## *Space explorers* **Teaching and learning plan**

## Learning intentions

Students will be able to:

* identify and describe the features of the planets in our solar system
* understand that scientific knowledge is used to inform personal and community decisions
* use data and evidence to develop explanations of events and phenomenon
* pose questions to clarify practical problems
* predict findings of an investigation
* use tables to organise data
* identify patterns in their data and use this as evidence in developing explanations.

## Suggested time for this CLE

The time needed to complete the *Space station explorers* CLE will depend on the depth of the prior knowledge of students, whether the optional investigation: ‘The Penguin Project’, Investigation 2: ‘What should a penguin ‘wear’ to keep warm?’ is done, the time required for researching information and deep discussion. Allow 6–7 hours.

**[Planning ahead and equipment list](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Space explorers_Yr5_Planning and equipment list.docx)**

## Safety considerations

When you and your class are completing your Risk Assessment consider the following safety points and add any other relevant ones to the list.

* Students should be able to move easily and safely around the room.
* Ensure computers and cords are secure.
* Protocols for discussion should be explicit so that new and innovative ideas can be explored without risk of harassment.

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## Introduction

This CLE focuses on features of the eight planets of our solar system in the context of scientists considering setting up a space station on Mars. It uses data to compare features and movement of the planets which students analyse to determine how these affect planetary conditions. The CLE links to Year 5 Australian Curriculum: Science.

### Equipment needed

Per class:

* a computer, screen and Internet connection to watch videos
* the means for recording questions or for creating a ‘wonder wall’ (for example, large sheet of paper, whiteboard, sticky notes, digital media).

*For an example of a wonder wall see ‘Sharing good practice – Wonder wall activity’, Deira International School**website,* [*http://www.disdubai.ae/uploaded/Secondary\_Department\_Files/T\_L/Wonder\_Wall\_Activity.pdf*](http://www.disdubai.ae/uploaded/Secondary_Department_Files/T_L/Wonder_Wall_Activity.pdf) *(Accessed April 2016)*

### What to do

1. Introduce the concept of space stations by watching the video ‘Mars applicants apply here’, (Skype interview August 9, 2013) CNN news website, <http://edition.cnn.com/2013/04/22/world/mars-one-way-ticket/> (3:42 min)

The following website has more videos that may also be useful – ‘MarsOneProject’, YouTube, <https://www.youtube.com/user/MarsOneProject>

Use a discussion approach such as ‘community of inquiry’. For more information see:

‘Conducting a Community of Inquiry’, Museum of Victoria website, <http://museumvictoria.com.au/education/community-of-inquiry/>

1. Ask students whether they would like to be part of the mission to Mars and use the discussion process to explore their reasons, questions and concerns. Where possible, rephrase their comments as questions and record these where students can access them for further reference. For example, “There might be Martians”, could be recorded as “Is there life on Mars?” or “Mars is the closest planet” could be recorded as “Is Mars the closest planet?”
2. Allow discussion to flow between students without giving answers or personal viewpoints, but stimulate discussion by asking **provocations** such as:

* Why do you think they say the astronauts could never return? What assumptions are you making?
* Why do you think Mars was chosen? Is Mars really the best planet for a space station? Can you clarify why you think that?
* What information would be important to know before you decided to go?
* Why do you think they are waiting until 2023/2026?
* What do you think the astronauts would be doing on Mars? Why do you think that? What would be the purpose of doing that?

Ask further **clarifying questions,** such as:

* What makes you think that?
* Are there any other possible reasons/solutions/ideas?
* Do you all agree?
* Would that always be true?

**Tip**: Use protocols (such as giving a limited number of ‘talking stones’ for each person) to encourage all students to participate in the conversation, without any individual student monopolising it.

1. Create a human graph

Designate one side of the room as ‘absolutely agree’ and the other side as ‘absolutely disagree’ Students ‘vote with their feet’ by standing somewhere between the two ends to show the degree to which they agree with the following questions:

* Do you think the expedition should be allowed to go ahead?
* Would you be keen to volunteer to go?
* Do you believe Mars is the best planet to set up a space station colony?

1. Ask several students to explain **why** they placed themselves in their chosen position. Ask them what else they might need to know before making a final decision.
2. Read out the questions that have been generated from the discussion. Ask students if they have any other **questions** to add.
3. Create a ‘wonder wall’ to display student questions.

**Teacher notes:** 2023 was originally the date set as the Mars One launch date, but that was subsequently postponed to 2026. It is envisaged that the journey would take 7 months.

Discussion could include whether the concept is authentic and the ethics of a one-way trip. (The Mars settlers would not have the capability of launching a rocket back to Earth.)

