Ages:
5-8th grade

Duration:
45 minutes

Materials:
Per pair of students

- Textured cardboard plates (Chinette works well)
- 1/2 container each of 3–4 different colors of Play-Doh®

~ LPI Education/Public Outreach Science Activities ~

Sticking the Early Planets Together

Overview —

The students will use small clumps of Play-Doh® to model how planets may have formed through the process of accretion of smaller particles in the early days of our solar system formation.

Objective —

The students will:

- experience a model for how our planets may have begun to form, early in the history of our solar system.
- discuss the model's limitations and successful representations.

Before You Start: The students should be familiar with current theory of how our solar system formed (see Background section).

Activity —

Invite the students to discuss how the solar system formed.

- What are the components of our solar system?
- What was it like during the early stages of formation? *(dusty!)*
- How did our planets form? *(by small particles clumping together – accreting)*.

1. Group students into pairs and allow them to choose colors of Play-Doh®. Encourage students to use at least four different colors to best represent features of the solar system.

2. Have groups place their Play-Doh® into a shallow tray and tear the dough into small pieces, about the size of dried peas or beans.
   - What do the pieces represent for our early solar system? (*dust and gas*)

3. Using a circular motion, ask the students to move their hands around in the trays, applying a slight pressure to the small pieces of Play-Doh®.
   - What happens to the clumps as the students swirl them together? *(they get larger)*
   - What do scientists call this process of clumps clumping together to make larger and larger clumps? *(accretion)*
   - What do the larger clumps represent? *(planets)*
   - In what ways is this model an accurate representation of what scientists believe happened in our early solar system? *(particles clumped together, making larger and larger clumps)*

4. Class discussion on this model In what way is it not an accurate representation?
   Time – the process took millions of years.
   Material – Play-Doh had not yet been invented, hydrogen gas and dust were the primary components, also the materials that collected in the hot inner solar system are different from those that collected in the cooler, outer solar system.
   Cause of motion – the students had to provide the swirling motion and cause the "collisions;" in reality, the particles in the cloud from which our solar system formed were all part of a rotating cloud, but they also were moving relative to each other, causing collisions.
   Cause of collisions – collisions in the early solar system were random; sometimes particles stuck and sometimes they did not – sometimes collisions caused particles to break apart!
   Speed of growth and cause of attraction – as planets grew larger, they eventually reached a point where they were large enough to have their own field of gravity – and they attracted more and more particles, growing larger faster and faster.

How could the students change the model to better fit the theory?

Background —

How did our Solar System form?

Our Solar System began about 4.6 billion years ago when a cloud of dust and hydrogen gas drifting in our galaxy began to condense and contract under its own gravity, forming a wide, flat, rotating disk. Most of the material collected in the center as a large sphere of gas; pressures and temperatures in the sphere eventually increased to the point that nuclear fusion began to occur and the Sun, the central star of our Solar System, began to shine. The remainder of the cloud formed a wide disk, swirling around the Sun, called the solar nebula. Dust and gas particles in the nebula occasionally collided and merged. Through this process, called "accretion," these tiny particles formed larger and larger bodies, eventually becoming planetesimals up to a few kilometers across. Some of the planetesimals became so massive that their gravity pulled on other planetesimals, causing more and more collisions. Because of this, the largest planetesimals grew the fastest, sweeping up material in their paths, and eventually becoming the planets we know today.

Why are the inner and outer planets so different?

The rocky, terrestrial planets – Mercury, Venus, Earth, and Mars – all formed in the inner, hotter part of our Solar System. It was so hot that volatile materials – materials that evaporate easily at normal temperatures and pressures – could not condense. Much of the gas and ice in the solar system could not exist at the high temperatures in the inner region. However, metals and silicates could withstand the high temperatures and these materials became concentrated in the inner solar system. It is from these heavier materials that the rocky inner planets are made.

In the outer, cooler portion of the Solar System more volatile materials such as water ice and gases were able to accumulate onto the giant planets. Our outer gas giant planets – Jupiter, Saturn, Uranus, and Neptune formed from these materials. These planets have small icy rocky cores surrounded by thick accumulations of gases.

Ties to Standards —

Texas TEKS

Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B) use models to represent aspects of the natural world such as a model of Earth's layers;

(C) identify advantages and limitations of models such as size, scale, properties, and materials;