



Physics of SPHERES



Physics and Zero Robotics

- To compete successfully in Zero Robotics, you will need to put your knowledge of physics to use, especially **dynamics** (the study of motion and changes in motion.)
- If you haven't yet taken a physics course in school, don't worry. These tutorials will guide you, and you will learn along the way as the competition progresses.

Physics in Space

- When programming your SPHERES, you do not have to worry about forces like friction and air resistance in the simulation.
- Even in the 2-D phase of the competition, it is as if the SPHERES are in zero gravity but can only move in one plane.

Weightlessness

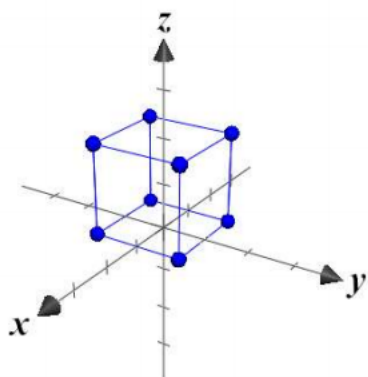
- **Weight** is the force with which gravity pulls on an object. It varies depending on the object's location in the universe.
- For all practical purposes, the SPHERES are weightless on board the International Space Station. You will program your satellites to move weightlessly in space.
- However, no weight does not mean no **mass**. Mass is the amount of matter in an object, and is constant everywhere in the universe.

- When your satellite moves, all parts of the satellite are moving together. The satellite does not change shape, so it is called a **rigid body**.
- Although each satellite occupies a space larger than one point and has considerable volume, we will consider the position of the satellite to be the point at which its center is located.

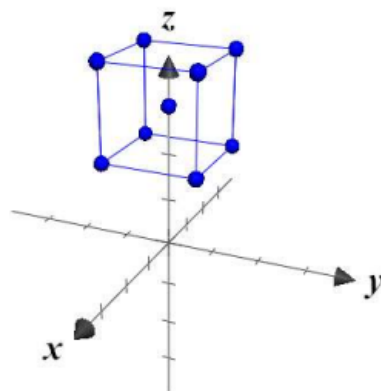
Translation and Rotation

- **Translation** and **rotation** are the two essential types of motion. Both are crucially important to controlling your satellite.
- Translation is change in position (forward, sideways, up, down, etc).
- Rotation is movement about an axis or a fixed point.
- **Attitude**, or orientation, describes how much an object has rotated from its original position.

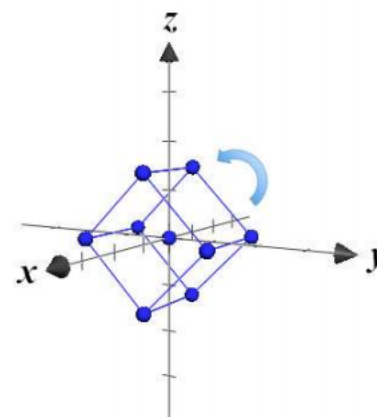
Translation and Rotation



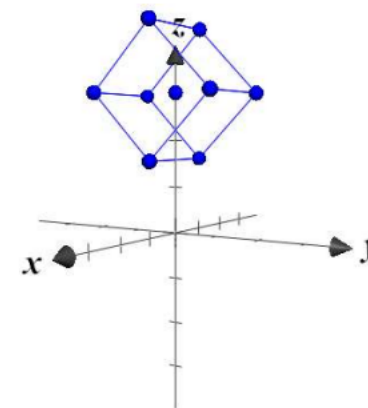
Original



Translation



Rotation



Both