# Dynamic Design: A Collection Process

# Modeling Solar Wind Collection

## TEACHER GUIDE

### BACKGROUND INFORMATION

In this activity students will model how different materials collect different solar wind particles. In the Genesis spacecraft, the wafers will be made out of different materials in order to anlayze different elements and isotopes. All elements from atomic number 3 through 92 will be collected on all wafers, but some materials lend themselves for better analytical techniques for some elements than others. In the first activity, students will throw projectiles onto different surfaces and determine which projectiles embed into different materials. In the second activity, students will use UV sensitive beads to model the different materials and solar wind particles. Black light will be used to analyze the results. Finally, in part three, students will discover that there are no visible solar wind particles that will be collected on the wafers.

### NATIONAL SCIENCE STANDARDS ADDRESSED

**Grades 5–8**

*Science As Inquiry*

Abilities Necessary to do scientific inquiry
Understandings about scientific inquiry

*Science and Technology*

Abilities of technical design

**Grades 9–12**

*Science As Inquiry*

Abilities Necessary to do scientific inquiry
Design and conduct scientific investigations
Formulate and revise scientific explanations and models using logic and evidence

*Science and Technology*

Abilities of technical design

*(View a full text of the National Science Education Standards.)*

### NATIONAL MATH STANDARDS ADDRESSED

**Grades 5–8**

*Math Standard: Statistics*

Systematically collect, organize and describe data

*(View a full text of the National Math Education Standards.)*

### MATERIALS

For each group of three to four students:

**Part 1**

Choose four projectiles. Examples include:

| | | |
|---|---|---|
| M & M's® | stone | cotton |
| plastic bead | rubber bead | hard candy |
| polystyrene | paper ball (wet and dry) | rice |

Note: Each projectile should be similar in size.

Each of the four stations should include one of the following surfaces or surface materials:

| | | |
|---|---|---|
| bread spread with jelly | ping pong balls | M & M's® |
| moist sponge | cake with icing | stones |
| Jell-O® with whipped cream | polystyrene | prepared pudding |
| flour or dried rice | hard candies | plastic beads |

**Part 2**

- Student Text "Continuous Collection"
- Small background frame master
- UV sensitive beads
- 3-4 forceps
- Glue stick and or two-sided tape
- Black light

**Part 3**

- One bowl of uncooked rice
- 10 small safety pins
- Blind fold
- Watch or clock (minute timer)

## PROCEDURE (Part 1) Sticky Situation

1. Explain to students that the solar collectors on the Genesis spacecraft are wafers attached to a frame. The wafers are made of different materials based on the type of solar wind particles that the scientists plan to analyze. In this Exploration activity, students will throw objects and discover which projectiles embed into various surfaces.

2. Relate experiences where students have "played" with food. Have students share some experiences. On the board, list and describe the materials that will be used. Allow the students to predict which projectiles will embed into each surface and which will not. Solar wind particles will be embedded into the collectors so students should note only those projectiles that are embedded, and not just stuck on the surface. This would be a good opportunity for students to operationally define "embed." Students may use the following grid to help them make their predictions. Students may use this key:

**E = projectile will embed** **N = projectile will not embed** **?= unsure**

| | Projectile 1 | Projectile 2 | Projectile 3 | Projectile 4 |
|---|---|---|---|---|
| Surface 1 | | | | |
| Surface 2 | | | | |
| Surface 3 | | | | |
| Surface 4 | | | | |

3. Discuss with students what variables they should try to control. Some may include: size of the projectile, force with which it is thrown, and the distance from the launch site and the surface. List these and other variables on the chalkboard.

4. Distribute materials and let the students construct their projectiles. Once done, students should test their projectiles against the various backgrounds. One way to manage this is that there be a different surface at each workstation. Students could take their projectiles to the different workstations to complete their trials.

5. Students may record their results in the following table or they may create a table to record their data. Students should complete three trials per projectile per surface.

**E = projectile embedded** **S = projectile stuck** **N = projectile did not stick or embed**

| Surface 1 | Projectile 1 | Projectile 2 | Projectile 3 | Projectile 4 |
|---|---|---|---|---|
| Trial 1 | | | | |
| Trial 2 | | | | |
| Trial 3 | | | | |

| Drawing and Additional Observations: |
|---|
| |

6. Once students have completed their experiment, debrief students by asking these questions:
   a. Which surface had the most projectiles that were embedded? Expect more projectiles to be embedded into softer materials such as jelly, whipped cream, or icing. Materials that have spaces between particles such as dried rice, hard candies, stones, or plastic beads may also have projectiles embedded in them.
   b. Why do you think this is so? Students may suggest that softer materials provide less resistance to the projectiles.
   c. What may have caused your results to differ from those of another lab group? Perhaps variables such as projectile speed were different in other groups.
   d. What would you suggest next time to have more particles embed? (Answers will vary.) Use more force when throwing projectiles or using different materials.
   e. If you were going to design wafers to collect the most number of different kinds of projectiles, which surface would you choose and why? Answers will vary, but should be based on experimental results.
   f. If you were going to design boxes to collect specific projectiles, which would you choose? Answers should be based on experimental results. This should summarize the activity.

