Cosmic Collison **Name** _____
Exercise: The Effects of Impact **Date** _____
by Keith Milam, Ohio University

Instructions: In this exercise, we'll use a program called the *Earth Impact Effects Program* to calculate the effects of an impact of a projectile, such as an asteroid or comet, with planet Earth. This program allows the user to change the size, density, speed, and the angle of entry of the projectile in addition to the physical characteristics of the target, or planet. You can also specify the distance from which you are observing the impact event.

The *Earth Impact Effects Program* can be accessed at: http://impact.ese.ic.ac.uk/ImpactEffects/

Part I: The Faster the Asteroid . . .

Purpose: For this part, let us see how the speed of a projectile, in this case an asteroid, affects the final size of an impact crater.

Step #1: Enter the following parameters into the *Earth Impact Effects Program*:

Distance from impact: 10 km
Projectile Diameter: 250 m
Projectile Density: 3000 kg/m^3 (select from the list – this value is representative of some asteroids)
Impact Velocity: 17 km/s (a typical impact velocity for an asteroid)
Impact Angle (in degrees): 45 (the most probably angle of impact)
Target Type: Sedimentary Rock

Push the "Calculate Effects" button near the bottom of the webpage and a results page will display.

Question #1: What is the final diameter of the resulting crater? _____km
Question #2: What is the final depth of the resulting crater? _____km

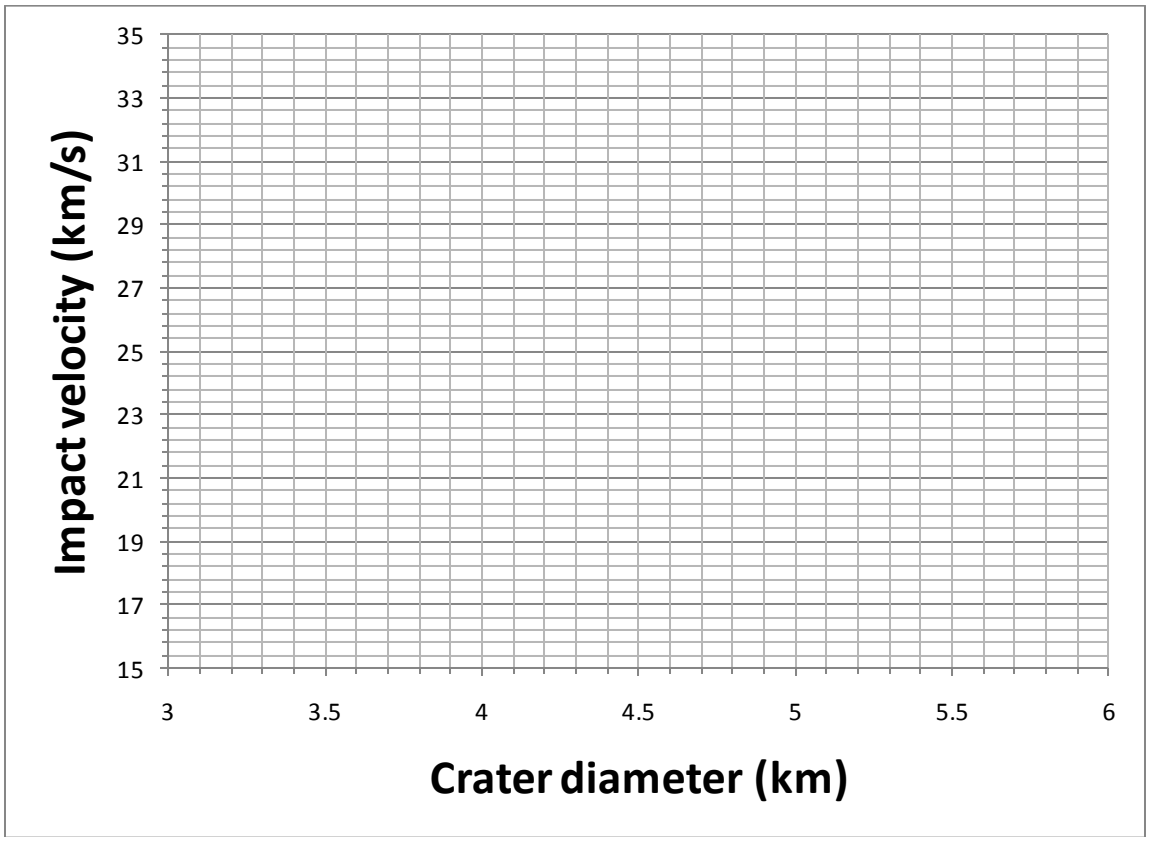
Step #2: Now go back, reset the form, and enter *exactly* the same parameters as you did in Step 1, but this time change the impact velocity to 25 km/s.

