UV DETECTIVES
Inquiry and Investigation Lesson Plan

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Core Curriculum standard Fulfilled: Standard IV: Students will understand the relationships among energy, force, and motion.

Core Curriculum Objective Fulfilled:
Objective 1: Investigate the transfer of energy through various materials.
b. Compare the transfer of energy (i.e., sound, light, earthquake waves, heat) through various mediums.
Objective 4: Analyze various forms of energy and how living organisms sense and respond to energy.
c. Cite examples of how organisms sense various types of energy.
d. Investigate and report the response of various organisms to changes in energy (e.g., plant response to light, human response to motion, sound, light, insects' response to changes in light intensity).

Intended Learning Outcomes (ILO's) Fulfilled:
1. Use Science Process and Thinking Skills
   b. Sort and sequence data according to a given criterion.
   e. When given a problem, plan and conduct experiments in which they….
4. Communicate Effectively Using Science Language and Reasoning
   a. Provide relevant data to support their inferences and conclusions.
   b. Use precise scientific language in oral and written communication.

Time Needed To Complete Inquiry: Approximately one-two 45 minute class periods

Inquiry: How can we determine whether different strengths of sunscreen provide better protection from the sun and if different strengths of sunscreen do provide different levels of protection? How can we rank unknown strengths of sunscreen using UV sensitive beads? (Guided Inquiry) Students will devise an experiment to determine whether different strengths of sunscreen provide better protection and to identify unknown strengths of sunscreen using UV sensitive beads. They will use the results of their experiment to compare the amount of light energy transferred through the unknown sunscreen strengths and use their results to list the unknowns in order of weakest to strongest.

Prior Knowledge Needed: Students need to have background on the electromagnetic spectrum; that electromagnetic waves (including ultra violet waves) are energy waves that can propagate through a vacuum.

Introduction: Students will be using UV sensitive beads to rank three unknown sunscreen strengths. Additionally, students will discuss human response (sunburn) to light energy (UV light specifically) and how we can use various mediums (different strengths of sunscreen, type of clothing) to manipulate the amount of UV light we are exposed to.

Materials / Resources Needed for the Investigation:

- 28 UV sensitive beads per group
- 4 Paper cups per group (cups need to be thick enough to stop UV light)
- SPF 15, SPF 30, and SPF 45 sunscreen. The teacher will label each set of samples given to students so they can check the accuracy of the students' results. Sample strengths should be unknown to students.
- Plastic wrap
- Stopwatch (optional)

Procedures of the Investigation: Students are given the materials above and asked to design an experiment that answers the question: How can we determine whether different strengths of sunscreen provide better protection from the sun and if different strengths of sunscreen do provide different levels of protection? How can we rank unknown strengths of sunscreen using UV sensitive beads? **Special Note:** Teachers should explain that the amount and thickness of the sunscreen needs to be constant otherwise unnecessary variables are introduced into the experiment. Additionally, the sunscreen should be spread very thin.

Data Collection: Students will likely test the sunscreen strengths by putting the plastic wrap over the top of the cups with the beads inside then smearing sunscreen over the plastic. (It is important to the inquiry in this activity that teachers allow students to come up with their own experimental procedures. Teachers will have the opportunity to address concerns and correct experimental mistakes at the end of the lesson.) Data will be collected by observing the effect on the beads.

Closure: After the lab is completed, the results will be discussed, including experimental methods decided on by student groups. Instructors should be aware that students will often neglect to include a control in their experiment. If this mistake occurs it needs to be addressed by the teacher. The instructor will then ask questions regarding the transfer of energy through various materials and human response (sunburn) to light energy (UV light specifically) and how we can use various mediums (different strengths of sunscreen, type of clothing) to manipulate the amount of UV light we are exposed to.

Assessment: Students will be assessed based on their participation in the classroom discussion and the results of their experiment.

Name: _____
Date: _____
Period: _____

UV DETECTIVES

Problem

How can we determine whether different strengths of sunscreen provide better protection from the sun and if different strengths of sunscreen do provide different levels of protection, how can we rank unknown strengths of sunscreen using UV sensitive beads?

RESEARCH

Answer the following true/false questions:

True/False	Ultraviolet light and visible light are both forms of radiation.
True/False	Since I can't see ultraviolet light, it can't hurt me.
True/False	Ultraviolet light can easily pass through any material.
True/False	Ultraviolet radiation can cause sunburns.

Procedure

(Use the space below to describe the procedure your group decides to use to find a solution to the given problem.)

IDENTIFICATION OF VARIABLES

Identify the **Independent Variable, Dependent Variable, Constants** and **Control** of this experiment.

Independent Variable	
Dependent Variable	
Constants	
Control	

Data Collection

(Use the space below to create a data chart and graphical representation of your results.)

Analysis

Rank the unknowns in order from weakest to strongest.

Conclusion

(Make sure you address all issues in the experimental "Problem" given in this activity.)

Question

What evidence was there of energy being transferred by waves in this activity?

UV Detectives

Background Information and Instructions

Instruction 1: *Silently read through this information and be prepared to discuss it as a group.*

Have you ever been burned by the sun? OUCH! You have probably experienced the invisible energy that comes from our nearest star. How can something that you can't even detect hurt you? It's all about electromagnetic waves...

