(2) Motion (continue)

Kinematics : when we describe the motion only of any object or particles or body it is known as Kinematics.

Dynamics : when we relate the motion to the forces acting on the object, that part of physics is known as Dynamics

Force: It's a vector quantity. This quantity is expressed on the concept of mass and acceleration. Mathematically.

Force = mass x acceleration.

SI Unit: Newton (N)

Inertia: It's an fundamental property of any object. The resistance of any object to be accelerated when a force acts on it. this property is known as inertia. It is quantified by mass. More mass more inertia.

Laws of motion:

According to Aristotle (384-322 BC). a constant force has to be applied on a body so as to keep it in motion with constant velocity. Later on, Galileo (1564-1642 AD) stated that no force is required for a body to move with uniform velocity. Newton (1642-1727) was the first person to formulate the

laws Concerning rest and motion. There are three laws of motion:

First law:

Every body in this Universe, continues to be in its state of rest or Uniform motion in a straight line, Unless it is compelled to change that state by forces impressed on it.

Second law: The rate of change of momentum of a body is directly proportional to the impressed force and takes place in the direction of force.

Third law: To every action there is always an equal and opposite reaction.

Thank You

(2) Motion (Continued)

Mathematical representation of Newton's law / law of motion:

(1) If $F = 0$, then $v = 0$ or constant

Here, F = force, SI Unit : Newton (nt)
v = velocity of any object
unit : ms^{-1}.

(2) $P = mv$

Here, P = momentum of any object
m = mass of the object
v = velocity of the object

According to Newton's second law of motion,

$$F \propto \frac{dp}{dt}$$

or, $F \propto \frac{d}{dt}(mv)$

or, $F \propto m\frac{dv}{dt}$

or, $F \propto ma$

or, $F = Kma$ [K constant]

If $F = 1$ nt, $m = 1$ kg, $a = 1 ms^{-2}$

Then, $K = 1$

So, $F = ma$

Here, F = Resultant force applied on the body
m = mass of the body
unit (Kilogram)
a = acceleration of the body, unit (ms^{-2})

(3) $F_2 = -F_1$

Here, F_2 = Action
F_1 = Reaction

If two body isolated and they are moving in a straight line with masses and velocities are m_1, m_2 and u_1, u_2 respectively. Imagine, a collision occures after a time t, and they again move with velocities v_1 and v_2 respectively. then

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

This relation is simply derived from action and Reaction relationship.

(4) $\frac{dp}{dt} = F_{ext}$ (special case of 2nd law

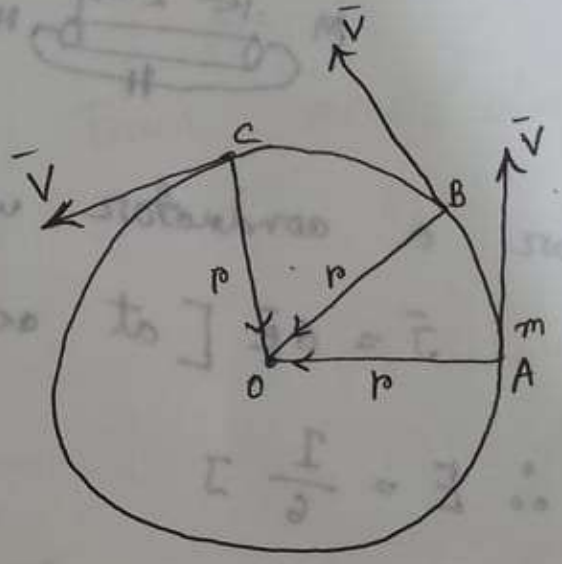
Here, p = momentum of a body
F_{ext} = Total external force on the body

If $F_{ext} = 0$

Then, p = constant
$= m_1v_1 + m_2v_2 + \cdots + m_nv_n$

"The vector sum of the linear momentum of all the particles in an isolated system remains constant in the absence of any external force".

Mathematical representation of Uniform Circular motion : (Centripetal force)



Suppose a body (m) is moving on a horizontal circle (radius r) with a uniform velocity v.

