Infrared Wavelengths- Thermal Mapping

Objective:
Investigate how a satellite uses thermal energy to map the atmosphere or surface of a planet or moon.

Engage: Infrared: More than Your Eyes Can See (NASA). https://youtu.be/2--0q0XlQJ0
NASA's Eyes: Juno Spacecraft Instrumentation. https://eyes.nasa.gov

Discuss: Look at an infrared map and discuss use of colors to depict differences in temperature.
How can this be useful in understanding the surface of a distant planet or moon?

Explore:
Use your "heat sensors" to map the surface of an exoplanet, and identify landforms and landing sites

Per group of 4:

1) Embed heat pads and cold packs into trays filled with packing peanuts or a similar material.

2) Cover tray completely with heavy-duty foil. Lay coordinate plane on top. Longitude / latitude also works!

3) Students in each group slowly run hands across pan, feeling temperature differences.

4) Color corresponding grid with colors representing temperature of the planetary surface, *brightest color = hot, darkest color = cold

5) Using coordinates, map the warmest and coolest locations on the planet's surface.

A fun addition: Students can overlay a transparency with a topographic map on top of the grid. Possible tasks:

- Create a 3-D model of the map
- Identify possible landforms at various coordinates
- Evaluate locations of heat and / or cooling and discuss possible sources (ie. volcano)
- Where would your team choose as a possible landing site? Why? (based on temperature and landforms)
- What are the coordinates of your landing site?

Explain:
Team to explain (on paper and / or to class) their map, landforms, potential landing sites.
Quick write: Explain how infrared and other wavelengths in the electromagnetic spectrum are useful in space exploration.

Extend – Mathematics:
Plot points on a coordinate plane. Calculate the area and perimeter of different shapes. Use the 3-D model to calculate volume. Find mean, median, mode, range, and interquartile range using area values.

Evaluate:
Maps, Quick Write, Critical Thinking Questions, and Calculations

**Lesson is modified from NASA's Museum in a Box "Detecting Clouds Using Infrared Energy"*

Topics Covered:

Science:	Thermal energy: conduction / convection / radiation Electromagnetic spectrum- infrared wavelength Solar system exploration and techniques Landforms
Math:	Coordinate planes, area, perimeter, volume, mean, median, mode, range, and interquartile range
Social Studies:	Topographic maps, latitude and longitude

Science TEKS, Grade 6 Learning Standards:

- 6.2 (A) Plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology.
- 6.2 (B) Design and implement experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology.
- 6.2 (C) Collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers.
- 6.2 (E) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
- 6.3 (A) In all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student.
- 6.3 (B) Use models to represent aspects of the natural world such as a model of Earth's layers.
- 6.3 (C) Identify advantages and limitations of models such as size, scale, properties, and materials.
- 6.9 (A) Investigate methods of thermal energy transfer, including conduction, convection, and radiation.
- 6.9 (B) Verify through investigations that thermal energy moves in a predictable pattern from warmer to cooler until all the substances attain the same temperature such as an ice cube melting.
- 6.11 (C) Describe the history and future of space exploration, including the types of equipment and transportation needed for space travel

Math TEKS, Grade 6 Learning Standards:

- 6.11(A) graph points in all four quadrants using ordered pairs of rational numbers
- 6.8(D) determine solutions for problems involving the area of rectangles, parallelograms, trapezoids, and triangles and volume of right rectangular prisms where dimensions are positive rational numbers
- 6.12(C) summarize numeric data with numerical summaries, including the mean and median (measures of center) and the range and interquartile range (IQR) (measures of spread), and use these summaries to describe the center, spread, and shape of the data distribution
- 6.12(D) summarize categorical data with numerical and graphical summaries, including the mode, the percent of values in each category (relative frequency table), and the percent bar graph, and use these summaries to describe the data distribution
- 6.4(E) represent ratios and percents with concrete models, fractions, and decimals
- 6.5(C) use equivalent fractions, decimals, and percents to show equal parts of the same whole
- 6.5(A) represent mathematical and real-world problems involving ratios and rates using scale factors, tables, graphs, and proportions

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Magnetism – Locating Magnetic Fields

Engage: NASA's Eyes - Juno spacecraft instrumentation

Explore: Design and build a magnetometer to detect magnetic fields.

Suggested materials:
Tray – 1 per group of 4, 2 coordinate plane sheets, magnets, iron filings, masking tape, coffee filters, paper, string, misc. recyclables

Challenge criteria:

- Use only the materials provided, unless you have permission from the teacher
- Device may not be more than 30 cm^2 (It can be any shape!).
- Device may not touch the surface of the planet

Each team will have:

- 2-3 minutes to discuss materials and possible designs
- 15 minutes to design, test, and redesign your device
- One practice magnet

Once complete, pass magnetometer over tray slowly to detect areas of magnetism.

- Highlight perimeter of magnetic fields.

** Remember! Keep something between the filings and the magnet! Investigate the effect of magnetism on the filings. Build in pieces… test as you go. **(This takes kids about 30 minutes)**

Explain:

- How are grids useful for creating maps?
- Why are NASA scientists interested in magnetic fields? What can magnetism tell us about a planet?
- Why does the Earth have a magnetic field?
- Why the Earth's magnetic field is critical for life.

Extend – Mathematics:
Plot points on a coordinate plane. Calculate the area and perimeter of different shapes. Find mean, median, mode, range, and interquartile range.

Evaluate:
Maps, Quick Write, Critical Thinking Questions, and Calculations

**Lesson is modified from NASA's "Inspector Detector".*

Topics Covered:

Science: Magnetism
Magnetic fields
Solar system exploration and techniques

Math: Coordinate planes, area, perimeter, mean, median, mode, range, and interquartile range

Science TEKS, Grade 6 Learning Standards:

- 6.2 (A) Plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology.
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- 6.3 (B) Use models to represent aspects of the natural world such as a model of Earth's layers.
- 6.3 (C) Identify advantages and limitations of models such as size, scale, properties, and materials.
- 6.8(B) identify and describe the changes in position, direction, and speed of an object when ac ted upon by unbalanced forces
- 6.11(C) Describe the history and future of space exploration, including the types of equipment and transportation needed for space travel

Math TEKS, Grade 6 Learning Standards:

- 6.11(A) graph points in all four quadrants using ordered pairs of rational numbers
- 6.8(D) determine solutions for problems involving the area of rectangles, parallelograms, trapezoids, and triangles and volume of right rectangular prisms where dimensions are positive rational numbers
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