Kids as Airborne Mission Scientists -- KaAMS --

Remote Sensing Pathway

Student Activity and Assignment Journal

Shadowing a NASA Mission

Using

Aeronautics and Remote Sensing

to investigate active lava flows on the

Kilauea Volcano

Student's Name: _____

Teacher's Name: _____

Table of Contents

Lesson: What is airborne remote sensing?
Mission request letter (ARS-1)

Pacific Disaster Management Agency

NASA Airborne Mission Science Division
NASA Dryden Flight Research Center
Edwards, California 93536

Dear airborne mission scientist,

Our agency studies many types of natural hazards in the pacific region including tsunamis, landslides, earthquakes, and volcanic eruptions. Kilauea, an erupting basaltic shield volcano on the island of Hawaii, has been continuously active since January 1983. Since the beginning of the eruption, over 180 homes in many communities have been destroyed. In addition, the eruption has affected the island's road network. The main Chain of Craters Road linking the area near the top of Kilauea with the community of Kalepana has been covered by lava causing problems for the residents. Our agency constantly monitors Kilauea in a number of ways. We often utilize airborne image data to map the locations of recent lava flow deposits and, more importantly, the areas of the volcano where lava flows are currently active.

We would like to request your help in locating active lava flows on Kilauea. The knowledge of their location will aid the Agency in providing information concerning the location and extent of lava flow activity and support the Agency's on-going effort to re-examine our emergency evacuation plans in the event of substantial eruptions.

Thank you for your time and cooperation in this matter. I look forward to receiving your report after completing your study and data analysis.

Sincerely,

Gary Kilulani

Gary Kilulani, Director
Pacific Disaster Management Agency

Lesson: What is airborne remote sensing?
Activity sheet: Defining the terms (ARS-2)

Name: _____

Explore the given materials and develop definition of the following terms in your own words:

- **remote sensing:**
- **aerospace:**
- **aeronautics:**
- **astronautics:**

How are aerospace and aeronautics different?

What is airborne remote sensing?

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Describing an airborne mission scientist (AMS-1)

Name: _____

Instructions: In the space below either describe what you think airborne mission scientists are and do, or draw and label a picture of airborne mission scientists at work.

List 5 tasks that airborne mission scientists complete during explorations.

1.

2.

3.

4.

5.

Lesson: What are airborne mission scientists and what do they do?

Problem scenarios (AMS-2)

Problem scenario 1: Study the decrease in the amount of ozone in the Earth's atmosphere

Why is it important? How can we measure the amount of ozone in the atmosphere? How can we study ozone loss and the gain we hope occurs in the future?

Ozone is a gas found in Earth's atmosphere that screens the harmful form of radiation from the sun, ultraviolet radiation, that is responsible for sunburn and skin cancer. Most of the ozone in Earth's atmosphere is found in a part of the atmosphere known as the stratosphere. The stratosphere is the region from about 30,000 feet to 180,000 feet above the Earth's surface. Within the stratosphere, the amount of ozone is greatest between 50,000 feet and 100,000 feet. Even though we say greatest, it's not very much. Only one or two molecules of ozone for every one million air molecules found there! Remember that air is about 78% nitrogen, 21% oxygen, and 1% other elements.

Problem scenario 2: Study effects of smoke and aerosols on climate

Why is it important and how can we study the effects on the clouds and the climate due to smoke from burning biomass and aerosols? (Biomass is vegetation and wastes from animals, which includes wood, grass, algae, garbage, and plant products. It can be used as an energy source like gasoline or coal.)

Scientists are interested in things that man does on the earth that affect the atmosphere. When someone burns leaves in their backyard or uses an aerosol hairspray for instance, it can actually affect the weather. One or two people doing those things might not have any effect, but when you multiply one or two by the millions of people in cities and include industrial companies who do those things on a much larger scale, the weather and climate can actually be changed. Man can have a serious effect on his environment. A series of experiments to help scientists better understand the effects on the clouds and the climate due to smoke from burning biomass and aerosols are called The Smoke/Sulfate Clouds and Radiation experiments. In the experiments scientists carefully examined gases and clouds in the atmosphere containing chemicals from aerosols and biomass burning as well as those found on the Earth's surface.

Lesson: What are airborne mission scientists and what do they do?

Problem scenarios (AMS-2A)

Problem scenario 3: Study the effect of snow and ice on climate

Why is it important and how can we study the effect of snow and ice on climate?

Snow covers about 40% of the entire surface of the Earth during winter in the Northern Hemisphere. Because it is white, snow reflects a lot of light and therefore it has an effect on the amount of radiation falling on and being reflected from the Earth. The balance of radiation has an effect on biological (life processes), chemical (chemical processes), and geological processes (processes associated with the earth itself). Many areas of the earth depend on the melting of snow to water crops and for drinking water. It is necessary to carefully watch snowpacks throughout the winter and spring to keep track of the water supply and the possibility of flooding.

Problem scenario 4: Study moisture levels in hurricanes

Why is it important and how can we study the amount of moisture in hurricanes?

