

Cratering Brownies Activity

Materials:

Each group will need:

- 1 9 x 13 pans
- 1 apron for each group member
- 1 plastic garbage bag
- 1 and 1/3 cup unsweetened cocoa in a shaker
- 3.5c sugar
- 3c flour
- 1T vanilla
- 4-6 eggs
- 1/2 t baking powder
- 1/4 t salt
- 2 sticks butter
- 1 package chocolate chips
- Candy impactors (M&Ms, milk duds, whoppers, etc.)

Part 1: Craters

Research Leaders walk groups through making craters by reading/explaining the following instructions

- 1) All group members wash their hands! (we'll be eating the materials later!)
- 2) Spread a flattened garbage bag on the ground and all group members put on an apron
- 3) Place your 9x13 bin on top of the garbage bag
- 4) Place 3c of flour in one half of your bin and 3c of sugar in the other.
- 5) Smooth the sections out so that the surface of the bin is flat, doing your best to keep the contents of each half separate.
- 6) Devise a way to remember which half of the bin is flour and which is sugar
- 7) Measure out 1 1/3c cocoa and place in a shaker
- 8) Sprinkle cocoa from your shaker in a thin, even layer over the surface of the bin (don't use it all!)
- 9) drop identical impactors onto each side of the bin from the same height (~shoulder high)
- 10) Sketch the shape and composition of the resulting craters, noting carefully everything that you observe about them and their differences

-----Pause for group discussion-----

What is the relationship between the depth/shape/appearance of the crater and the material beneath the surface?

- 11) Use a spoon to mix the contents of the bin to make one, uniform flat surface (the original two subsurfaces + cocoa)
- 12) Sprinkle a thin layer of cocoa over the entire surface of the bin.
- 13) Experiment with candy impactors based on the question: How does the

appearance of the crater change based on the impactor? Make notes in your observing journal.

Leaders: you can prompt your groups to use different size/mass/shape impactors, drop from different heights, at different angles. They may want to try throwing the impactors at the bin at different speeds. Don't let them do this, but try to lead them to the idea that dropping from different heights accomplishes the same goal! They may also flatten and recover the bin with cocoa as needed.

-----Pause for group discussion-----

Groups volunteer variations in appearance and their explanations for what each can tell them about the impactor.

-----Pause for group discussion-----

Group brainstorms ways in which this might NOT be representative of REAL impact cratering on earth, moon, etc. (presence of atmosphere, variations in density of surface, etc., whether hits land or water, etc)

Part 2: Backsolving

- 1) mix the contents of the bin well
- 2) Pour half of the mixture into another 9x13 pan
- 3) team constructs a “topography” of the surface before leaving (mountains, valleys, canyons, craters, etc.)
- 4) All but 2 team members leave the room.
- 5) The remaining team members do the following in ANY order and write their procedure down on a list (to be kept secret, may be different between the two bins each group has)
 - A) Sprinkle half of the remaining cocoa from the shaker into each bin
 - B) Sprinkle $\frac{1}{2}$ t baking powder and $\frac{1}{4}$ t salt over the mixture
 - C) Crack 4 eggs into a bowl and beat them together. Pour them over the mixture.
 - D) Sprinkle your bag of chocolate chips over the bin and/or any other mixers that your group decided to add to the brownies (nuts, coconut, etc)
 - E) pour an additional half cup sugar onto the surface in a mound
 - F) pour in 1T vanilla
 - G) use spoonfulls of butter as (gentle) impactors

Part 3: Deconstruct the Mystery Mix

Invite the remaining group members back in the room to deconstruct the order in which the components were added in Part 4. Once they've decided on an order, they check it against the secret lists compiled by the constructors.

Part 4: Brownies!

Group members pour the contents of each bin into a mixing bowl and beat it together. They grease the pan before adding the mixture back in and placing it in the oven.