Question #3: What is the final diameter of the resulting crater? _____km
Question #4: What is the final depth of the resulting crater? _____km

Step #3: Go back again, reset the form, and enter *exactly* the same parameters as you did in Step 1, but this time change the impact velocity to 30 km/s.

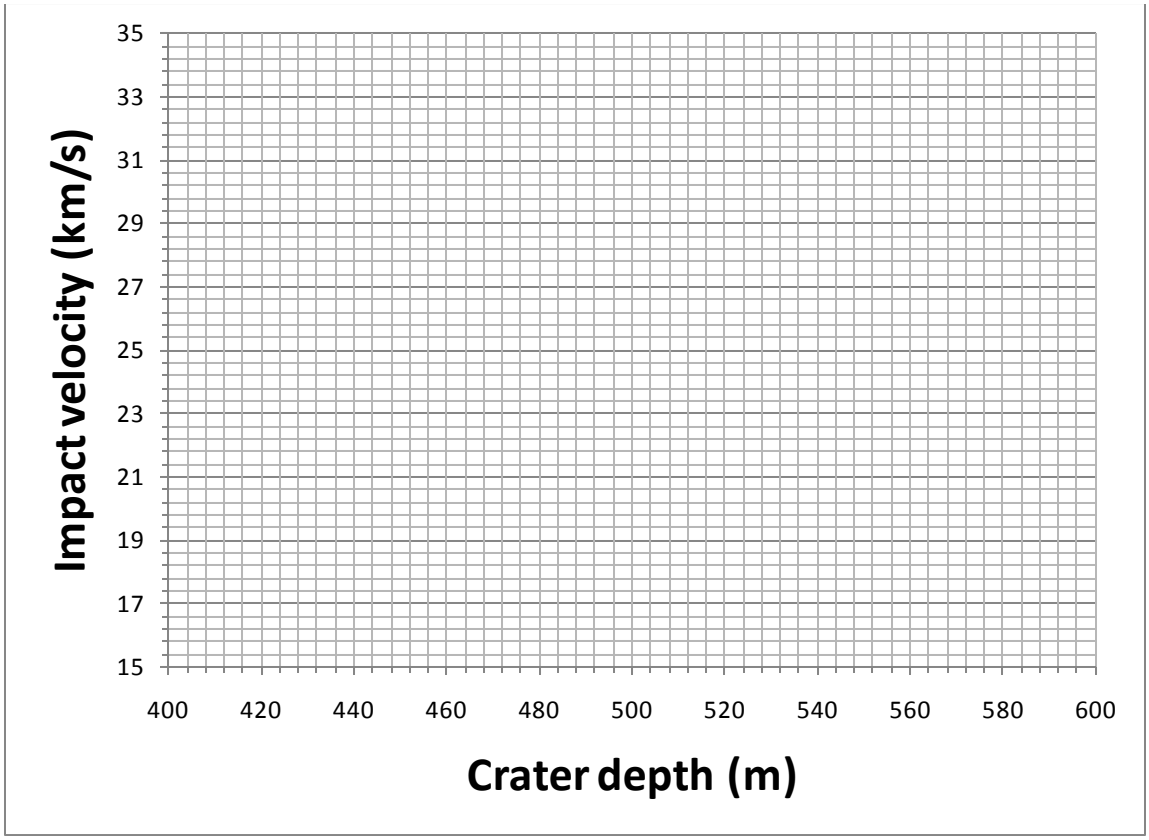
Question #5: What is the final diameter of the resulting crater? _____km
Question #6: What is the final depth of the resulting crater? _____km

Step #4: Now plot crater diameters that you recorded in the answers to questions #1,3, and 5 and the different impact velocities that you used in each of the above three steps on the bivariate or x-y diagram below. Clearly label each crater (Crater #1, Crater #2, and Crater #3) and draw a line between the data points. Look for any patterns or trends that might exist in your data.



CONCLUSION #1: The faster the asteroid, the _____ the crater diameter.

Step #5: Now plot crater depths that you recorded in the answers to questions #2,4, and 6 and the different impact velocities that you used in each of the above three steps on the bivariate or x-y diagram below. Clearly label each crater (Crater #1, Crater #2, and Crater #3) and draw a line between the data points. Look for any patterns or trends that might exist in your data.



CONCLUSION #2: The faster the asteroid, the _____ the crater depth.

So, based on conclusions #1 and #2 above, one might say that . . . .

CONCLUSION #3: The faster the asteroid, the _____ the impact crater.
Meaning that the size of the impact crater is dependent upon the _____.

Part 2: The Larger the Asteroid . . .