NASA uses remote sensing instruments to learn about the way hurricanes are formed, how they move, and how they change. Knowledge of this kind can help hurricane forecasters make better predictions. If they have a better idea where a hurricane will make landfall, fewer people may have to evacuate their homes. Better predictions could also improve the early warning times for areas that might be affected. This could potentially save lives.

Lesson: What are airborne mission scientists and what do they do?
Group activity instructions (AMS-3)

Your goal is to create a flight request for your given problem statement. You will need to determine what questions need to be answered to complete the request form. Then, working with your team, you will need to complete the flight request form. Your goal is not to "solve" the stated problem; it is to develop a plan on **how** to investigate this problem using aircraft and remote sensing.

1. **In your group**, review the NASA Airborne Science Flight Request Form and:
   - ❑ develop a list the questions or information needed to complete the form
   - ❑ separate the questions by expertise, who is most likely able to answer the question?
     - o a science expert
     - o an aeronautics expert
     - o a remote sensing instrumentation expert
2. Assign each member of your team a different role:
   - ❑ Science expert - becomes familiar with information about the problem scenario
   - ❑ Aeronautics expert - becomes familiar with information about the aircraft
   - ❑ Remote sensing expert - becomes familiar with information about remote sensing instruments
3. When directed by the teacher, separate into **expert groups**, each member of your group will now meet with the team of aeronautics, remote sensing, or science experts.
4. **In expert groups,** review the provided expert information and work together to answer your assigned question.
5. When directed by your teacher, return to your **original group**.
6. **In your original group**, each member should share the information learned during the expert group meeting and together, complete the NASA Airborne Science Flight Request Form. Your group should develop a short presentation that explains your request to use NASA resources. Presentations should meet the following criteria:
   - ❑ Did we make a strong case for the importance of the environmental issue being studied?
   - ❑ Did we provide evidence supporting the choice of aircraft?
   - ❑ Did we provide evidence supporting the choice of remote sensing device?
   - ❑ Did we show evidence of working together as a team?

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Question categorization (AMS-4)

Record the types of questions you will need to find to complete the NASA Airborne Science Flight Request Form. Then, categorize the questions by expertise:

A=aeronautics, R=remote sensing, S=science

Questions	Expert
Sample: What is each type of remote sensing instrument used for?	*R*
Sample: How have the available aircraft been used for remote sensing missions in the past?	*A*
Sample: What will I need to "sense" to investigate my problem?	*S*

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: NASA Airborne science flight request form (AMS-5)

AIRBORNE SCIENCE FLIGHT REQUEST FORM

National Aeronautics and Space Administration

Investigation title:

Reason for requesting use of NASA facilities:

Investigator(s):

Background and primary science objectives:

Aircraft required: **ER-2** **DC-8** **P-3B Orion** **King Air** **Pathfinder** **SR-71 Blackbird** (circle)

Data requirements and aircraft sensor:

TYPE OF DATA BEING COLLECTED: (describe)

SENSORS (circle):

MODIS AVIRIS MAMS MACAWS Harvard Co2

Dual-Beam UV-Absorption Spectrometer Aerial Camera Systems

General flight window (month):	**General site location** (state or country):
A)	**A)**
B)	**B)**
C)	**C)**
D)	**D)**

This form must be completed and returned to NASA/DFRC by:

(Do not mark in this space/For office use only)

Mail completed forms to:

Dryden Flight Research Center
National Aeronautics and Space Administration

Lesson: What are airborne mission scientists and what do they do?

Remote sensing instrument descriptions (AMS-6)

Instrument	Description	Example missions
Multispectral Atmospheric Mapping Sensor (MAMS)	The MAMS is designed to study weather related events including storm system structures, cloud-top temperatures, and upper atmospheric water vapor. MAMS measures reflected radiation from the Earth's surface and clouds and thermal (heat) emission from the Earth's surface, clouds, and atmospheric water vapor. It can provide detailed pictures of atmospheric and surface features as well as clouds and thunderstorm features.	• Clouds and snow • Water vapor in hurricanes
MODIS - Moderate Resolution Spectroradiometer - Airborne Simulator (MAS)	MAS is designed for the measurement of biological and physical processes and atmospheric temperature. The MODIS program remotely senses data to monitor variation in environmental conditions for assessing both natural and human-influenced global change.	• Clouds and snow; • Cloud & atmospheric radiation • Smoke, Clouds, and Radiation • Arctic Radiation • Snow, Glaciers, and Sea Ice; • Forest/Atmosphere Interaction.
Harvard Carbon Dioxide Experiment (Harvard CO2)	This instrument is used to explore carbon dioxide levels. It detects the concentration of carbon dioxide in the different layers of the atmo sphere	• Pollution levels • Ozone depletion
Dual-Beam UV - Absorption Ozone Photometer	This instrument detects measures of radiation to determine the ozone density.	• Ozone levels
Multicenter Airborne Coherent Atmospheric Wind Sensor (MACAWS)	MACAWS is an airborne Doppler laser radar which measures wind fields, vertical wind profiles, and aerosol backscatter from clear air and clouds. It was especially designed to map the speed and direction of winds in storms.	• Wind directions inside hurricanes • Strong wind storms
Aerial Camera Systems	There are a variety of film camera systems used for remote sensing. Color infrared, natural color and black and white film may be used with the choice determined by investigator requirements. • RC-10 Mapping Cameras provide image scales of two miles to the inch and one mile to the inch. • HR-732 Aerial Cameras are used to acquire high-resolution photography providing an image scale of half-mile to the inch. • Iris II Panoramic Camera has been employed to acquire high-resolution land use and land cover data.	• Forestry, wetlands inventories, wildlife habitat • Assess timber resources • Monitoring gypsy moth defoliation
Airborne Visible InfraRed Imaging Spectrometer (AVIRIS)	The science objectives of the AVIRIS are: • Identify, measure, and monitor constituents of the Earth's surface and atmosphere based on molecular absorption and particle scattering signatures • Research directed towards understanding processes related to the global environment and climate change.	• Ecology • Oceanography • Geology • Snow hydrology • Cloud and atmospheric studies