## Core

### Investigation 1: What do we know about the planets?

This investigation asks students to research the eight planets of our solar system, and collate the information on a shared class data table. (This could be digital, whiteboard or paper.) It is recommended that students work in small groups. Whether the resources used are accessed by computer or print will depend on the availability and number of computers and Internet access.

### Equipment needed

Per class:

* Internet access or printed materials.
* Resource for collaboratively contributing to a data table (For example, Excel/Google docs, large paper or whiteboard, sticky notes or paper slips).

### What to do

1. Begin a class glossary of terms and meanings, juxtaposing words with the same meaning (such as orbital period/revolution or spins/rotates). Include information about different measurement units. Students can add to this glossary over the course of the investigation/s, and keep a record of it for personal reference.
2. Each group of 2–3 students will collect data on one planet.

**Tip**: It is advantageous if:

* students use information from several websites/resources, and
* more than one group is researching the same planet.

1. Collate the data on a collaborative class spreadsheet.

This could be done using technology such as Google docs or an interactive whiteboard, or using a large sheet of paper or sticky notes. Students could add their own criteria to the data table spreadsheet, such as diameter, number of moons, mass, distance from the Sun, average surface temperature, rotation period, orbital period, etc. Teachers could differentiate for ability by choosing or allocating websites appropriate to student literacy skills. Examples of websites that could be used include:

* ‘How far are the planets from the Sun?’, *Universe today* website, <http://www.universetoday.com/15462/how-far-are-the-planets-from-the-sun/> (April 2014)
* 'The planets of the solar system’, *The Planets* website, <http://theplanets.org/> (Accessed April 2016)
* ‘Interesting facts about space’, *Space Facts* website, <http://space-facts.com/> (Accessed April 2016)
* ‘Solar System Trading Cards,’ Space Telescope Science Institute's Office of Public Outreach *Amazing Space* website, http://amazing.space.stsci.edu/resources/explorations/trading/ (Accessed April 2016)
* ‘The Sun and the planets’ *BBC Solar System* website, <http://www.bbc.co.uk/science/space/solarsystem/sun_and_planets> (Accessed April 2016)
* ‘Planets Solar System Exploration’, NASA website, <https://solarsystem.nasa.gov/planets/> (Accessed April 2016)
* ‘The Solar Map’, The Planets today.com website, <http://www.theplanetstoday.com/images/solar_system_map.jpg> (Accessed April 2016)

1. Instruct students to look at the data table they have constructed and discuss what they notice. Did the information from the different sites agree? Speculate possible reasons why, with prompts such as:

* The validity of different sources. Who authored it? How old is it?
* Different measurement systems and units (metric/imperial, Kelvin/celsius etc).

1. Students write the name of each planet on a sticky note. Include whether it is a gas planet or made of rock (terrestrial). Use the information from the data table to sort the planet names in the following different ways.

* Distance from the sun (from closest to furthest)
* Average temperature (from hottest to coldest)
* Length of day (from shortest to longest)
* Size of planet (smallest to largest)
* Sorting criteria of their own

Students should record the different ordering results.

1. Ask students what they noticed. Use question prompts such as:

* Are there rules you can generalise? (For example, was there a relationship between distance from the Sun and temperature)
* Did any information seem odd? Point out things like the comparative temperature of Venus to that of Mercury, (Venus is much hotter, but further from the sun than Mercury), or the rotation rate of Mercury compared to its orbital period etc., or the fast rotation rate of Jupiter in relation to its large size.
* Ask students if they have any questions to add to their wonder wall, and to explain whether any of their questions have been answered.

### Expected results and explanation

Students will be showing an understanding of the data when they notice the following relationships:

* With the exception of Venus, the average temperature of a planet gets cooler the further it is from the sun. Venus is an exception because of the insulating effect of its atmosphere.
* Gas planets rotate faster than rock planets.
* Planets not only have a shorter orbit, they also move faster the closer they are to the Sun, due to the Sun’s gravitational pull.

Different websites may use unfamiliar measurement units, such as:

* Au (astronomical unit) is a unit of measurement, roughly the distance of the Earth to the Sun (about 150 million km)
* Kelvin is the primary unit of measurement for temperature in the physical sciences. Each unit has the same magnitude as Celsius but it has the lowest temperature as 0 K which is also called absolute zero. 0 K = -273°C.

### Investigation 2: What do we need to know?

Remind students that the purpose of collating the data is to inform their thinking about whether a planet would be suitable for human settlement.

In this activity, students will decide which information they have collected is important in order to make a decision, and which information is less relevant to the task.

