Frame of Reference Encyclopedia Article

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To measure the position and **time** of an event, we rely upon frames of reference. The frame of reference is an imaginary three-dimensional coordinate grid that allows us to specify where an object is in time and **space** as compared to other objects in different **reference frames**.

In the early seventeenth century, Italian astronomer **Galileo** reasoned that everything in **motion** can only be measured in relation to something else. **Isaac Newton** later elaborated on this idea, using frames of reference to determine that measurements of speed depend on who measures them. We observe such inconsistencies every day. To a person standing on the side of the road, a cup sitting on the dashboard of a car moves at the speed of the car. To the driver of the car, the cup is stationary. Newton concluded that any physics experiment, such as measuring the **force** of **gravity**, conducted either by the person in the moving car or the person on the street would yield the same results. Therefore, it is just as correct to say that the cup is at rest as it is to say that the cup is moving at the speed of the car. Newton called the two viewpoints inertial frames of reference, because there is no difference in the perspective of an observer moving at a constant speed and one who is stationary.

Albert Einstein borrowed Newton's idea that the laws of **mechanics** are valid in all inertial frames of reference for his special theory of relativity published in 1905. A fundamental concept of that theory is that no one viewpoint from which measurements can be made is privileged over any other, if the viewpoints are either stationary or moving at a constant **velocity**. To Einstein, there exists no absolute frame against which we can measure distance, time, or velocity. The only absolute, from any frame of reference, is the speed of **light**.

Though Einstein used old ideas as the basis of his theory, his conclusion was revolutionary for physics. It meant that time and space are not absolute: two people may measure the same object with entirely different results.