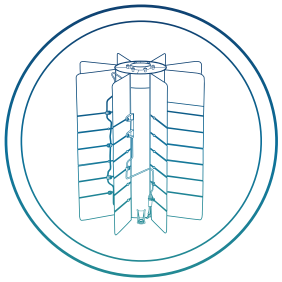


SCIENCE LESSON WORKSHEET

LEARN ABOUT RPS SCAVENGER HUNT

It takes a special kind of power to explore the extremes of our solar system, and NASA wants to hear how it would energize your space exploration dreams! But before you plan a mission exploring the solar system – or further– you need to know exactly what RPS power can do and where it can go. Follow the trail and pick up all the know-how you need on this scavenger hunt to help you design a mission that will explore far beyond our own planet Earth. The hunt is on!

VOCABULARY:

- Radioisotope Power Systems (RPS)
- Plutonium-238
- Nuclear Energy
- Solar Energy
- Power Systems
- Thermal Systems
- Thermocouple
- Mission
- Multi-Mission Radioisotope Thermoelectric Generator
- Flyby
- Orbit
- Land
- Rove

SCAVENGER HUNT

You have been given this list of questions and tasks. Show the list who's boss by giving it a good long stare. You will notice that your scavenger missions are split into sections, and each section has a handy QR code after the introduction that you can use to navigate your way to the answers and see how much you can discover before time runs out!

THE POWER TO EXPLORE CHALLENGE

Knowledge is power! This scavenger hunt will lead you on a deep dive into the world of RPS and distant space exploration, which will, in turn, prepare you to submit an entry for the Power to Explore Challenge!

CLICK OR SCAN

1. Briefly explain what the Power to Explore Challenge wants you to do.

_____

_____

_____

2. What is the maximum number of words you can have in your challenge entry (not including the title)?

- ☐ 250
- ☐ 500
- ☐ 750

RADIOISOTOPE POWER SYSTEMS

We've already learned that Radioisotope Power Systems (RPS) are a type of nuclear energy technology that uses heat to produce electrical power. Now let's dig a little deeper to give you a head start on planning a mission.

CLICK OR SCAN

3. Where does the heat for RPS come from?

4. Approximately how long has RPS technology been used in the U.S. space program?

- [ ] Since 2011
- [ ] Over 40 years
- [ ] Since 1958
- [ ] Over 60 years

5. How sharp are your eyes? Find these paragraphs and fill in the missing words.

RPS offer several important benefits. They are _____, rugged and provide reliable power in harsh environments where _____arrays are not practical. For example, Saturn is about ten times farther from the sun than Earth, and the available sunlight there is only one hundredth, or one percent, of what we receive at Earth. At_____, the available sunlight is only six hundredths of a percent of the amount available at Earth. The ability to utilize radioisotope power is important for missions to these and other incredibly distant destinations, as the size of solar arrays required at such distances is impractically large with current technology.

RPS offer the key advantage of operating _____over long-duration space missions, largely independent of changes in sunlight, temperature, charged particle radiation, or surface conditions like thick clouds or dust.

In addition, some of the excess _____produced by some radioisotope power systems can be used to enable spacecraft _____and on-board systems to continue to operate effectively in extremely cold environments.

In the future, radioisotope power systems could continue to support missions to some of the most extreme environments in the_____, probing the secrets of Jupiter's ocean moon Europa, floating in the _____of Saturn's moon Titan or touring the rings and moons of the ice giant planet _____. With this vital technological capability, the possibilities for exploration and discovery are limited only by our imaginations.

6. Match the acronym to the full name.

RTG	_____	Radioisotope Powered Systems
DOE	_____	Multi-Mission Radioisotope Thermoelectric Generator
MMRTG	_____	Radioisotope Heating Unit
RHU	_____	Radioisotope Thermoelectric Generator
RPS	_____	Department of Energy

PLUTONIUM-238

Plutonium-238 is the radioisotope of choice for RPS! It has proven to be a very dependable and safe heat source on more than two dozen U.S. space missions. Let's find out more about how it can help you in designing your mission.

Click or Scan

7. Take a screenshot or draw a picture of a pellet of plutonium-238.

8. To be suitable for space missions, a radioisotope must meet a list of specific criteria. Plutonium-238 meets all of them! Name two of these criteria.

Watch this video and see what sticks in your brain. (*Hint: For the answers to the questions below, start at minute 4:43.*

CLICK OR SCAN

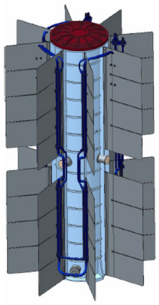
9. Radioisotopes are measured by the rate at which they decay. This is known as the half-life.

a. What is the half-life of plutonium-238? _____

b. Why is plutonium-238 ideal for long-lived space missions? _____

_____

10. Look at the pictures below and answers the questions that follow.



a. What are these devices called, and what is their abbreviation? *(Hint: One is a Next gen- _____ and the other is an Multi-Mission_____)*

_____

b. What do these devices do?

_____

_____

c. Unscramble this anagram of an unlikely superhero to reveal the device's name that converts heat into electricity. *(Hint: The name of the device is one word)*

HERO CLUMP TOE

_____

MISSIONS & MISSION GOALS

Click or Scan

One of the most important things we do is learn from the past, building on the expertise of scientists, engineers, and people at NASA that have powered previous missions. If we stand on the shoulders of the knowledge that already exists, we can see further into the future. Let's take a journey through past and current NASA missions to see what RPS are truly capable of.

