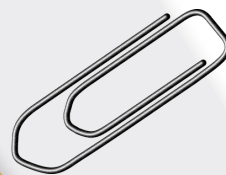


Engineer's Document



Verification of Dark Matter
Engineer's Document
- PHYSICS -
NovaScience



Background

You are a group of scientists specialized in the detection of dark matter in space.

Your mission: **To send your pilot to the space station** to get **information about several stars**. In exchange, NASA will give you information on five stars from the galaxy UGC 11748, a galaxy we have strong reason to believe contains dark matter.

The team will have to first prove their competencies by carrying out several simulations **before blasting off to the space station.**

To accomplish the mission, the pilot, mission chief and engineer will have to work together and pool the complementary information available to them.

Good luck!



Calculation of the energy required

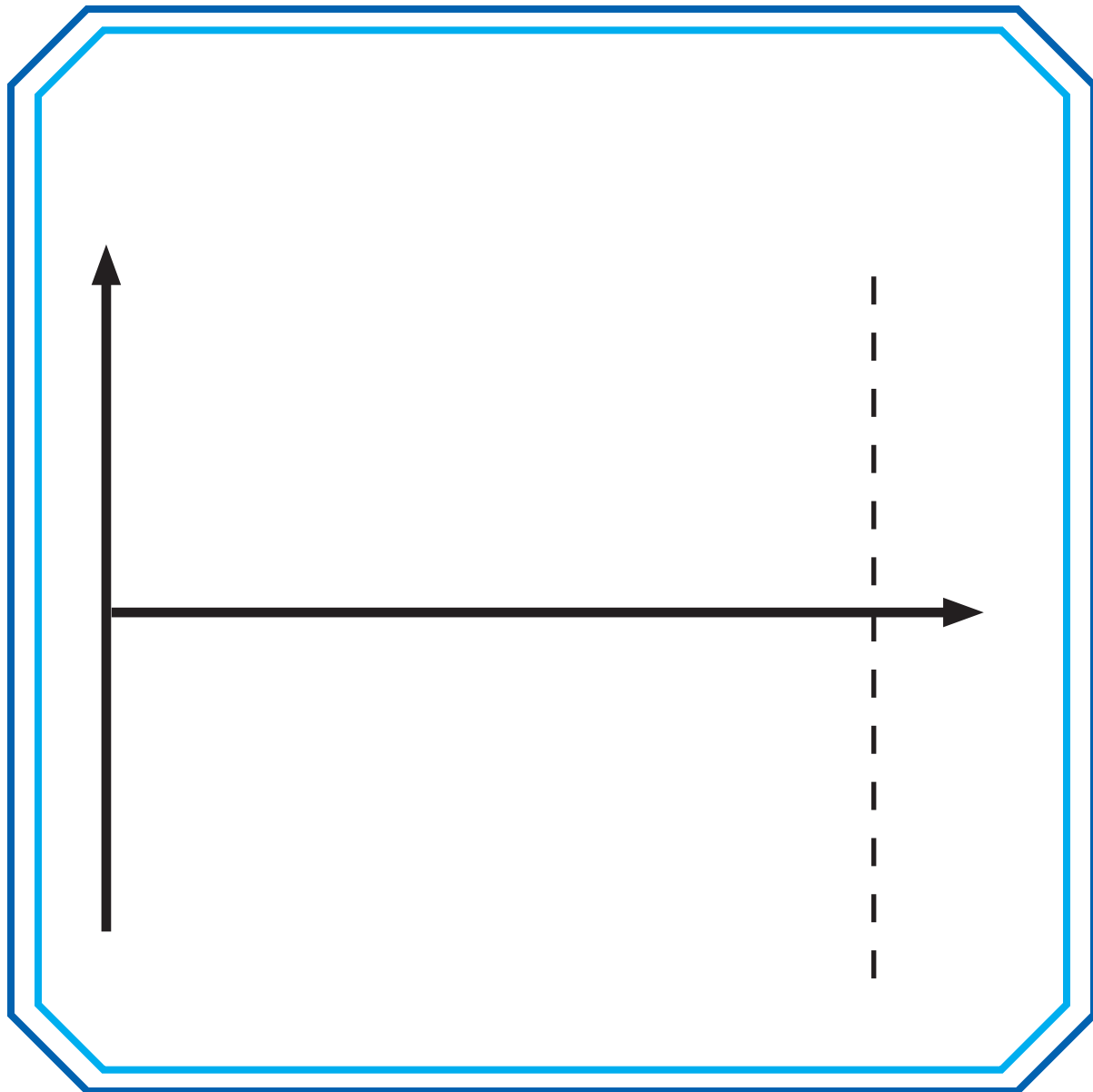
By this step, you should have the information you need to calculate the energy required for the launch. Namely:

Mass of the Earth: m_E (Celestial analysis station)	$m_E =$
Mass of the rocket: m_R (Piloting simulation station)	$m_R =$
Distance from the centre of the Earth to the launch pad: r_E (Piloting simulation station)	$r_E =$
Distance from the centre of the Earth to the space station : r_{ISS} (Celestial analysis station)	$r_{ISS} =$
Orbital speed of the space station : v_{ISS} (Piloting simulation station)	$v_{ISS} =$
Rotational speed of the Earth : v_E (Celestial analysis station)	$v_E =$
Gravitational constant : G	$G = 6,674 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$

Lift off

Before, on page 8 of the Mission Preparation Document, you made predictions about the shape of the curves in three graphs.

You will be able to validate or invalidate your hypotheses shortly, when your pilot boards the rocket to go to the station. Draw these graphs below. Do they match your predictions?



Space Station

Before you can analyze the information about these new stars, your pilot will have to find five stars in the sphere and send their data to NASA. These five stars can be found in the Mission Chief's Document.

Just like during training, your pilot will have to manually point to each star shown in the Mission Chief's Document in order to get the information to send to NASA.



The values will then be automatically entered into the computer and exchanged with NASA to get the values you will use in the calculations. These values will be displayed on the analysis station's left screen.

Your role as the engineer is to calculate the speeds of the stars using these data and to communicate them to your pilot, who will enter them in the analysis station's computer, where they will be compared to the observed speeds.



Space Station

Stars to analyze

Enter in this table the information provided by NASA on the analysis station's left screen.

Abbreviation	Complete name of the star	Observed speed (m/s)	Orbital radius (m)	Mass of the galactic center (kg)
A	Alpha-Y56I			$1,54 \times 10^{41} \text{ kg}$
B	Beta-P84F			$1,54 \times 10^{41} \text{ kg}$
C	Ceta-G22T			$1,54 \times 10^{41} \text{ kg}$
D	Delta-966I			$1,54 \times 10^{41} \text{ kg}$
E	Epsilon-44LD			$1,54 \times 10^{41} \text{ kg}$

Space station

Calculation of star speeds

Using the data provided by NASA, calculate the speeds of the stars using the formula determined on page 10 of the Mission Preparation Document.

Abbreviation	Calculated speed (m/s)
A	
B	
C	
D	
E	

