RAY SHIELDING

Student Section Student Name _____

Lesson Objective

To analyze different materials to simulate space radiation shielding on a spacecraft and select the best material to build a spacecraft.

Part 1: During this lesson, you will

- gather data on space radiation shielding by observing a flashlight beam as it shines through different material.
- gather data by measuring, predicting, counting, and weighing the materials that will shield simulated space radiation.
- analyze the data and select the most protective and lightweight material for a space exploration spacecraft.
- develop a conclusion based upon the results of this activity.

Part 2: During this lesson, you will

- determine properties of materials to analyze and select testing methods.
- conduct a materials analysis, gather data, and compare the properties of the given materials.
- apply findings from the radiation shielding and material analysis to select the best material for a space exploration spacecraft.
- develop a conclusion based upon the results of this activity.

Problem

Which of the materials provided will block the most simulated space radiation, and be the best material to build a spacecraft?

Observation

Space radiation comes from the Sun and from other stars from other galaxies. This radiation can have devastating effects on materials and the human body.

On Earth, the atmosphere contains a layer of ozone that prevents most of the ultraviolet rays from reaching us. We can use sunscreen on our skin to keep more of the ultraviolet rays from harming our skin. However, when astronauts live and work in space, away from Earth's protective atmosphere, they are exposed not only to ultraviolet rays but also to space radiation. Current spacecraft materials cannot block all of the radiation, so astronauts in space are exposed to more than the average person on Earth.

For longer missions, especially those taking astronauts far away from low-Earth orbit, more protection from space radiation will be needed. NASA is already working on how to make the spaceship safer by using different materials to provide protection.

In Part 1 of this activity, you will test the ability of different materials to shield simulated space radiation. The light from a flashlight will represent space radiation. Due to weight restrictions, the ship material will need to be as lightweight as possible but thick enough to keep the radiation at a minimum.

In Part 2 of this activity, you will conduct a materials analysis to gather more information on properties of each material. You will observe and record your materials analysis findings and choose the best material for design of a new spacecraft.

Use the first column of this KWL chart to organize your observations about ray shielding.

Brainstorm with your group what you want to know about radiation shielding, then list in the second column of this KWL chart.

KNOW	WANT TO KNOW	LEARNED

Hypothesis

Based on your observations, answer the "problem question" with your best guess. (Which of the materials provided will block the most simulated space radiation, and be the best material to build a spacecraft?) Your hypothesis should be written as a statement.

My hypothesis: _____

Materials

Per group

- 1 flashlight
- 1 metric ruler
- materials to test (all the materials should be the same color and about the same size)
    - unlined copy paper
    - tissue paper
    - construction paper
    - card stock paper

Per student

- 1 pair of safety glasses

Safety

Review your classroom and lab safety rules. You should not look directly into the beam of the flashlight. Put on safety glasses when instructed.

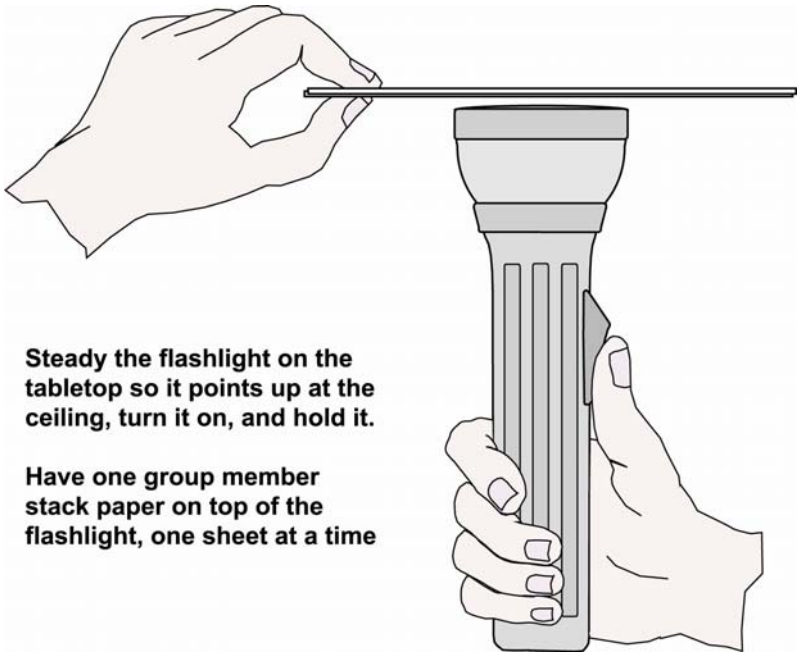
Test Procedure

PART 1:

1. Each group member will have a designated job:
    - One student will hold the flashlight.
    - Another student will hold and stack the paper on top of the flashlight.
    - A third student will measure and weigh the material and record the data.

