Properties of Dust

Materials and Tools
Graph paper, magnifying glass (2x and 4x bifocal), tweezers, cleaning pad (e.g., Swiffer or Grab-it mitts) or paper towel, brushes, wide clear packing tape, clear metric ruler showing millimeter marks.

Engage
Referring to the infrared images on the poster, ask students what these objects may be and how big they are. Continuing probing students’ prior knowledge by asking “What is dust?” “What are everyday examples of dust?” “Why would an astronomer study dust?” Finally, suggest that the class break up into groups to investigate dust inside the classroom.

Get Ready to Explore
Divide students into science teams of 2 – 4 members. Ask each group to pick their 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 their assigned area.
2. Organize their dust sample into groups based on physical characteristics.
3. List the properties of the dust they discover.
4. Suggest origins for the dust they found.
5. Explain how their investigation of dust is related to an astronomer investigating dust in space.

Explore
Over 5 days, each group uses the clearing pads or paper towels to collect dust from their chosen place in the classroom. Students place each sample in separate baggie, 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 pad or clear tape.
2. Carefully remove particles from the pad (scrap 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 size of the particles – the slightest breath will scatter the particles.
3. Measure the size of the particles. Using the clear plastic metric ruler and magnifying glass at 4[J], students can see particles down to 100 microns (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?” or “What is the largest size that qualifies something as dust?” Dust is considered to be a particle 63 microns (6.3 \( \times 10^7 \) meters) or smaller in size; for comparison, one millimeter is 1000 microns, a period (.) is about 200 to 300 microns in diameter.
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 student can still see them with the magnifying glass.

Explain
Students explain the origin of the dust based on the results of their investigation. For instance, do the analysis of 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.

Elaborate
Read the following statement by SIRTF scientist Dr. Neal Evans. Relate origins of dust in your classroom to dust in space. Astronomers are asking the same sorts of questions about dust that drive the students’ classroom investigations.

“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. For distant galaxies, even the fully formed stars are “hidden” because their visible light is shifted to the infrared by the Doppler shift. Clearly 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.”

Dr. John Lacy describes interactions between infrared light and dust grains:

“Dust grains that are large compared to the wavelength of the light hitting them cast shadows; therefore, if the wavelength of the light is larger than the dust grain, the light can go around it. The basic reason for this is diffraction.”

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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 baggies.
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