### Equipment needed

Per group:

* sticky notes or paper slips

### What to do

1. Students work in their small groups of 2 or 3. Refer them to the criteria on the data table from investigation 1 and write each criterion on a separate sticky note/slip of paper.
2. Instruct students to sort their criteria on an imaginary scale of 1–10 according to how important, (or not important) they think a particular piece of information is to their decision.
3. Ask students if they can identify any information that wasn’t collected that would be important to know and why they think that information would be important.
4. Students then research this additional information and add it to the data table from investigation 1. They compare their ideas with another group and explain their reasoning.
5. Discuss ideas as a whole class. Consider the following points and questions.

* What would it be like to live on a planet where a day is 58 Earth days long (Mercury), or 243 days long (Venus)? What would that mean for the length of the ‘night time’? How would that affect settlers on that planet? How might it affect temperature?
* Is it important for the planet to be made mainly of rock? Why/Why not?
* Is the size of the planet important? Why/Why not?
* Is the orbital period important? Why/Why not?
* Venus is closer to Earth than Mars, but it is very hot—even hotter than Mercury. This is despite the fact that Mercury is closer to the sun, and despite the fact that each rotation takes 243 Earth days. What possible reasons might be the cause of the consistently hot temperature? Ask students to come up with as many ideas as they can.

Inform students that one reason Venus is so hot is because it has a thick atmosphere that absorbs the heat from the Sun and so insulates the planet and stops it from cooling down.

### Expected results and explanation

Students should begin to understand some of the implications of the features of different planets, and how difficult those challenges would be to solve. Encourage them to add any important features that may have been omitted from the data table (such as such availability of water and oxygen, availability of a solid surface, toxicity, etc.).

Remember the main objective is to help students develop a deep understanding of the different features of the planets and to be able to use the data to justify a point of view about the best planet for establishing a space colony.

### *Optional investigation*

The Year 3 CLE ‘The Penguin Project’, Investigation 2: ‘What should a penguin ‘wear’ to keep warm?’, Science ASSIST website, <http://assist.asta.edu.au/resource/2984/penguin-project-year-3-cle> may be a useful investigation at this time, as it demonstrates the effect of insulation on temperature.

### Investigation 3 – How far away are the planets?

A common misconception is that the planets in our solar system are close together.

In this investigation, students undertake a range of activities to help them understand how large our solar system is. An important consideration should be the proximity of the different planets to Earth. Activities include video, digital interactives, and a worksheet.

### Equipment needed

For each group of 2–3 students:

* Internet access and computer/iPad
* student worksheet, [‘How far away are the planets?’](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Space explorers_Yr5_Student worksheet How far away are the planets.docx)
* a calculator
* pens

### What to do

1. Show the students the video ‘Bill Nye bikes the distance between planets’, from *The kids should see this website* (4:17 min) <http://thekidshouldseethis.com/post/80268526000> (Explain that Pluto was considered to be a planet when the video was made, but is now classified as a dwarf planet.)
2. Use the interactive ‘A Scale Model of our Solar System’, University of Manitoba website <http://umanitoba.ca/observatory/outreach/solarsystem/> to create a scale model of the solar system on a map of **your** local area.
3. Ask students to predict how long it would take humans to travel to different planets. Ask them what information they would need to know? (For example, speed of craft and distance to be travelled.)
4. Hand out the student worksheet [‘How far away are the planets?'](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Space explorers_Yr5_Student worksheet How far away are the planets.docx)

This activity is aimed at helping students to read a table and to read large numbers.

1. Give students time to notice the different parts of the worksheet.
2. Discuss the tip ‘Reading large numbers’ under the right hand box.
3. Instruct students to use the ‘Average distance between planets’ data table and the other information on the worksheet to answer the questions in the right-hand box.
4. Refer students to the data table. Ask them what information has been provided? (Distance between different planets) and what information are they being asked to supply in the white boxes? (The average distance from Earth.)
5. Inform the students that the shaded boxes are not required to be filled in and ask them why that might that be. (Space exploration would leave from Earth.) The additional information may be interesting to students, but is primarily included to support students to think about the relevance of information to the question they are answering and as an opportunity to ask further questions of their own to each other.
6. Refer students to the section at the bottom of the worksheet. Remind students that they will need to know both the distance to be travelled and the speed of the craft. The speed to be used is the speed of Voyager 1 (61,000 km per hour), which is 1,000 times faster than a car.
7. Tell students that they can use a calculator and work with a partner. They will need to calculate how far Voyager 1 would travel in a day (24 hours) and how far it would travel in a year (365 days). Students should discuss the algorithm they use, explain why they used it, and fill in their results in the two boxes at the bottom of the worksheet. (61,000 x 24 hours = 1,464,000 km per day and 534,360,000 km per year.)
8. Ask students to predict how long it would take to travel to the different planets. They could record their predictions on the back of the sheet. Ask students to share anything interesting or surprising.
9. Ask students to devise an algorithm for working out how long it would take to reach each planet. Record their different ideas for doing this.