Purpose: For this part, let us see how the size of a projectile, in this case an asteroid, affects the final size of an impact crater.

Step #6: Enter the following parameters into the *Earth Impact Effects Program*:

Distance from impact: 10 km
Projectile Diameter: 250 m
Projectile Density: 3000 kg/m^3 (select from the list – this value is representative of some asteroids)
Impact Velocity: 17 km/s (a typical impact velocity for an asteroid)
Impact Angle (in degrees): 45 (the most probably angle of impact)
Target Type: Sedimentary Rock

Push the "Calculate Effects" button near the bottom of the webpage and a results page will display.

Question #7: What is the final diameter of the resulting crater? _____km
Question #8: What is the final depth of the resulting crater? _____km

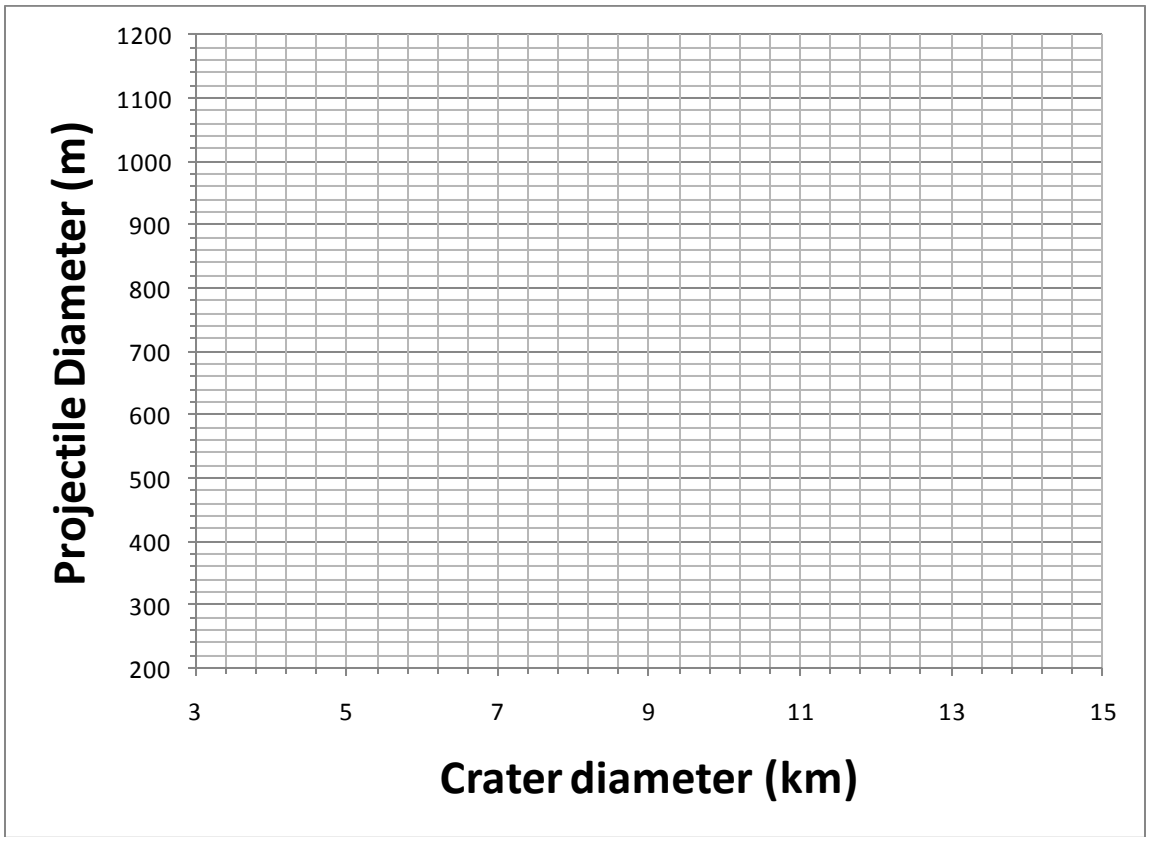
Step #7: Now go back, reset the form, and enter *exactly* the same parameters as you did in Step 1, but this time change the projectile diameter to 500 m.

Question #9: What is the final diameter of the resulting crater? _____km
Question #10: What is the final depth of the resulting crater? _____km

Step #8: Go back again, reset the form, and enter *exactly* the same parameters as you did in Step 1, but this time change the projectile diameter to 1000 m.

