

1 April 2011

Teacher's Guide for the BLOSSOMS Video Module: 1-page INTRODUCTION

“Gravity Assist or Stealing a Planet’s Angular Momentum and Getting Away With It”

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Dear Classroom Teacher,

Your mission is to send a spacecraft to the outer solar system on a limited budget of rocket fuel; and that's not all, the trip must take you less time than what your fuel-carrying capacity allows. As the present video module will show, this mission is not mission impossible, **not even with high school students!**. It turns out to be relatively easy to achieve, and also to understand, with basic Newtonian mechanics.

This video module will present Gravity Assist, or what is wrongly referred to as the gravitational slingshot. “Gravity assist” is a maneuver performed by interplanetary spacecraft to travel farther on less fuel. It is a classic exercise in Newtonian mechanics. The basics are covered in high school physics curricula: conservation of linear momentum (to explain rocket propulsion), angular momentum, Newton's law of universal gravitation, and energy conservation. These concepts will be combined to explain orbits in the solar system. Gravity assists turn out to be carefully choreographed jumps between orbits. Only a single topic needed is usually not covered in high school curricula: distances in the solar system. A quick introduction into distances in the solar system will be enough to put the problem of fuel constraints in interplanetary travel into perspective and also to later highlight the importance of gravity assists in solving this fundamental problem. In short, “Gravity Assist” will integrate many seemingly disparate parts of high school Newtonian mechanics to present and explain a real application.

“Gravity Assist” will touch upon many exciting topics: rocketry, interplanetary travel, the solar system, etc. The most striking aspect of it will be to show that these topics can be understood using only high school physics, hence demonstrating the importance of physics in serving humanity's thirst for space exploration. The proposed video module is i) a new way of looking at, and applying various concepts of Newtonian mechanics studied in high school physics, ii) extends the theory studied in the classroom, and iii) a real world application to a very real problem, that of exploring the solar system.

Your students should have a working knowledge of all the above concepts. The best time to show this module is at the end of the mechanics part. You may wish to show in your class first, though it is not essential, Walter's Lewin's Ice Skater's Delight: <http://blossoms.mit.edu/video/lewin.html>, and Pervez Hoodbhoy's The Mystery of Motion <http://blossoms.mit.edu/video/hoodbhoy.html>.

You can find below a duet-by-duet teacher's guide.