- If you are working in groups of 4, the fourth student will be the recorder.

2. Measure in centimeters, the dimensions (length and width) of the materials (pieces of paper) your group will test and record on the Ray Shielding Analysis Chart.
3. Choose one material for radiation shield testing and predict how many pieces of that material it will take to completely block the simulated space radiation. Record the predicted amount on the Ray Shielding Analysis Chart.
4. The flashlight holder should steady the flashlight on the tabletop so it points up at the ceiling, turn it on, and keep holding it. CAUTION: Do not look directly into the flashlight beam.
5. *Collect Data*: Have one group member stack paper on top of the flashlight, one sheet at a time, to block the simulated space radiation (flashlight beam). As each piece of paper is added, the light beam should become weak. Continue adding one sheet at a time until the simulated space radiation is completely blocked. (See diagram.)



6. Record the number of sheets used to block the simulated space radiation on the Ray Shielding Analysis Chart.
7. Using a balance or scale, weigh the sheets used to block the simulated space radiation and record on the Ray Shielding Analysis Chart. Use your measurement and estimation skills to determine the weight in grams.
8. Keep this stack of paper together, and set it aside to use later in the activity (Part 2).
9. Repeat steps 3–8 with each type of material/paper. Everyone in your group should switch roles when a new material is tested, so that every group member performs each duty.
10. After taking all measurements, study the data and draw conclusions by answering the questions following the Ray Shielding Analysis Chart.

PART 2:

1. Gather the materials that were tested (stacks of paper) from Part 1 of the activity. Continue with the materials analysis by classifying the tested material. If you could classify all these materials in to one category, what would it be? Write your answer at the top of the Further Materials Analysis Web.

2. Brainstorm properties of these materials that your group would like to test. These properties should be important factors that will help you decide which material to use to build your spacecraft. Some examples might be “will the material tear?” or “will the paper stretch?“.
3. List the properties that you want to test in the first column of the Further Materials Analysis Chart. A few properties have already been filled in.
4. With your group, decide how you will test each property and write a short description in the second column of the Further Materials Analysis Chart.
5. Put on your safety glasses.
6. Conduct your tests for each property by stacking the same number of tested material (pieces of paper) that blocked the simulated space radiation (during Part 1), and then perform your test on that material. Rank each material (stack of paper) and record your ranking in the Further Materials Analysis Chart.

   The ranking will be from 0 to 5:

   - If the material shows no sign of that property, assign it a 0.
   - If the material shows a small sign of that property, assign it a lower number.
   - If the material shows a large sign of that property, assign it a larger number.
7. Once you have conducted your tests and assigned a rank to each material, add up the numbers in each column. This will be the total rankings for each material.
8. Study the data from the Ray Shielding Analysis Chart (from Part 1) and the Further Materials Analysis Chart.
9. After taking all measurements, study the data and draw conclusions by answering the questions following the Further Materials Analysis Chart.

Record Data

PART 1:

Ray Shielding Analysis Chart

Dimension of sheets in centimeters:

Length _____

Width _____

	Copy		Tissue		Card stock		Construction	
	Predict	Actual	Predict	Actual	Predict	Actual	Predict	Actual
Total weight of all sheets in grams								
# sheets to block the simulated space radiation								

Study Data

1. Use the data from the Ray Shielding Analysis Chart and construct a graphic organizer to show the data. Make sure to title and label your graphic organizer.

2. Study your graphic organizer and decide which material was the best at shielding the simulated space radiation with the least amount of weight. Explain what data helped you to make this decision.