Centripetal force is defined as that force which acts towards the centre along the radius of a circular path on which the body is moving with a uniform velocity.

The acceleration on the body acting towards the centre of the circular path.

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

∴ Centripetal force, F_c = mass × acceleration

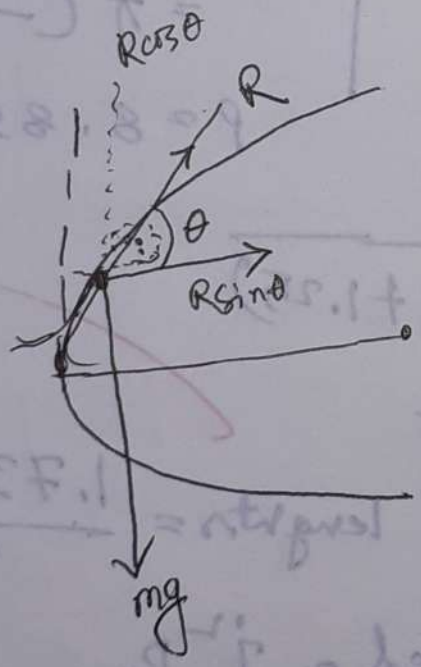
$$= \frac{mv^2}{r}$$

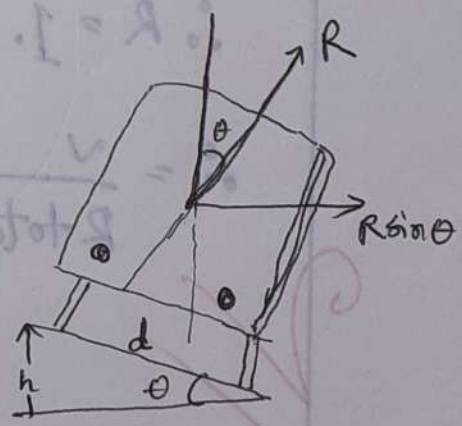
Banking of Tracks :

When move in circular path of curvature

or

When a Train moves along a curve.





active centripetal force

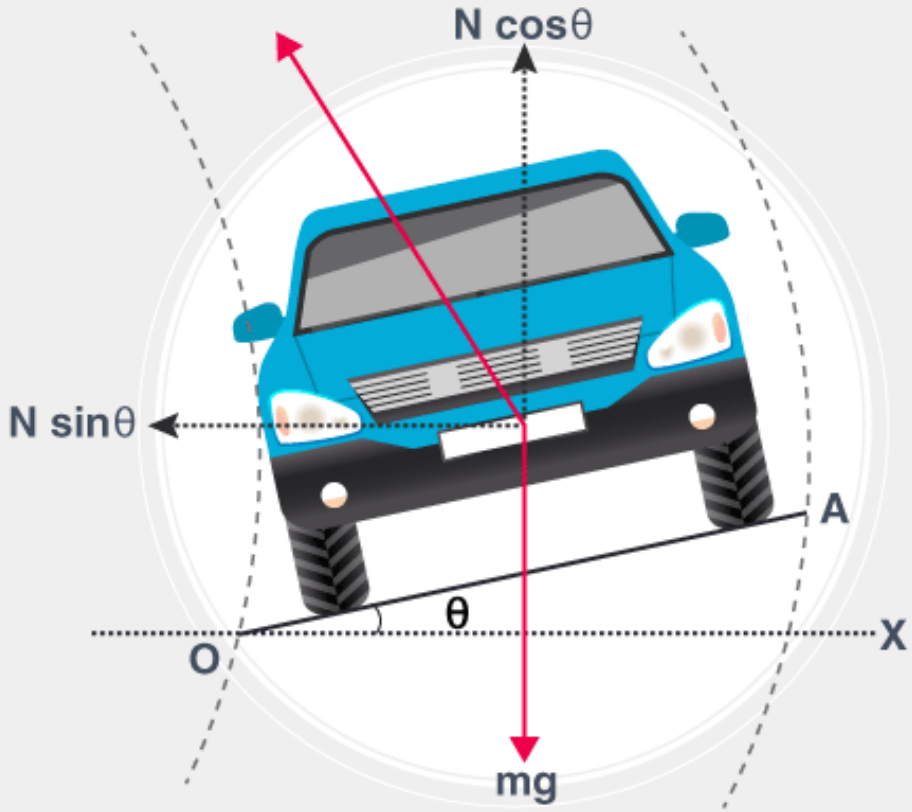
$$F^{ca} = \frac{mv^2}{r} = R\sin\theta$$

