Earth Impact!

Student Activity

Name ______________

Class ______________

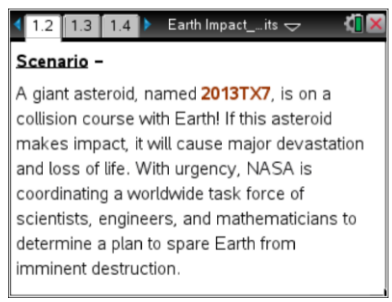
Open the TI-Nspire document *Earth_Impact.tns*

In this activity you will play the role of a scientist on an international team of scientists, engineers, computer programmers, mathematicians, and other experts. The problem is that a giant asteroid is on a collision course with Earth. You and your team must evaluate the asteroid and use your knowledge of math and science to figure out a way to deflect it from colliding with Earth. Although this specific scenario is not real, it is important to note that there have been major asteroid impacts on Earth over the life of our planet, and there are teams of experts that constantly monitor Near Earth Objects (NEOs).

You will determine mass from density and volume, time of impact from average velocity and distance, and gravitational force using Newton's law of universal gravitation. Understanding these concepts will help the team determine a plan to avoid disaster!

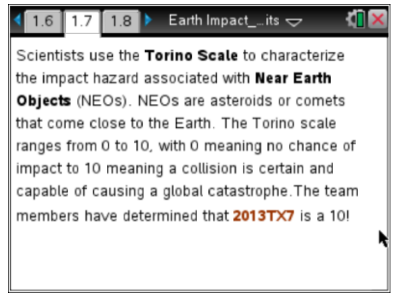
Move to pages 1.2–1.6

1. Read the scenario of the collision course of asteroid 2013TX7 with Earth. Pages 1.3 to 1.6 show the potential aftermath of a collision.



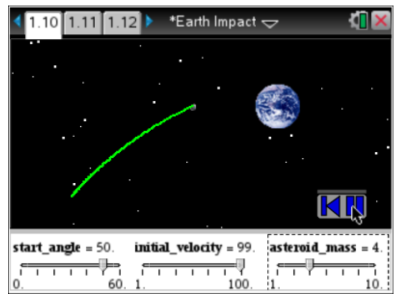
Move to pages 1.7–1.10

2. Page 1.7 describes the **Torino Scale**, a tool used by astronomers to characterize the impact hazard associated with Near Earth Objects (NEOs).



Tech Tip: Select the button to reset the simulation and run it again with different parameters. The reset button will remove all data from the graphs. Note: This will not reset any Zoom applied.

3. On page 1.10, you will explore a simulation that one of the team members has created to help understand the impact scenarios. Try changing the different variables to gain insights about what can be done to save Earth. As you explore different combinations, note the change to the trajectory. Can you discover a way to prevent the asteroid from colliding with Earth?



Tech Tip: To adjust the Zoom setting on page 1.10, the top part of the page must first be active (bold outline around it). Use the **+/-** keys on the keyboard to Zoom In/Out. To reset the Zoom or Pan, select **Menu or Tools > Parameters > Reset Zoom/Pan**.

Tech Tip: To adjust the Zoom setting, select **> Parameters > Zoom In/Out**. You can also reset the Zoom and Pan here.

Move to pages 1.11–1.18. Answer the following questions here or in the .tns file.

Q1. Adjust the variables to have the asteroid collide with Earth and then run the simulation again. Now explore the graphs on the next pages. What do you notice about the velocity of 2013TX7 compared to its distance from Earth?

A. Velocity is always constant.
B. Velocity decreases as distance decreases.
C. Velocity increases as distance decreases.

Q2. Look at the data on the velocity vs. time graph on the next page (if there is no data, run the simulation again, but do not reset it). What point on the graph represents the point at which the asteroid is farthest from Earth? Which point represents the point at which the asteroid is closest to Earth?

Farthest =

Closest =

Q3. From the graph on page 1.13 (from Q2), how can we tell the asteroid is getting faster as it approaches Earth?

Q4. On the following two graphs, “force_g” represents the gravitational force between 2013TX7 and Earth. What can you say about the gravitational force as the asteroid gets closer to Earth?

Q5. Based on the data in the force_g graphs, how are distance and gravitational force related?

A. Directly. As distance decreases, so does gravitational force.

B. Inversely. As distance decreases, gravitational force increases.

Move to pages 2.1 – 2.4. Answer the following questions here or in the .tns file.

4. After exploring the simulation of the asteroid–Earth collision, the team needs to study the physical characteristics of the actual asteroid. Page 2.1 describes the density and volume, and the team asks that you determine the mass of 2013TX7.

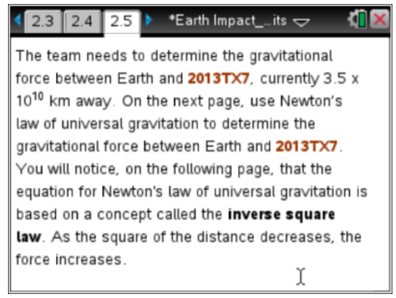
Q6. If 2013TX7 has a density of 8 g/cm^3 (8,000 kg/m^3) and a volume of 6 km^3 or 6×10^9 m^3, calculate the mass of the asteroid.

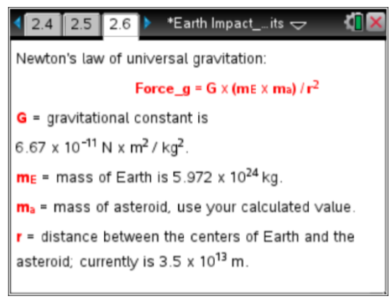
Q7. The asteroid is traveling at an average speed of 25 km/sec. Based on a distance of 3.5 billion km from Earth, when will the asteroid hit Earth? Express your answer in days.

Q8. Based on your answer to the previous question, it may seem odd to worry about something that is years away. In your opinion, why is the team so worried about this situation?

Move to pages 2.5–2.12. Answer the following questions here or in the .tns file.

5. Pages 2.5 and 2.6 introduce Newton's law of universal gravitation as a tool to use to determine the gravitational force between Earth and the asteroid.





Q9. Use the calculator and enter the force you calculated below.

Q10. Now, determine the force when you cut the distance in half. Enter your answer below.

Q11. Divide the last force you calculated, when distance was cut in half, by the first force you calculated. Round to the nearest whole number. Why is this number significant?

Q12. The forces you calculated in the previous problems were very small due to the great distances. See what happens when you use $r = 3.5 \times 10^6$ m in the calculator below. (Hint: You can copy and paste calculations from previous problems.)

Q13. NASA's Jet Propulsion Laboratory (JPL) constantly monitors asteroids and other NEOs and their trajectories. They are working on a project that will enable us to learn how to deflect these objects if they threaten to strike Earth. What are some possible methods you think JPL should consider when thinking about deflecting a real asteroid from hitting Earth?

Q14. When the distance between Earth and the asteroid is cut in half, its gravitational force increases by four times (based on the inverse-square law). Based on this, what would you say about the importance of *when* to divert the asteroid?

Move to pages 2.13–2.14.

6. Thanks to the work done by your team, the asteroid was diverted. Page 2.13 gives a visual model of the new trajectory of the asteroid, narrowly missing Earth! Congratulations!