dunes, yardangs, craters
Iani Chaos	Layered rocks,* chaos terrain**, canyons, lava flow, sand dunes
Jezero	Delta, river valley, lava flow, crater rim, craters
Nili Fossae	Sand dunes, craters, lava flow, cliff

* Layered rocks are ambiguous. Sometimes they form in water, other times not.
** Chaos terrain itself (best seen in the Viking data online at planets-stem.org/remote-sensing) is thought to be water-related!