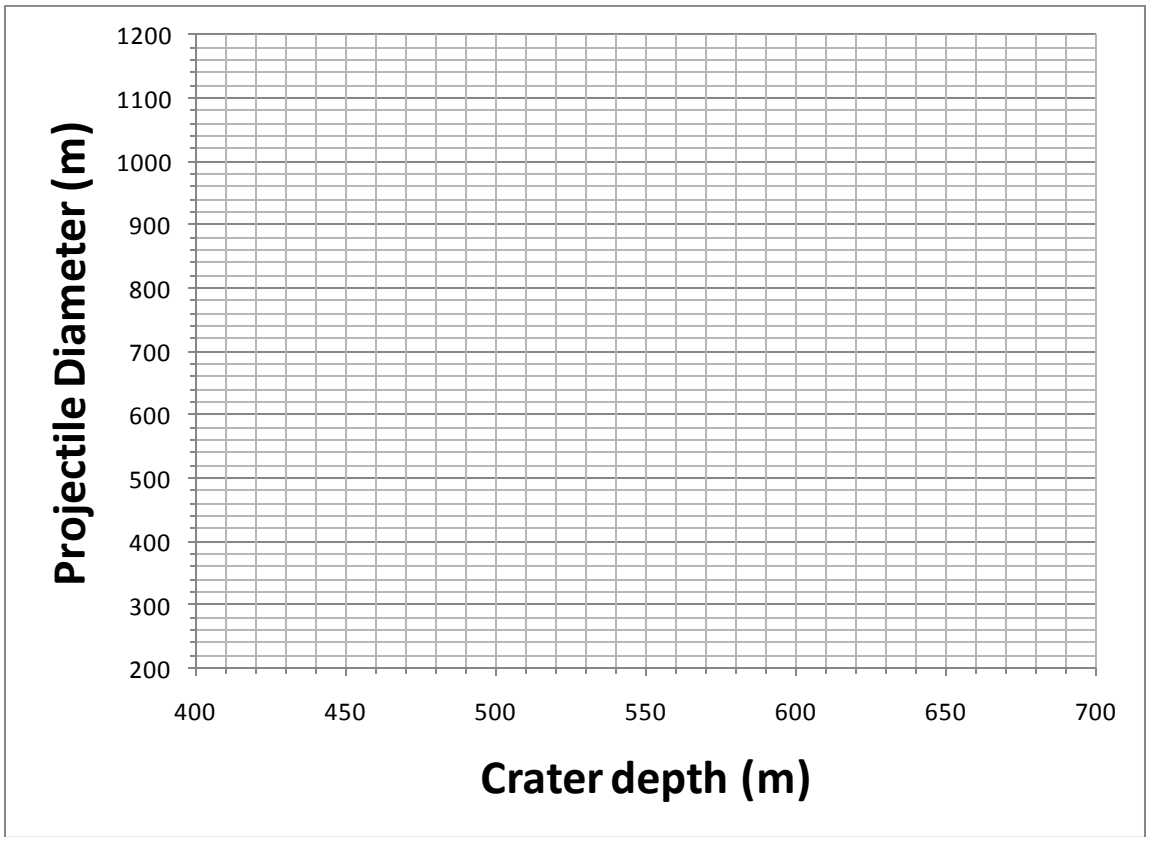
Question #11: What is the final diameter of the resulting crater? _____km
Question #12: What is the final depth of the resulting crater? _____km

Step #9: Now plot crater diameters that you recorded in the answers to questions #7, 9, and 11 and the different projectile diameters that you used in each of the above three steps on the bivariate or x-y diagram below. Clearly label each crater (Crater #1, Crater #2, and Crater #3) and draw a line between the data points. Look for any patterns or trends that might exist in your data.



CONCLUSION #4: The larger the asteroid, the _____ the crater diameter.

Step #10: Now plot crater depths that you recorded in the answers to questions #8, 10, and 12 and the different projectile diameters that you used in each of the above three steps on the bivariate or x-y diagram below. Clearly label each crater (Crater #1, Crater #2, and Crater #3) and draw a line between the data points. Look for any patterns or trends that might exist in your data.



CONCLUSION #5: The larger the asteroid, the _____ the crater depth.

CONCLUSION #6: The larger the asteroid, the _____ the impact crater.
Meaning that the size of the impact crater is dependent upon the _____.

Impact events are created by the explosions that result from the collision of a projectile, such as an asteroid or comet, with the surface of a target, typically a planet. The amount of energy released is dependent upon the mass (m) and velocity (v) of the two objects. This can be seen in the formula for kinetic energy (KE):

$$KE = \tfrac{1}{2}\, mv^2$$

Try plugging in your own numbers into the equation above, holding the velocity constant first, then changing the mass and vice versa and witness what happens to the kinetic energy. In the two parts to this exercise above, we kept all parameters constant, but changed the velocity and the size of the projectile. With a constant density in each event, increasing the projectile diameter allowed us to increase the mass with each impact. These changes affected the amount of energy released, which in turn affected the size of the impact crater produced.