Lesson: What are airborne mission scientists and what do they do?

Activity Sheet: NASA Airborne science flight request presentation scoring rubric (AMS-7)

Date:			
Reviewer's name:	Presenter's name(s):		
Environmental problem description:			
	strong	good	weak
Did the presenter(s) make a case for the importance of the environmental issue to be studied with NASA resources?			
Did the presenters provide evidence supporting their choice of aircraft?			
Did the presenters provide evidence supporting their choice of remote sensing device?			
Did the presenters provide evidence of working effectively as a team?			

❑ Recommend to accept request ❑ Recommend to deny request

Why? Support your decision: _____

_____

Lesson: What are airborne mission scientists and what do they do?

Activity Sheet: Describing an airborne mission scientist (AMS-8)

Name: _____

Instructions: Now that you have been an airborne mission scientist and worked with your classmates as airborne mission scientist, write a new description or draw and label a new picture of airborne mission scientists at work.

List 5 tasks that airborne mission scientists complete during explorations.

1.

2.

3.

4.

5.

Lesson: What are airborne mission scientists and what do they do?

Activity sheet: Reflection page (AMS-9)

Name: _____

Use this page to record your thoughts about the problems you are solving in KaAMS and what you are learning along the way. Since this is your first time using this worksheet sample answers have been provided to guide your responses. For now, use the open spaces to record your own ideas. Later versions of this worksheet are black.

What is the overall problem you are investigating?

Sample response: Where are the active lava flows on the Kilauea volcano?

What problem were you solving during this lesson?

Sample response: How can aeronautics and remote sensing help investigate the lava flows? What else would you add?

What did you learn during this lesson?

- ❑ *Sample response: Many types of scientist who work together to explore the earth.*
- ❑ *Sample response: NASA uses planes and remote sensing to conduct science missions.*
- ❑ _____
- ❑ _____
- ❑ _____

How did the findings help you investigate the overall problem?

Sample response: I need to know how scientists work together and what tools they use to explore the earth. Knowing these things will help me plan a mission to explore Kilauea. What else?

What new questions do you have about the overall problem?

- ❑ *Sample response: How can I tell if there are active lava flows on a volcano?*
- ❑ *Sample response: What airplanes and remote sensing instruments can I use?*
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: Volcanology

Activity sheet: Volcano model (V-1)

Name: _____

1. Draw a picture of your volcano model and label its features.

2. What does this model demonstrate about real volcanoes?

Lesson: Volcanology

Activity sheet: Volcano research project (V-2)

Research volcanoes and create a project on volcanoes that answers the following questions: Be sure to get teacher approval for your group's project before you begin!

- How do scientists determine whether a volcano as active, dormant, or extinct?
- What are the different types of volcanic eruptions? Describe each.
- What is lava and what are its characteristics?
- What types of shapes do lava flows form?
- How can you tell the difference between old lava flows and new lava flows?
- What are the different types of lava? Describe each.
- Where is lava on an active volcano?
- What do you need to know about the Kilauea volcano to determine if it has active lava flows?
- How can airplanes and remote sensing instruments help you investigate volcanoes?

Volcano vocabulary: Define each of these terms in your presentation

Active	Magma	Eruptions (types)
Dormant	Lava (types)	Lava flow shapes
Extinct	Lava layers	Re-vegetation

Lesson: Volcanology

Activity sheet: My understanding of volcanoes (V-3)

Name: _____

1. Is an ongoing eruption the only way to tell if a volcano is active? Are visible lava and gases the only signs of an active volcano?

2. What do we need to know about this volcano to determine if it is active? How can we do to get the information we need?

3. How can remote sensing instruments help determine if a volcano has active lava flows?

4. What role do aircraft have in collecting remote sensing images?

5. How would aeronautics scientists, remote sensing scientists, and volcanologists work together to determine if the Kilauea volcano currently has active lava flows?

