What are the problems affecting the habitability of Mars?

Rich Task 2 Activity 3

Introduction:

Our planet is in a seemingly unique position of supporting life. Many of us wonder why Earth is such a habitable environment while other worlds in our solar system are harsh and unforgiving. The question of habitability is pertinent today when we think of the climate crisis and the Earth we are leaving to future generations.

There are also many upcoming and ongoing ESA and NASA missions exploring Mars as a potential planet that Humans could colonise. There are many problems to overcome if we wish to colonise another planet like Mars. This Rich Task is designed to encourage students to think about the reasons why Earth is habitable in comparison to Mars, and to reflect on why the climate crisis poses such a danger to life on this planet. The activities in this Rich Task have been planned to support the teaching of E & S LO 5.

This activity provides an opportunity for students to continue investigating the question of habitability on Mars. Like the previous activity, this activity aligns with the stage of the ISLE process where students investigate their hypothesis. This activity scaffolds the next (Rich Task 2 Activity 4), in which students decide to agree or disagree with their hypothesis

Preparation Required: Printing, Ping pong balls, string, cellotape, Tablets/Computers for students.

Downloadable Materials:

- Worksheet 2.3
- Expected Student Responses Worksheet 2.3
- Table 1 for Worksheet 2.3

Relevant Junior Cycle Learning Outcomes:

Students should be able to…

E & S LO 3: Interpret data to compare the Earth with other planets and moons in the solar system, with respect to properties including mass, gravity, size, and composition.

E & S LO 5: Describe the cycling of matter, including that of carbon and water, associating it with biological and atmospheric phenomena.

E & S LO 7: Illustrate how earth processes and human factors influence Earth's climate, evaluate effects of climate change and initiatives that attempt to address those effects

NOS LO 4: Produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions.

PW LO 3: Investigate patterns and relationships between physical observables.

Learning Intentions:

Students will be able to…

- Investigate the factors affecting the habitability of Mars through analysing visual and numerical data.
- Apply their prior knowledge to an unfamiliar situation to identify physical properties of Mars.
- Explain the difference between weight and mass.
- Explain the concept of the Escape Velocity of a molecule in a planet's atmosphere through modelling.
- Draw connections between the impact of the climate crisis on Earth, the carbon and water cycles, and the habitability of Mars.
- Recognise the role of Earth's magnetosphere in the habitability of Earth.
- Represent and communicate their ideas in a small group and whole-class setting.

Prior Knowledge/Horizon Content Knowledge:

- States of matter
- Water cycle (from Junior Cycle Geography and Rich Task 2 Activity 2)
- Mass
- Atmospheric pressure
- Magnetism
- Climate change:
    - Increasing levels of carbon dioxide in the atmosphere
    - Greenhouse gases and global warming
- Noticing patterns or anomalies in data

Differentiation and Accessibility Suggestions:

This activity requires some prior knowledge of the topic or can be used to teach other topics in tandem (see above). Students can decide the depth of questioning and discussion based on the question prompts.

The activity could be conducted remotely, if necessary, as students can access the video and simulation links online and discuss answers in break-out rooms. Jamboard can also be used in collaborative settings to record students' thinking.

The activity can be completed in small groups, pairs or individually.

Table 1 is provided as a separate document to make it easier for students to view the table and the worksheet simultaneously. The table could also be displayed on the board while students complete the activity using worksheet 2.3.

Instead of physical models, students could draw comic style posters outlining the behaviour of molecules of water as it is boiled or the behaviour of molecules of CO_2 in the Martian or Earth atmosphere, if necessary.

As an extension of the activity students could research other planets in the solar system and compare their mass, distance from the Sun, acceleration due to gravity and atmosphere to Earth. Students could work in groups and present PowerPoint slides or posters of their research.

Activity Outline:

Activity Name	Earth Vs Mars
Alignment to ISLE investigation	Investigating hypothesis
Rationale	To allow students to investigate their hypothesis - in particular, to compare the mass of Mars, its distance from the Sun, its acceleration due to gravity, its atmosphere and lack of magnetic field to Earth, as all of these factors affect the carbon and water cycles of Mars. To prompt discussion of the Carbon cycle and water cycle on Earth and the role Carbon Dioxide plays in the climate crisis.
Activity Description	(*please see downloadable materials for the resources for this activity)* (*Q1. worksheet 2.3)* Students use a simulation (access on computer not Tablets/phones) to explore how much closer to the Sun Earth is than Mars. Students apply this knowledge to explain data provided in part b) of Q1. (*Q2. worksheet 2.3)* The students are presented with data about the core composition and mass of different planets. In part b) students calculate the weight of different objects on Mars, recognising the difference in acceleration due to gravity between Earth and Mars. (*Q3. worksheet 2.3)* Students are asked to act out a model of the behaviour of water molecules as water is heated, to prompt discussion of heat as a form of energy. In part b) students make a model to explore and demonstrate the pull of gravity on a molecule of CO_2 as it orbits a planet in the planet's atmosphere,

	scaffolding the idea of escape velocity. In part c) students then make a second model to consider the escape velocity of a molecule of CO_2 in the atmosphere of Mars and Earth. In part d) students consider the reasons for different escape velocity values of different planets, with focus on atmospheric pressure. In part e) students apply prior knowledge, and the concepts in Rich Task 2 Activity 2, to explain why Mars is not undergoing a climate crisis in the same way as Earth. (*Q4. worksheet 2.3)* This question focuses students attention on magnetic fields and the role of a magnetic field in the habitability of a planet. Students reflect on how the Carbon cycle on Earth would be affected without the presence of a magnetic field, using Mars for comparison. (*Q5. worksheet 2.3)* Students must present their findings in a table, highlighting the similarities and differences between Earth and Mars, that they have identified through Q1 - 4 of worksheet 2.3.
Link to other activities	Scaffold for Rich Task 2 Activity 4
Link to current research in DIAS Dunsink Observatory	DIAS Dunsink Observatory has many PhD students, postdocs and professors who study different aspects of Astronomy and Astrophysics, including solar physics and planetary science. More information on specific projects can be found here: https://www.dias.ie/cosmicphysics/astrophysics/
Related DIAS Dunsink Observatory Podcast	Podcast Description: An interview with Dr Áine Flood who is a science communicator and the current Education and Public Engagement Manager, at I-LOFAR, Birr. The podcast offers insight for students on the reason why clear communication in science is important and how it is possible to move from one area of STEM to another, because of the versatility of STEM degrees. (physics → science communication) Podcast episode: Coming soon!