7. Assign the Student Text "Continuous Collection" to be read as homework or classwork.

## PROCEDURE (Part 2) Better Beads

1. Students will read the Student Text "Continuous Collection". This text contains information about methods of collecting data, examples of collecting insects, and an analogy of sound relating to solar wind.

2. List the different materials (colors) of wafer material on the board. Ask each group to determine which type of bead they would like to use in their collector. Students should also note that there are some contaminants among the atoms they chose.

3. The beads change to a color when exposed to UV light (black light). To organize the materials, have each color of beads (when exposed) in a separate container. For instance, all white to red beads could be in a container marked silicon, all white to blue beads should be in a container marked sapphire, and so on. See bead colors and materials chart. Have another container with several colored beads and contaminants in another container marked “solar wind particles.”

4. Ask students to gather enough beads of one material to cover the hexagon on their student sheets.

5. Students should have several beads of one type. With their small

Bead Colors and Materials

You may use the following key for bead colors and materials.

| Bead Color | Material |
|---|---|
| White to Red | Silicon |
| White to Blue | Sapphire |
| White to Orange | Aluminum |
| White to Yellow | Gold |
| White to Purple | Germanium |
| Silver to Copper | Contaminants |

wafer and two-sided tape, students should apply the tape to the wafer and place the beads on the tape. The beads will represent the atoms that make up the elements of the wafer material.

6. Once the students have applied the beads to the wafers, ask them to place the wafers close to one another on a table. Students should get several beads from the container of "solar wind beads" (*an assortment of the various colors*). All students should throw the solar wind assortment beads at the wafers at the same time.

7. Each group should retrieve their wafer and take it to the ultraviolet light. Ask the class to then use an ultraviolet light to analyze the type of solar wind particles that were collected by noting the colors that are seen under the ultraviolet light. Students should record their results. For example, if the material used for the wafer turned blue during the UV analysis, any blue solar wind particles there were embedded in the wafer could not be analyzed. Certain materials were better for analysis of some elements than others.

8. Ask: "Were there any surprises? Did some materials collect solar wind better than others? Why do you think this is so?" (As in the Genesis mission, all solar wind elements will embed into the wafers and some materials were better for analyzing certain elements than others. In the actual mission the analysis will not be based on colors.)

9. Ask: "In what ways is this model similar to the actual Genesis mission? In what ways is the model different than the actual Genesis mission?" (When completing the analysis, the solar wind beads that were the same as the material in the wafer were impossible to detect.)

10. Ask: "What were some of the problems you encountered when trying to detect the beads that were embedded into the wafer?"

11. Ask: "How would you solve some of these problems?" (Use various materials for analyzing various solar wind particles.)

## PROCEDURE (Part 3) Invisible Analysis

1. Explain to students that in the "Better Beads" activity, the model was insufficient because the collector wafers will not change color at all and that a non-visual analysis will have to take place.

2. Distribute materials for part 3. Explain that students will take turns trying to pick out the safety pins from the bowl of rice while blindfolded.

3. Have one student put the blindfold on and another student keep time. The blindfolded student will have one minute to pick out as many safety pins as possible. Once this is done, record results in a data table.

4. Students should switch tasks and repeat the process.

5. Review the questions on the student sheet. If students need help, explain to them that in this model the rice represents the material in the collector wafers and the safety pin represents the solar wind particles.

6. Ask: "Why were you blindfolded for this activity? How does this model solar wind analysis?" (Students may suggest that no one can see the solar wind particles. This model shows that further analysis with a mass spectrometer will need to take place.)

## REFERENCES

**Books:**

Mohl, B. (1968) Auditory sensitivity of the common seal in air and water. J. Auditory Res., ch. 8, pages 27-38.

Grier, James, W. (1984) Biology of Animal Behavior. St. Louis, Times Mirror/Mosby.

**World Wide Web:**

http://www.umassd.edu/specialprograms/lloyd/leps.html
Moth Research

http://www-curator.jsc.nasa.gov/curator/genesis/Collectors.htm
Johnson Space Center Genesis Page

http://www.inhs.uiuc.edu/cwe/wwwtest/collect/HTML/d18.html#4
How to collect insects

http://www.inhs.uiuc.edu/cwe/wwwtest/collect/HTML/d16.html
Sifting, separating and extracting

http://www.pitt.edu/~biohome/Dept/Nonframe/Faculty/luo.htm
Animal Senses