EHC Mission VI

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Introduction

Juri Gagarin was the first human in space 1961. Now it's your turn to guide the Kerbals on their first manned orbital flight. Assemble your own spacecraft and follow in the footsteps of Vostok's flight around the planet to learn about changing orbits and re-entry.

In this mission, you have more freedom over the make of your spacecraft and the course of your flight, preparing you for more independent missions in the future. In the process, you can compare your experiences and progress with Gagarin's flight in 1961 - what differences and what similarities are there?

Age of Student(s)

10 - 18 years

Objectives

Game concepts:

- Loading and merging spacecraft
- Navball markers
- Manoeuvering in the orbit

Physics concepts:

- Orbiting

Working skills:

- Working independently

Historic concepts:

- R-7 rocket
- Vostok spacecraft
- Yuri Gagarin

Timeline

The mission consists of two parts: designing and assembling the rocket and the flight. Assembly takes **5-10 minutes**. The flight takes **10 minutes** but may take several attempts to complete. After the flight, the students should reflect by compare their experiences with Gagarin's flight. Allocate at least **10 minutes** for reflection.

The lesson is self-paced and the students follow the on-screen instructions to progress through the activities.

Learning Activities

Design and assemble a spacecraft

The first activity tasks the students to build a spacecraft that will take a Kerbonaut to space. So far the flights have been mostly unmanned but now the students' task is to take a manned capsule to the orbit. The idea of the lesson is to build on the foundation of the previous missions and gradually give the students more responsibility over the design of the rockets and the flight itself.

The students' first task is to build the spacecraft that the R-7 carrier rocket will take to the orbit. The students can build a rocket of their own design according to the following requirements:

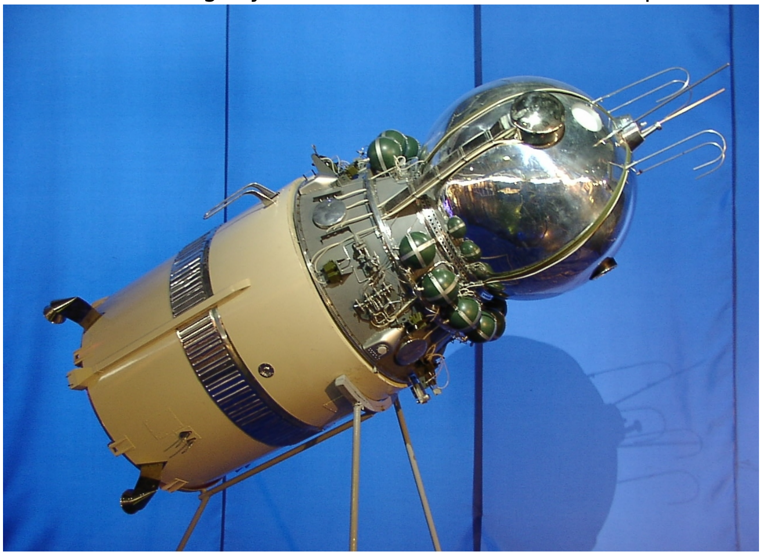
The spacecraft needs:

- a command pod for the crew
- a small fuel tank and an engine
- parachutes for landing
- a separator at the bottom of the vessel

After assembling the spacecraft, the students are asked to **Load** the R-7 and **merge** it with their creation. If the students placed the separator correctly, the R-7 should snap right under neath it.

The requirements state that the engine and fuel tank need to be small - if the students attach too heavy engines or fuel tanks, the carrier won't be able to bring them to orbit. If you want to you can ask the students to determine the maximum weight of the spacecraft. To do this, they need to develop a test, measure the results and present data to support their conclusions.

The mission also features parts to assemble **Vostok 3KA**, Gagarin's spacecraft. If you want to play up the history aspect and add an extra challenge, you can task the students to replicate the spacecraft.



Orbital flight

After finishing the spacecraft, the students will arrive in the launch pad to begin their flight. If they haven't yet, they should pay attention to **staging** to make sure different actions take place in the right order.

Tip: when you hover the mouse over staging, the corresponding part in the rocket is highlighted.

After the take off, students are guided through the orbital flight. This time the mission doesn't hold their hand - rather the instructions are given as goals that structure flight. The goals are:

- After launch, tilt rocket 5-10° east
- Press M to open map view to monitor apoapsis
- When apoapsis > 70 km, press X to kill engines
- When close to apoapsis, turn prograde & thrust full speed

If students are having problems with the mission, they can play through **Earth History Campaign V** that guides them through the process. Before they launch, they are asked if they want to return to the training mission to practice orbiting.

If the students encounter problems during the flight, ask them to do some troubleshooting: What went wrong and what could have caused this? Common problems with the flight include: too heavy spacecraft, wrong staging order and asymmetrical spacecraft.