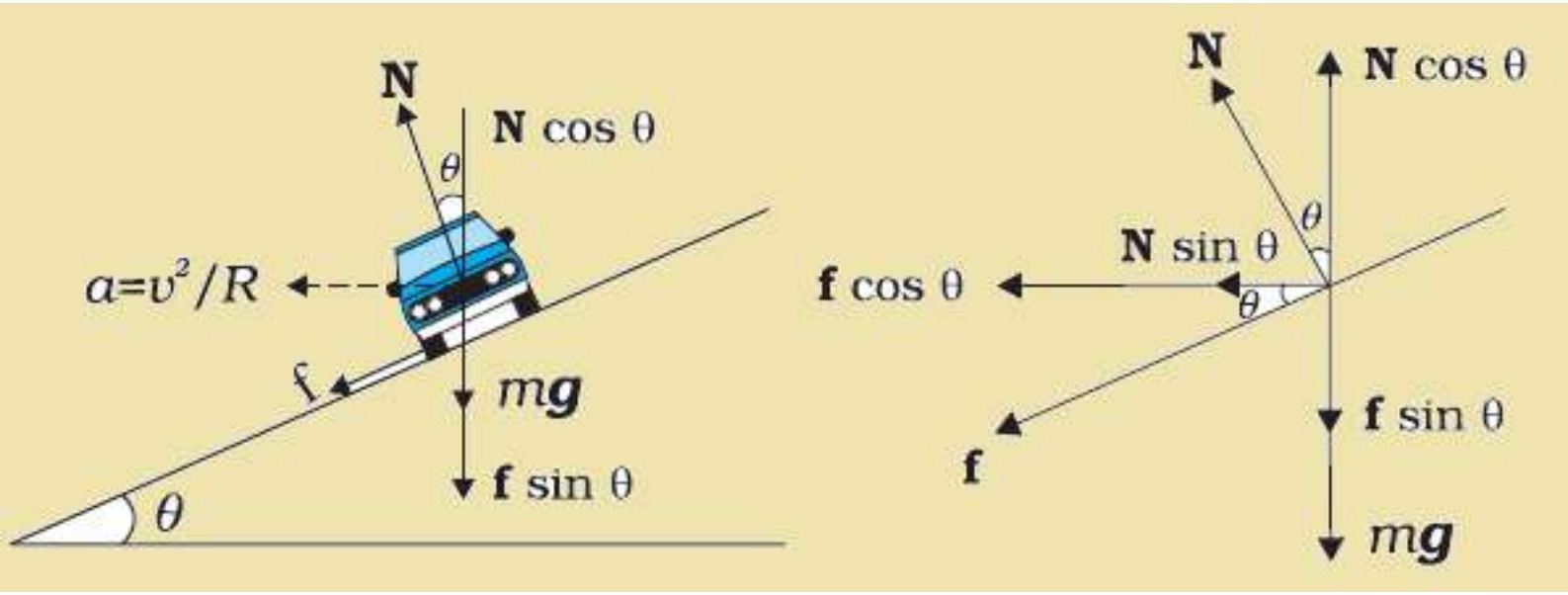
and $R\cos\theta = mg$

so, $\tan\theta = \frac{v^2}{rg}$

θ is the angle through which bends from the Vertical.

BANKING OF ROADS




N
N cos θ
θ
a=v²/R
f
mg
f sin θ
θ
N
N cos θ
θ
N sin θ
f cos θ
θ
f
f sin θ
mg