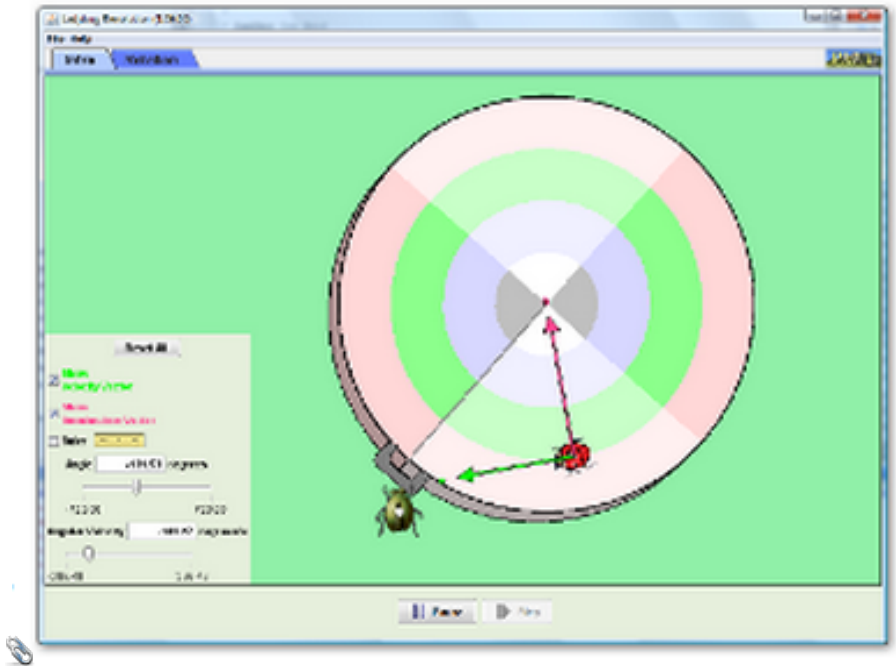
CIRCULAR MOTION

Ladybug Revolution



Uniform Circular Motion

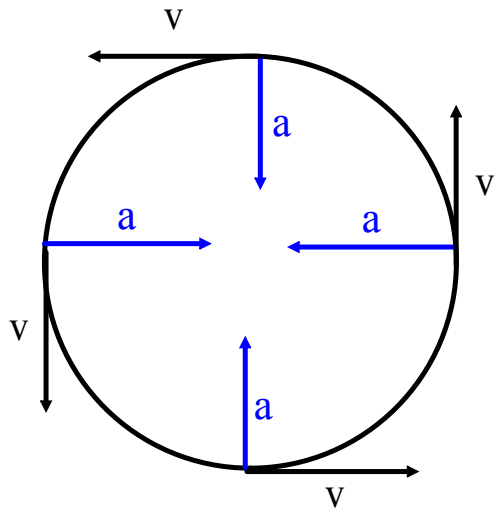
An object with uniform circular motion is an object that travels at constant speed in a circular path.

Although the object has the same speed at every point on the circular path, the direction of the object is continually changing.
Because the direction of the object is continually changing, the velocity is changine, and by definition the object must be accelerating.

The acceleration of anobject travelling in a circular path is called centripetal acceleration.

Horizontal Circular Motion

Imagine you are looking down on a circular track with an object travelling counterclockwise.



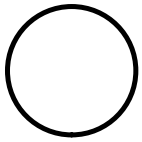
The object's speed is sometimes called the tangential speed - it is always drawn tangent to the circular path

Centripetal acceleration is always directed toward the center of the circular path.

centripetal -> center-seeking

Formulae for Horizontal Cir. Motion

$$v = \frac{d}{t}$$



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

$v = 2\pi r f$

v -> speed (m/s)
r -> radius (m)
T -> period (s) (time for one revolution)

Remember: $T = \frac{1}{f}$

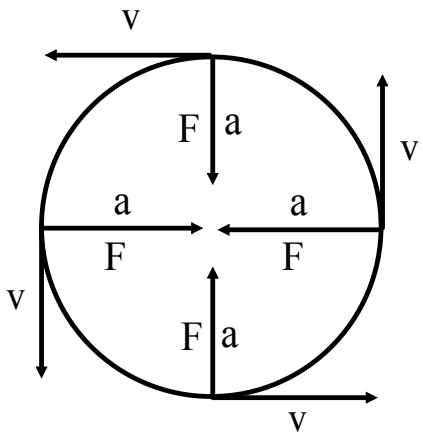
f = frequency (Hz)
the number of revolutions per second.

