
Portal

Posted by Nurta - 2008/02/11 18:02

** This thread discusses the Content article: Portal **

In Portal, flinging is possible due to the property of Portals such that "speedy thing goes in, speedy thing comes out." In the game, GlaDos explains that momentum is conserved. However, those who remember Physics 101 know that Momentum equals mass times velocity. This makes momentum into what is known as a vector. But in the game, the direction will change depending on the Portal's position. So is momentum really conserved?

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Velocity

Velocity is simply a vector version of speed. For those that remember, a vector is something that keeps track of two things: magnitude and direction. Speed is a scalar, which means it only remembers magnitude. So speed would be like saying "I'm traveling 20 mph" and velocity would be like saying "I'm going 20 mph 20 degrees north of west."

Momentum

Momentum is the product of mass and velocity. Momentum is traditionally used in physics for finding what happens after a collision. Mass is a scalar and velocity a vector. Therefore, momentum is a vector (the direction from velocity carries through). This means that two people of equal mass (weight) traveling at the same speed in different directions have different momentums.

Kinetic Energy

Kinetic Energy is the integral of Momentum relative to velocity. or for those of you who don't know calculus, kinetic energy can be found by half of the product of mass and the square of velocity ($.5 * m * v^2$). The act of squaring velocity turns it into a scalar (don't worry about why). Therefore, since kinetic energy is the product of scalars, it too is a scalar. This means that someone walking north at 3 mph has the same kinetic energy as someone else of equal mass walking south at 3 mph.

So what?

The fact that momentum is a vector while kinetic energy is a scalar is fundamental in solving the question of "momentum

versus kinetic energy." Assuming that going through a portal does not change your mass, anytime when the magnitude of momentum is conserved (same direction) kinetic energy is conserved. This is because there is only one number that times a constant will equal a certain other constant. What that means is there is only one solution to $3 \cdot X = 6$, 2. If mass does not change and the magnitude of momentum does not change, speed has not changed and therefore the magnitude of velocity has not changed. In the same way, there is only one answer to a constant times a square of a number equals a certain constant (e.g. $3 \cdot X^2 = 12$ is only true if $X = 2$). From that, it is true that the only difference is whether direction is conserved when going through a portal.

This should be clear to almost everyone that when going through a portal you change directions. Even if you walk north through a portal, you could end up going west if the end portal is on a different wall. From that, it is not true that direction is conserved and therefore, only kinetic energy is conserved since it is a scalar.

The same argument could be made with whether velocity or speed is conserved, but talking about momentum versus kinetic energy makes us seem smarter.

However, if we think of things from a different perspective, things seem different.

Frame of Reference

Frame of Reference is a term used to describe the observer of a situation. In most situations, the Frame of Reference is considered to be a person standing on the ground not moving watching things. From that perspective, the person going through the portal goes at a certain speed through a portal North and comes out the other portal at the same speed going South has changed velocity but not speed.

But what if we consider a reference frame of the person going into the portal? From this reference frame, he is not moving, the world is moving. First the world is moving South and when he enters the portal, the world suddenly starts moving North!

Usually in physics, to use a reference frame, it has to be what's called an Inertial Frame of Reference. This means that it has to follow the rules of physics. Usually, this translates into the question of whether the Frame of Reference is moving and if so, if it is accelerating or not. A Frame of Reference of a sky diver jumping out of a plane is not inertial since it is accelerating towards the ground. However a Frame of Reference of an observer watching the skydiver from the ground is inertial because it's standing still. Technically there is acceleration due to the earth's moving around the sun and rotating, but this is small and inconsequential.

So is the first Frame of Reference inertial? Yes. It is not accelerating.

Is the second Frame of Reference inertial? Initially, yes. Even though it is moving north towards the wall, it is doing so at a steady speed and not accelerating. However after it goes through the portal, it changes directions. Therefore it has changed velocity and oddly enough, it has accelerated and is not inertial. Even though its speed is unchanged, it has accelerated because it has changed velocity (because direction changed).

According to Newton, anytime something accelerates, something has to do a force on it. Therefore, the Portal actually does a force on Virtual You anytime you go through a portal!

The one problem comes from the instantaneous transportation between portals, which violates Einstein's Theory of Relativity. But that's why this is a video game and not real life.

Resolution

Technically speaking, it is not true that momentum is conserved. The magnitude of momentum is in fact conserved, but not momentum itself. Kinetic Energy on the other hand, is conserved,

But suffice it to say, the best description of the conservation between portals really is GLaDOS when it says "speedy thing goes in, speedy thing comes out."

Have any comments, questions, or criticisms? Leave a comment or take it to the forums down below. And while you're here, check out some other articles from the menu up above. If you must leave and break my heart, give us a thumbs up or digg first, please.

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Re:Portal

Posted by Dizzy - 2008/02/11 18:04

Damn great article!

Only one problem. Portals aren't logical to begin with. Technically they could do whatever they wanted with them because they write the rules.

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Re:Portal

Posted by moose007 - 2008/04/21 07:21

Who cares if we break the laws of physics as long as there is cake.

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