Chapter 6

1

Circular motion

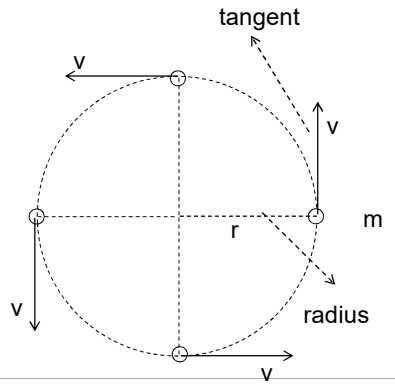
Uniform Circular Motion

2

Uniform circular motion occurs when an object moves in a circular path with a constant speed.

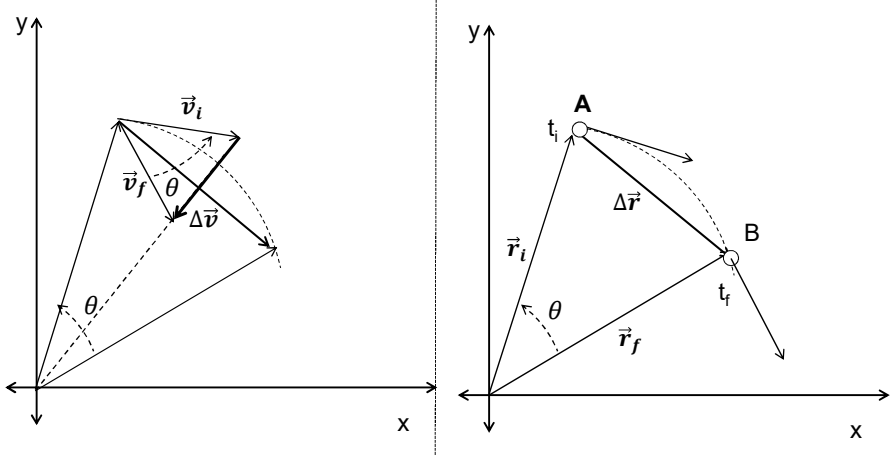
The constant-magnitude velocity vector is always tangent to the path of the object.

An acceleration exists since the direction of the motion is changing .



Changing Velocity in Uniform Circular Motion

3



Changing Velocity in Uniform Circular Motion

4

The change in the velocity vector is due to the change in direction.

The direction of the change in velocity is toward the center of the circle.

The vector diagram shows:

- $\vec{v}_f = \vec{v}_i + \Delta\vec{v}$

Centripetal Acceleration

5

The acceleration is always perpendicular to the path of the motion.

The acceleration always points toward the center of the circle of motion.

This acceleration is called the centripetal acceleration.

- It is also called the radial acceleration.

Centripetal Acceleration, cont

6

The magnitude of the centripetal acceleration vector is given by

- $a_c = \frac{v^2}{r}$

The direction of the centripetal acceleration vector is always changing, to stay directed toward the center of the circle of motion.

Period

7

The period, T, is the time required for one complete revolution.

The speed of the particle would be the circumference of the circle of motion divided by the period.

- $v = \frac{2\pi r}{T}$

Therefore, the period is defined as

- $T = \frac{2\pi r}{v}$

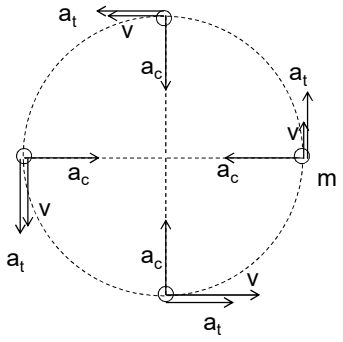
Tangential Acceleration

8

The magnitude of the velocity could also be changing.

In this case, there would be a tangential acceleration.

The motion would be under the influence of both tangential and centripetal accelerations.



Tangential Acceleration, equation

9

The tangential acceleration:

- $a_t = \left|\frac{dv}{dt}\right|$
- Direction: Same as velocity vector if (v) is increasing, opposite if (v) is decreasing

Total Acceleration

10

The tangential acceleration causes the change in the speed of the particle.

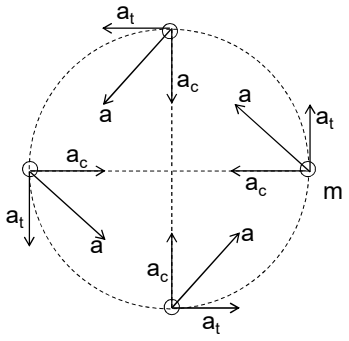
The centripetal acceleration comes from a change in the direction of the velocity vector.

The total acceleration:

$$\vec{a} = \vec{a}_c + \vec{a}_t$$

Its magnitude:

$$a = \sqrt{a_c^2 + a_t^2}$$



Uniform Circular Motion, Force

11

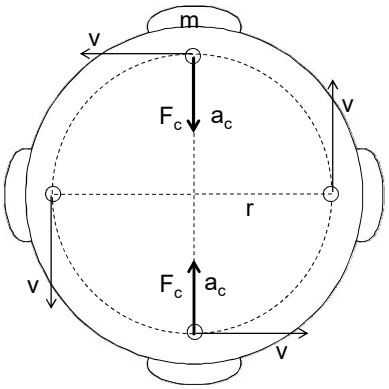
According to Newton's second law, all accelerations are caused by a net force.

In circular motion, the net force is called the centripetal force:

$$\sum F = ma_c$$

$$F_c = \frac{mv^2}{r}$$

The force is also directed toward the center of the circle.



Uniform Circular Motion, Force

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The centripetal force is NOT a new kind of force;

It is any force that keeps an object moving in a circular path without changing its speed.

It causes a change in the direction of the velocity.

It can be a tension force, a frictional force, a gravitational force, … ,.

Without this force, an object will simply continue moving in straight line.