teachers guide

Satellites 2: Satellite motion

Components

	NAME	DESCRIPTION	AUDIENCE
	*Satellite motion* teacher guide	The guide shows how students may use the resources to explain and solve problems related to satellites in circular orbits.	teachers
	*Satellites* fact sheet	Shapes, centricity, altitudes and inclinations of satellite orbits are described.	students
	*Satellite calculations* worksheet	The worksheet contains information and questions to help students integrate concepts of circular motion and gravitation, and gain an understanding of satellite motion.	students

Purpose

To **Explain** satellite motion and the sensation of weightlessness experienced by astronauts by integrating students' understandings of Newton's Law of Universal Gravitation and circular motion.

Outcomes

Students:

- explain Newton's Law of Universal Gravitation and the concept of gravitational acceleration, and apply the relationships $F_g = G\frac{m_1 m_2}{r^2}$ and $g = G\frac{M}{r^2}$;
- explain conditions required for a satellite to remain in a stable circular orbit in a gravitational field, and calculate the parameters of such satellites using the relationships $v_{av} = \frac{s}{t}$, $a_c = \frac{v^2}{r}$, resultant $F = ma = \frac{mv^2}{r}$, $F_g = G\frac{m_1 m_2}{r^2}$ and $g = G\frac{M}{r^2}$; and
- explain the sensation of 'weightlessness' experienced by astronauts in orbiting spacecraft.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Teacher poses questions about satellite motion, such as: • Why don't satellites need to burn fuel to stay in orbit? • What happens to a satellite's orbit as it begins to slow down? • Why do objects in the International Space Station appear to be weightless?	whole class discussion, think-pair-share
Students use the worksheet, *Satellite calculations*, to solve qualitative and quantitative problems about satellite motion and 'weightlessness' in orbiting satellites.	individual or small group exploration and report

Technical requirements

The guide, fact sheet and worksheet require Adobe Reader, which is a free download from adobe.com. The worksheet is also provided in Microsoft Word format.

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Using the fact sheet, *Satellites*

Possible strategies for using the fact sheet include:

- class or small group discussion of the completed fact sheet,
- literature research exercise to complete a partially completed fact sheet,
- 'cloze' exercise to complete a partially completed fact sheet, or
- 'jigsaw' exercise to complete a partially completed fact sheet.

Possible questions/tasks for whole class or small group discussion:

- List uses for the information that satellites could gather from a polar, inclined and a geostationary orbit.
- Why do satellites in low Earth orbit slow down over time?
- What happens to satellites in low Earth orbit as they slow down and re-enter Earth's atmosphere?

Using the worksheet, *Satellite motion*

The worksheet, *Satellite motion*, provides qualitative and quantitative problems for students to solve as they demonstrate their understanding of satellite motion, and 'weightlessness'. The worksheet is in two sections, with each section introduced by some essential information.

Questions 1-7 probe students' understanding of satellite motion by linking together concepts of circular motion and gravitation. Questions 8-10 address the phenomenon of 'weightlessness' as experienced by astronauts in orbiting spacecraft.

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Web: spice.wa.edu.au
Email: spice@uwa.edu.au
Phone: (08) 6488 3917

Centre for Learning Technology (M016)
The University of Western Australia
35 Stirling Highway
Crawley WA 6009

Associated SPICE resources

Satellites 2: Satellite motion may be used in conjunction with related SPICE resources to address the broader topic of motion and forces in a gravitational field.

DESCRIPTION	LEARNING PURPOSE
Satellites The learning pathway shows how a number of SPICE resources can be combined to teach the topic of motion and forces in a gravitational field.	
Satellites 1: Orbiting Earth An interactive learning object engages students' interest in satellites and their impact on everyday life. It also allows students to explore a range of satellite orbits, and visualise Earth from the perspective of an orbiting satellite.	**Engage/Explore**
Satellites 2: Satellite motion Students integrate their knowledge of Newton's Law of Universal Gravitation with their understanding of forces and circular motion to explain satellite motion. The worksheet provides qualitative and quantitative problems related to satellites and the sensation of 'weightlessness' experienced by astronauts in orbiting spacecraft.	**Explain**
Satellites 3: Impact of satellites Students elaborate on their understanding of how satellites and their associated technologies impact on everyday life.	**Elaborate**

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