One way of devising an algorithm for working out how long it would take to reach each planet is to:

* divide the distance to the planet by the speed travelled (number of hours it would take);
* divide this by 24 (to find number of days);
* divide by 365 (to find number of years). (Students may decide to use 365.25 to be more accurate).

1. Ask students to complete the table.

### Investigation 4: Investigating the planets orbit around the Sun

A common misconception is that the planets in our solar system remain in alignment, or the same distance apart.

### Equipment needed

For each group of 2–3:

* Internet access and computer/iPad

### What to do

1. Inform students that the distance between the planets changes and that is why the term ‘average distance’ was used on the worksheet. Some students may think that this is due to their elliptical orbit, but that only makes a small difference. Ask them what they notice about the distance between planets as they watch the video, ‘Planets of the Solar System 2015’, The Planets Today.com website (2:14 min) <http://www.theplanetstoday.com/solar_system_video.html>
2. Have students play the interactive ‘A live view of the solar system’, The Planets Today.com website, <http://www.theplanetstoday.com/> to see how the different orbital periods of the planets affect their relative distance from each other over a longer period of time.

*Teacher notes*:

* This interactive works best with Flash installed. It won't work on the Apple iPad.
* When operating the interactive, clicking the top left-hand arrow reveals the panel that adjusts the speed.
* The interactive also includes the orbits of the 5 known dwarf planets; Makemake, Eris, Ceres, Haumea and Pluto.

1. Ask students what they notice, and any other questions they have.
2. Tell them to use the information on the video to decide whether they think 2026 would be the best time to travel to Mars and if there is any other information they would need to know before making that decision. Remind them that, when the space ship takes off, it will need to aim for where Mars will be at that time the space craft is supposed to reach the planet.

Students could also research the answers to any unanswered questions on their wonder wall.

## Conclusion

The final activity asks students to synthesise and apply the information they have learnt, by deciding which features of the planets indicates that they could be favourable for human settlement. Finally, students creatively manipulate this information as they construct an enticing advertisement for their planet.

### Equipment needed

For class:

* 7–14 large sheets of paper
* pens
* equipment and materials for creating advertisement, for example paper, pens, digital devices

### What to do

1. Place large sheets of paper around the room, each with the name of a different planet. Ask students to move from sheet to sheet, adding information under one of two headings, ‘Features that would make it very difficult to settle on this planet’ and ‘Features that would be in favour of colonising this planet’. Students should not repeat Information that has already been written.
2. If any of the information/facts written on the sheets by students seems to be incorrect, it should be checked by subsequent students and corrected if necessary.
3. Divide the class into seven groups, and allocate each group a planet (other than Earth).
4. Ask each group to refer to the information and data they have collected and create an advertisement enticing people to live on that planet. They may consider the benefits of ‘your feet never touching the ground’ on a gas planet, or the excitement of the volcanoes on Venus. They may also consider some of the technology that would be required in order to travel to the planet, or what is required in order to survive once they are there.
5. Students present their advertisement to the class.

### Reflection

Human graph

Revisit the original questions about colonising Mars, and ask students to again locate themselves on the graph. Ask them the following questions:

* Do you think the expedition should be allowed to go ahead? Why?
* Would you be keen to volunteer to go? Why?
* Do you believe Mars is the best planet to set up a space station colony? Why?
* Could there be life on another planet?
* Play the time lapse video ‘ASKAP telescope time-lapse’ YouTube (3:37min) <https://youtu.be/FDoDk4D2RAw>
* Tell students that often we cannot see many stars in the sky due to light pollution or cloud cover. Tell students to reflect on the number of stars visible in the video, and tell them that the sun of our solar system is only one star of a **100 billion stars** in our galaxy, the Milky Way. There are believed to be 300 sextillion stars (300,000,000,000,000,000,000,000) in the universe. (See ‘How Many Stars Are In The Universe?’, *Wonderopolis* website, <http://wonderopolis.org/wonder/how-many-stars-are-in-the-sky/>)
* Ask students to discuss whether they think it is possible that one of the planets orbiting one of those stars could have life?

## Assessment opportunities

Investigation 1 and the conclusion provide opportunities to assess student understanding of the concepts related to:

* the key features of the planets in our solar system; and
* how scientific knowledge is used to inform personal and community decisions.

In addition, the level of student achievement of the following science inquiry skills could be assessed in Investigations 2, 4 and in the conclusion:

* processing and analysing data and information; and
* communicating.