Lesson: Volcanology

Activity sheet: Reflection page (V-4)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

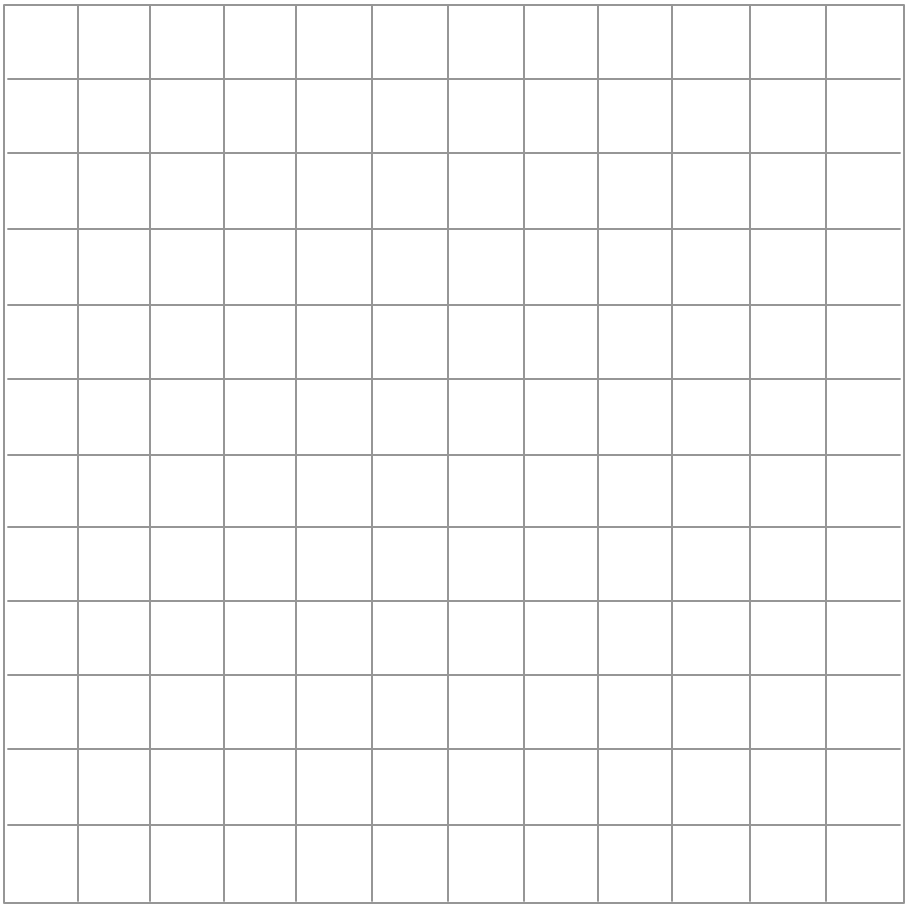
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: What is Remote Sensing?

Activity sheet: Sensory map (RS-1)

Name(s): _____

What does the tabletop area look like? Draw a topographical map of what you see, indicating the high and low areas in the space.



After drawing your visible map, indicate the areas that are:

- hottest with a red “X,”
- warm with a pink “X,”
- coldest with a dark blue “0,”
- cool with a light blue “0.”

Lesson: What is Remote Sensing?

Activity sheet: Defining the elements (RS-2)

Name(s): _____

Define the elements of the remote sensing process, in your own words.

1) **Definition:** What is remote sensing?

2**) Elements**: What are the main elements of remote sensing?

