

Centripetal Force, Centrifugal Force - what's the deal?

A COUPLE OF commenters expressed concern over the use of centrifugal force after [my rant on the use of the word force](#). So, what is the deal with these two terms? Are they ok to use? Are they real forces?

First, are they real forces?

It depends on what you mean by real. What is a force? [Here is a quick overview of what a force is](#). I previously talked about [real vs. non-real forces](#). For me, I say that if the force is essentially one of the 4 fundamental forces then it is "real". With this definition, centripetal force would be real and centrifugal not real.

Centripetal Force

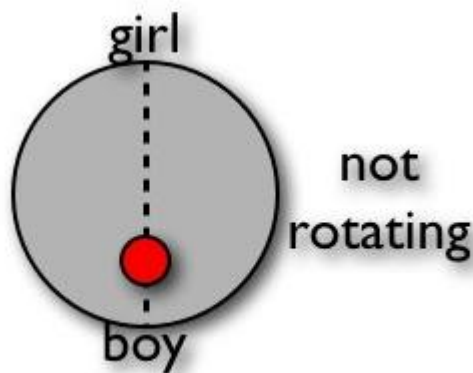
Centripetal force is the force needed to make something move in a circle. Well, maybe it would be better to say that centripetal force is the force needed to make something change direction. A constant magnitude centripetal force that is always perpendicular to the direction of motion will make

It is important to note that centripetal force is still some force. For instance, suppose you swing a rock around your head with a string. There is a force acting on the rock to make it move in a circle. This force is the tension in the string (which is a real, fundamental force based on the electrostatic interactions between atoms). In this case, the tension would be the centripetal force. Another example - a car moving in a circular path. In this case there is a centripetal force, it would be the frictional force between the tires and the road. In both of these examples, if you take away the centripetal force (break the string or drive on ice), the object would move in a straight line.

Most textbooks use the centripetal force term and use it correctly. However, it really isn't needed. They may also instead refer to centripetal acceleration as the acceleration of an object moving in a circle. Most textbooks write it like this:

$$a_{\text{centripetal}} = \frac{v^2}{r}$$

This form does not include the vector nature of the acceleration. The direction of this acceleration should always be pointing towards the center of the circle.

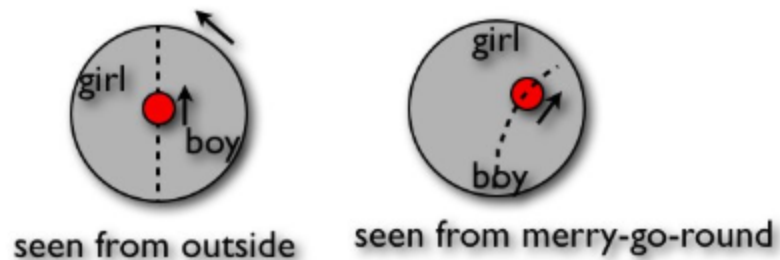


Centrifugal Force

This term is much less common in introductory physics texts. It is not a real force (according to my definition of real above). It does, however, have a useful role in some physics. Let me start with an example. Suppose a boy (or girl, it really could be a girl too) was sitting on a stationary merry-go-round with a ball. He then rolls the ball across to a girl on the other side. No problem, right? Speaking of merry-go-round, they just don't put these things in parks anymore do they? Anyway, here is a diagram.

In this case, with the merry-go-round not rotating, the ball goes straight across to the girl. No problem. Now suppose the merry-go-round is spinning. If the boy tries to roll the ball straight across to the girl, the ball will indeed still go in a straight line (assume small frictional forces) as seen from someone not on the merry-go-round. The ball will not make it to the girl because she will rotate out of the way.

The boy and girl sitting on the spinning merry-go-round will see the ball not moving in a straight line (in their reference frame of the merry-go-round). Here are two diagrams that might help.



The problem is with the boy and the girl on the merry-go-round. They see the ball NOT going in a straight line. Since they understand force and motion, they are saying "hey - if it is not moving in a straight line, there must be a force on it". They make a good point. However, they are not in an inertial frame of reference. Their frame is actually accelerating (because it is moving in a circle). In order for things to work out in a non-inertial frame, a force needs to be added (a non-real force). This force is the centrifugal force.

The centrifugal force is the force (non-real force) that is needed to make things work as you would think in a reference frame that is accelerating. The best example is when you are in a car that is turning. If the car is turning left, it FEELS like there is a force pushing you to the right (in your frame of reference inside the car). This would correctly be called the centrifugal force. The only real problem is that if you call the centrifugal force a real (as in fundamental interaction) force.

So, in the end, most people don't really need either of these terms. Of the two, centrifugal is the more needed but also more likely to be used incorrectly.