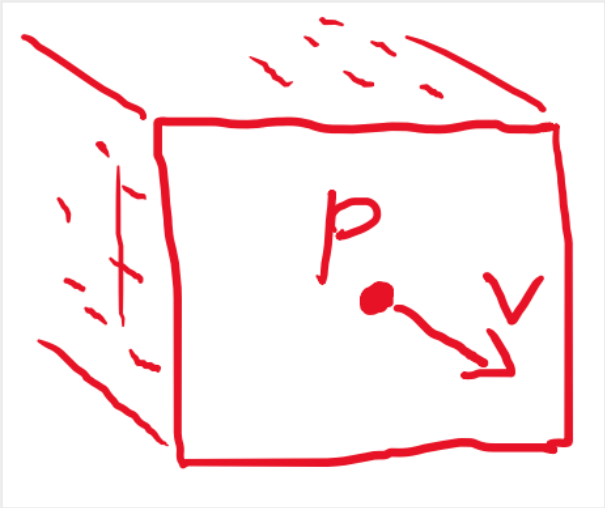
Rigid Body : 2D Physics Engine

2D Rigid Body Properties:

Linear:

- position : *Vector2.*
- velocity : *Vector2 : V*
- mass : *int (kg) : M*
- *momentum : Vector2 : P*



Angular:

- angle : *Double (radians) :* θ
- angular velocity : *Vector2 (radians/second) :* ω
- moment of inertia : *Tensor2 (kg * meters^2) (NEEDS IMPLEMENTATION* https://www.youtube.com/watch?v=ICxxKeE4GuA*) : I*

Movement of a rigid Body:

Linear Equation of Motion

Pnew is the Value of the Object's Momentum in the Current Frame
Pold is the Value of the Object's Momentum in the Previous Frame
Tdelta is Current Time minus Time recorded in the Previous Frame
Vold is the Value of the Object's Velocity in the Previous Frame

```
Pnew = Pold + Tdelta * Vold
```

Angular Equation of Motion

Similar to the Variables in the previous Equation new represents the values in the current frame and old represents the values
that was recorded in the previous Frame.

ω - Omega is the angular Velocity
θ - Theta is the Angle

```
θnew = θold + Tdelta *  ωold
```

Impulse:

Definition - *Impulse is an instantaneous change in momentum*

Momentum = mass * velocity
Impulse is represented by Letter J

Applying Impulses to a rigid Body at the Center of Mass:

Applying linear Impulse

Linear Impulse Formula = Force * Time

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Vnew = Vold + Jlinear / M
```

Applying angular Impulse

It is the moment of Inertia

Angular Impulse = Torque * Time

