Does the Sun have Seasons?

Rich Task 1 Activity 5

Introduction:

The Sun is our nearest star and provides the conditions for life to exist on Earth. It's about halfway through its lifetime and acts as a nuclear reactor, giving us heat and light. It accounts for 99% of our solar systems' mass and one million Earth-sized planets could fit inside it. Within the Sun there are atoms of Hydrogen and Helium that are densely packed and collide violently with each other. The fusion of atoms that occurs in the Hydrogen core of the Sun generates light, which takes a hundred thousand years to escape the Sun's core and then travel for a further eight minutes to reach the Earth. Understanding the role the Sun plays in our lives is fundamental to understanding the Sun-Earth system (E & S LO 4).

This activity asks students to investigate magnets, magnetic fields, the connection between electricity and magnetism and apply this knowledge to the context of solar flares on the Sun. This activity scaffolds the next (Rich Task 1 Activity 6), which explores the solar cycle (caused by magnetism and moving plasma).

Preparation Required:

- Printing
- Set up for experiment 1: Blank page; Compass; Bar magnet; Pencil (*Q1 worksheet 1.5*)
- Set up for experiment 2: 1.5V battery; Compass print out; 2 or 3 Compasses; 1 copper wire; 2 connecting wires with crocodile clips (*Q2 worksheet 1.5*)

Downloadable Materials:

- Worksheet 1.5
- Expected Student Responses to Worksheet 1.5
- Compass print out
- Solar "Weather" images

Relevant Junior Cycle Learning Outcomes:

Students should be able to…

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

CW LO 4: Classify substances as elements, compounds, mixtures, metals, non-metals, solids, liquids, gases and solutions.

NOS LO 2: Design, plan and conduct investigations; explain how reliability, accuracy, precision, fairness, safety, ethics, and the selection of suitable equipment have been considered

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

E & S LO 4: Develop and use a model of the Earth-sun-moon system to describe predictable phenomena observable on Earth, including seasons, lunar phases, and eclipses of the sun and moon.

NOS LO 2: Recognise questions that are appropriate for scientific investigation, pose testable hypotheses, and evaluate and compare strategies for investigating hypotheses.

NOS LO 7: Organise and communicate their research and investigative findings in a variety of ways fit for purpose and audience, using relevant scientific terminology and representations.

Learning Intentions:

Students will be able to…

- Investigate the effect of a magnetic field generated by a bar magnet on a compass.
- Investigate the effect of an electric current on a compass.
- Record their observations.
- Communicate their ideas in a small group and whole-class setting.
- Discuss their observations.
- Infer conclusions about the connection between magnetism and electricity.
- Apply new knowledge about magnetism and electricity to explain features observed on images of the Sun. (plasma ejected from solar flares travelling through magnetic field lines of the Sun).

Prior Knowledge/Horizon Content Knowledge:

- Electricity
- Simple circuits
- Structure of the atom
- Formation of Ions
- Making and recording observations
- Noticing patterns or anomalies in data

Differentiation and Accessibility Suggestions:

This activity requires some prior knowledge. Students can decide the depth of questioning and discussion in the class.

All questions/activities can be completed in small groups, pairs or individually depending on the classroom layout.

The teacher could share the pdf as a presentation and facilitate class discussion without the small group element.

The teacher could allow time for the students to play freely with the magnets and compass to develop understanding before conducting the experiment in Q1 worksheet 1.5.

If students are already familiar with magnets and magnetic fields then the teacher could start with Q2 of the worksheet instead of Q1.

The teacher could demonstrate the two experiments (Q1 and Q2 worksheet 1.5) and facilitate class discussion or small group discussion if the equipment required per pair is unavailable.

The teacher may wish to use Q4 - 6 worksheet 1.5 as class or small group discussion prompts. A link to the NASA Goddard Media Studio webpage is included in Q4 Worksheet 1.5, detailing the images in Q4, which may be useful for further exploration.

For an extension task, students can analyse the images of solar eruptions of Q4. worksheet 1.5 and also look at some visualisations of plasma on Earth (neon lights and lightning strikes). A Van de Graff generator could be used to generate plasma, if available. They can compare how the ejected material of the Sun and the visualisations of plasma look.

Extra Video Resources on Plasma:

Time stamp at 5:00 shows lightning strikes ocean in slow motion for about 2 minutes:
https://www.youtube.com/watch?v=qQKhIK4pvYo

SciShow: explains plasma more thoroughly and gives examples of plasma on Earth (most suitable for second/ third year students)https://www.youtube.com/watch?v=AVEGJZxgIIg

Useful plasma visualisation tool, recommended to keep sound off, as explanation is too advanced:
https://www.youtube.com/watch?v=A9ECEGs_r2U

Activity Outline:

Activity Name	What are some features of the Sun?
Alignment to ISLE investigation	Investigating the hypothesis
Rationale	Conducting experiments with magnets and electricity to aid the investigation of whether or not the Sun has seasons. To help students to form connections between the moving ions in plasma, magnetic field lines and the solar flare loops visible in images of the Sun.
Activity Description	(*please see downloadable materials for the resources for this activity)* *(Q1. Worksheet 1.5)* Using the worksheet students can investigate the effect of a magnet on a compass and record observations. *(Q2. Worksheet 1.5)* Students can investigate the behaviour of compasses when an electric current is passed over and under them (the connection between electricity and magnetism) and record observations. *(Q3. Worksheet 1.5)* Students consider the existence of any connection between electricity and magnetism as a result of conducting the experiments of Q1 and Q2. *(Q4. Worksheet 1.5)* Students analyse the images of the Sun and reflect on how the solar flares in images appear to follow loops that look similar to magnetic field lines. The students can also notice that the changing landscape of the Sun is similar to the weather on Earth. *(Q5. Worksheet 1.5)* Students consider a scenario of the compass placed near solar flares to recognise that the loops in the images are magnetic field lines.

	(Q6. Worksheet 1.5) Students recall knowledge from Rich Task 1 Activity 4 and their new knowledge of electricity and magnetism to think about how a compass acts near moving plasma (moving ions acting the same as electric current). Students can recognise that the Sun spews out plasma in solar eruptions.
Link to other activities	Scaffold for Rich Task 1 Activities 6 - 7 and links back to Rich Task 1 Activity 1 and 4.
Link to current research in DIAS Dunsink Observatory	The Solar and Space Weather group at DIAS Dunsink consists of PhD students, postdocs and professors who study different aspects of the Sun and Space Weather. Through their research, scientists can get daily updates on the activity of the Sun (https://solarmonitor.org) and advise on precautions that can be taken to protect Ireland's power grid from potential solar storms. More information on specific projects can be found here: https://www.dias.ie/solarphysics
Related Magnifying Science Podcast from DIAS Dunsink Observatory	Podcast Description: An interview with Alberto Cañizares who studies energetic explosions on the Sun, at DIAS Dunsink Observatory. The podcast offers insight for students on the reason why the study of the Sun is important and how it is possible to move from one area of STEM to another, because of the versatility of STEM degrees. (engineering → physics) Podcast episode: Coming Soon!