S2/3 BGE Physics Course 1

Unit 2 - Dynamics and Space

3. Satellites

Summary Notes

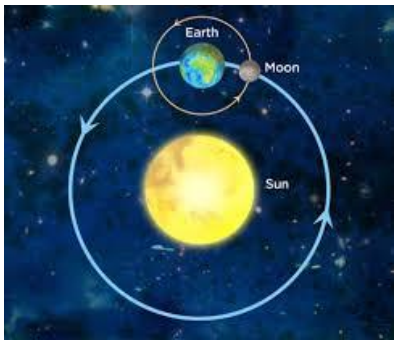
Topic 3 – Satellites

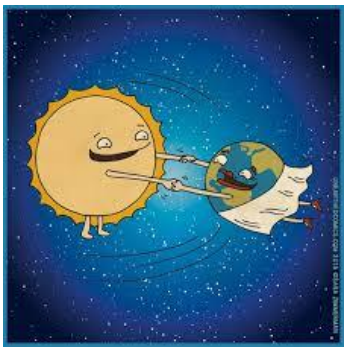
Useful Background Knowledge

The rotation period of the Earth is 24 hours = 1 day.

This is the time that it takes the Earth to complete one full revolution on its own axis.

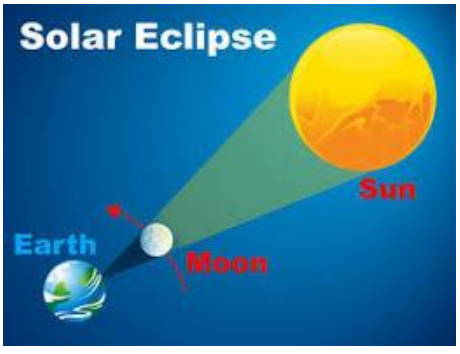
The revolution period of the Earth is 365 days = 1 year. This is the time that it takes to make one full revolution around the Sun.





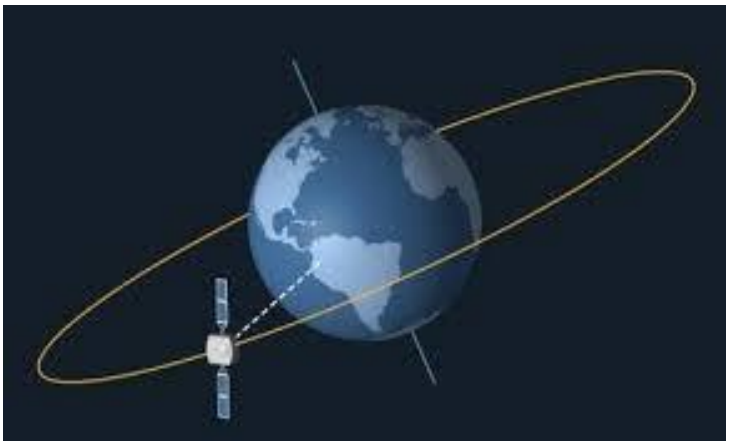
The moon orbits the Earth once every 27.3 days which is almost a month.

A **Solar Eclipse** occurs when the Moon passes between the Earth and the Sun. This casts a shadow which blocks our view of the Sun.



Satellites transmit signals around the world. One complete path around the Earth is called an **orbit**.

The **period** of a satellite is the **time taken** to complete an orbit of the Earth.

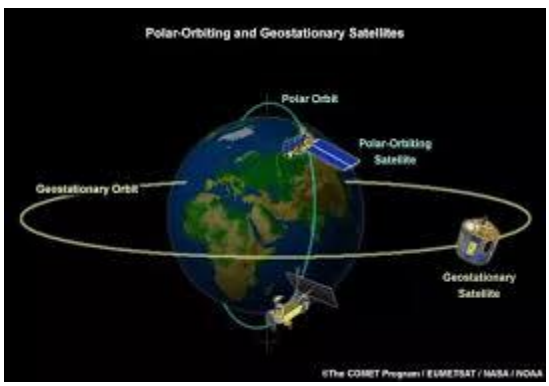


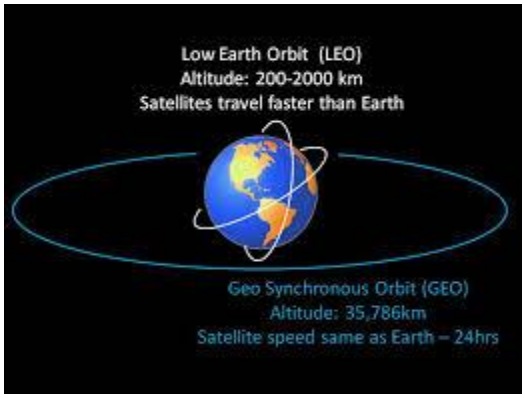
The **greater the height** of a satellite above the Earth's surface, the **greater the period** of the satellite.

