NAME: KEY

Centripetal Force

Concepts

A. In what direction are you accelerating if you are moving in a circle with a constant speed?

To the center of the circle

B. If you are accelerating to the left, in what direction is the net force on you? Generalize this statement for any acceleration.

To the left! Net Force and Acceleration always in the same direction because the Net Force causes the acceleration.

C. In what direction is the net force on you if you are moving in a circle with a constant speed?

To the center of the circle.

D. Centripetal Force is just another name for the Net force acting on something when it is doing what?

It is the net force when an object moves in a circle.

E. If there is no net force on you, can you move in a circle at constant speed? Explain.

Nope. You will just move in a straight line with a constant speed if there is no net force on you.

Calculations

1. A 1500 kg car is traveling in a circle with a 12 meter radius and a centripetal acceleration of 3 m/s^2.

   a. How fast is the car traveling?

$m = 1500$ kg, $r = 12$ m, $a_c = 3\ m/s^2$

$a_c = \frac{v^2}{r}$ $\quad 3 = \frac{v^2}{12}$ $\quad v^2 = 36$ $\quad$ **$v = 6\ m/s$**

   b. What is the centripetal force on the car?

same thing!

Two ways!

① $\Sigma F = ma = (1500)(3) = 4500\ N$

② $F_c = \frac{mv^2}{r} = \frac{(1500)(6)^2}{12} = 4500\ N$

   c. Where does the centripetal force come from?

Friction between tires & road. (That's why you can't turn when it is icy.)

2. A 75 kg person is on a Ferris Wheel of 5 meter radius that is rotating, If the person has a speed of 2 m/s,

   a. What is the centripetal acceleration of the person? (Give magnitude and direction.)

$m = 75$ kg, $r = 5$ m, $v = 2\ m/s$

$a_c = \frac{v^2}{r} = \frac{(2)^2}{5} =$ **$0.8\ m/s^2$** & **to the center of the circle.**

Centripetal Force

b. What is the centripetal force on the person? (Give magnitude and direction.)

$\Sigma F = ma$
$= (75)(0.8)$
$= 60N$

OR

$F_c = \frac{mv^2}{r} = \frac{(75)(2)^2}{5}$
$= 60\ N$

3. An airplane of mass 15,000 kg is traveling with a speed of 75 m/s. If turns with a radius of 200 meters, what is the centripetal force needed to let the airplane turn?

$m = 15{,}000\ kg$
$v = 75\ m/s$
$r = 200\ m$

$F_c = \frac{mv^2}{r}$ $F_c = \frac{(15{,}000)(75)^2}{200}$ $F_c = 422{,}000\ N$

4. There is a 1700 kg car traveling in a circle with a radius of 15 meters a centripetal force of 5000 N acting on it. How fast is the car going?

$m = 1700\ kg$
$r = 15\ m$
$F_c = 5000\ N$

$F_c = \frac{mv^2}{r}$ $5000 = \frac{(1700)v^2}{15}$ $v^2 = \frac{(5000)(15)}{(1700)} = 44.2$

$v = 6.6\ m/s$

5. A 75 kg person is running in a circle. There is a centripetal force of 50 N acting on the person, and they are running at 3 m/s. What is the radius of the circle?

$m = 75\ kg$
$F_c = 50\ N$
$v = 3\ m/s$

$F_c = \frac{mv^2}{r}$ $50 = \frac{(75)(3)^2}{r}$ $r = \frac{(75)(3)^2}{(50)}$ $r = 13.5\ m$

6. An airplane of mass 15,000 kg is traveling with a speed of 75 m/s. It turns with a radius of 2000 meters.
   a. What is the centripetal acceleration of the plane?

$m = 15{,}000\ kg$
$v = 75\ m/s$
$r = 2000\ m$

$a_c = \frac{v^2}{r} = \frac{(75)^2}{(2000)}$ $a_c = 2.81\ m/s^2$

   b. What is the centripetal force on the plane?

$F_c = ma_c = (15{,}000)(2.81)$
$F_c = 42{,}200\ N$

OR

$F_c = \frac{mv^2}{r} = \frac{(15{,}000)(75)^2}{(2000)}$
$F_c = 42{,}200\ N$

   c. What is the net force on the plane

$42{,}200\ N!$

Remember: "Centripetal Force" is just another name for "Net Force" when something moves in a circle.

Centripetal Force

7. A 2500 kg car is driving around a circle with a radius of 15 meters. There is a centripetal force on the car of 10,000 N.
   a. How fast is the car going?

$m = 2500\ kg$
$r = 15\ m$
$F_c = 10{,}000\ N$

$F_c = \frac{mv^2}{r}$ $\quad 10{,}000 = \frac{(2500)v^2}{15}$ $\quad v^2 = \frac{(10{,}000)(15)}{2500} = 60$

$v = 7.75\ m/s$

   b. What is the net force on the car?

10,000 N!

   c. If there was no friction, what would happen to the car?

It would just continue in a straight line that is tangent to the circle and it would also have a constant speed.

8. A 5 kg bag is swung in a circle at a speed of 3 m/s. There is a centripetal force of 20 N acting on the bag.
   a. What is the radius of the circle?

$m = 5\ kg$
$v = 3\ m/s$
$F_c = 20\ N$

$F_c = \frac{mv^2}{r}$ $\quad 20 = \frac{(5)(3)^2}{r}$ $\quad r = \frac{(5)(3)^2}{20}$ $\quad r = 2.25\ m$

   b. What is the centripetal acceleration of the bag?

$a_c = \frac{v^2}{r} = \frac{(3)^2}{2.25}$

$a_c = 4\ m/s^2$

OR

$F_c = ma_c$
$20 = (5)a_c$
$a_c = 4\ m/s^2$

Answers:

1. a) 6 m/s b) 4500 N c) friction between tires and road
2. a) 0.8 m/s², to the center b) 60 N, to the center 3) 422,000 N 4) 6.64 m/s
5) 13.5 m 6. a) 2.81 m/s² b) 42,200 N c) 42,200 N
7. a) 7.75 m/s b) 10,000 N c) car would fly off tangent with a constant velocity
8. a) 2.25 m b) 4 m/s²