

Squaring Off With Velocity

c is the velocity of light in a vacuum. Why is c^2 part of Albert Einstein's equation and not just c ? In this activity, you will measure the energy delivered to an object (flour) by another object (a marble) to determine the relationship between energy and velocity as expressed in $E=mc^2$.

Procedure

- 1 Working over your pan, use the spoon to fill both of your cups a little above the rim with flour. *Do not pack the flour down.*
- 2 Tap the base of the cup three times to remove air pockets. Use your wood dowel or skewer to even off the flour with the top edge of the cup.
- 3 Use a felt-tip pen and plastic ruler to mark ten 1-centimeter tick marks on the wood dowel or skewer. You will use this to measure the depth of penetration by your marble.
- 4 Your class will be dropping the glass marbles into the flour from 10, 25, 50, and 100 centimeters. Your teacher will tell you which part of the class data your team will be responsible for gathering.
- 5 Use your meter stick to measure your assigned height above the rim of the cup. Drop a marble into the cup from that height (see illustration on your "Data Sheet" handout). Make sure the marble does not strike the side of the cup.
- 6 Pick up the cup and place it at eye level as you use the wood dowel or skewer to measure the depth of penetration from the top of the marble to the top of the flour. Record the depth of the hole made by the marble to a tenth of a centimeter. Add half the marble's diameter (.5 centimeter for a standard-sized marble) to your measurement in order to measure to the marble's center of the mass.
- 7 Repeat this procedure at the same height three more times. If you run out of clear space in which to drop your marble, use your spoon to retrieve your marble(s) and refill the cup with flour. Tap the cup three times after it has been refilled and use the wood dowel or skewer to level off the top.
- 8 Add your data to the class data table.
- 9 After your class determines the average depth at each height, enter the depths in the table on your "Data Sheet" handout. Follow the instructions on that handout to create your graphs.

Measuring Energy

Energy is usually measured in joules. In this experiment, you will be measuring energy by the depth of the crater the marble creates in the flour. Then you will be graphing depth (energy) against the velocity at which the marble falls over a certain distance.

