How does an artificial satellite stay in orbit?

A satellite is an object that revolves around another object. Our moon is a satellite of Earth. Earth’s gravity pulls on the moon, causing the moon to travel forward at the same time it falls toward Earth in a curved path, or orbit.

To place an artificial satellite into orbit, it is first launched vertically from a launch vehicle. Then the rocket-powered satellite tilts so that its flight is parallel to Earth’s surface. When the correct orbital speed and the desired altitude are reached, the satellite’s rocket engine is cut off. To keep an artificial satellite in orbit, it must have sufficient horizontal speed to counteract Earth’s gravitational pull.

The distance between Earth’s surface and a satellite’s orbit is called orbital altitude. The period is the amount of time it takes for a satellite to revolve around Earth. The launch vehicle’s payload is the mass of the satellite that it carries. The plane on which the satellite travels is measured in relation to Earth’s equatorial plane – the plane that separates the northern hemisphere from the southern hemisphere.

U.S. space shuttles fly in low earth orbits (LEO) at an altitude of about 160 km from Earth. The shuttles are both launch vehicles and satellites. They travel at a speed of 28,000 km/hour and their period is 88 minutes. A space shuttle cannot stay in orbit more than a few weeks, because air at that altitude creates drag that gradually slows the shuttle.

Different satellites have different missions. Many satellites are used for space observation. Some are used to transmit radio and television programs worldwide, or to facilitate economical long distance communication. Other satellites gather scientific data. For example, weather satellites constantly monitor Earth’s global weather patterns.

In this Virtual Lab you will launch satellites into various Earth orbits by matching the satellite’s mission specifications to the capabilities of a launch vehicle.

Objectives:

* Investigate satellite orbits around Earth
* Investigate use of satellites
* Explore the relationships among orbital speed, period, and altitude of satellites
* Compare launch vehicle specifications.

Procedure: FIRST – prepare a data table (see below)

1. Click the Earth Orbit Information button to obtain information about Earth’s orbits. Click the Close button to close the information.
2. Click the About Mission button to obtain information about each mission. Click the Close button to close the information.
3. Analyze the satellite specifications – Orbit Type, Orbital Altitude, and Payload. Record this data.
4. Click Launch Vehicle to open a launch vehicle data table.
5. Using the satellite specifications and launch vehicle data, determine which launch vehicle is the most efficient for the satellite. Select a launch vehicle by clicking it ion the data table. Then click the Close button.
6. Click the Launch button to try to launch the vehicle carrying the satellite into space. If the selected launch vehicle is unable to launch, or if a more efficient launch vehicle is available for the selected mission, click the Close button, and reexamine the satellite specifications and launch vehicle data, and try again.
7. When the launch vehicle has successfully launched, you will see an animation of the satellite orbiting Earth. Record the satellite data in the Table.
8. Click the Next Mission button to get a different satellite and repeat the Virtual Lab until you have completed 10 different missions. (There are two for Earth-Sensing, and two for Weather)
9. Click the Rest button to get a different set of missions.
10. Answer the 10 Questions below.

Data Collection: Prepare a table with the following headings….. Complete a Total of 12 Missions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type of Satellite | Name of Launch Vehicle | Payload  (kg) | Orbit | Altitude (km) | Speed km/sec | Period  Hour & min |
|  |  |  |  |  |  |  |

Continue adding rows up to 12 – for 12 different Satellites (**NOTE:** There are 2 different Weather Satellites, and 2 different Earth-Sensing Satellites) **ALSO** – Launch Vehicles do not always have the same speeds and orbital periods.

Questions:

1. Use your data to describe the relationship between the satellite’s speed and orbiting altitude. How does the speed change with altitude of orbit?
2. Use your data to describe the relationship between the satellite’s period and altitude. How does the period change with altitude?
3. What might happen to a satellite in Low Earth Orbit? Why?
4. Why is a satellite in Geostationary orbit convenient for antenna tracking and ground-space-ground relay procedures?
5. Does a satellite at a low tilt angle, low altitude orbit see more or less of Earth’s surface than a satellite at a high tilt angle, low altitude orbit as it revolves around Earth?
6. If you wanted to launch a satellite to an orbit where it could see all parts of the globe within each 24-hour period, what would its orbit be? Why?
7. A satellite in a 24-hour circular orbit with non-zero tilt angle (slight tilt away from the equatorial plan of Earth) will appear from the ground as if it is making a nodding motion in the sky; that is, it will travel north and south each day along the same line of longitude, crossing the equator. At what intervals will it cross the equator?
8. If you were shopping for an economical launch vehicle to launch 66 satellites within a year into Low Earth Orbit, to form a constellation of communications satellites, what would be some of the parameters (variables) you would need to know?
9. Internet Research: Approximately how many satellites are currently orbiting Earth?
10. Internet Research: Identify at least ten satellites that are collecting data from space. (Put your answers in a **Data Table**)
    1. Name
    2. Identify the country of origin
    3. Original orbit date
    4. Original mission
    5. Relative/important information collected