



Roche Limit – VEGA Teaching Scenario

Topic: Roche Limit

Subject(s): Physics

Age / Grade: 8th - 9th grade

Short description of the game (incl. time, pictures, links to tutorials): Universe Sandbox is an interactive sandbox gravity simulator video game and educational software. Using Universe Sandbox, users can see the effects of gravity on objects in the universe run scale simulations of the Solar System, various galaxies or other simulations, while at the same time interacting and maintaining control over gravity, time, and other objects in the universe.

Introduction to the scenario

In this scenario students learn the concept of the Roche limit and how it pertains to celestial bodies. Another significant concept is that of tidal forces, which are intrinsically linked to the moons of a given planet (in the case of Earth, the singular Moon). Working with Universe Sandbox, students have the opportunity to test the effects of celestial objects passing through the Roche limit and its inevitable causes. With VR goggles, this experience is further enhanced and made all the more exciting and tangible for the students.

Learning outcomes:

The students are able to:

- to learn and understand the concept of the Roche limit
- to run simulations of the Moon and understand how it plays a role in tidal forces
- to see how complex and sensitive planetary bodies and their surfaces are
- test how the Roche limit truly works
- discuss and review the lesson's content with fellow students

A selection of learning outcomes from the Finnish Curriculum

- T5 encourages the student to form questions about the phenomena under consideration and to further develop questions as starting points for research and other activities
- T8 guides the student to understand the operating principles and meaning of technological applications and inspires them to participate in the ideation, planning, development and application of simple technological solutions in cooperation with others
- T9 guides the student to use information and communication technology for information and to acquire, process and present measurement results and support the student's learning through illustrative simulations

- T10 guide the student to use physics concepts accurately and to structure their own conceptual structures towards concepts in accordance with natural scientific theories
- T11 guide the student to use different models in describing and explaining phenomena and making predictions

Formative assessment

Number of students: Duration (estimated time/number of lessons):

- One session. 2x 45 mins recommended. 60minutes minimum.
- 2-3 students can work on the same computer / VR-goggles. Number of students is based on how many pairs are available and / or if the group is split into different activities. It is possible to do this with computers only and have VR as an extra experience that students only visit briefly.

Prerequisites (necessary materials and online resources):

- Please see the [powerpoint](#) provided with the lesson.
- Before the program begins (preparatory work for teacher):
- Please make sure the VR goggles and computers work and can run the software.

The main part of the scenario (number of lessons): 1 60-90 mins

Preparations:

- Please see the [powerpoint](#) for a walkthrough.
- Offline - Please go through the 'theory phase' on the [powerpoint](#) slides.
- The slides introduce the basics of the Roche limit and how to calculate it.

Devices - When your students can actually perform the relatively simple formula, please move to the Play phase on the [powerpoint](#) and start using the devices.

Please ask your students to follow the questions provided. Their task is to answer those questions while playing. It is good practice to have at least one student without a device, so they can take notes. Students should rotate and take turns with the computer / VR.

When your students are ready with the questions / time runs out, please put down the devices and move to the next phase. ...

Debriefing: Share & Discuss

Please follow the share and discuss section on the [powerpoint](#) to debrief the session.

You may ask your students at the end to provide ideas of what you could study with the software and use those ideas in the future.

Summative assessment:

Grades 5-10	5	6	7	8	9	10
Activity and engagement	The student has had challenges to get the task finished. The student hasn't shown signs of engagement neither at school nor at home.	The student has only occasionally shown interest in the work and has had difficulty finding motivation.	The student has mostly shown interest in the work both at home and at school.	The student has shown interest and commitment to the work both at home and at school.	The student has shown great interest and commitment both in lessons and at home.	The student has shown great interest, responsibility and commitment both in lessons and at home.
The overall picture of the work when completed.	The student misses several parts of his work and several points are not checked in the list.	The student lacks several parts of the checklist in his work.	The student lacks certain parts of the checklist, but it is largely complete.	The student has done all the parts on the checklist.	The student has done all the parts on the checklist and you can see that the student has made an effort to include all the parts.	The student has done every single part on the checklist and it can be seen that the student has processed the content.
Images and captions	The student lacks pictures.	The student has few pictures and no captions.	The student has pictures but no captions.	The student has pictures with accompanying text.	The student has several pictures and descriptive captions.	The student has versatile pictures and descriptive and explanatory text.

<p>Showing responsibility for the completion of the work. Cooperation and peer response</p>	<p>The student had difficulty cooperating with his group and did not listen to his classmates. The student did not give a peer response and did not take into account what the group gave in response.</p>	<p>The student had some difficulties in cooperating with his group and listening to his classmates. The student gave peer feedback without following the instructions. The student did not take into account the response given by the group.</p>	<p>The student mostly cooperated well with his group. The student received and gave feedback from his group almost always according to the instructions. The response was mostly constructive.</p>	<p>The student showed responsibility and mostly a good ability for cooperation. The student received and gave feedback from his group. The response was constructive.</p>	<p>The student showed evidence of good responsibility and a good ability for cooperation. The student gave a versatile response and took the response he / she received from his / her group into account.</p>	<p>The student showed evidence of excellent responsibility and an excellent ability for cooperation. The student made an effort to formulate himself in a constructive and valuable way for the task in order to help his group further in his work. The student received a response from his group and took it into account in his own work.</p>
<p>Skills</p>	<p>The student shows obvious shortcomings in the understanding of the subject.</p>	<p>The student shows some shortcomings in the understanding of the subject.</p>	<p>The student shows evidence of a certain understanding and some learned knowledge of the subject. .</p>	<p>The student shows evidence of a good understanding and has assimilated the most important content in the subject.</p>	<p>The student shows an excellent understanding and has assimilated the most important content in the subject but lacks some knowledge.</p>	<p>The student shows evidence of an excellent understanding and fully masters the content.</p>

Language learning/English	The student has big difficulties in learning the English words.	The student struggles with and has some challenges with the English words.	The student knows the most important concepts and words in English.	The student shows evidence of understanding most parts In English.	The student has a good understanding and has learned most of the concepts and knows all the words in English.	The student masters all concepts and words in English.
The VR part and the app use	The student presents obvious difficulties in understanding how Universe Sandbox app works. Shows a lack of interest and is careless in the use of equipment needed.	The student presents some difficulties in understanding how Universe Sandbox app works. Trying to do according to the instructions, but can not keep the interest up all the time. The student is sometimes careless in the use of equipment needed.	The student understands the main features of how Universe Sandbox app works. Mostly follows the instructions, but sometimes lacks perseverance. Is usually careful with the equipment.	The student shows a good understanding of how Universe Sandbox app works. The student always follows the teacher's instructions and is careful with equipment.	The student shows an excellent understanding of how Universe Sandbox app works. Always follows the teacher's instructions and is very careful with the equipment.	The student masters the use of the Universe Sandbox app. Always follow the teacher's instructions and help their classmates. Always be careful with technology.