Circular Motion

Name : **Date :**
Level : Physics **Teacher : Kim**

1. Uniform Circular Motion

- According to Newton's 1st law, an object in motion will move in a straight line at a constant speed unless an unbalance force acts upon it

- If there is an unbalance force, continuously acting toward a common center, then the motion of that object is called **uniform circular motion**.

- The velocity is tangent to the path and perpendicular to the radius of the circle

- Though the speed is constant throughout the circular motion, the direction is constantly changing.

=> Centripetal acceleration

2. Newton's Second Law Applied to Uniform Circular Motion

- Observe video on 'circular motion'

- Some examples of centripetal forces

~ *Centripetal force is not another type of force. Any inward force that contributes to circular motion becomes a centripetal force*~

i) Tension force : if a ball tied to a string is spun in a circle, the string is continuously pulling the ball inward, forcing the ball to move in a circular motion

ii) Gravitional force : our moon is constantly pulled towards the Earth, forcing the moon to move in a circular motion

iii) Frictional force : an object place on the surface of a spinning desk is forced to move in circular motion due to frictional force between the object and the surface of the disk

~ Observe demonstration~

iv) Normal force: if an object is placed in a empty bucket and spun, the object is continuously 'pushed' inwards by the inner surface(the bottom of the bucket), forcing the object to move in a circular motion

~ Observe video 'Rotor' in an Amusement Park~

~ Observe video 'Cars driving on Banked Wall' ~

- If we apply **Newton's 2nd law** along the radial direction, we find that the value of the net force causing the centripetal acceleration can be

$$\sum F_r = ma_r = \frac{mv^2}{r}$$

3. Centripetal Acceleration

- The acceleration in uniform circular motion is always perpendicular to the path and always points toward the center of the circle.

- The acceleration of a uniform circular motion is called a **centripetal acceleration**, and its magnitude is

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

Q1) A 4kg mass on the end of a string rotates in a circular motion on a horizontal frictionless table. The mass has a constant speed of 2m/s and the radius of the circle is 0.8m. i) What is the centripetal force? ii) Find the magnitude of the centripetal force.

Ans) 20N

Q2) A highway curve has a radius of 140m and is unbanked. A car weighing 12000N goes around the curve at a speed of 24m/s without slipping. i) What is the centripetal force? ii)What is the magnitude of the horizontal force of the road on the car?

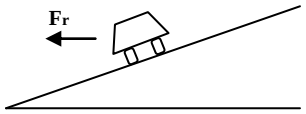
Ans) 5037N

Q3) A coin placed 0.3m from the center of a rotating, horizontal turntable slips when its speed is 0.5m/s. What is the coefficient of static friction between the coin and turntable?

Ans) 0.085

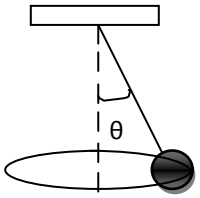
$$f = \mu F_N \qquad \sum F_r = ma_r = \frac{mv^2}{r}$$

Q4) A car is expected to move around a curve of radius 200m at 25m/s. What should be the value of the banking angle if no dependence is to be placed on friction?



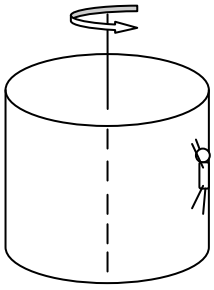
Ans) 17.7°

Q5) A small ball is fastened to a string 0.24m long and suspended from a fixed point P to make a conical pendulum. The ball describes a horizontal circle about a center and the string makes an angle of 15° with the vertical. Find the speed of the ball.



Ans) 0.404m/s

Q6) At an amusement park there is a ride in which cylindrically shaped chambers spin around a central axis. People are standing on the floor facing the axis, their backs against the wall. When the chamber reaches the speed of 3.2m/s, the floor opens but the people stay on the wall. An 83kg person feels a 560N force pressing against his back. a) What is the radius of a chamber? b) What is the coefficient of friction?



Ans) a) 1.5m b) 1.45