Displacement Sensor (5C)

- Gyroscope

Please send corrections (or suggestions) to youngwlim@hotmail.com.

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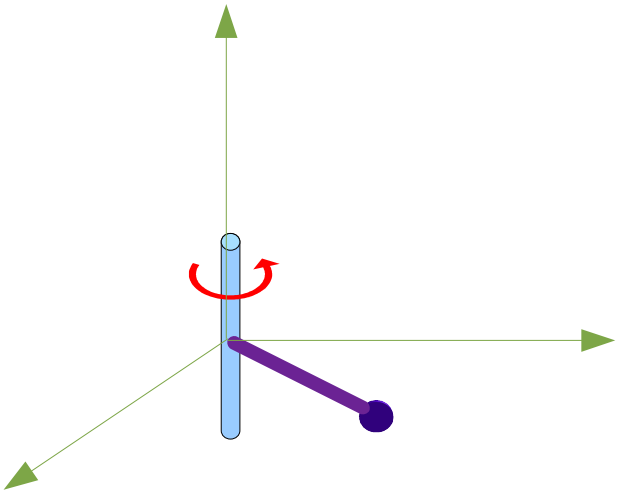
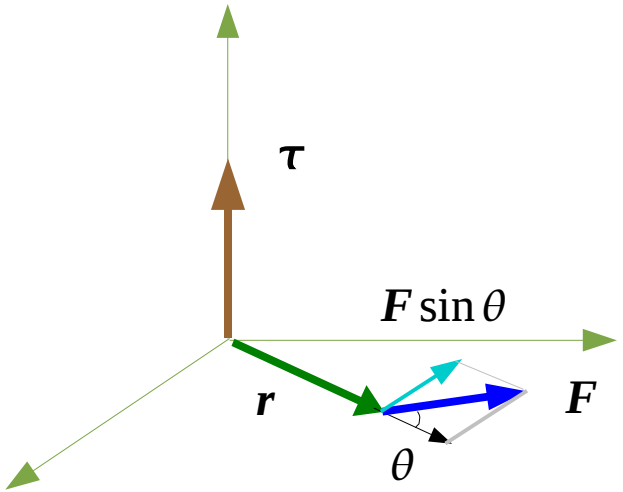
Torque

- *force necessary to rotate an object about an axis*
- *torque measures how hard something is rotated*

