Shaking BBs Lab Teacher Notes

Setting Up:

Materials per group:

- 3 stacked paper coffee cups* (keep them together)
- ~ 2 tablespoons of BBs in the bottom of the three cups
- plastic lid** (a “mini”1/2 cup disposable plastic food storage container fits well onto the coffee cups)
- infrared temperature gun

* This is to insulate the BBs from the heat emanating from students’ hands. You could also get the extra insulated paper cups, or styrofoam ones, and not need 3.

** You could also use cardboard “tins”, such as those from Trader Joes, that already have lids. If you do use coffee cups with plastic, lids, make sure the students hold their hand over the lid to make sure it doesn’t fly off during the shaking.

Notes on the Procedure:

- BB’s can be purchased in large bins on Amazon – you only need ~1000 for this lab, and they often come in much larger quantities. Copper *should* cause the most temperature change (low heat capacity), so those are recommended but not required. Here is an option if you need to order some:
    - https://amzn.to/2V4dgYE

- The temperature guns are crucial to this lab because you need to do a very rapid read to catch the temperature change. One option for where to purchase them is linked underneath this, though they’re not super cheap (there are cheaper options from less reliable sites, like wish.com). Check with your school’s physics teacher, if there is one- they might have some.
    - https://amzn.to/32bmGTR

- It helps to have the students practice measuring with the temperature gun before starting the lab, since it’s very important for students to get accurately measurements quickly after shaking the bb’s.

Framing the Lab:

This lab is designed to help students, in a fairly simple way, understand that energy is heat (measured as temperature). This is an important concept for students to understand because Earth’s formation involved many collisions (lots of energy) that transferred into a lot of heat (early Earth was entirely molten rock). The story of earth doesn’t make sense unless you acknowledge this process.

There are two energy formulas that we commonly use. The first is potential energy (PE), which applies to all objects on earth but is used when you have a sense of the position of the object (i.e. its height above the ground). The equation for PE = (mass) x (acceleration of gravity) x (height).

Based on the PE formula, an increase in *mass* creates more Potential Energy, and an increase in *height* creates more potential energy. During the object's fall (i.e. a meteorite), PE goes to zero (because of height going to zero).

However, during that same fall, the kinetic energy (KE) of the object increases throughout the fall. The equation for KE = ½ (mass) x (velocity)^2. So, because of gravity, the velocity of the object will increase during the fall, increasing the KE. Note that KE initial (at the beginning of the fall) is zero, since the object wasn't moving.

Since KE and PE are related like this, we can say that all the PE before the drop was turned into KE upon impact (PE initial = KE final). So the higher the starting mass, and the higher the starting height, the more KE final, and the bigger the crater.

Again, the overall goal of this lab is to make sure students have a sense of how much energy (and by energy, we mean heat) is generated during an impact.

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.