Gravitation - Lesson 4
Formation of Orbits

Let’s for a moment put our thinking hats on and think that we have infinite energy and we can throw it at any distance we want to. Let’s go up on the terrace of a multi-storey building and start throwing stones (imaginary ones, or else it will get dangerous!). So whenever we throw a stone, remember that it will fall about a constant in 1 second. So when we throw a stone horizontally, it covers some horizontal distance (depending on the strength of the throw) but covers the same vertical distance (i.e., the building’s height) vertically every time. Therefore, when you start increasing the strength of the throw, the stone goes farther and farther from you but falls the same amount, the height of the building, every time. But, as soon as we reach the realms of superman’s throwing capacities, we need to keep in mind that the earth is round, and at some point, we will throw the stone with such a strength that it will fall greater than the height of the building as the earth’s surface curves. So, the stone is trying to fall to the surface from the stone’s perspective, but the earth’s surface keeps on curving, and the stone takes longer to fall. And, in fact, we will find a sweet point, when the earth curves the same amount, the stone falls, and in this bizarre case, the stone never touches the ground but is continuously "falling". Man, it would be damn difficult being this stone, it’s like trying to reach a delicious fruit, but it is just out of our reach.

You should, now, be able to answer the following questions:

1. What would happen if we did the same activity as above, but the earth was flat?
2. In the fourth animation, why does the stone take longer time to fall?
3. Would we observe the same for any object like a paper ball or a table tennis ball? Does this experiment hold true for all types of objects? Give it a thought.

Conclusion

Orbits are formed when an object attains a perfect velocity such that the amount by which the earth curves is the same amount by which the object "falls".

Note to Teacher

The text aims to give a visual narrative for gravitation and the formation of orbits. Along with the animation, it provides an experimental insight on the formation of orbits. It tries to relate the simple concept of falling with the formation of orbits, eventhough falling is not scientifically correct. The goal is to understand the consequences of gravitation before jumping into the mathematical modelling for the same. Just as falling is a consequence of gravity, so is formation of orbits, but the relation betweem them is not straight-forward. Here the text tries to connect the two.

Student Worksheet

1. How much distance is the stone falling during the initial phase of the imaginary activity?
2. Is there any scenario where the stone travels more than the building’s height?
3. Under what condition does the stone travels more than the building’s height?

Answers

1. If the earth was flat, the stone will fall the same amount of distance in every scenario. (Although the physics is very weird and different, under some assumptions, this will be the answer).
2. Because the earth's surface starts to curve, hence the stone travels more than the building's height.
3. Yes, this is true for all objects which has mass.

Student Worksheet Answers

1. The building's height.
2. Yes
3. Once the earth's surface starts to curve, the stone travels more than the building's height.