3. Does this data support your hypothesis? Why or why not?

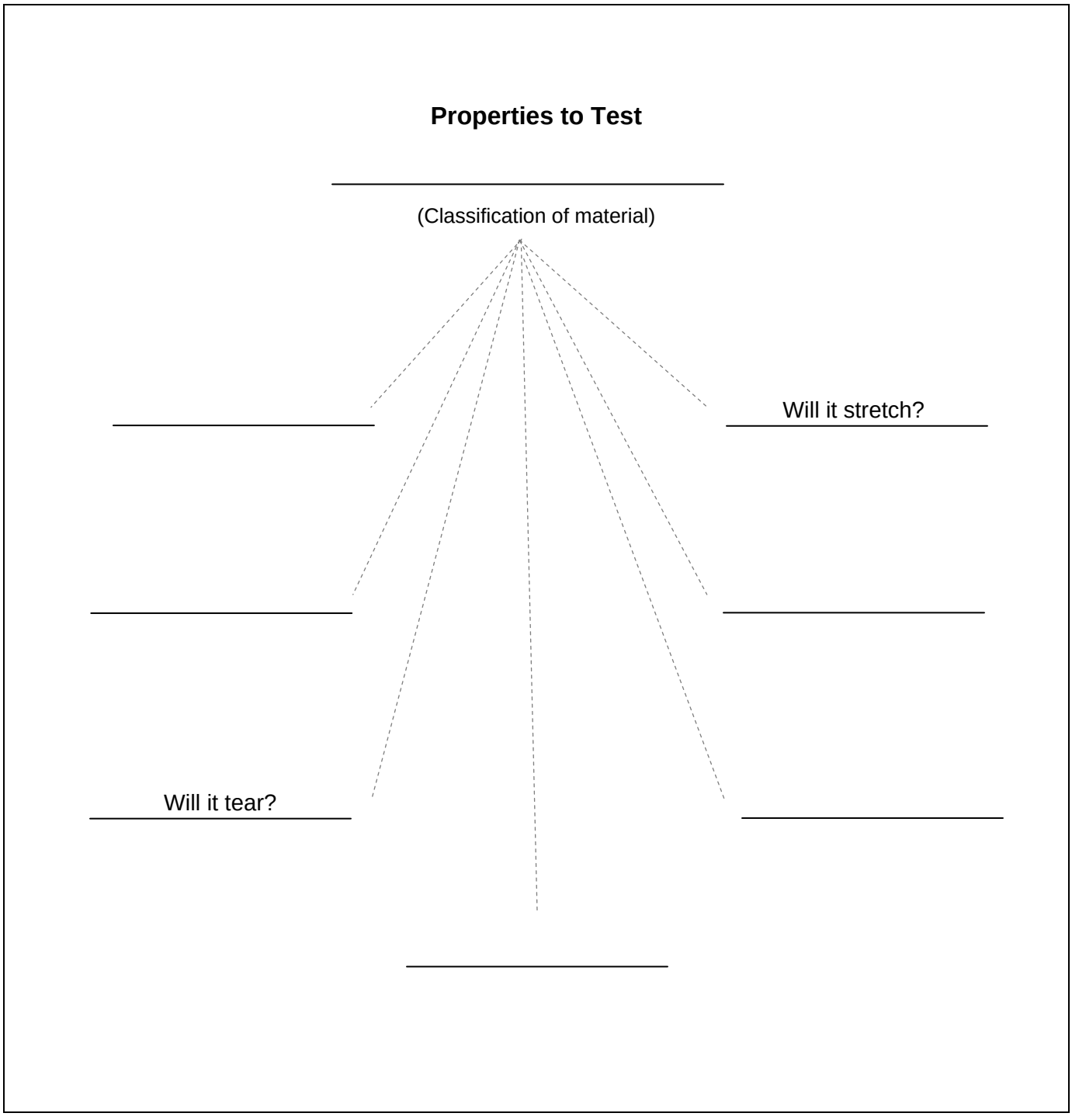
4. How do your results compare to class results?

5. Based on your findings, what would you recommend to NASA scientist and engineers about the materials used to build a spacecraft that will be lightweight and provide the best protection from space radiation?

Record Data

PART 2:

Further Materials Analysis Web



Record Data

PART 2:

Further Materials Analysis Chart

Rank the materials from 0 to 5					
0	1	2	3	4	5
No sign of property		Medium sign of property			Large sign of property

Property to test	Describe the test	Copy	Tissue	Card stock	Construction
Will it tear?	I will tear the material with my hands.				
Will it stretch?	I will pull outward on the sides of the paper.				
TOTAL RANKING (Add the ranking for each column)					

Study Data

1. Use the “TOTAL RANKINGS” from the Further Analysis Data Chart and decide which material is the best to construct a spacecraft. State your decision and what data helped you to make this determination.

2. Compare the Ray Shielding Analysis Chart (from Part 1) to the Further Materials Analysis Chart. Was the best material for the spacecraft construction also the best at shielding space radiation?

3. Using all your findings, decide which material is the best to build a spacecraft that will shield the most amount of space radiation with the least amount of weight. Explain what data helped you to make this decision.

4. Does this data support your hypothesis? Why or why not?

5. How do your results compare to class results?

Conclusion

- Update the LEARNED column in your KWL chart.
- Restate your hypothesis and explain what happened during testing.