4/12	4.3
4/14	Review
4/19	Test 3 (3.2, 3.4, 4.1, 4.2, 4.3)
4/21	5.1 & 5.2
4/26	5.3
4/28	5.4
5/3	5.5
5/5	Review
5/12	Test 4

Quiz 4/12 (4.3)

In two dimensions, $L = mrv_\perp$.

In 3D, $\vec{L}$ is _____

A) $\vec{r} \times \vec{p}$ B) $\vec{p} \times \vec{r}$ ½ credit for (B)

C) $\vec{\omega} \times \vec{r}$ D) $\vec{r} \times \vec{F}$

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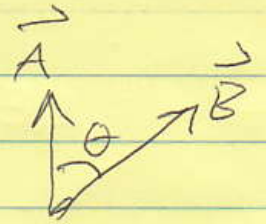
$$\begin{cases} \vec{v} = \vec{\omega} \times \vec{r} \\ \vec{L} = \vec{r} \times \vec{p} \\ \vec{\tau} = \vec{r} \times \vec{F} \end{cases}$$

geometry $\vec{C} = \vec{A} \times \vec{B}$

thumb | hand; arm | Fingers

$$|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin\theta .$$

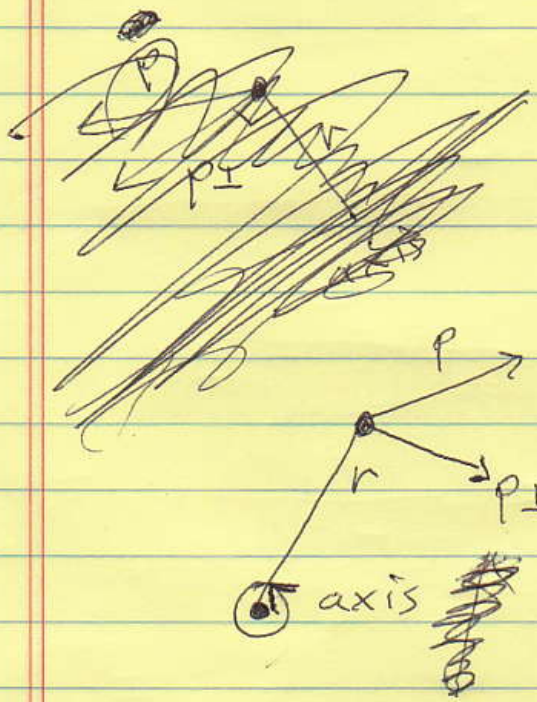


2D

$|L| = mr|v_\perp|$

$|L| = r(m|v_\perp|)$

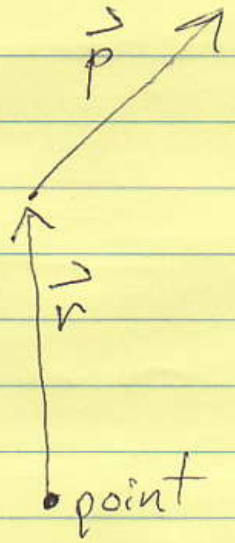
$|L| = r|p_\perp|$



L negative if counterclockwise is +

3D

$\vec{L} = \vec{r} \times \vec{p}$



$\vec{L}$ ⊗

⊗ = points in to paper

⊙ = points out

2D

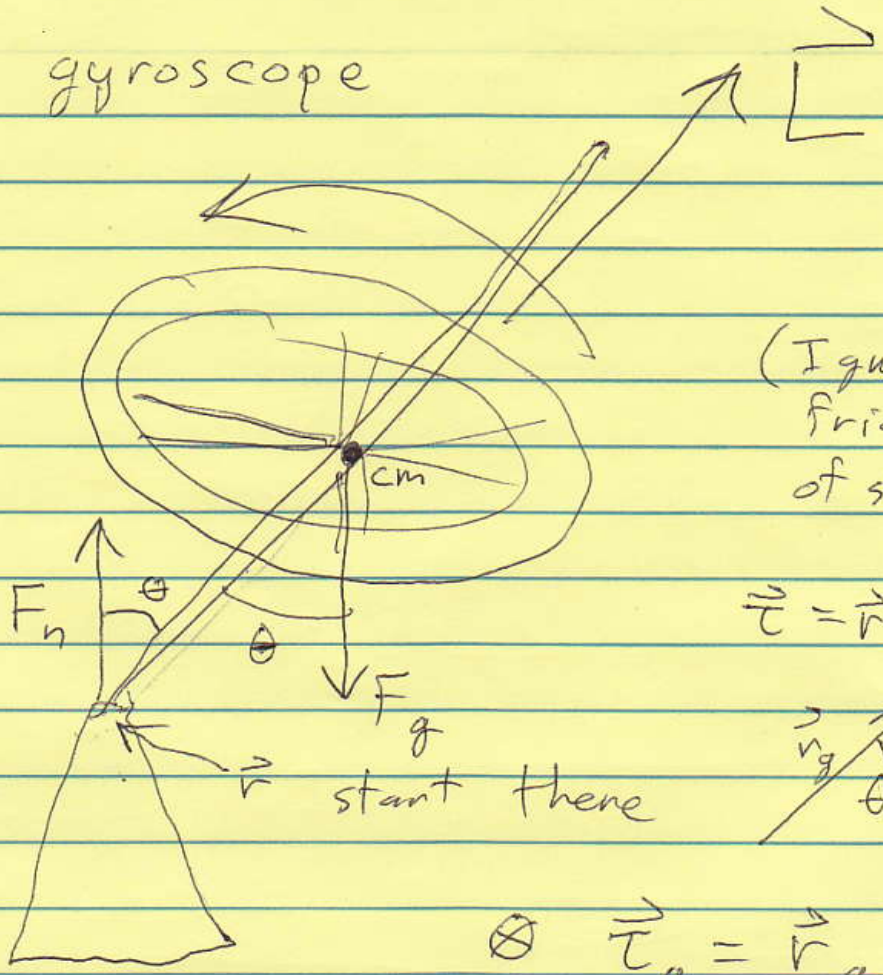
$L = I\omega$

3D