Energy travels from the sun in photons that move in waves. Each wave contains many different kinds of "light" energy; some we can see and some we cannot. These waves carry both electric energy and magnetic energy, that's why we call them electromagnetic waves. (Plus, it makes us sound smart when we say "electromagnetic" ☺)

Visible light is just a very small portion of electromagnetic energy. Other forms of this energy include radio waves (used for AM/FM radio), microwaves (used in cell phones), infrared waves (heat), ultraviolet waves (the ones that give you a sunburn), x-rays (to detect broken bones), and gamma rays (not just in Star Trek!) The part of electromagnetic energy that we can see is called visible light. Visible light looks white, but it is actually all colors of light mixed together.

The differences among these kinds of waves are the wavelengths. Radio waves have very long wavelengths, but don't carry much energy. Visible light has "medium length" waves. Gamma rays have very short wavelengths and carry the highest energy level. Sometimes we call electromagnetic energy "radiation."

Ultraviolet rays are just the right wavelength to penetrate our skin and burn us – that's why they get such a bad rap! Things that can block UV radiation are clothing with tightly woven, dark threads and polarized sunglasses. Scientists have also created liquids that we can put on our skin to keep UV rays from penetrating it. In the store, you can buy several types of this sunscreen with different "strengths" that supposedly give more or less protection from damaging UV rays.

Some plastic beads have been made with a special chemical that changes color when it absorbs light wavelengths in the ultraviolet range. In fluorescent or incandescent light, (or no light) the beads appear white, but in the presence of UV light, they change to orange or red or purple – cool beads!

Instruction 2: *With your group, discuss the answers to these questions, and be prepared to share your reasoning with the class*

1- True/False	Ultraviolet light and visible light are both forms of radiation
2- True / False	Since UV light can't be seen with our eyes, it is harmless.
3- True/False	Ultraviolet light can easily pass through any material.
4- True/False	Ultraviolet radiation can cause sunburns.
5- True False	White light is actually several colors of light blended together.

UV Detectives

Student Name _____ Period _____

With your group, design your own experiment to answer this question...

Question: Do sunscreens with different strengths really provide different levels of protection from UV radiation?

Prediction:

I think that _____.

I predict this because _____.

Materials: (each group may select from these materials to create their experiment)

4 opaque cups	4 pieces of stretch film	16 UV sensitive beads
1 drop sunscreen A	1 drop sunscreen B	1 drop sunscreen C
stopwatch	bright sunlight	

Procedure: Our group will answer this question by:

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Independent Variable (the thing we are testing) _____.

Dependent Variable (the outcome we are measuring) _____.

We will measure by recording _____.

Constants (The things we will keep the same for all trials) _____

_____

Comparison groups: We will compare _____

We will designate _____ as the control group.

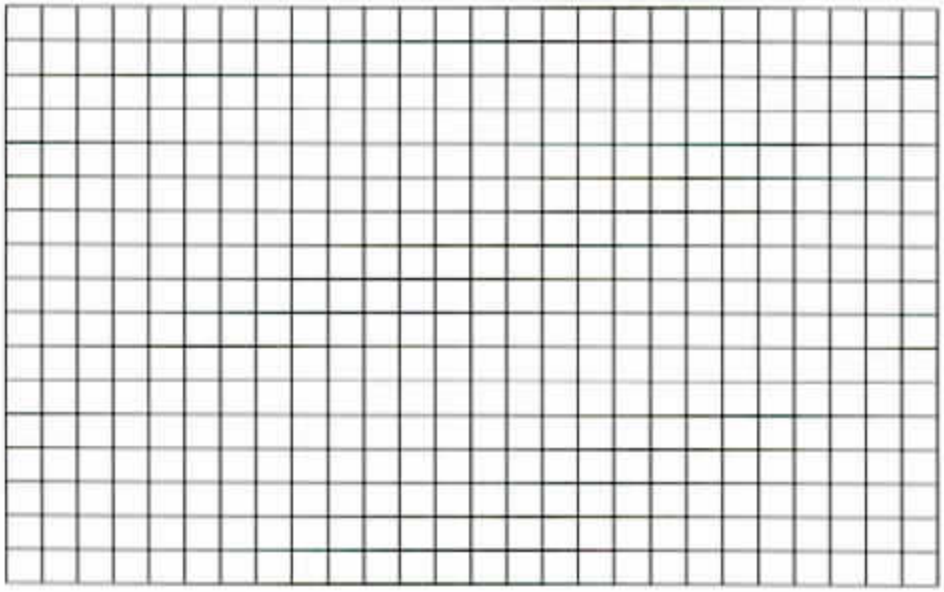
Hold On...

Check your procedure with your teacher ***before*** you gather your materials and begin.

Once your teacher is satisfied with your prediction, procedure, and variables, you can GO!

Data Collection
Use the space below to record your data. Be sure to label.

Data Analysis
Create a graph to better analyze your data. Be sure to label.



Conclusion:
1-Look at your data and rank the sunscreens from weakest to strongest.

2- Was your prediction accurate? What is your group's answer to the initial question?

3-Did your group encounter any problems or unexpected outcomes during this experiment?

4- What evidence was there of energy being transferred by waves in this activity?