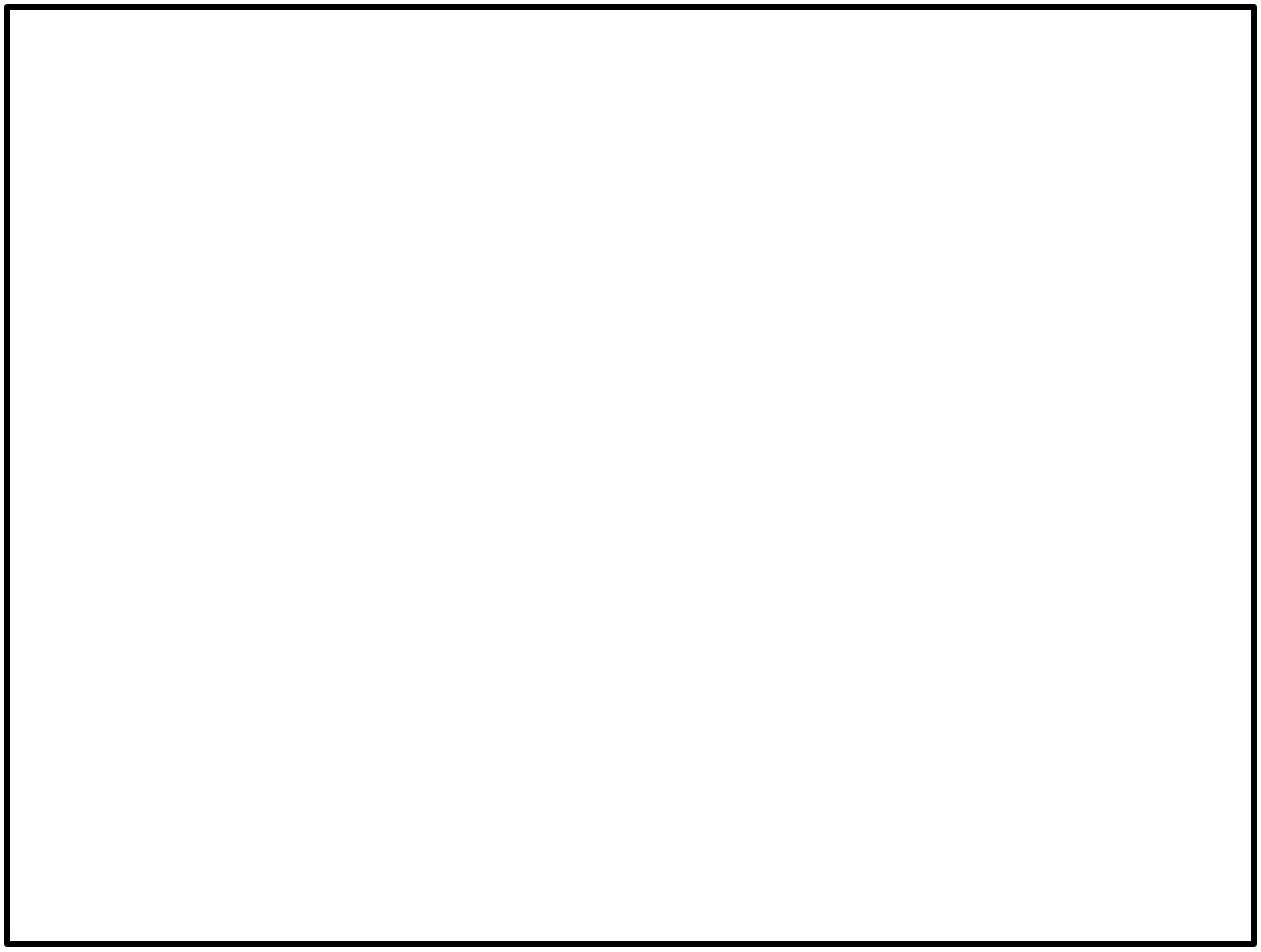
	Element in the tabletop mapping activity	**This element in the tabletop area is similar to what element in the remote sensing website?**	**This element represents what part of the remote sensing process?**
Part of remote sensing	Hot and cold items under the surface	***Example response: target***	***Example response: Energy Source***
	Temperatures emitted from hot and cold items		
	Hand waving over the surface area		
	Students describing what they are feeling while waving their hands over the surface area		
	Topographical and sensory map of area		

Lesson: What is Remote Sensing?

Activity sheet: Remote sensing process cycle (RS-3)

Name(s): _____

Draw and label a picture of how remote sensing works. Be sure to include energy sources, targets, remotes sensing instruments, transmission of data, interpretation of data, and application of data (final version).



Lesson: What is Remote Sensing?

Activity sheet: Applying you understanding (RS-4)

Name(s): _____

Apply your understanding of remote sensing to the Kilauea Volcano mission.

1. What can be sensed from the Kilauea volcano to tell where the active lava flows are?

2. What are the possible energy sources on a Kilauea volcano mission?

3. Where will the remote sensing instruments be sensing from during the investigation of Kilauea?

4. What might the final data look like?

5. Draw and label a picture of the remote sensing process for studying Kilauea. Be sure to include the energy sources, remote sensing instruments, the transmission of data, and data processing.

Lesson: What is Remote Sensing?

Activity sheet: Reflection page (RS-5)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: What do Remote Sensors Sense?

Activity sheet: Invisible light observations (RSS-1)

Name(s): _____

1. Draw or describe your observations of the Invisible Light Demonstration.

2. The light that passed through the prism was from the room lights or from light coming into the room from outside. What do you think the demonstration tells you about what that light is made up of?

Lesson: What do Remote Sensors Sense?

Activity sheet: How does Remote Sensing Work? (RSS-2)

Name(s): _____

1. Define and illustrate the following terms: (You may want to draw a picture illustrating the term.)

   Wavelength –

   Frequency –

2. Complete the following table. In the comparison section, compare the wavelength of a typical wave to one meter. (For example: The distance across your fingernail is about $1/100^{th}$ of a meter.)

Type of EM radiation	Comparison of wavelength of type to 1 meter	Examples/uses of this type
Radio waves		
Microwaves		
Infrared		
Visible (light)		
Ultraviolet		
X-rays		
Gamma rays		

Lesson: What do Remote Sensors Sense?

Activity sheet: Nature of light (RSS-3)

Name(s): _____

1. What did you observe on the underside of the white paper when you placed construction paper of different colors underneath it?

