Orbits and satellites

For many centuries, astronomers described the Solar system as a bunch of planets and the Sun all traveling along complicated routes around the Earth. In 16th c., a Polish astronomer Nicholas Copernicus built a new model in which it is not the Earth, but the Sun in the center of the Solar System, and the planets rotate around the Sun.

1. Who was "right" and why?

Nicholas Copernicus was right, because the sun has greater mass which could cause greater gravitational attraction force.

2. What does it mean that a satellite is in Earth's "orbit"? How do satellites move (describe their trajectory, velocity, etc.), and why? Is the Sun "stationary" or is it rotating around something?

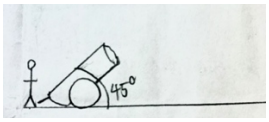
A satellite is in Earth's orbit means the satellite is orbiting or rotating around Earth.

Satellites move horizontally at a high speed if we look at it from the Earth's perspective. When travelling horizontally on a high speed, and Earth pulling it vertically, it never falls to the ground but instead orbit around the earth because it was moving very fast.

The Sun is revolving around the center of the Milky Way galaxy.

3. When sending satellites to Earth's orbit, we use a rocket. What if instead we wanted to build a large "satellite launcher" or "satellite cannon" to achieve the same goal?

- Draw a simple design of such launcher: what direction (expressed as angle with Earth's surface at the point where you are standing) should you aim the cannon's barrel?



- Can you figure out the force you would need to give the satellite at launch to make sure it stays on Earth's orbit? (Hint: You might have to Google things such as "escape velocity" if you have not hear about it before!)

The escape velocity from earth is 11,200 m/s, and the velocity for satellites if to orbit the Earth is 8000 m/s, we assume the satellite to accelerate to this speed in 1 second, then the acceleration would be 11,200 m/s^2 and 8000m/s^2. $Force = mass \times acceleration$, so if we know the mass of the satellite we can calculate the force to launch the satellite. The problem is that the mass of the satellites range from 3.1kg to 8211kg. So if we want to launch a 3.1kg satellite we would need at least 24,800N and no more than 34,720N. If we want to launch a 8211kg satellite we would need at least 65,688,000N and no more than 91,963,200N.

- List all the assumptions you make, values of constants you use (such as Earth's gravitational acceleration) and other ideas you have.

Earth's gravitational acceleration is 9.8

Air resistance is 0

Efficiency of the cannon is 100% with no energy lost.

- Why don't we use "space cannons" like this to send satellites to space?

It is not possible for a cannon to have the amount of energy to boost the satellite into space. Even if the cannons have enough energy, they are on the ground. If we use this large amount of energy on the ground, it would also damage the ground, the ground would probably be burnt badly.

4. Is it possible to build an elevator to take people to space? If possible, what would be key challenges when building such elevator? If impossible, why?

It is possible, but people would need to find materials that has higher tensile strength than carbon nanotubes to build the elevator to remain stable, function at extreme heat and cold, unpredictable force from the atmosphere, radiation from outer space, and survive micrometeorites and particles from solar wind striking constantly. It would also need a huge heavy object about 1/3 of the moon on the top of it to balance the mass,