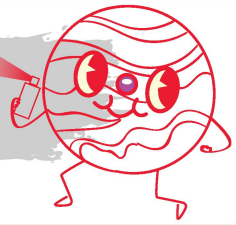
Activity sheet (Secondary level)

"China's Lunar and Mars Exploration" Special Exhibition

Rovers for Lunar and Mars Exploration

In this project, we will unveil the mysteries of deep space with the help of unmanned rovers. Come and study how these remarkable rovers navigate the terrains, withstand harsh environments, and uncover the secrets of our nearby celestial bodies.

Project Learning



Task 1: Get to know Moon and Mars

Choose either Moon or Mars for research and answer the following questions.

1 How is the atmosphere of Moon / Mars differ from Earth's atmosphere?

The lunar atmosphere is extremely thin.
The Martian atmosphere is thinner than that of Earth, with a volume that is only 1% of Earth's. It is mainly composed of carbon dioxide, which accounts for about 95%.
(or other reasonable answer)

2 How does the atmosphere of Moon / Mars affect its environmental conditions?

Moon: The thin lunar atmosphere does not provide protection like Earth's atmosphere. As a result, the lunar surface is directly exposed to strong radiation, including ultraviolet rays and cosmic rays, leading to extremely high radiation levels on the Moon. Additionally, the thin atmosphere cannot regulate temperature, resulting in significant temperature variations on the lunar surface.
Mars: The Martian atmosphere contains only a small amount of water vapour. Furthermore, because the density of the Martian atmosphere is lower than that of Earth, the greenhouse effect is weak, despite its high carbon dioxide content. This contributes to Mars's dry and cold climate. (or other reasonable answer)

3 What are the temperature extremes on Moon / Mars? How do these extreme temperatures affect the operation of the rover?

Moon: The daytime temperature is about 120℃, while the nighttime temperature drops to about -170℃.
Mars: The daytime temperature in summer can reach about 20℃, while the nighttime temperature can fall to about -150℃.
(Temperatures will vary at different latitudes and seasons. Teachers can determine the answer based on the students' reference sources.)
The extreme temperature differences may affect the stability and accuracy of the instruments on the rovers.
(or other reasonable answer)

4 Are there any natural resources, such as water or minerals, on Moon / Mars? How can humans make use of them?

Moon: rare-earth elements, helium, minerals, etc.
Mars: minerals, water-ice, soil, etc.
Humans can mine rare resources and transport them back to Earth for use, or use them in situ during future landings.
(or other reasonable answer)

5 How does the day-night cycle on Moon / Mars differ from that on Earth? How does this affect the rover with respect to electricity generation and communication using solar energy?

A lunar day is approximately 708.7 hours.
A Martian day is approximately 24.6 hours.
Taking Moon as an example, the long period of darkness prevents the rover from relying on solar energy for operation. The rover needs to go into dormant mode, and communication would be suspended. (or other reasonable answer)

6 What are the geological features of Moon / Mars? What do they tell us about the history of Moon / Mars?

Moon: mountains, basins, valleys, etc.
Mars: mountains, plains, canyons, volcanoes, etc.
Geological features reflect environmental evolution caused by crustal movements, impact events, etc. By studying these features, scientists can figure out the formation and evolution of Moon / Mars.
(or other reasonable answer)

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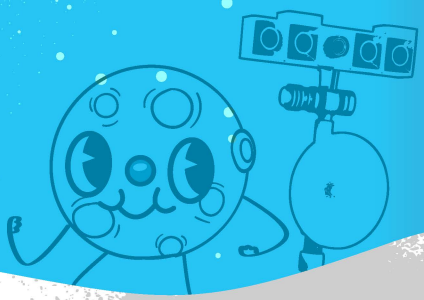

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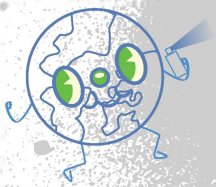
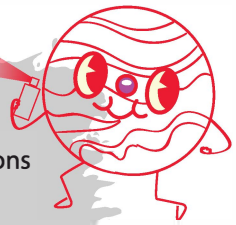
Task 2: Study the rovers

Rovers can move on rough surfaces, withstand tough environmental conditions, and collect valuable scientific data for researchers.