Polar Orbiting Environmental Satellites (POES)

They travel in a circular orbit from pole to pole and can see the entire planet twice in 24 hours. They travel with a speed greater than Earth and are in orbits that are relatively small which are close to the Earth's surface.

POES are very useful to gather information in great detail of storms, volcanoes, mudslides, wildfires and other natural phenomena on Earth.





Geostationary Satellites

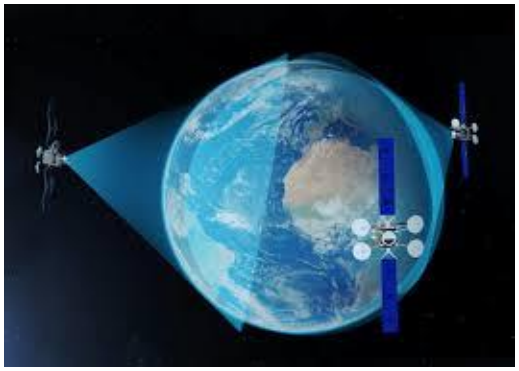
They have a **period of 24 hours** and they are always above the same point on the Earth's surface 24/7.

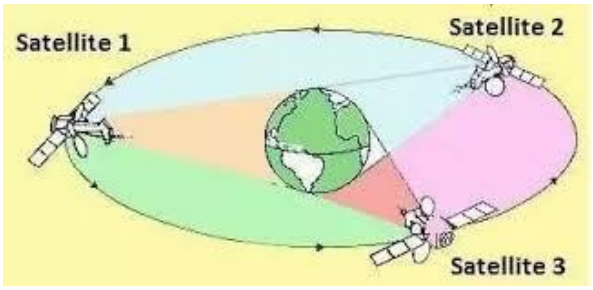
They have an orbital height of approximately **36,000km**.

Geostationary Satellites are used in telecommunications and transmit signals usually in the form of microwaves between any two points on Earth. They transmit and receive signals on different frequencies so that they cannot interfere with each other.

Microwaves travel at a speed of **300,000,000ms^{-1}** ($3x10^{8}ms^{-1}$) and they are part of the EM Spectrum. The time taken to transmit and receive signals is almost instantaneous, due to the fact that these signals can travel around the world approximately 7.5 times per second.

The **minimum number** of Geostationary Satellites required to give 24/7 communication between any two points on Earth is **three**.





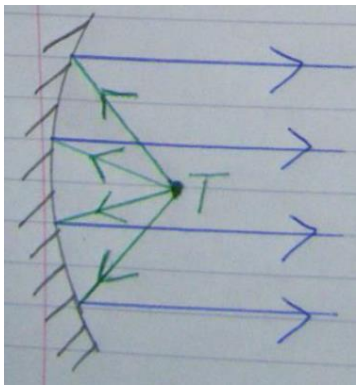
Geostationary Satellites are used for:

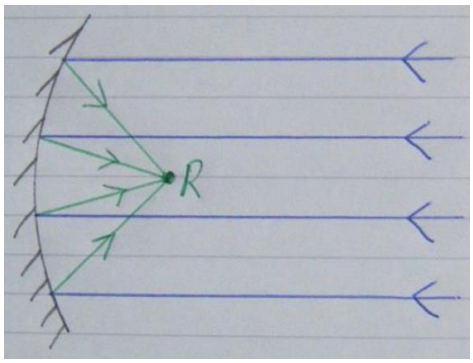
- predicting the weather
- TV and entertainment
- military purposes
- Global Positioning Systems (GPS)

