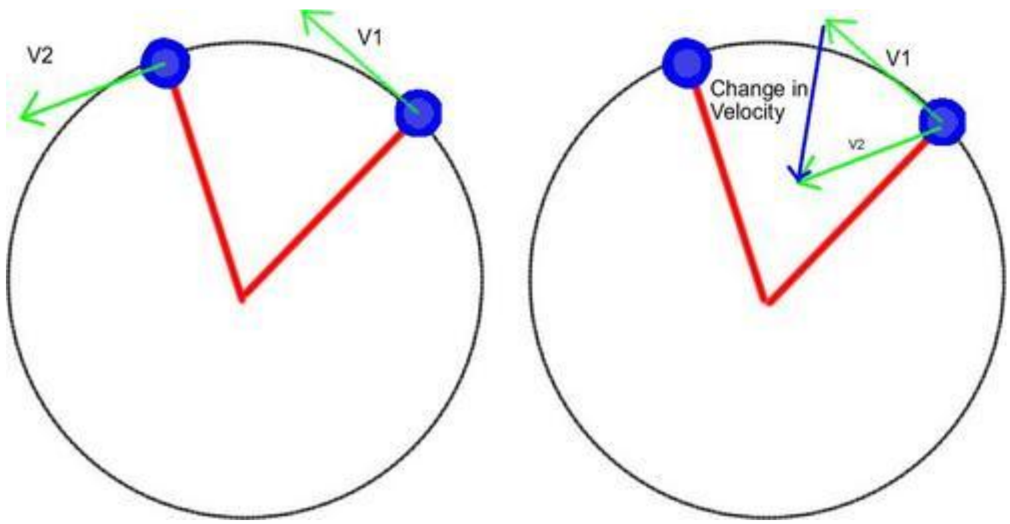
Uniform Circular Motion

2.6.1 Draw a vector diagram to show that the acceleration of a particle moving with uniform speed in a circle is directed toward the centre of the circle.

Review of basic kinematics: If the acceleration and velocity of an object are parallel (or anti-parallel) then the object's speed will increase (decrease). If the acceleration and velocity of an object are perpendicular then only the direction of the velocity will change and the speed (i.e. the magnitude of the velocity) will remain constant.

If a ball is attached to the end of string and swung at a constant speed (i.e. only the direction of the velocity is changing not the magnitude) then there must still be an acceleration. The acceleration is directed towards the center of the motion. This acceleration is call centripetal acceleration!



2.6.2 State the expression for centripetal acceleration.

The acceleration of any object moving in a circle at a constant speed is given by the equation:

(1)
$\vec{a} = v2\, r$

It is important to note that centripetal acceleration is very special. It is the acceleration required for an object to move in a circle at a *constant* speed.

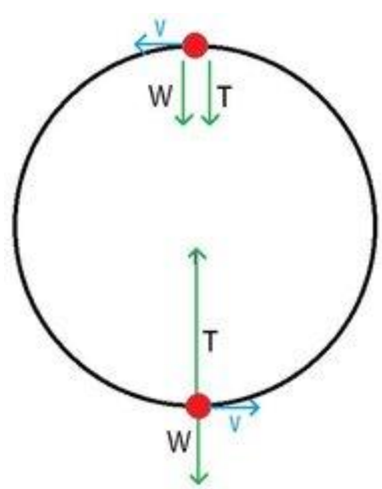
The reverse is also true if an object's acceleration is equal to $v2r$ (and perpendicular to the velocity) then the object must be going in a circle.

If an object is moving in a circle at with a changing velocity, then the overall acceleration is not equation to the centripetal acceleration. However the acceleration perpendicular to the velocity (that is the part changing the direction) is still equal to $v2r$

2.6.3 Identify the force producing circular motion in various situations

Sometimes people will make reference to the "centripetal force." This is not a real force, its a pseudo-force. In general the centripetal force is made up of many other forces and is the sum of those forces. This is not unlike the idea of a net force which is also generally the sum of multiple forces.

If you have a ball on the end of a string and you swing it in a vertical circle the "centripetal force" or the forces causing the acceleration will be a combination of the *tension* from the string and *gravity*. At the top of the circle the ball will be going slower than at the bottom (conservation of energy). Since the speed is lower at the highest point the centripetal acceleration will be reduced. The weight remains the same, so the tension must be reduced to maintain circular motion. While at the lowest point the ball will be moving faster and thus the centripetal acceleration will be increased, so the tension must have increased to maintain circular motion.



The Tension and Weight are the forces causing the acceleration. The ball is also moving in a circle so at the highest and lowest points $Tension + Weight = CentripetalForce$. Some care should be taken with the sign (+/-) of the tension force as its direction changes throughout the motion.

Take it a step farther:

(2)
$$F_{net} = ma$$

(3)
$$T + W = ma$$

(4)
$$\frac{T + W}{m} = a = \frac{v^2}{r}$$

Source: http://ibphysicsstuff.wikidot.com/uniform-circular-motion