11. RPS use spacecraft that are designed for flyby, orbit, land, or rove missions. You will need to decide what your mission will be and what your spacecraft will do. Use the RPS missions page and NASA image "Flyby, Orbit, Rove, and Land" to answer the multiple-choice questions below.

What kind of missions were Voyager 1 and Voyager 2?

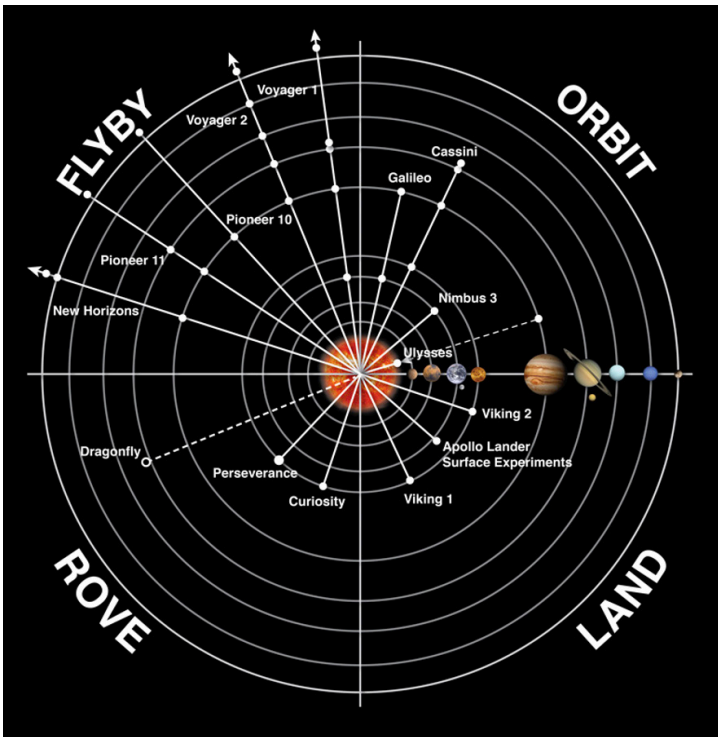
- ☐ Flyby
- ☐ Orbit
- ☐ Land
- ☐ Rove

Galileo was the first spacecraft to orbit and study what planet?

- ☐ Mars
- ☐ Jupiter
- ☐ Neptune
- ☐ The Moon

NASA's Viking mission to mars was composed of two pairs of spacecraft - Viking 1 and Viking 2 - each consisting of an orbiter and lander. This was the first mission to land on what planet?

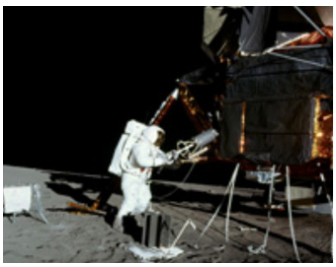
- ☐ Mars
- ☐ Jupiter
- ☐ Neptune
- ☐ The Moon



12. Use the picture below and the RPS Missions link to answer the following questions.
(Hint: On the mission page, click on "Past Missions.")

CLICK OR SCAN

a. Name this crewed mission (one with astronauts) that used RPS.



b. What did RPS power on this crewed mission?

13. RPS sounds like new technology, but we've been using it for over 60 years. Screenshot or quickly sketch the first space object to use an RPS. No points for artistic skills, but you do get unlimited glory if you can also name it and provide the date it launched.

Name of the first space object to use RPS: _____

Date Launched: _____

14. Which is the most recent piece of NASA technology to use an MMRTG?
(Hint, it launched in 2020. Click this link to find out where the MMRTG is located.)

CLICK OR SCAN

15. Ulysses is the spacecraft named after an intrepid adventurer from ancient times. Ulysses was launched in 1990 with very specific mission goals and ten instruments; what did those instruments measure?

16. Name the twin rovers that use both solar power and RPS.

17. Name the two longest-running active missions using RTGs and the dates they were launched.

18. This piece of text is located somewhere in the Missions pages. Use your hawk-sharp eyes to find it and fill in the blanks!

> The **Mars 2020** "Perseverance" rover is conducting geological assessments of its landing site on Mars; Perseverance is determining the _____ of the environment, searching for signs of_____, and assessing natural resources and _____for future_____.

19. Sometimes spacecraft carry a friendly hitchhiker. Can you name the orbiter that dropped off the European Huygens probe on one of Saturn's moons? And which moon was it?

FUTURE EXPLORATION

NASA is always looking to the future! Find out what's in store next for RPS.

CLICK OR SCAN

20. Dragonfly, which is set to launch in 2027, is the next mission with plans to use an MMRTG. Part of NASA's New Frontiers program, Dragonfly is an octocopter designed to do what?

CLICK OR SCAN

Check out this video to find out how Dragonfly's pioneering mission is pushing the boundaries of human exploration.

BONUS QUESTION

Every NASA mission is a massive achievement, a unique testament to what humankind can accomplish with collaboration and an unquenchable thirst to discover what lies beyond our planet. NASA's groundbreaking work ignites a global passion for space exploration, generation after generation. We want to know what has inspired you.

21. What is your favorite NASA RPS-powered mission, and why?