Properties of Dust *page 1*

Grades 6 – 8

National Science Education Standards (5-8)
- Content Standard A: Science as Inquiry
  Understanding about scientific inquiry;
  abilities necessary to do scientific inquiry.
- Content Standard B: Physical Science
  Properties and changes in properties of matter.

Materials and Tools

Graph paper, magnifying glass (2x and 4x lenses), tweezers, cleaning pad (e.g. Swiffer or Grab-it mitts) or paper towel, watercolor brushes, wide clear packing tape, clear metric ruler showing millimeter marks, copies of “About the Spitzer Space Telescope” and “Resources” pages on the back of this poster.

Engage

Dust is everywhere — on the floor, floating in the air, orbiting the Sun in our solar system, and in huge clouds in space like the Eagle Nebula and the Tarantula Nebula. Begin by asking students:

- What is dust?
- What are everyday examples of dust?
- Why would an astronomer study dust?

Get Ready to Explore

Divide students into science teams of 2-4 members. Ask each group to pick its own physical area of the classroom to investigate, or assign investigation areas (locations) to groups. Tell the groups that their objectives are:

1. Collect dust in your assigned area.
2. Separate out the dust sample into different groups based on physical characteristics.
3. List the properties of the dust they discover.
4. Suggest origins for the dust that they find.
5. Explain how they think their investigation of dust is related to an astronomer investigating dust in space.

Explore

Over several days, each group uses the cleaning pads or paper towels to collect dust from its chosen place in the classroom. Students place each sample in a separate bag and label it according to where the dust was collected, the time, date, and science team name.

An alternative dust collection method is to use the clear plastic tape to sample classroom areas. Use the sticky side of the tape to pull dust off surfaces. Although this is an easier collection method, it limits the ways students can sort the dust particles in the sample.

Example investigation:

1. Collect dust samples using the cleaning pad or clear tape.
2. Carefully remove particles from the pad (scrape with the tweezers and gently shake the pad) onto the graph paper. Then sort the contents by features (size, color, shape) on the graph paper. Clear tape can be used to hold down the samples while students measure the sizes of the particles — the slightest breath will scatter the particles.
3. Measure the sizes of the particles. Using the clear plastic metric ruler and magnifying glass at 4×, students can see particles down to 100 micrometers (0.1 mm), but the limit of their measurement accuracy is half the smallest unit of measurement on the ruler, or 0.5 mm. Prompt groups with questions to guide their investigation, such as:
   - What range of sizes do students observe?
   - What is the largest size that qualifies something as dust? Interstellar dust (dust between stars and inside nebulae) is about 1 micrometer or smaller in size. For comparison, one millimeter is 1,000 micrometers. How a massive clump of micrometer size dust particles condenses into a planet thousands of kilometers wide is still a mystery. A planet is about one trillion (1,000,000,000,000) times bigger than the dust particle!
4. List the basic properties of dust for each location. Some of the material might not qualify as “dust” (hair, seeds, and string). Many things will be too small to accurately measure, but students can still see them with the magnifying glass.

Explain

Students explain the origin of the dust based on the results of their investigation. Help students with their explanations with guiding questions such as:

- Do the observations suggest a relationship between dust and where it was collected?
- If so, what are the most likely origins of the dust?
- How could you better determine the source of the dust?

Students should also explain their reasoning behind their dust organization and what evidence helps them support their dust origin hypothesis. Some guiding questions to ask students are:

- How did you decide to organize your samples?
- What evidence do you see that supports your hypothesis?

Students may find evidence that does not support their original hypothesis, but instead points toward another explanation.

Elaborate

Ask students to consider the following questions:

1. What unique tools did you use to investigate dust in your classroom?
2. What are the physical properties of the dust you investigated that can help you figure out where the dust came from?

