SAVE THE EARTH FROM ASTEROIDS!

EDUCATIONAL GAME

UK SPACE AGENCY

The Geological Society

Learn about planetary defence against asteroids with this game for KS1-2 students.

LEARNING OBJECTIVES

Pupils will learn that:

- Planetary defence refers to a set of measures taken to monitor and protect Earth from external threats, including asteroids, comets and other objects in space;
- Millions of small particles enter the atmosphere and burn up every day. More rarely, they land on Earth, and in extreme cases they cause damage to property or even life. However, no known asteroid able to cause such damage is in an orbit that could hit the Earth;
- Space agencies (including ESA) have missions to monitor and reduce this risk, like the DART and Hera missions;
- [KS2 only] A risk assessment is a systematic process to evaluate risks. Risk is often calculated as the likelihood of a hazard occurring, multiplied by the impact or severity of the hazard.

MORE TEACHING RESOURCES

are available at: **www.geolsoc.org.uk/resources**

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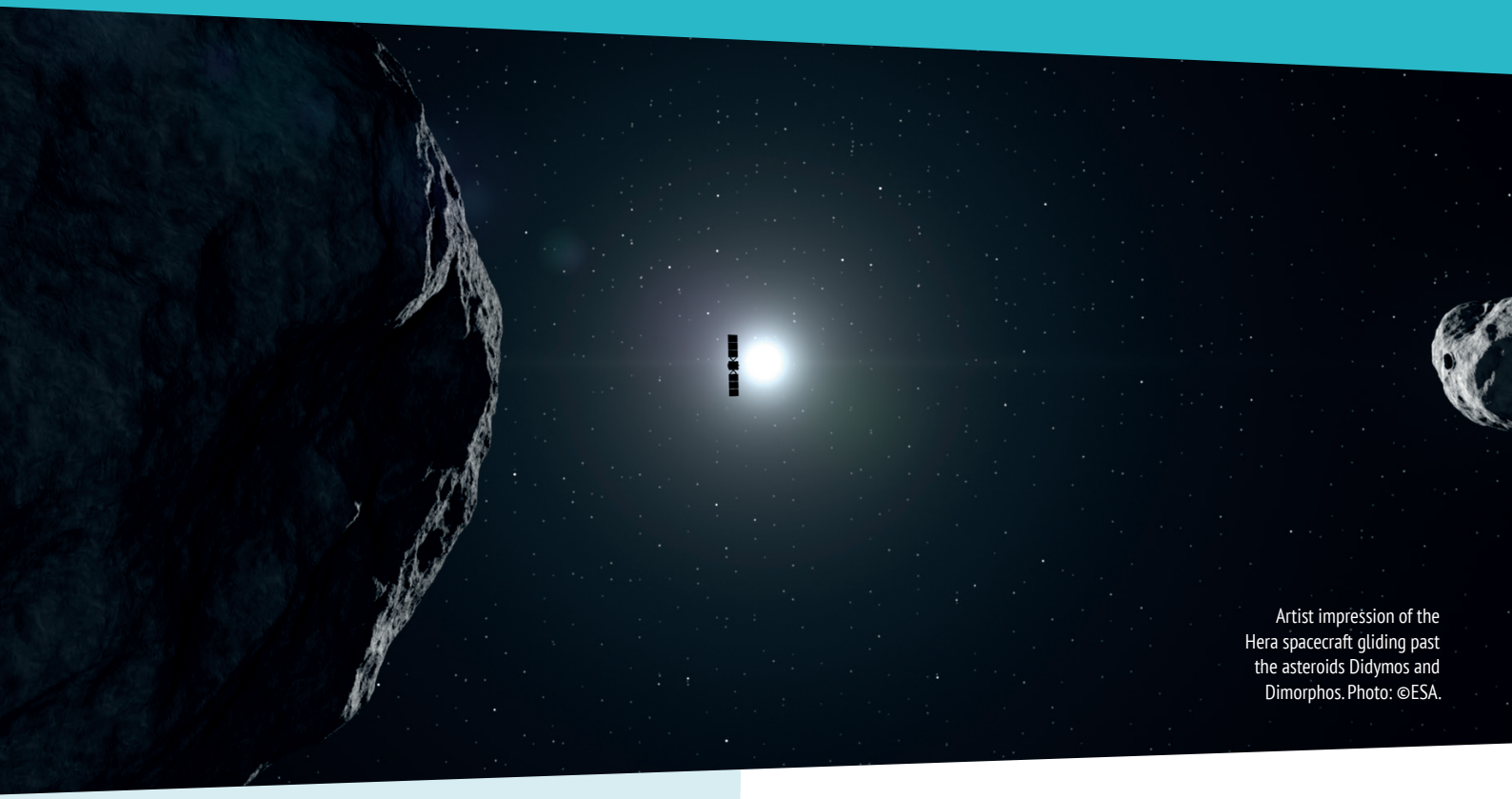
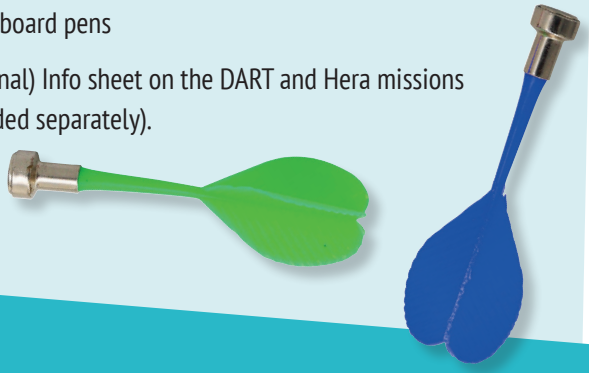


Artist impression of the Hera spacecraft gliding past the asteroids Didymos and Dimorphos. Photo: ©ESA.