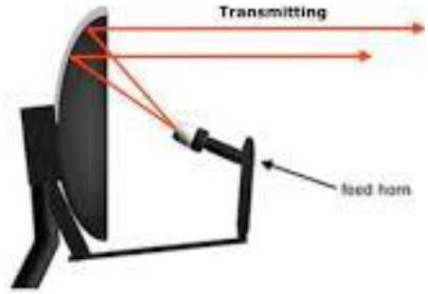
Parabolic Curved Reflector Dishes

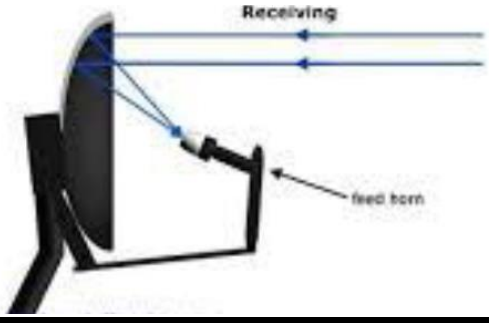
The strong signal at the focus of the **transmitter** can produce a wide parallel beam of microwave signals to send to the satellite in space.

The **receiver** is placed at the focus of the dish. At the focus a maximum strength of microwave signals are located here after the reflections from the parabolic curved reflector dish to this point.









Calculations with Satellites

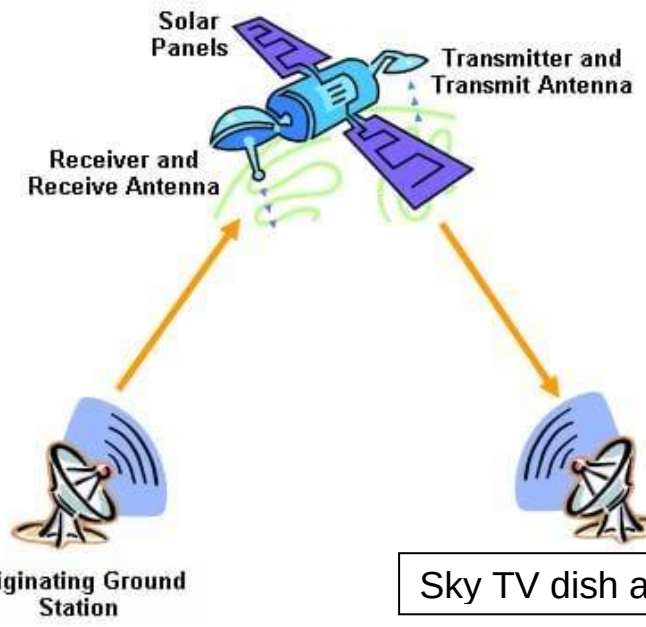
The calculations using **d = v x t** involve microwaves which have a speed of 300,000,000ms^{-1} or 3x10^{8}ms^{-1}.

To calculate the time to receive a signal from the geostationary satellite in space then use t = d/v.

d is the distance from the geostationary satellite in space, which will be **much greater than 36,000km** and v is **3x10^{8}ms^{-1}**.

Geostationary Satellites as Transmitters and Receivers

- The microwave signals are transmitted from the Ground Station at the STV studios in Glasgow to a geostationary satellite in space, 36,000km above the Earth's surface.
- The microwave signals picked up by the geostationary satellite in space are weak due to the distance travelled.
- The geostationary satellite in space then amplifies (boosts) the signals as it was so weak.
- The signal is then re-transmitted to a customer's home in Larbert and received by their **Sky TV** dish.



STV Studios in Glasgow

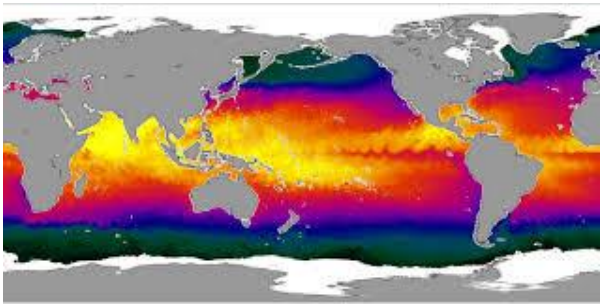
Sky TV dish at a home in Larbert

Two other important points:

- The satellite in space gets its energy from the sun. It contains solar panels which are directed to the sun to convert light energy into electrical energy.
- **Virgin Media** customers have the signal received by a large satellite ground station, which then sends the signals through an optical fibre link underground to each of the customer's homes.

Using Satellites to Understand Global Impacts

Satellites are used extensively to help develop our understanding of global impacts caused by the actions of mankind.



This looks at areas involved with climate change like:

- Warmer oceans
- Rising sea levels
- Change in plant life cycles
- Higher temperatures
- Stronger storms
- More droughts and wildfires
- Less snow and ice
- Changing rain and snow patterns
- Changes in animal migration and life cycles
- Thawing permafrost