# In a galaxy far, far away

Students use graphing applications to explore transformations of hyperbolas.

Students will need at least one digital device per pair to interact with Desmos or Polypad during this lesson.

## Visible learning

This learning episode incorporates Path content and assumes students are confident with related Core content.

### Learning intention

* To know how , and affect the graph of .

### Success criteria

* I can identify connections between the equation of a hyperbola and its graph.
* I can transform hyperbolae to meet given conditions.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* interprets and compares non-linear relationships and their transformations, both algebraically and graphically **MA5-NLI-P-01**

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## Activity structure

### Launch

1. Students will begin by watching a short clip from the movie ‘The Martian’.
2. Prior to showing the clip, briefly explain the following to set the scene in context:

* A scientist is inadvertently left behind on a mission to Mars.
* His food supply is running out.
* The spacecraft capable of making the trip is currently heading back to Earth.
* In the time it would take for the spacecraft to return to Earth, refuel and then fly back to Mars, the scientist will not survive.
* The people in the clip are working on a solution to retrieve this scientist.

1. Display for all students the following clip ‘The Martian | "Checks Out" Clip [HD] | 20th Century FOX (1:33)’ ([bit.ly/martianvideo](https://bit.ly/martianvideo)).
2. Once the clip is finished, initiate a whole class discussion and ask students the following questions:

* What does the word ‘acceleration’ mean?
* How would accelerating away from Mars, towards Earth, help in getting back to Mars more quickly?
* Does anyone have any idea what maths might have been used by Donald Glover’s character to make sure that the plan ‘checks out’?

The discussion and questions are aimed more at sparking interest in the concept of gravitational sling-shotting and not necessarily intended for students to be able to answer comprehensively at this point.

For more information on the concept of gravitational sling-shotting, please visit ‘Basics of Spaceflight – Solar System Exploration: NASA Science’ ([solarsystem.nasa.gov/basics/primer/](https://solarsystem.nasa.gov/basics/primer/)).

This concept applies the mathematics of hyperbolic functions as part of the process.

1. Inform students that the technique being discussed in the clip is known as ‘gravitational sling-shotting’, and although the maths involved is very complex, the foundations stem from a function known as a hyperbola.

### Explore

1. Assign the Desmos classroom activity ‘Hyperbola asteroids’ to the class [bit.ly/desmoshyperbolic](https://bit.ly/desmoshyperbolic) ([bit.ly/desmosclassroomstrategy](https://bit.ly/desmosclassroomstrategy)) and use the pacing feature to restrict students to screens 1–7.
2. With one digital device between pairs, direct students to the Desmos activity ‘Hyperbola asteroids’ ([bit.ly/desmoshyperbolic](https://bit.ly/desmoshyperbolic)).
3. Using the teacher dashboard, student responses can be highlighted to facilitate class discussion.
4. Use the pacing feature to restrict students to screens 8–10. Encourage students to thoroughly explore these screens.
5. The teacher dashboard can once again be used to highlight students’ responses and facilitate class discussion.

### Summarise

1. Students write notes to their future forgetful selves ([bit.ly/notesstrategy](https://bit.ly/notesstrategy)) describing how the values k, b and c transform the graph of .
2. Write the following equations on the board:

* .

1. For each equation, students work in their pairs to draw an approximate sketch of the graph on mini whiteboards ([bit.ly/miniwhiteboards](https://bit.ly/miniwhiteboards)).
2. The teacher may ask students to raise their mini whiteboards to informally assess class understanding.

### Apply

1. Pairs return to screen 11 of the same Desmos activity from the Explore section.
2. Students create their own challenge. Once completed, it will be shared with other students in the class.
3. Students can then complete their peers’ challenges.
4. Using the teacher dashboard, student challenges can be highlighted to show the various equations created by the class.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* For further exploration of the concept of hyperbolic asteroids, students can interact with spacereference.org’s hyperbolic asteroid’s tracker ([bit.ly/hyperbolicasteroids](https://bit.ly/hyperbolicasteroids)).
* Students could draw or act out the situation described in the clip.

**Summarise**

* Students could be challenged to draw and write the equations of asymptotes. Alternatively, students could draw approximate sketches, focusing on the transformations.
* If students are not ready or able to sketch graphs, they could use their arms to make the hyperbola shape. Then ‘apply’ transformations by moving up and down, left and right or dilating its shape.
* Correct vocabulary such as ‘dilation’, ‘horizontal translation’ and ‘vertical translation’ should be used; however, students might benefit from initially describing transformations informally.

**Apply**

* Students choose 1, 2 or 3 gates for their slalom, differentiating the difficulty they interact with. They can then choose which of their peers’ challenges they attempt based on the number of gates.

### Suggested opportunities for assessment

**Explore**

* Using the teacher dashboard, student responses can be assessed following the lesson. Student responses could be snapshotted and highlighted in a following lesson for students to discuss and explain their reasoning.
* Students will demonstrate their Working mathematically skills in discussions and justifications**.**

**Summarise**

* Review students’ notes to future forgetful selves.
* The teacher could either quickly scan student graphs when mini whiteboards are held up or the teacher could take a photo to assess later.

## References

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