2. What did you observe when the color of the filter was the same as the color or the object?

3. What did you observe when the color of the filter was different than the color or the object?

4. Based on your experiences with invisible light demonstration, construction paper investigation, and the color reflected from the colored objects demonstration, how would you explain where the light comes from when you look at someone wearing a multi-colored shirt? How do the colors you see on the shirt end up getting to your eyes?

5. Which types of EM radiation would be most useful for locating active lava flows?

Lesson: What do Remote Sensors Sense?

Activity sheet: Defining the terms (RSS-4)

Name(s): _____

Define the following terms: (You may want to draw a picture illustrating the term.)

array -

spectrum –

electromagnetic (EM) -

radiation -

EM spectrum -

Lesson: What do Remote Sensors Sense?

Activity sheet: Reflection (RSS-5)

Name(s): _____

1. Describe how the visible and infrared images of the crater of a very active volcano might look.

2. How do our own sensory systems sense things that are hot without physically touching them?

3. If we fly over a volcano in an attempt to sense light and heat, what factors will need to be considered when flying over the volcano?

Lesson: What do Remote Sensors Sense?

Activity sheet: Reflection page (RSS-6)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the learnings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: What's hot? What's not?

Activity sheet: Defining the terms (WHWN-1)

Name(s): _____

Define the following terms. You may want to draw a picture illustrating the term.

reflected energy -

emitted energy –

absorbed energy -

Lesson: What's hot? What's not?

Activity sheet: Construction paper and hot plate burner demo (WHWN-2)

Name(s): _____

1. What did you observe when the paper burner and the hot plate burner were held next to one another?

2. What is the source of the orange light in each case?

3. Some of the EM radiation we see (and detect with remote sensing devices) is **emitted** and some of it is **reflected**. Sometimes we see (or detect) both emitted and reflected EM radiation. Write your definitions of these terms:

   reflected EM radiation:

   emitted EM radiation:

Lesson: What's hot? What's not?

Activity sheet: Construction paper and hot plate burner demo (WHWN-2A)

Name(s): _____

4. Is there any way to know whether or not the orange light that seems to come from the burner (emitted EM radiation) isn't also orange light reflected from the room lights (reflected EM radiation)?

5. What if you were not allowed to walk over to the stove and feel if it is hot or not (this is like using an infrared detector)? Could you still solve the orange paint vs. left-on burner question?

6. Should the remote sensing mission over Kilauea be flown during the day or at night? In the space below or on another piece of paper, write a letter to the NASA project director for the volcano mission in which you make a recommendation for what time of day to fly the KaAMS mission. Support your recommendation with the evidence you gathered in the orange paper and burner activity.

Lesson: What's hot? What's not?

Activity sheet: Student reflection (WHWN-3)

Name(s): _____

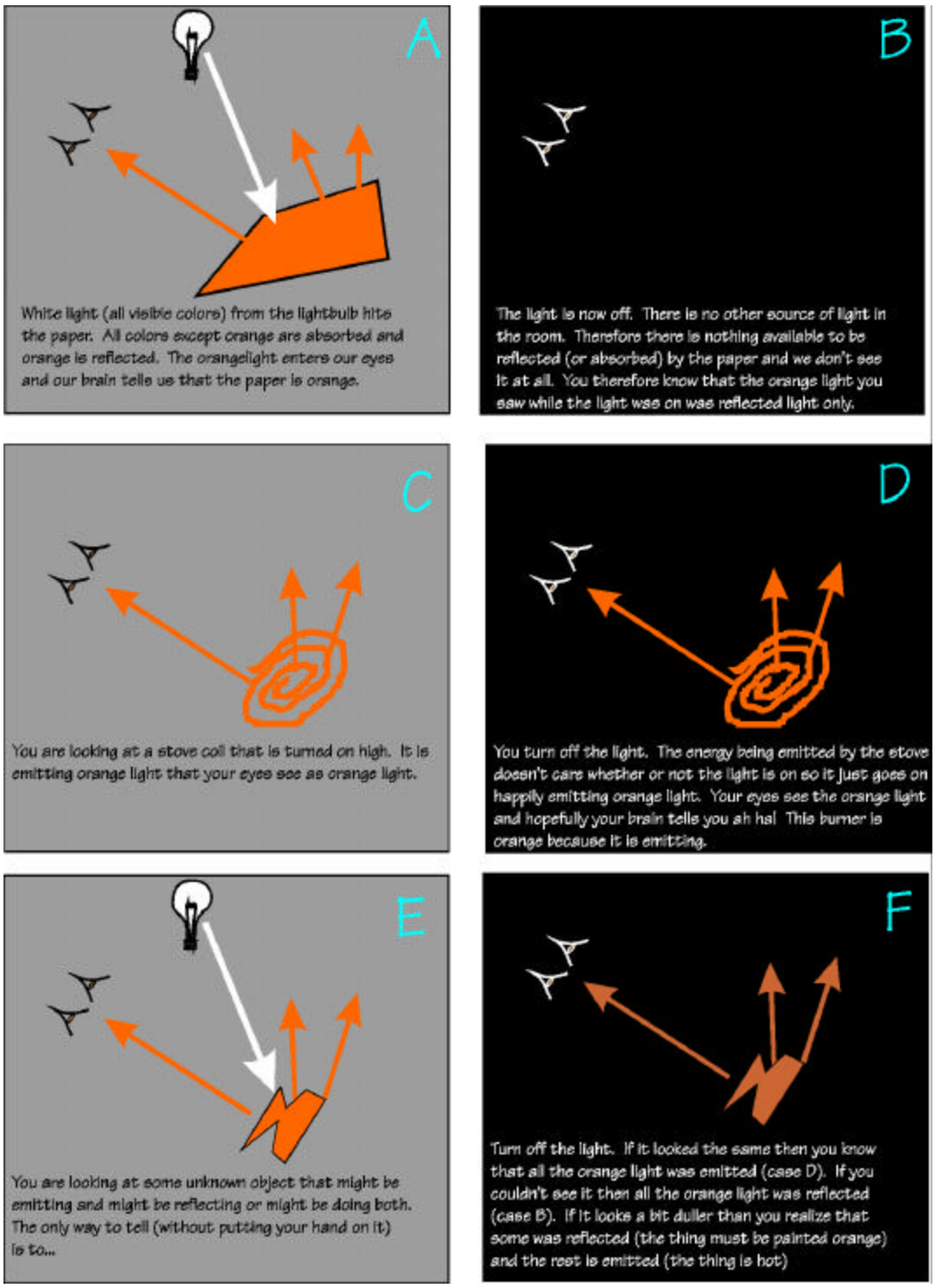
1. Some materials, like the glass in windows, allow certain wavelengths of EM radiation to pass through them and not others. What types of EM radiation do you think are transmitted through glass, and what types are not transmitted?