YOU WILL NEED:

- Magnetic white board (please note that the board is likely to become dented by the darts)
- Printed asteroids in different sizes (provided separately)
- Magnets to attach asteroids to the white board
- Magnetic darts, ideally in different colours for different teams
- Coloured tape
- White board pens
- (Optional) Info sheet on the DART and Hera missions (provided separately).



SET UP (~30 MINS)

- Using tape, create 5 or 6 parallel bands of risk (see example setup on Page 1);
- Label the middle band as "3", then moving outwards, label the other risk bands in descending fashion ("2", "1", "0");
- Print out asteroids in 3-4 different sizes;
- Label the largest asteroids with "4", second largest as "3", etc.
- Arrange the asteroids in each risk band using magnets, aiming for a mix of sizes in each band;

  Note: The size of the asteroid corresponds to the severity of the asteroid collision with the Earth, and the risk band corresponds to the likelihood of impact;
- (Optional) Print out or write information on the DART and Hera missions on the board.

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ACTIVITY RUN-THROUGH (20-30 MINS)

The activity is most suitable for teams, who could work together or compete against each other. The activity can be run for individuals rather than teams by removing the scoring element. It is primarily designed for KS2 but can be adapted for KS1 pupils (see below).

1. Explain that rocks from space enter the Earth's atmosphere all the time – millions of pebble- and sand-sized rocks enter the atmosphere every day, burning up to create shooting stars. More rarely, they land on Earth as meteorites. In incredibly rare instances, meteorite impacts can cause damage to property, or even life (like the meteorite that hit during the era of dinosaurs). Although these events are rare, their consequences can be huge, so planetary defence aims to prevent them from happening. Planetary defence refers to a set of measures taken to monitor and protect Earth from external threats, including asteroids, comets and other objects in space. One way to prevent being hit is to try to change the trajectory of the incoming asteroid, which is something that space agencies have been learning how to do with the DART and Hera missions. This is also what the students will aim to do in this activity.
2. On the board, point out the "danger zone" delineated by red tape, which contains the asteroids most likely to hit the Earth.
3. Explain that each team has limited resources (however many darts of one colour you have) to deflect incoming asteroids, so they need to use them wisely. They should aim to hit only the asteroid(s) which pose the highest threat.
4. Discuss which asteroids pose the highest threat.

Answer: the largest asteroids within the danger zone pose the highest risk. This is the same principle as risk being calculated as likelihood x severity in risk assessments. Here, the likelihood is given by the risk band delineated by tape, and severity is based on the size of the asteroid.

5. Give each team darts of different colours and ask them to try to hit the chosen asteroids.

Note: avoid giving darts before this point – once they have the darts, pupils will be less likely to take in the instructions.

6. When an asteroid is hit, move it to a lower risk band (e.g. from 4 to 3).

Scoring:

- **KS1:** They get the number of points written on the asteroid that was hit.
- **KS2:** They get the points written on the asteroid, multiplied by the risk level on the band that the asteroid is on. When an asteroid is moved down a risk band, its future score will be lower because they pose less of a risk to Earth, so other teams will need to take this into account.

Note: depending on your darts and white board, sticking the darts to the board might prove quite difficult. You may wish to offer points for merely touching an asteroid (without sticking the dart) or giving extra points for sticking the dart.

7. Repeat until each team runs out of darts.
8. Ask the pupils to sum up the scores within each team to see who won. If everyone worked together, they could sum up all the scores to see how well they did. If the "danger zone" is clear, they have defended the planet against incoming asteroids!
9. [KS2 only] Explain that the process they just did to figure out which asteroid to hit is called a risk assessment – risk is often quantified as likelihood times impact. Quantifying risk is important everywhere in life!

- Further discussion (optional): can you think of a day-to-day example when it is important to quantify risk?

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PLANETARY SCIENCE BACKGROUND

Asteroids are small rocky bodies, ranging in diameter from 2 metres (about the same as a tall wardrobe) to hundreds of kilometres (the distance between London and Edinburgh!). There are many different types of asteroids, but the most common ones are made of loose rocky material. More rarely, asteroids are made of iron-nickel metal, similar to the Earth's core. We know what asteroids are made of from telescope observations and asteroid missions. We also know that most meteorites (rocks from space that landed on Earth) came from asteroids, and sometimes it is possible to match meteorites with the asteroid that they came from.

Most asteroids are found in the asteroid belt between Mars and Jupiter. However, some asteroids (known as 'Near-Earth Asteroids') have orbits that get close to the Earth, which could risk hitting us.

There is no known imminent risk, but space agencies are developing methods to protect the Earth against incoming asteroids if they start posing a risk.

One method is to change the orbit of an asteroid by hitting it. The method was tested using DART, a NASA mission that targeted the asteroid Dimorphos in 2022, and succeeded in changing its orbit. Fortunately, Dimorphos never risked hitting the Earth, but it is reassuring to know that the method works. To further study the results of DART, ESA will launch a mission called Hera in 2024, which is set to reach the same asteroid in 2026. For more information, check out 'The Incredible Adventures of the Hera Mission', a series of ESA educational videos.

Asteroid Dimorphos, as photographed by the DART mission. Photo: ©NASA.

HELPFUL LINKS:

https://science.nasa.gov/mission/dart/
https://www.esa.int/ESA_Multimedia/Sets/The_Incredible_Adventures_of_the_Hera_mission/