Read out loud the paragraph in which Spitzer Space Telescope scientist Dr. Neal Evans describes the nature of his research and its relationship to the Spitzer Space Telescope:

> **"Life can exist on planets around stars, which are organized into galaxies. What is the origin of stars, planets, and galaxies? The origins of all of these are hidden from view if we use visible light. Stars form in clouds of molecules and dust. The dust blocks visible light. Planets form in disks around the forming stars; planets like Earth form FROM the dust itself. The origin of galaxies is intimately related to the origin of the stars within them and again this is often hidden by dust.**
>
> **Infrared light is the key to understanding origins. But we need a cold telescope above the Earth's atmosphere to study many aspects of infrared light. Once we have this, we can study the light of stars in distant galaxies, study the origin of those stars in the dusty clouds in our own and other galaxies, and study the disks that form planets. We can even trace the nature of the dust as it changes to produce planets, comets, and asteroids. We can learn when the building blocks of life, the icy mantles containing carbon, nitrogen, and oxygen form, on the dust particles. And we can study the end of planets and stars as they create new dust. We can study the cycle from dust to dust."**

Pass out copies of the pages "About the Spitzer Space Telescope" and "Resources" from the back of the poster for students to read. Ask students to respond to the following questions:

3. What are the unique capabilities of the Spitzer Space Telescope that astronomers need in order to investigate interstellar dust?
4. Based on your classroom dust investigation, what challenges do you think astronomers have to overcome in order to investigate interstellar dust hundreds of light-years away?

Evaluation Rubric

Engagement: 0-20 points

- Students actively engage in the activity, with each member contributing to the investigation objectives.

Methodology: 0-40 Points

- **Planning 0-10 points**
  Simple, thoughtful plan for collecting the dust and organizing the samples.
- **Collection: 0-10 points**
  Consistent collection method and care taken to preserve the dust samples in their labeled plastic bags.
- **Measurement: 0-10 points**
  Consistent measurement technique and reasonable particle size estimates. Shows understanding of accuracy and precision.
- **Organization: 0-10 points**
  Dust samples are clearly marked and organized by the particles' physical properties. The organization helps students see relationships between the particles and their possible origin.

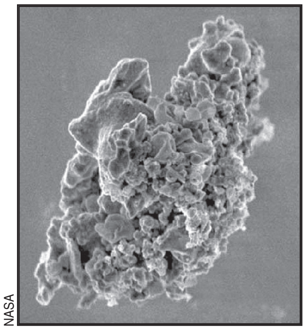
Synthesis: 0-40 points

- Clear relationship between the dust investigation and the astronomer's research. Student supports claims with relevant examples and evidence from the dust investigation.

Total: 100 points

Metric Background

Meters	Unit name	Example(s)
10^{0} (1)	meter	doorway width, meter stick,
10^{-1} (0.1)	decimeter	human hand
10^{-2} (0.01)	centimeter	pebble
10^{-3} (0.001)	millimeter	coarse sand
10^{-4} (0.0001)	(no name)	human hair, pollen, sand, sandpaper grit
10^{-5} (0.00001)	(no name)	bacteria, pollen
10^{-6} (0.000001)	micrometer	interstellar dust, fungal spores, bacteria
10^{-7} (0.0000001)	(no name)	smoke, bacteria
10^{-8} (0.00000001)	(no name)	smoke
10^{-9} (0.000000001)	nanometer	molecules



NASA

This tiny speck of dust shed from a comet is only about 6 by 10 micrometers, but it is huge compared to interstellar dust. Most interstellar dust grains are one micrometer (the size of the small white scale bar) or smaller.

http://www.jsc.nasa.gov/jscfeatures/images/hires/IDP.jpg

Properties of Dust

Texas Essential Knowledge and Skills

Science:

§112.18. grade 6 (b)-4(A) use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum.

§112.20. grade 8 (b)-3(B) use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature.

§112.20. grade 8 (b)-8(C) explore how different wavelengths of the electromagnetic spectrum such as light and radio waves are used to gain information about distances and properties of components in the universe.