



AEROSPACE PALACE ACADEMY, NIGERIA
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LESSON 2: TRASH IN SPACE

A mysterious object about six feet across is predicted to enter the atmosphere and burn up on Friday, November 13. Here are a couple of links with information on the item and the event (a quick internet search for "WT1190F" will bring up much more):

- <https://en.wikipedia.org/wiki/WT1190F>
- <http://www.nature.com/news/incoming-space-junk-a-scientific-opportunity-1.18642>
- http://www.slate.com/blogs/bad_astronomy/2015/10/27/wt1190f_rocket_booster_will_re_enter_on_november_13_2015.html

As this piece is being written, very little is known about this object; more will likely be discovered between the writing and the reading of it. The reader is encouraged to search the internet briefly to find up-to-date information.

GRADES K-2

WT1190F is a piece of space debris. That means that it is a piece of garbage orbiting high above Earth.

How did it get there? (Answer: Astronauts leave debris in space when they go on missions because gravity there will not pull things down to a convenient floor for them to sweep. One astronaut lost a tool bag outside the Space Station in 2008 when it drifted away from her. Also, old rocket parts, supplies, and old equipment can all end up as space debris.)

What kinds of things orbit earth? (Answer: *Satellites, space stations, astronauts, rockets, the Moon, rocks, and other things*).

What is "orbit"? (Answer: *If something is in orbit, it means it is travelling in big circles around the earth*. Satellites, humans, and even the moon are in orbit – they go around and around and around. Spacecraft orbit between 100 and 1,000 miles above the earth – that's 20 to 200 times higher than a passenger plane! However, unless engineers do things to keep them up, all of our spacecraft that are now in orbit around the earth will eventually come back down. It may take a very, very long time, though).

Here is an illustration of orbits: <http://spaceplace.nasa.gov/how-orbits-work/en/>

GRADES 3-5

The reason things in orbit stay in orbit for so long is that there is essentially no air to slow them down with drag. In the case of WT1190F, the main reason it is hitting the earth now instead of years from now is that its orbit was extremely elliptical, with its perigee at an altitude of about 9,200 miles above the surface of the earth while its apogee was at an altitude of more than 400,000 miles, or almost twice the distance to the moon. The gravity of the moon changed its orbit over the years so that instead of pointing around the earth it

is now pointing towards the earth. However, things hit the Earth all the time – old spacecraft, meteors, and other space items.

What happens when things hit the Earth? (Answer: Our thick atmosphere protects us as most things burn up before they can hit the ground. That is what will happen with WT1190F)

How can we know if something will hit Earth? (Answer: Many professional and amateur astronomers all over the world use sophisticated telescopes to keep track of space objects near Earth. NASA has a large catalog of Near-Earth Objects which it tracks).

Here are two more references about orbital debris:

http://www.nasa.gov/audience/forstudents/k-4/home/F_What_Goes_Up_K-4.html

http://www.nasa.gov/mission_pages/station/news/orbital_debris.html

GRADES 6-8

Astronomers using a large telescope in the Arizona desert found WT1190F, and have since been able to identify WT1190F on photographs taken before the object was identified. How is this possible? Astronomers use telescopes to look for things in space. When a telescope detects something, the astronomers can track its path across the sky to figure out how it is orbiting Earth. Once they figure out the orbit, they can calculate its track backwards to earlier times when they were photographing parts of the sky where the thing may have been in the past.

Here are some further links for further reading:

- <http://blogs.scientificamerican.com/guest-blog/where-did-all-that-space-debris-come-from/>
- <http://geeked.gsfc.nasa.gov/?p=139>
- <http://earthobservatory.nasa.gov/IOTD/view.php?id=40173>
- <http://orbitaldebris.jsc.nasa.gov/photogallery/photogallery.html>

GRADES 9-12

How do astronomers know what they do about WT1190F? They have observed it with telescopes. But the best ground-based telescope can only resolve angles to about one arc- second (meaning that it sees objects closer than that as a single object). This means that at a distance of 13,200 miles (WT1190F's perigee—measured from the center of the earth) a ground-based telescope cannot distinguish anything smaller than about 300-350 feet. So the object appears only as a dot. (They will not use precious Hubble time on this.)

The object's position, velocity, and orbit can be measured and calculated with great precision. So can the apparent brightness. The apparent brightness of something depends on how far away it is (which is known very precisely), the amount of light it receives (also known very precisely), its reflectivity (which is guessed at), and the surface area that is reflecting the light. In this way, scientists can estimate the surface area of one side of the object, and from that the object's size.

The mass of very light objects in space can be estimated by observing their orbits at widely separated times. The sun's light exerts a very slight pressure on the object and over much time, this pressure will push the object away from the orbit it would have purely from gravitational effects. Astronomers can measure the change in orbit, calculate the pressure exerted by the light, and from that estimate the object's mass.

Astronomers have been able to estimate the density of WT1190F as being about 0.1 grams per cubic centimeter, which is one tenth the density of water. The density is the mass divided by the volume.

Why is WT1190F so lightweight (i.e. not dense)? What could it be? It is almost certainly a discarded rocket stage – a big hollow metal cylinder that used to be filled with rocket fuel. But they are not sure; shortly after its discovery there was talk of it being a solar panel that was face on. A solar panel is flat, though, and would be expected to turn edge-on at some time during its orbit. When this did not happen, astronomers turned more toward the theory that it is a discarded rocket stage.

The orbital period of WT1190F is 22 days and 16 hours. This means that between its recovery (meaning its rediscovery, since it had been seen before) on October 3, 2015 and its destruction on November 13, it will have gone around the earth about twice. (It would make sense for it to have been discovered near perigee as it is so much brighter then.)