$$\boldsymbol{\tau} = \boldsymbol{r} \times \boldsymbol{F}$$

$$\tau = r F \sin\theta$$



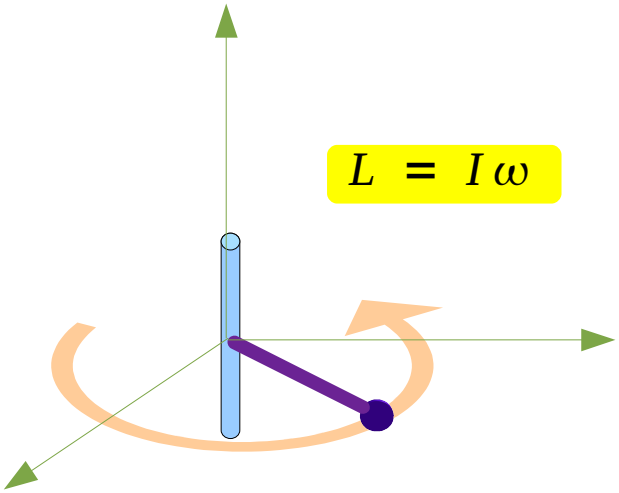


Angular Momentum

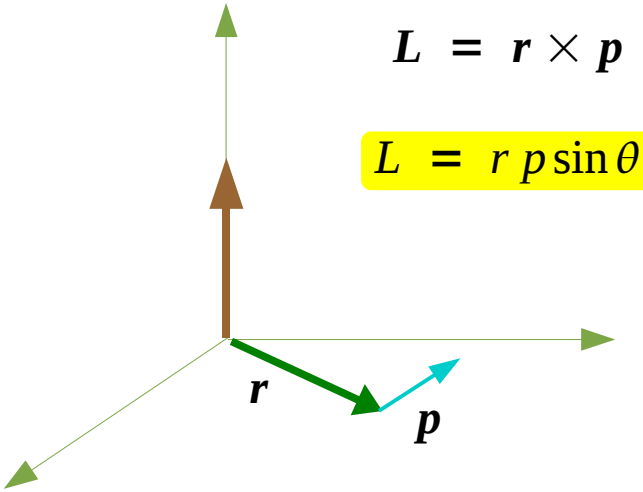
- *Moment of Inertia :* I

  measure of an object's resistance to changes in its rotation rate

- *Angular Velocity :* ω



$$L = I\omega$$



$$L = r \times p$$

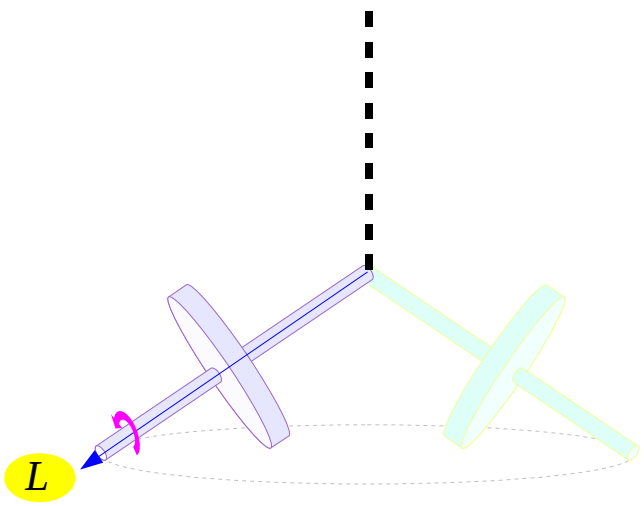
$$L = r\,p\sin\theta$$

r : *instantaneous position vector*

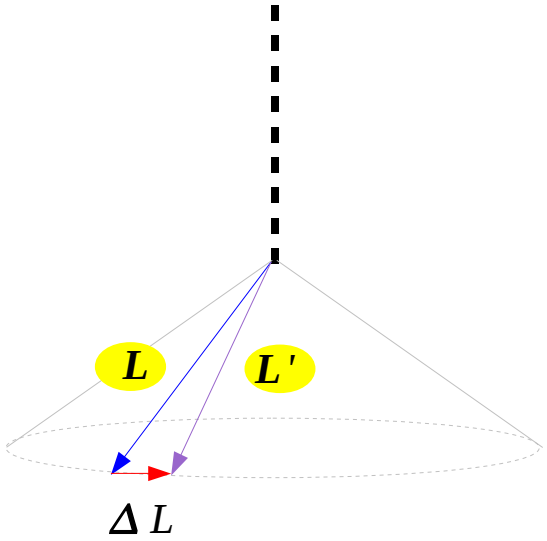
p : *instantaneous linear momentum*

Precession – angular momentum

suspended by a rope



- *Instantaneous Angular Momentum changes*

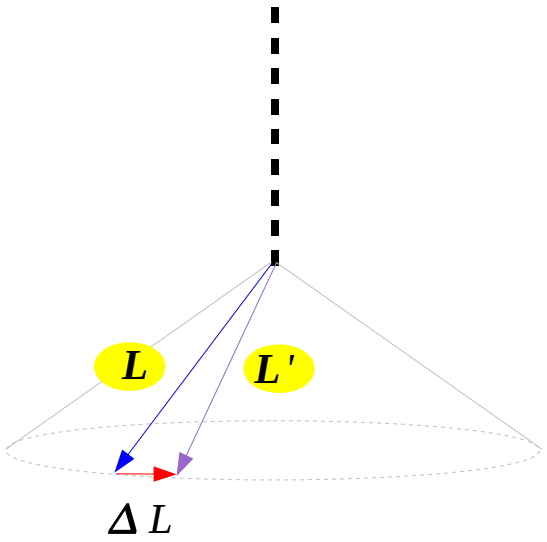


$L = I\,\omega$ *magnitude*

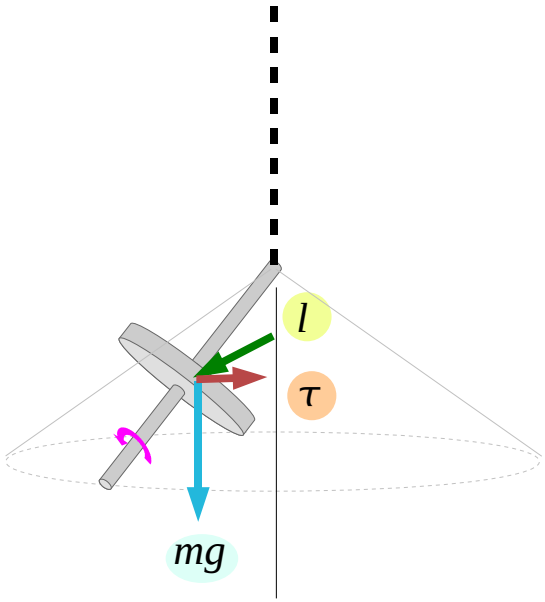
$\boldsymbol{L} \rightarrow \boldsymbol{L}'$ *vectors*

Precession - torque

$L = I\omega$ *magnitude*



$\tau = mgl$ *magnitude*



$\tau \rightarrow \Delta L$

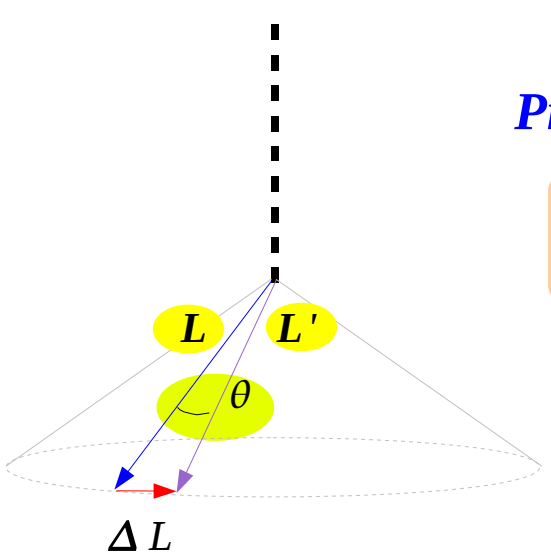
$$\tau = \frac{dL}{dt}$$

the direction of a precession rotation is the same as that of the applied torque

Precession – precession rate

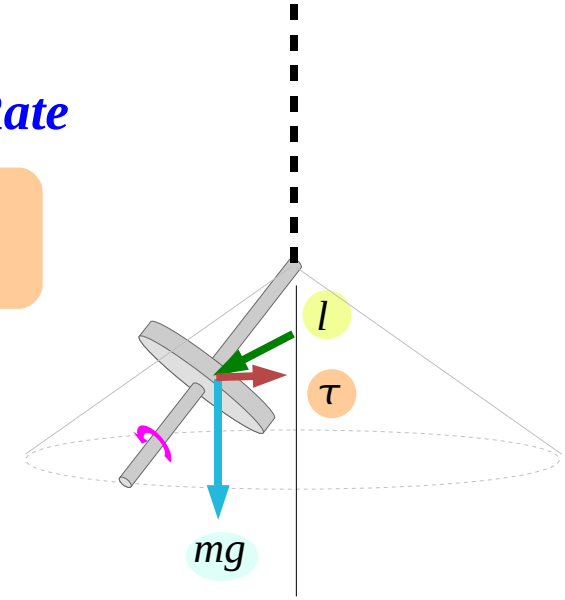
$L = I\omega$ *magnitude of an angular momentum*

$\tau = mgl$ *magnitude of an torque*



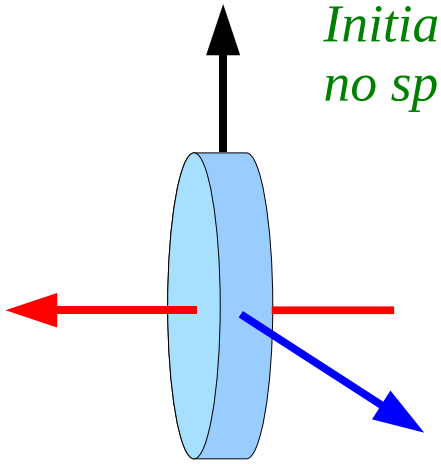
Precession Rate

$$\Omega = \frac{d\theta}{dt}$$

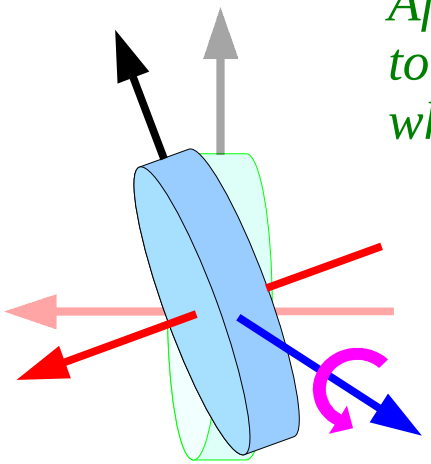


$$dL = L \cdot d\theta \quad \Rightarrow \quad \tau = \frac{dL}{dt} = L\frac{d\theta}{dt} = L\Omega = I\omega\Omega$$

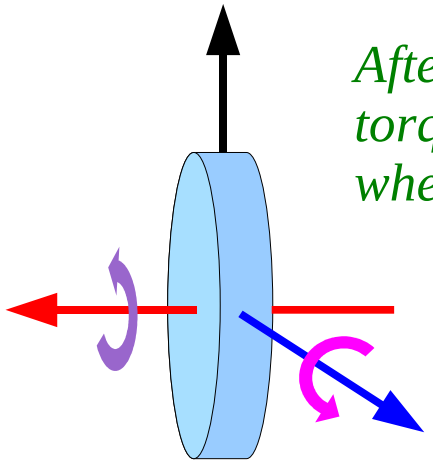
Precession – applied torque



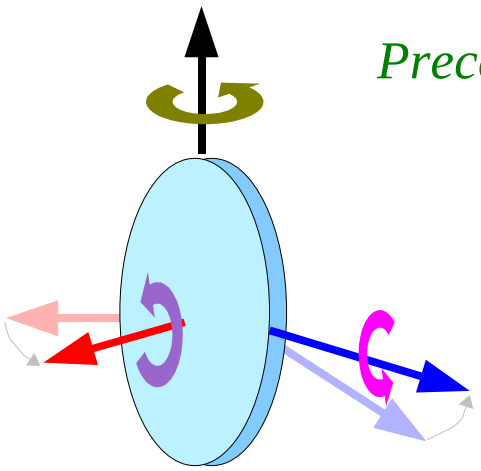
Initially, no spin



After applying a torque to a resting wheel

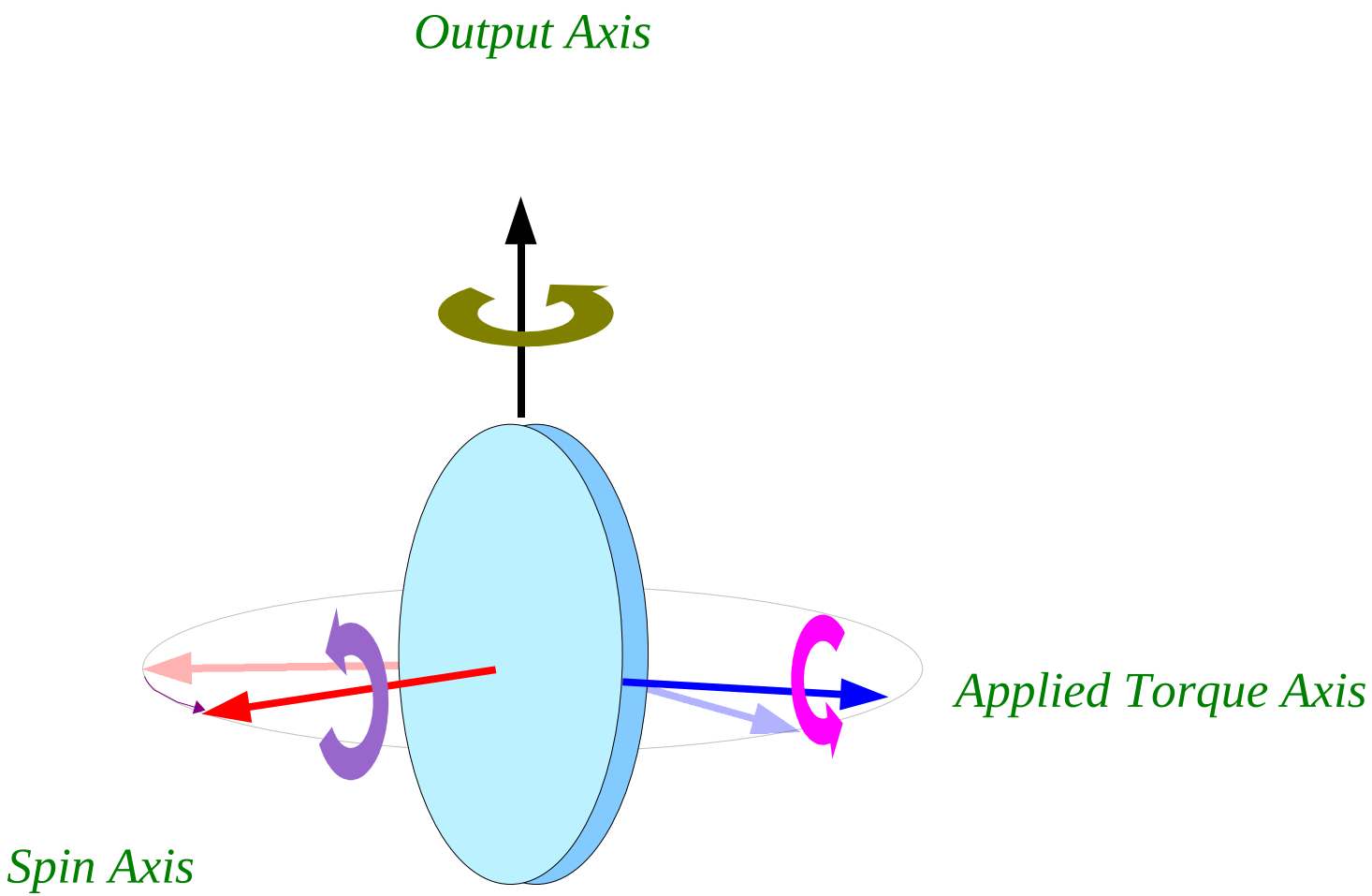


After applying a torque to a spinning wheel



Precession

Precession – input and output axes



References

[1] http://en.wikipedia.org/
[2] Nam Ki Min, Sensor Electronics, Dong-il Press