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

a_c -> centripetal acceleration (m/s^2)
v -> speed (m/s)
r -> radius (m)

Centripetal Force

Centripetal acceleration is due to a centripetal force. Centripetal force is the net force required to keep an object moving in a circular path. It may be a tension, force of friction force of gravity or a combination of force components that point along the radial direction.



Centripetal force is always directed toward the center of the circular path.

CENTRIPETAL FORCE

The magnitude of the centripetal force is the quotient of the mass times the square of the velocity and the radius of the circle.

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

Quantity	Symbol	SI unit
centripetal force	F_c	N (newtons)
mass	m	kg (kilograms)
velocity	v	$\frac{\text{m}}{\text{s}}$ (metres per second)
radius of circular path	r	m (metres)

Unit Analysis

$$(\text{newtons}) = \left(\frac{\text{kilogram}\left(\frac{\text{metres}}{\text{second}}\right)^2}{\text{metres}}\right)$$

$$N = \frac{\text{kg}\left(\frac{\text{m}}{\text{s}}\right)^2}{\text{m}} = \frac{\text{kg}\frac{\text{m}^2}{\text{s}^2}}{\text{m}} = \frac{\text{kg}\cdot\text{m}}{\text{s}^2} = \text{N}$$

Read MHR pg 551 - 555

Centripetal Acceleration and Force

Grade: 12

Subject: Physics 122

Date: 2014

1 The velocity vector for an object traveling in a circle points _____.

A Towards the centre.

B Directly away from the centre.

C At a tangent to the circle.

2 The centripetal force on an object moving in a circle always points _____.

A Towards the centre.

B Directly away from the centre.

C At a tangent to the circle.

3 Centripetal acceleration is independent of the object's mass.

True

False

4 What is the force that is required for an object to move in a circle?

A Force of gravity

B Centripetal force

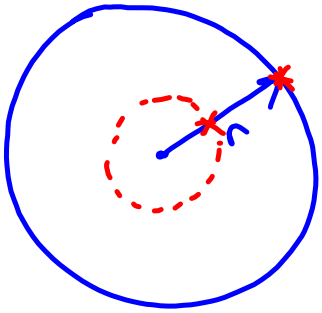
C Force of friction

5 Two identical objects are placed on a rotating disc. One object is twice as far from the centre as the other. How do there velocities compare?

A Closer object moves twice as fast.

B Closer object moves twice as slow.

C The have the same speed.

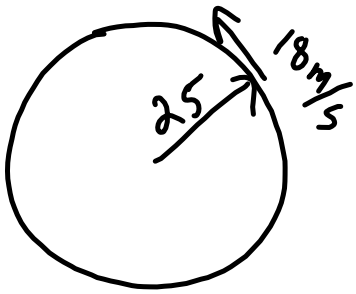


$$v = \frac{2\pi r}{T}$$

Examples

A 500 kg car is driving in a 25 m circle at 18 m/s.

- Calculate the period of the car.
- Calculate the centripetal acceleration.
- Calculate the centripetal force.



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

$$18 = \frac{2\pi(25)}{T} \qquad 18 = \frac{157}{T}$$

$$18T = 157$$

$$\boxed{T = 8.72\,s}$$

$$a = \frac{v^2}{r} = \frac{(18)^2}{25} = 13\ m/s^2$$

$$F_c = \frac{mv^2}{r} = (500)(13) = 6480\ N$$

$\uparrow \frac{v^2}{r}$

A 5.2 kg rock is attached to a 1.8 m string and is swung in a horizontal circle.

- Calculate the maximum speed of the rock if the string breaks under a tension of 215 N.
- Calculate the period and frequency of the rock.

$F_c = \frac{mv^2}{r}$ $m = 5.2\,kg, F_c = 215\,N$ $r = 1.8\,m$

$215 = \frac{(5.2)(v^2)}{(1.8)}$

$215 = 2.9v^2$

$74.4 = v^2$

$\sqrt{74.4} = v$ $\rightarrow$ $\boxed{v = 8.6\,m/s}$

$v = 2\pi r f \longrightarrow T = \frac{1}{f}$

$8.6 = 2\pi(1.8)f$

$\boxed{0.76\,Hz = f}$

$T = \frac{1}{0.76} = \boxed{1.3\,s}$

Attachments

rotation_en.jar