General Physics

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1 Dynamics

1.1 The three laws of Dynamics

- A body continues moving if no force comes to act on it. Same for a body that is not moving
- In a system of coordinates comes the following equivalence:

$$\vec{F} = m\vec{a}$$

- If a body A puts a force on a body B then the body B also puts a force on the body A.

2 Angular Momentum

We define the Angular Momentum as follows:

$$L = \vec{r_v} \times \vec{P}$$

Where $\vec{P}$ is equal to $m\vec{v}$ and $\vec{v}$ is the velocity of the point, so in a more general notation we have:

$$\frac{d\vec{P}}{dt} = \frac{d}{dt}(m\vec{v}) = m\frac{d\vec{v}}{dt} = m\vec{a} = \vec{F}$$

$\vec{r_v}$ instead is the vector that starts froma a chosen pole and goes to the moving point.
With that said we have $L = \vec{r_v} \times m\vec{v}$.

So the angular Momentum is equal to the ortogonal vector generate by the vectorial prodouct of $\vec{r_v}$ and $m\vec{v}$, basically $L = r_v mv \sin\theta$, where θ is the angle generated by the two vectors.

3 Differential equations

Lets suppose that the $\vec{F} = m\vec{a}$ its dependand by the following variables.

$$\vec{F} = (r(\vec{t}), \frac{d\vec{r}}{dt}, t) = m\frac{d^2\vec{r}}{dt^2}$$

this relation is called differential equation of the second order, because there is a derivative of the second order.

Example

If we consider the Hooke's law, one has the following differential equation:

$$m\ddot{x} = -Kx$$

Where $\ddot{x}$ is the second derivative of $x = x(t)$ and K is the Hooke's constant. more precisely if we call $\omega^2 = \frac{K}{m}$ we have:

$$\ddot{x} = -\omega^2 x$$

Having that said, if we want to resolve the current equation we have to find the initial conditions for the "Cauchy's problem" to be applied.
Lets put $\dot{x}(0) = 0$ and lets also suppose $x(0) = 0$.
the Cauchy's problem can be solved so if we have $\omega^2 = 1$ we will have:

$$\ddot{x} = -x$$

so the following equivalent solutions will be:

$$\dot{x} = \omega \cos(\omega t)$$

and

$$\dot{x} = -\omega^2 \sin(\omega t)$$

With $x(t) = \sin(\omega t)$ as the general solution.