```
ωnew = ωold + Jangular / I
```

Applying Impulses to a rigid Body at any Point:

This can be achieved by splitting Impulse into linear and angular Terms relative to the Center of Mass

Applying linear Impulse

Linear Impulse Formula stays the same

Applying angular Impulse

p is the Point we are applying the Impulse at and c is the Center
x is the Vector Cross Product

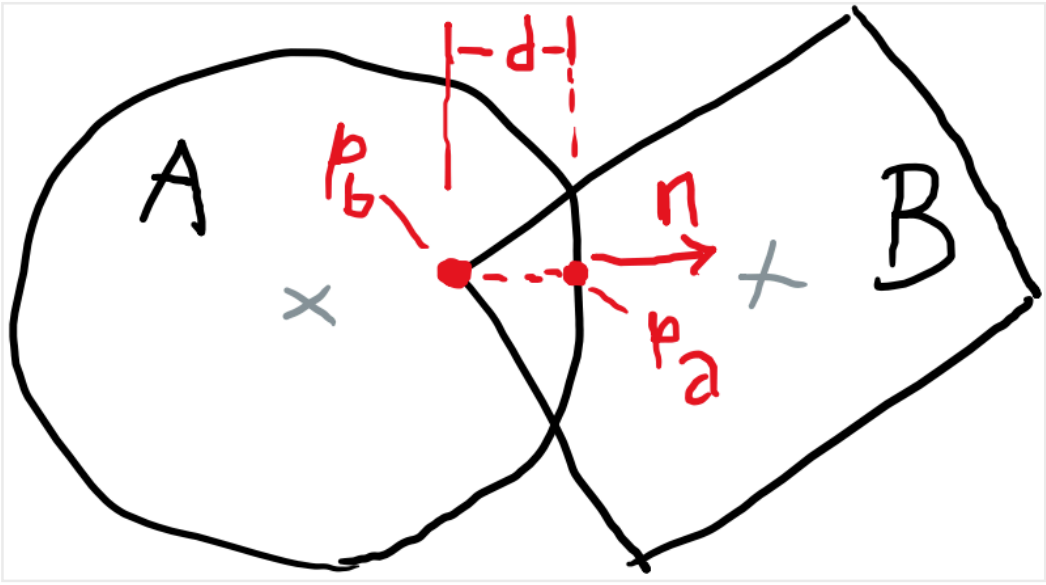
Angular Impulse Formula J = J x (p - c)

The same Formulas are applied only thing that changes between applying an Impulse at the Center of Mass and any Point are the Formulas of Impulses.

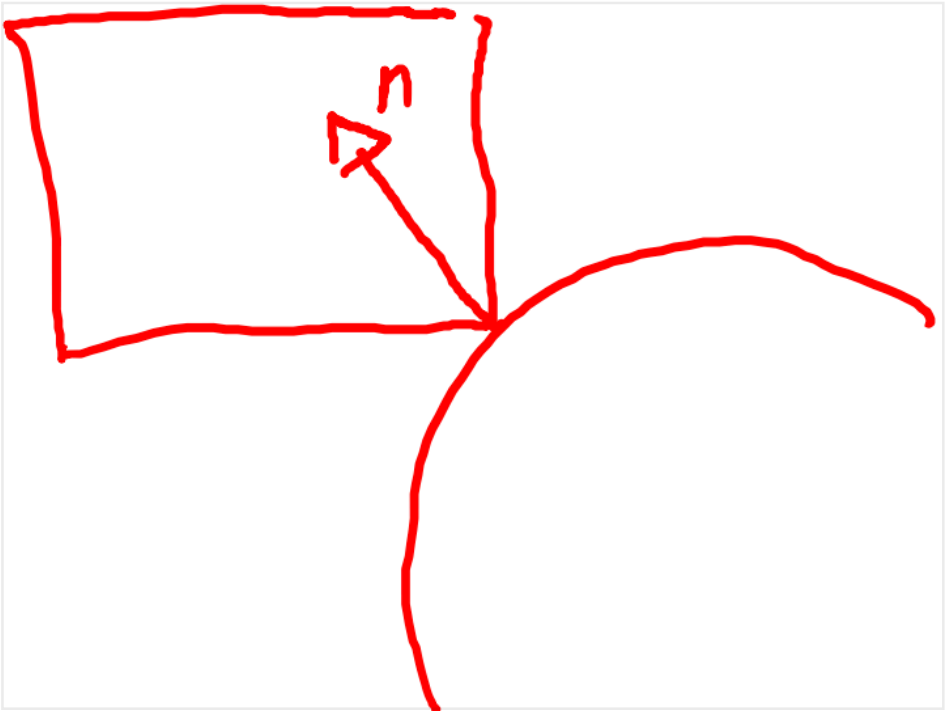
Collision Detection:

To describe a Collision several Variables come into Account

1. The Point of Collision *Pa* and *Pb* for both rigid Bodies
2. The Collision Normal : *n*
3. The Collision Depth : *d*



Example of Collision Normal:



Getting the Distance between Two Points

P1 = Point 1 *: Vector2 : X Y*
P2 = Point 2 *: Vector2 : X Y*

```
d = √(P1x – P2x)^2 + (P1y – P2y)^2
```

Getting the Distance between a Point and a Circle

R = Radius of the Circle *: float*
P = The Point *: Vector2 : X Y*
C = Center of the Circle *: Vector2 : X Y*

d = (√**(Px - Cx)^2 + (Py - Cy)^2) - r**

First, we get the Distance between the Point and the Center of the Circle and then subtract the Radius

See The Example below: