James Webb Space Telescope
DEEP SPACE DIARY

ACTIVITY 5.2
DATA DETECTIVE

From Chapter Five of the Deep Space Diary discoverydiaries.org/activities/data-detective/

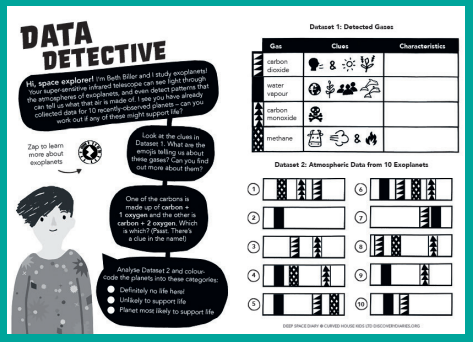
LEARNING LEVEL

KS2, P5-7, Y4-6

CURRICULUM LINKS & DIFFERENTIATION IDEAS

View detailed curriculum links for England, Scotland, Northern Ireland and Wales in the Teacher Toolkit, plus differentiation ideas for your region and year level.

discoverydiaries.org/resources/teacher-toolkit/



Learning Objective

To interpret and analyse data.

Resources Required

- Smartphone/device or computer to access Zap code (optional)
- Science Encyclopedia, Science Dictionaries or access to internet – to support research into the four gases: water, carbon dioxide, carbon monoxide, methane.

Background to this Activity

The James Webb Space Telescope plays a key role in helping us learn about the atmospheres of planets – even those in other solar systems (known as exoplanets). By analysing data collected by Webb, scientists can discover which chemicals are present in a planet's atmosphere. This means they can search for the building blocks of life – like water, carbon dioxide and methane – elsewhere in the Universe.

But how do scientists do this? One method involves studying a distant planet as it passes between us and its sun (a star). When a planet passes (or 'transits') in front of a star, a fraction of starlight is absorbed by the planet's atmosphere. Using spectroscopy – measuring the intensity of light at different wavelengths – scientists can determine which wavelengths have been absorbed. Different chemical elements and compounds absorb light at specific wavelengths, forming 'chemical fingerprints' which can be used to work out which gases are in exoplanet atmospheres.

This complex concept is explained clearly and simply in this animation, and will help students understand the premise of this activity: https://youtu.be/W1bel0ODIDE

Teachers wishing to simplify the theory behind this activity can explain to students that Webb's scientific instruments are used to identify the gases in an exoplanet's atmosphere.

Running the Activity

Hook:

What are exoplanets? What is needed on a planet to support life, and what might be signs of life? Why might we want to know about other habitable planets? Have an open discussion and question time with the class about this, uncovering prior understanding before going into more detail about the activity. Relate discussion back to Webb and its role in learning about exoplanets.

Starter:

Read through the activity and questions with the class. Model Dataset 1, asking the class what we know about these gases, and what we can interpret from the symbols.

Some facts about each gas you might like to cover include:

Carbon dioxide:

- molecules are made of one carbon atom and two oxygen atoms
- is essential for animal and plant life on Earth. Green plants use carbon dioxide during photosynthesis, producing oxygen for humans and animals to breathe.
- humans exhale carbon dioxide, which green plants can then use
- the fizz in fizzy drinks comes from dissolved carbon dioxide.

Water:

- molecules are made of two hydrogen atoms and one oxygen atom

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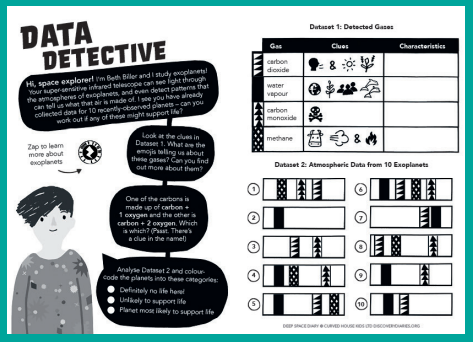

- is essential for life on Earth
- regulates human body temperature, carries nutrients and oxygen to cells, protects our organs and tissues and removes waste products
- 75% of the human brain and 50% of a living tree is water.

Carbon monoxide:

- molecules are made from one carbon and one oxygen atom
- is a colourless, odorless gas
- is toxic to humans and animals who breathe oxygen
- comes from car emissions.

Methane:

- molecules are made from one carbon atom and four hydrogen atoms
- is produced by living creatures, including cows and microbes
- is often used as fuel in the form of natural gas
- as a refined liquid, it can be used to fuel a rocket.

Classify each gas as one of the following:

- toxic to life
- useful for life
- required for life.

Students can create their own colour-coding system for these three options and colour in the circles on the worksheet accordingly.

Main Activity:

Using the information from Dataset 1, ask students to analyse each of the ten exoplanet 'fingerprints' in Dataset 2 and consider:

Which gases does it contain?

Does this planet contain anything toxic/useful/required?

For each data set, students need to discuss, reason and justify whether it is likely that life could exist on the planet, giving reasons for their answers. They can then colour-code that fingerprint accordingly.

Plenary:

Can students present back, communicating which exoplanet they think is most likely to support life and their reasons why?

Solutions to the Activity

Dataset 1:

Carbon dioxide (one carbon + two oxygen) – released by animals and humans when they exhale; used by plants in photosynthesis

Water – essential for life

Carbon monoxide (one carbon + one oxygen) – a poisonous gas

Methane – a greenhouse gas produced by some rocks and lifeforms, used as a fuel

Dataset 2:

Definitely no life here: 1, 3, 4, 6, 8, 9

Unlikely to support life: 2, 7, 10

Exoplanet most likely to support life: 5

Questions for the Class

- What is an exoplanet?
- Why are we interested in exoplanets?

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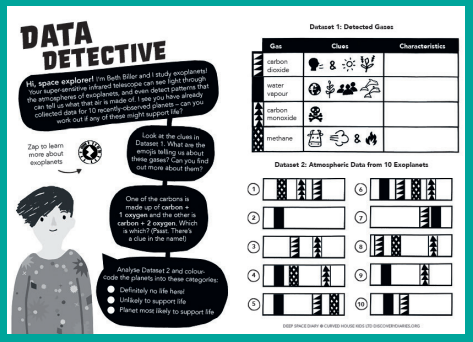

- Which exoplanet in the activity is most likely to support life and why?
- Which exoplanets in the activity cannot support life and why?

Additional Challenges / Extension Activities

For a simple challenge, students can research the four gases, giving reasons for how each affects life.

Students can research how Webb will work with TESS (the Transiting Exoplanet Survey Satellite, which was launch in 2018) to study exoplanets.

Can students, individually or in groups, research an exoplanet? How was it located? Which telescope found it? Where is it located? Is it likely to support life? Why? See Useful Links for resources to support this activity.

Ideas for Differentiation

Support:

- Give students fact files for water, carbon dioxide and carbon monoxide, to support their initial research.

Challenge:

- Allow independent research.
- Justify each exoplanet's likely to support life, with reasons. Can students use scientific evidence to justify their answers?

Useful Links

This image show how spectroscopy is used to study the atmospheres of Earth, Mars and Venus: https://webbtelescope.org/contents/media/images/2018/05/4183-Image

NASA's information about exoplanets and how we locate them, written for young readers: https://spaceplace.nasa.gov/all-about-exoplanets/en/

NASA animated clip for children about how we search for exoplanets: http://bit.ly/2UDLt1o

Animated clip about how we use Webb to study the atmospheres of exoplanets. This clip is more suitable for older viewers: http://bit.ly/2OTC2p6

Animated clip about how space telescopes capture images and spectra, so we can study exoplanets: https://youtu.be/ZoaklEFPHIg

This booklet contains nine practical activities about exoplanets, developed for KS2 (or equivalent) by ESERO-UK: https://www.stem.org.uk/resources/elibrary/resource/417024/are-we-alone-search-planets-beyond-our-solar-system

'Activity 1.1: Signs of Life' from the Mars Diary is a good introductory for educators wishing to revise indicators of life on planets: https://discoverydiaries.org/activities/signs-of-life/

ZAP! Students can independently access multimedia resources using the Zappar mobile/tablet app. See Zappar instructions at the link below and note that the mobile/tablet will need to be on a WIFI connection: discoverydiaries.org/toolkit/discovery-diaries-zappar-instructions/

If you don't have access to the internet in the classroom, all Zap code content is available to download on the activity's web page (see link to the left) as a PowerPoint presentation or as bundles of images.

zappar
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Find more great space-themed STEM resources at https://www.stem.org.uk/esero