

11. Exploring the Solar System - Space Probes

Edexcel GCSE Astronomy Course

11.26 Understand the advantages and disadvantages of the major types of space probe: a fly-by b orbiter c impactor d lander

- a. A **flyby** (pronounced /'flɪbɪ/) is a spaceflight operation in which a spacecraft passes in close proximity to another body, usually a target of its space exploration **mission** and/or a source of a gravity assist to impel it towards another target. [https://en.wikipedia.org/wiki/Flyby_\(spaceflight\)](https://en.wikipedia.org/wiki/Flyby_(spaceflight))
- b. An orbiter is a spacecraft placed in orbit around the Earth or another body in the Solar System - to be an orbiter it must make at least one full circuit around the object it is orbiting
- c. Impactors are designed to deliberately crash into the object being studied. Here is a list of examples: https://en.wikipedia.org/wiki/Category:Impactor_spacecraft
- d. Lander - these are designed to land on another object in a more controlled way than an impactor, and maybe even take off again and return to Earth

To understand the advantages and disadvantages of each you need to think about, or discuss, the following questions as if you were a mission director:

How far does the probe need to travel? Does it need to land or will images be enough? Does it need to study the object for a long period of time? Is the mission focussed on one object or several? Does it need to land in a specific place? Will the probe carry rovers or stay in one place? How delicate are the instruments and do they need to survive after landing? Make a list, or a table, to answer these questions for each type of space probe. Add any other advantages or disadvantages you think of.

11.27 Know an example of each type of space probe, including target body and major discoveries, including:

Print off this free chart of the Solar System and then use the links below to trace the path or label the destination of the space missions that are listed in a to d:

<https://www.bestcoloringpagesforkids.com/wp-content/uploads/2013/07/Plants-in-Orbit-Worksheet.png>

a fly-by – New Horizons (Outer Solar System) https://www.youtube.com/watch?v=kzyrBlySPWw&ab_channel=CBSN

b orbiter – Juno (Jupiter) https://www.youtube.com/watch?v=sYp5p2oL51g&ab_channel=NASAJuno
or Dawn (asteroids Vesta and Ceres) https://www.theplanetstoday.com/dawn_spacecraft_flight_path.html

c impactor – Deep Impact (comet Tempel 1) https://www.jpl.nasa.gov/news/press_kits/deep-impact-launch.pdf (Slide Number 20)

d lander – Philae (comet 67P/Churyumov–Gerasimenko)
https://www.esa.int/Science_Exploration/Space_Science/Rosetta/The_long_trek

Next, do some research about each one and find out what the missions discovered - this would be a nice opportunity to make a slide presentation or a poster or some flashcards about each one.

11.28 Understand that a space probe must reach the Earth's escape velocity, the energy requirements of which can be met only by the use of rockets

This website gives a fun introduction to the idea of escape velocity, the velocity a probe must have to escape from orbit around an object. The site lists the value of the escape velocity for the Earth and other planets:

<https://www.omnicalculator.com/physics/escape-velocity#how-to-calculate-escape-velocity>

The equation derives from the kinetic energy which must be transferred to gravitational potential energy of a space probe at a certain distance from the planet - to escape the planet completely, this is technically infinity! You may have learnt the equation for kinetic energy in your physics lessons:

$$KE = \frac{1}{2} mv^2$$

So for a 100kg space probe to reach 11.186m/s requires over 6000J of kinetic energy and a lot of space probes have far more mass than this which is why such large rockets are needed to launch them

https://en.wikipedia.org/wiki/List_of_heaviest_spacecraft

https://www.esa.int/Enabling_Support/Space_Transportation/Enhanced_Ariane_5_demonstrates_heavy-lift_capability

11.29 Understand the advantages and disadvantages of direct observation via manned missions

11.30 Understand the main features of the Apollo programme to land astronauts on the Moon

Humans are still generally better at doing certain tasks than robots - they can also take independent decisions. Here are some links about the science done by the Apollo astronauts - make notes on what they could do that a robot couldn't and some of their major discoveries:

<https://www.amnh.org/explore/news-blogs/news-posts/the-scientific-legacy-of-the-apollo-11-mission#:~:text=The%20Scientific%20Legacy%20of%20the%20Apollo%2011%20Mission&text=While%20on%20the%20Moon's%20surface,measure%20the%20Moon's%20seismic%20activity.>

https://www.youtube.com/watch?v=ASX2XAgaqnk&ab_channel=Seeker

Apollo Moon Rock Samples

Moon rocks at

<https://spacecenter.org/>

Houston, Texas, USA