2. How could you test your ideas?

3. Remote sensing devices, such as AVIRIS, have many small detectors on them. Each detector is sensitive to either a single wavelength or a small number of wavelengths. List some objects in and around Kilauea volcano. Identify the type of EM radiation each object is likely to reflect or emit

Lesson: What's hot? What's not?

Activity sheet: Burner diagram (WHWN-4)



Lesson: What's hot? What's not?

Activity sheet: Reflection page (WHWN-5)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: Planning a Remote Sensing Mission

Activity sheet: Defining the terms (PRSM-1)

Name: _____

Define the following terms. You may want to draw a picture illustrating the term.

1. swath -

2. spatial resolution –

3. temporal resolution -

Lesson: Planning a Remote Sensing Mission

Activity sheet: Planning a remote sensing mission (PRSM-2)

Name: _____

Mission statement

You are a member of an airborne mission scientist team. Your team's role is to identify where there are active lava flows on the Kilauea Volcano in Hawaii. Your team has access to AVIRIS as your remote sensing instrument and NASA aircraft at Dryden Flight Research Center in California. Before starting your mission, you need to present your remote sensing plan to other scientists at NASA. So, what do you need to consider in your remote sensing mission plan? Use what you know about remote sensing and the questions below to create a mission plan.

1. **The Process of Remote Sensing Data Collection**

What steps will you take to collect data for the remote sensing mission?

Step 1: Confirm the use of AVIRIS as the remote sensing instrument (example)

Step 2:

Step 3:

Step 4:

Step 5:

Step 6:

Lesson: Planning a Remote Sensing Mission

Activity sheet: Planning a mission (PRSM-2A)

Name: _____

2. The types of data (remote sensing image):

What kinds of remote sensing images will you collect and why will you collect those images?

3. The method of data collection:

Spatial resolution: What spatial resolution are you looking for in your images (high or low) and why?

High resolution: (Yes No) circle one

Why?

Low resolution: (Yes No) circle one

Why?

Lesson: Planning a Remote Sensing Mission

Activity sheet: Planning a mission (PRSM-2B)

Name: _____

4. Temporal resolution and the swath: Are you looking at changes in lava flow over time?

Changes over time: (Yes No) circle one

Why?

5. Why might you fly over Kilauea more than once for this mission?

Use your responses to the questions on this worksheet to create a plan for conducting a remote sensing mission over the Kilauea volcano. Be sure to state the mission objective and a list the criteria for the mission including types of images you will collect and the spatial and temporal resolution requirements. You should be prepared to describe why each of the mission requirements is necessary for addressing the mission objective.

Lesson: Planning a Remote Sensing Mission

Activity sheet: Reflection page (PRSM-3)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: Collecting data - Kite aerial photography

Activity sheet: Team assignments (CD-1)

Name: _____

Task 1: Assign team member to roles.

Rigging team - skills	Pilot / Mission planning - skills
Team members	**Team members**

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission planning (CD-2)

Task 2: Mission planning.