$\vec{L} = I\vec{\omega}$

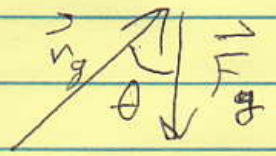
only if the object is rotating about an axis of symmetry.

gyroscope



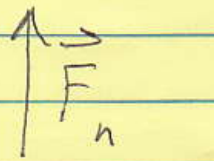
(Ignore friction of simplicity.)

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



$\otimes \quad \vec{\tau}_g = \vec{r}_g \times \vec{F}_g$

$|\vec{\tau}_g| = |\vec{r}_g||\vec{F}_g| \sin\theta$

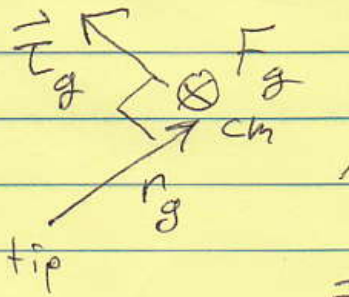


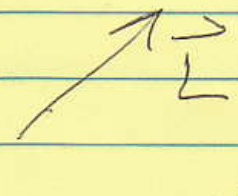
$\vec{\tau}_n = \vec{0} \times \vec{F}_n = \vec{0}$

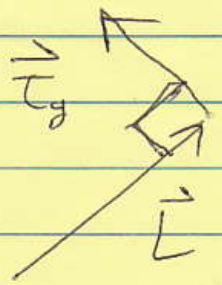
$\vec{r}_n = \vec{0}$

---

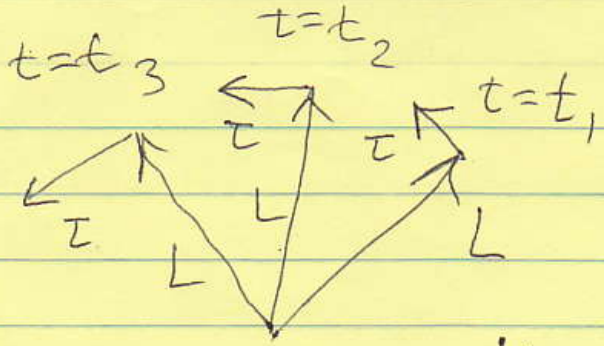
overhead view







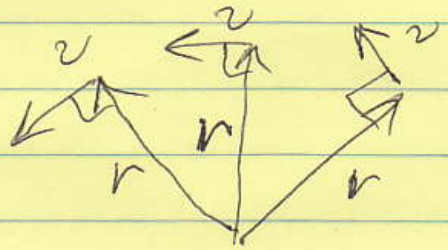
$\vec{\tau}_g = \frac{d\vec{L}}{dt}$



overhead view

time for 1 precession cycle is $\frac{2\pi L_{horizontal}}{\tau}$

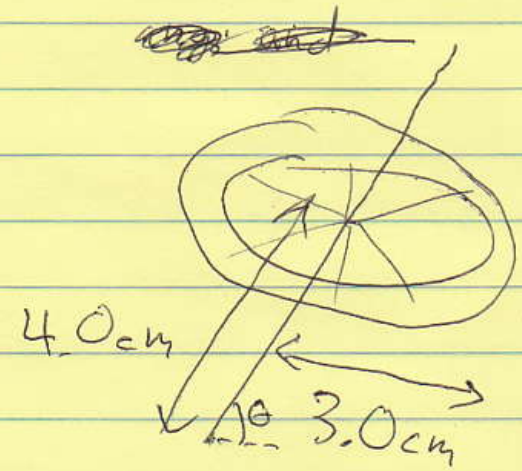
Similar to uniform circular motion:



$$v = \frac{2\pi r}{T}$$

$$T = \frac{2\pi r}{v}$$

~~Guestimate mass, radius,~~



HW

Assume all mass in ring

$\theta = 70°$

If it takes 0.45 seconds for one precession cycle, then find ω.