Meanwhile, the students will follow in the steps of Yuri Gagarin, the first human in space. There is an attached worksheet listing the events of Gagarin's flight. If you want to emphasize the history aspect of the lesson, have the students follow the worksheet and fill in the notes of their flight alongside Gagarin's.

Orbital manoeuvres

Once they have stabilized the orbit, the students are tasked with testing how different manoeuvres affect the orbit. They can use the attached testing sheet to help. In the sheet, the students need to fill in what effect thrusting in **six** different directions has on the shape, inclination or the size of the orbit.

The directions are:

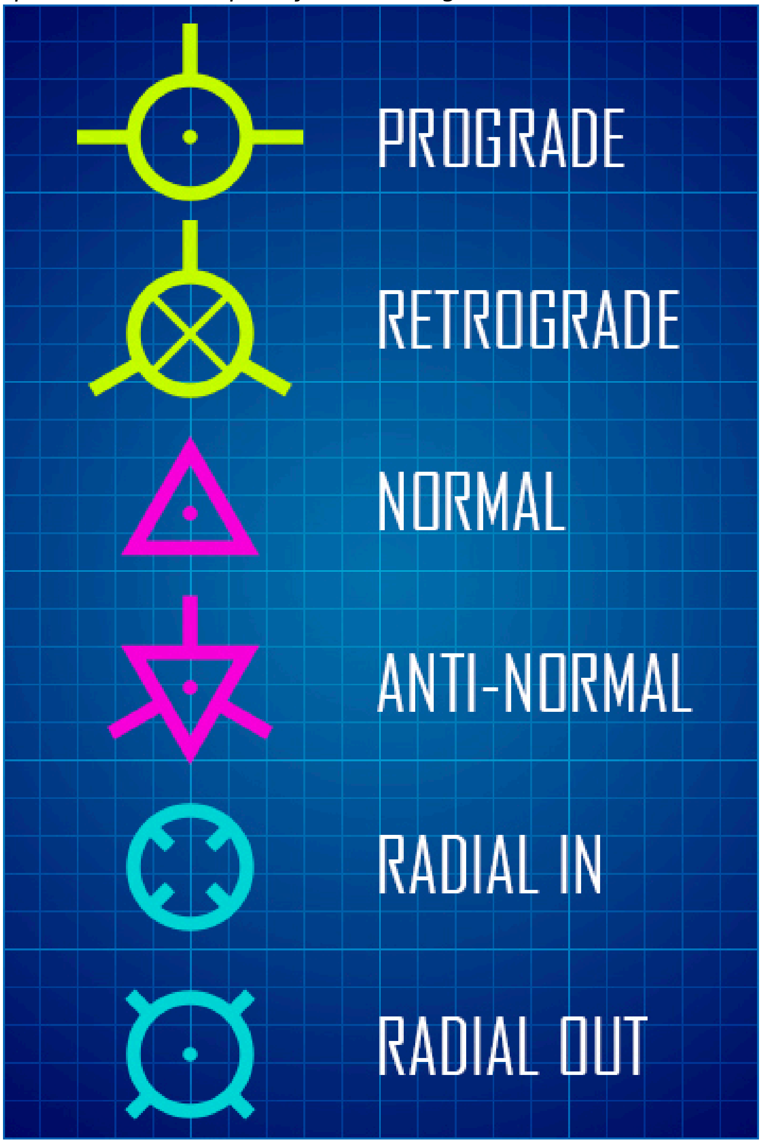
- Prograde and retrograde
- Normal and anti-normal
- Radial in and radial out

The easiest way to test this is in map view (press "M" to open). Students can bring up the navball and control the spacecraft by pressing the arrow key at the bottom middle of the screen.

In a nutshell, thrusting prograde will expand the opposite end of the orbit while retrograde will lower it. Normal and anti-normal will tilt the orbit up and down. Radial in and radial out turn the orbit around the spacecraft (like a hula hoop!)

After testing the directions players will begin their descent.

Tip: There's a known bug with regular Kerbal Space Program that sets the throttle to maximum every time *the player enters the map view. You can quickly kill the engines with "X" if the navball is visible.*



Re-entry

Students begin their descent by burning retrograde. Once the students re-enter the atmosphere, the spacecraft will start heating up. The drag will slow down the descent and once it's below **200m/s** students are told to deploy their parachutes.

After the slow descent and landing, the mission is complete!

At the end of the mission, you can ask the students to use the report sheet to reflect back on the flight and compare it with Gagarin's.

Assessment

The students will produce two documents: their flight report and the orbital manoeuvres. You can use these to assess their understanding of the topics. As usual, you can assess the students' work during the lesson. In this particular mission, the focus is on the students taking responsibility over their work and solving problems individually.

Alignment with Curricula and Standards

MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.