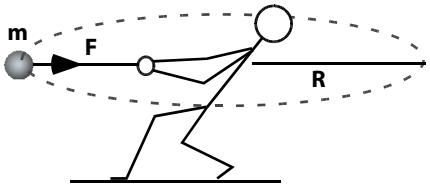
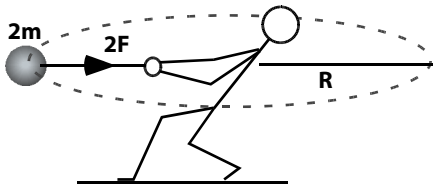
PhyzSpringboard
Centripetal Force Bill

1. FORCE AND MASS

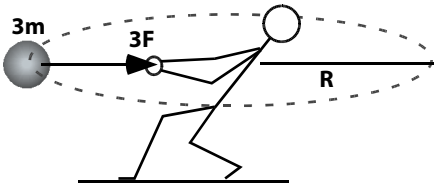
a. An object swung in a uniform circle with constant speed requires a certain amount of force.



b. An object with twice the mass swung in the same circle with the same speed requires twice as much force.



c. An object with three times the mass swung in the same circle with the same speed requires three times as much force.



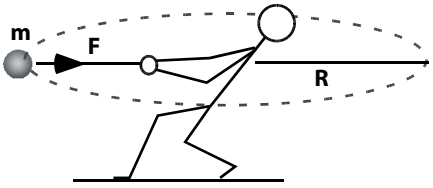
d. From this we can conclude that the force required to keep an object in uniform circular motion is
___ directly proportional to the mass of the object.
___ inversely proportional to the mass of the object.
___ some other proportionality:

e. Write the proportionality in symbols.

$F \propto m$

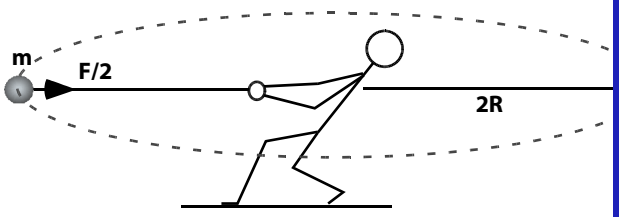
2. FORCE AND RADIUS

a. An object swung in a uniform circle with constant speed requires a certain amount of force.

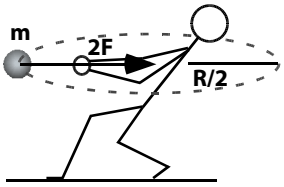


b. The same object swung with the same speed in a circle with twice the radius requires half as much force.

c. The same object swung with the same speed in a circle with half the radius requires twice as much force.



d. From this we can conclude that the force required to keep an object in uniform circular motion is
___ directly proportional to the radius of the circle.
___ inversely proportional to the radius of the circle.
___ some other proportionality:

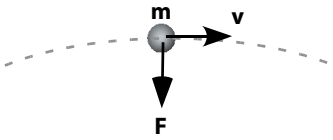


e. Write the proportionality in symbols.

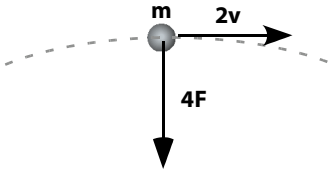
$F \propto 1/R$

3. FORCE AND SPEED

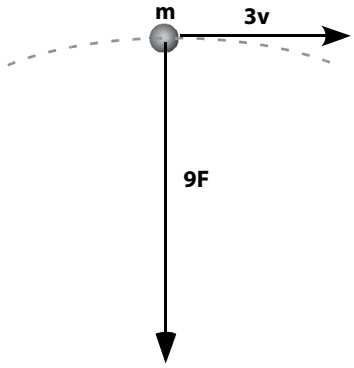
a. An object swung in a uniform circle with constant speed requires a certain amount of force.



b. The same object swung with twice the speed in the same circle requires four times as much force.



c. The same object swung with three times the speed in the same circle requires nine times as much force.



d. From this we can conclude that the force required to keep an object in uniform circular motion is

___ directly proportional to the speed of the object.
___ inversely proportional to the speed of the object.
___ some other proportionality:

e. Write the proportionality in symbols.

$F \propto v^2$

4. ALL TOGETHER NOW

a. Write a proportionality that incorporates all the findings regarding centripetal force.

$F \propto mv^2/R$

b. There is no constant of proportionality, so rewrite the proportionality as an equation.

$F = mv^2/R$

5. AN EVERYDAY IMPLICATION

Author Lew Epstein's drive home used to take him along a curve in the road. The posted speed limit for the curve was 20 mph. One day he took the curve at 30 mph. He was traveling 1.5 times as fast as he usually did. How much more force did he need the road to give him to make the turn? (He wound up in the ditch as the road could not supply this much force to him.)

$1.5^2 = 2.25$

6. NUMERICAL EXAMPLE

What is the force needed to keep a 0.2 kg object in circular motion at 3.2 m/s if the circle has a radius of 0.75 m?

$F = mv^2/R$
$F = 0.2\ kg \cdot (3.2\ m/s)^2 / 0.75\ m$
$F = 2.7\ N$