Dropping Objects Lab Teacher Notes

Setting Up:

Materials per group:

- Clear plastic cup (short, wide-mouth, about 9 oz. size)
- Flour (stir up flour right before use so it is fluffy)
- Chocolate powder
- Spoon
- Electronic scale
- Ruler
- 2 frozen dough balls (1 part flour + 1 part water mixed and frozen)
    - These should be prepared at least 2 days in advance of the lab
    - Since some students might test the two balls of different mass, make sure you make 50% (or so) that are ~ 1cm in diameter, and 50% that are least ~2 cm in diameter
- Cell phone with slow-motion video recording capability
- Plastic tray to hold everything

Preparation:

- Fill plastic cup with about 3-4 cm of flour (fluff right before lab starts)
- Shake gently to flatten top surface flour
- Get a spoon full of the chocolate powder and sprinkle it over the top of the flour, forming a darker colored surface layer.

Notes on the Procedure:

- Student Video—Many student phones (even less expensive phones) will have high-speed capture options for video, but your students may not know how to use these features. Have them do some research on their phone's capability the night before the lab. If there aren't sufficient video capture devices, decide to eliminate this piece of the data collection or use the few videographers you've identified to capture the impacts. Or consider performing the video capture yourself for one drop in each group (for example) once you've cleared they are ready to proceed. Video is NOT critical to making sense of impacts, though it can be very helpful. A sample video is included with the curricular materials so that you can anticipate what students might or might not get out of re-watching the slow-motion recordings.
- Recording Data—Students may not be focused on filling out the data table on their lab sheets while they are in the middle of the procedure. Be careful to not interrupt their "play" while reminding them to at least record the data and some of their observations before cleaning up the lab.

Framing the Lab:

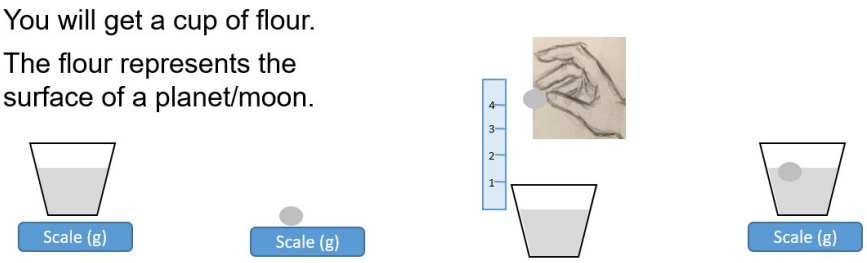
In this lab, we are seeking a good description of what happens to the surface of the planet or moon (flour and powder) during an impact, and what it looks like after the impact. We also want to investigate how the mass of the planet or moon is affected by each impact, and happens to the space rock after the impact. This last piece is arguably the most important- it allows us to transition into the idea of *accretion,* or the process of growth or increase, typically by the gradual accumulation of additional layers or matter, after this lab.

In order to investigate this, students will measure what happens in one of these two situations: a) you get two space rocks (frozen dough balls) of about the same size, but you drop each from a different height (maybe one from 3cm above the cup, and one from 10cm above the cup) and record what happens (video and written description), or b) you get two space rocks of different sizes (one small, one larger), and you drop each of them from the same height, and record what happens (video and written description). Having a slo-mo video is really useful to the students after they've finished, because the fall is quick, and unfortunately the balls can't be reused without the students having to re-measure everything. So, first time is the charm with this one.

One of the other things that we want students to be cognizant of is the realistic and unrealistic aspects of the lab. This is largely important because the behavior of meteorites and asteroids when they impact will be very different than the flour balls- rock vaporizes and explodes, and doesn't leave much behind besides the crater. Flour balls will do a great job of helping students see a) the shape of the crater and b) the mass increase of the overall system, but they don't do a great job of showing the vaporization process. That is something you will definitely want your students to recognize, so if that doesn't come in the discussion revolving around the lab conclusions, make sure you bring it up.

Images from PowerPoint Slides relevant to the lesson:

Besides providing students with the lab and data table, you'll walk them through the procedure using the slide shown here. The blurred image of the cup is a short video clip embedded in the Formation of the Earth PowerPoint.



Find and record the starting mass of your "planet" or "moon".

Separately, find and record the mass of space rock #1.

Record your dropping height in cm.

While your *impact videographer* is recording (in slow motion if available), drop the space rock.

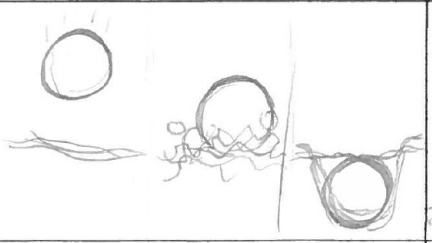
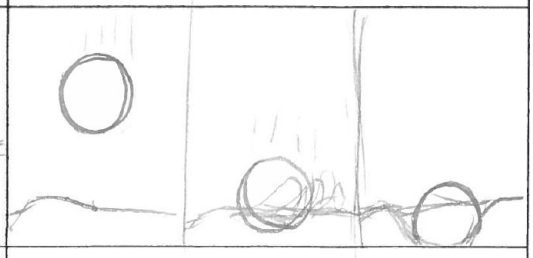
Find the mass of the system after impact.

Describe what happened in the data table.

Then test space rock #2 (repeat).

Answer the lab questions on the back.

Sample Student Data:

	Space Rock #1 Data	Space Rock #2 Data
Mass of planet/moon system **before** impact (g)	82.3	85.9
Mass of space rock (g)	3.6	1.6
Height of space rock above surface **before** drop (cm)	30	30
Mass of planet/moon system **after** impact (g)	85.9	87.9
Describe what happens to surface **during** the impact (watch slo-mo video)		
Describe the shape of the surface **after** the impact		

	Space Rock #1 Data	Space Rock #2 Data
Mass of planet/moon system **before** impact (g)	3.310	3.4
Mass of space rock (g)	0.090	0.090
Height of space rock above surface **before** drop (cm)	3	10
Mass of planet/moon system **after** impact (g)	3.4	3.495
Describe what happens to surface **during** the impact (watch slo-mo video)	Dust Ricked back up	the hole was bigger the dust had a bigger kickup
Describe the shape of the surface **after** the impact	the flower is lower where the dough hit	a larger crater then before

	Space Rock #1 Data	Space Rock #2 Data
Mass of planet/moon system **before** impact (g)	86.7g	89.5g
Mass of space rock (g)	2.7g	2.7g
Height of space rock above surface **before** drop (cm)	10cm	20cm
Mass of planet/moon system **after** impact (g)	89.5g	92.2g
Describe what happens to surface **during** the impact (watch slo-mo video)	it sank into the flour and coco powder, circle	circle a deeper whole.
Describe the shape of the surface **after** the impact	a little circular but a little jagged	same ⇔

	Space Rock #1 Data	Space Rock #2 Data
Mass of planet/moon system **before** impact (g)	86.7 g	89.5 g
Mass of space rock (g)	2.7 g	2.7 g
Height of space rock above surface **before** drop (cm)	10cm	20
Mass of planet/moon system **after** impact (g)	89.5 g	92.2 g
Describe what happens to surface **during** the impact (watch slo-mo video)	The meteor sent up debris that radiated outward, and it sank into the surface.	The meteor sent up debris that radiated ou outwards; the resulting crater was also deepe
Describe the shape of the surface **after** the impact	Dented	D t d