Be sure to address the following questions:

- What is the target for the mission?
- What conditions are necessary for the mission?
- When will the mission be flown?
- Will there be practice flights? When? How long?
- Who will coordinate the mission? How?
- How will the data be analyzed? Who will analyze the data? How will it be reported?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission debrief (CD-3)

Task 3: Conducting the mission.

What happened during the mission? Record your observations. Was it successful in meeting the planned objectives?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Mission debrief (CD-3A)

Task 4: Analyzing the data.

Were the images useable? What did they tell you?

Task 5: Comparing this experience to collecting data on the Kilauea Volcano.

How is this activity similar to collecting aeronautics remote sensing data on Kilauea? How is it different?

Lesson: Collecting data - Kite aerial photography

Activity sheet: Reflection page (CD-4)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How did the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: Analyzing data

Activity sheet: ER-2 Mission information (A-1)

Name: _____

Read the NASA Dryden Flight Research Center news release on the ER-2 missions over South Africa and answer the following questions.

1. What was the mission of the ER-2?

2. What data were collected?

3. How were data presented to the scientists?

4. What do you think the data could tell the scientists?

5. What could the visible images tell the scientists? Provide an example of what you might see in visible data from this mission.

6. What could the non-visible or infrared images tell the scientists? Provide an example of what you might see in non-visible data from the mission.

Lesson: Analyzing data

Activity sheet: Watching over our planet from space (A-2)

Name: _____

1. What types of features should you look for when analyzing visible remote sensing images?

2. Brief description of the activity you completed:

3. What did you see in the visible images?

4. Why are these images important? (What did they tell you?)

Lesson: Analyzing data

Activity sheet: Summary (A-3)

Name: _____

1. What is the difference between visible and mid-infrared images?

2. Why are colors in mid-infrared images different from those in visible images?

Lesson: Analyzing data

Activity sheet: Decision support tool (A-4)

Student Decision Support Tool: <u>Where are there active lava flows in the images?</u>

1) Are images day or night scene?

Type of Data	Day scene	Night Scene
	Objects are visible in the image	Objects are not visible

2a) Are there light reddish-brown flow shapes on or around the sides of the volcano?

Answer	Day scene	Night Scene
Yes	Indications of old lava flows	Not visible in night images
No	No old lava	Not visible in night images

2b) Are there dark reddish brown flow shapes on or around the sides of the volcano?

Answer	Day scene	Night Scene
Yes	Indications of newer lava flows	Not visible in night images
No	No new lava flows	Not visible in night images

3) Are there any bright spots in Mid-IR bands?

Answer	Day scene	Night Scene
Yes	Could be lava or fire	Could be lava or fire
No	No active lava	No active lava

4) Do bright spots in Mid-IR correspond to bright spots in the visible image?

Answer	Day scene	Night Scene
Yes	It is reflected solar radiation	It may not be lava. It may be Fire
No	Could be lava	It is most likely Lava

5) Do bright spots correspond to an area of existing lava flows?

Answer	Day scene	Night scene
Yes	It is most likely an active lava flow	
No	Most likely a fire	

Lesson: Analyzing data

Activity sheet: Analyzing the KaAMS mission data (A-5)

Group members: _____

Name: _____

Answer each of these questions by completing the table on the next page.

Part1: Searching volcano location

- What objects can we see in visible image?
- Where are there clouds in this image?
- Where is the forest in this image?
- Where is there lava in this image?

Part 2: Identifying the previous vs. new lava

- Where is the area of lava flow?
- How can you differentiate between old lava and new lava?
- What is the color of old lava?
- What's the color of new lava?

Part 3: Identify active lava flow

- Can you find active lava flow among the area of lava occupied?
- What are the features of active lava flow?

Lesson: Analyzing data

Activity sheet: Analyzing the KaAMS mission data (A-5A)

Group members: _____

Name: _____

What did our team find from analyzing data image?

Analyzing Elements Observing Objects	Location on image	Color of object (in visible image)	How do you know what this object is?
Clouds			
Forest			
Lava			

Lesson: Analyzing data

Activity sheet: Reflection Page (A-6)

Name: _____

What is the overall problem you are investigating?

What problem were you solving during this lesson?

What did you learn during this lesson?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

How do the findings help you investigate the overall problem?

What new questions do you have about the overall problem?

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1)

Group members: _____

Name: _____

Instructions: This chart is to help you think about what you did throughout this unit and organize the information that you will present in your final project. Answer the questions or fill-in the table and then use your answers to help design your project.

What was the key question you were investigating?

What process did you go through while investigating this question and what did you learn a long the way?

Steps: What did you do?	**What did you learn?**

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1A)

Steps: What did you do?	What did you learn?

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1B)

Steps: What did you do?	What did you learn?

Lesson: Go Public! Presenting your results

Activity sheet: Final project organization (GP-1C)

What was most exciting to you during this unit?

What five things did you learn that you want to share with others?

Lesson: Go Public! Presenting your results

Activity sheet: Final project design (GP-2)

Use this space to draw ideas for your final project:

- What information will you include?
- What will it look like?
- How will you present this information to the public?
- How will you organize the work among your team?