Based on your selection of the research subject in task 1, study the missions, functions and features of the lunar rover Yutu or Mars rover Zhurong, and answer the following questions:





1 What scientific instruments (payloads) are installed in the rover?

Yutu: Panoramic camera, lunar penetrating radar, visible and near-infrared imaging spectrometer, active particle-induced X-ray spectrometer
Zhurong: multispectral camera, penetrating radar, surface composition detector, magnetometer, climate station, navigation and terrain camera

2 What are the special designs of the rover's mobility system that allow the rover to move on rough surfaces?

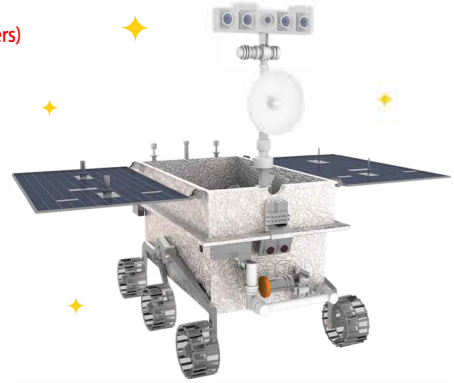
Yutu: wheels, rocker suspension
Zhurong: wheels, active suspension, different modes of movement

3 How does the rover obtain energy? Why is it possible for the rover to withstand extreme temperatures?

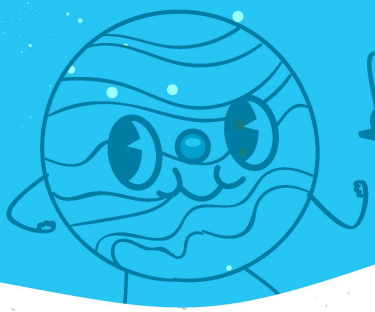
Yutu: It harnesses solar energy through solar panels. To cope with the severe cold of the lunar night, Yutu retracts its mast and one of its solar panels, switching to dormant mode. During the daytime, to prevent overheating of its instruments, Yutu can adjust the angle of the solar panel to minimise direct sunlight exposure.
Zhurong: This rover uses solar panels to capture solar energy and is equipped with a heat-collecting device. The chemical inside the heat-collecting device absorbs heat during the day and melts. When nighttime temperatures drop, the chemical solidifies and releases the stored thermal energy, helping to keep the rover warm. Additionally, Zhurong employs nano-aerogel for thermal insulation. In extremely low-temperature environments, Zhurong enters a dormant mode until conditions are suitable for operation.
(or other reasonable answers)

4 What are the purposes of the exploration mission? Any achievements made?

Yutu's missions: to conduct surveys on lunar surface topography and geology, lunar surface material composition and resource. Discovery: The data obtained from Yutu's lunar penetrating radar successfully created the first-ever lunar geological cross-section profile. Data from the visible and near-infrared imaging spectrometer, as well as the active particle-induced X-ray spectrometer, allowed scientists to discover a new type of lunar mare basalt.
Zhurong's missions: to explore Martian surface topography and geological structures, soil structure, types of elements, minerals and rocks on the Martian surface, atmospheric features, and so on. Discovery: Zhurong obtained a large amount of scientific data on the surface magnetic field, meteorology, topography, and other aspects of the roving area. For example, it revealed evidence that supports the existence of an ocean in the northern part of Mars.
(or other reasonable answers)



Let's explore the achievements China made in its lunar and Mars exploration!



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Task 3: Become an adventurous friend

Try to design and make a prototype rover.

1. Choose one of the challenges that a rover may face during its exploration on Moon / Mars.
2. Study how scientists and engineers address the challenge in designing the rover.
3. See whether there are ways, such as providing additional features or modifying current instruments, to enhance the rover's functionality.
4. Design or modify the current rover so that it can cope with the challenge more effectively.
5. Make a prototype rover using materials such as cardboard, wheels and solar panels. Alternatively, you can use design and engineering apps, such as Tinkercad, to create a virtual prototype.
6. Present to the class your design and explain the strategies used to cope with the challenge.

Draw the rover design in the space below.