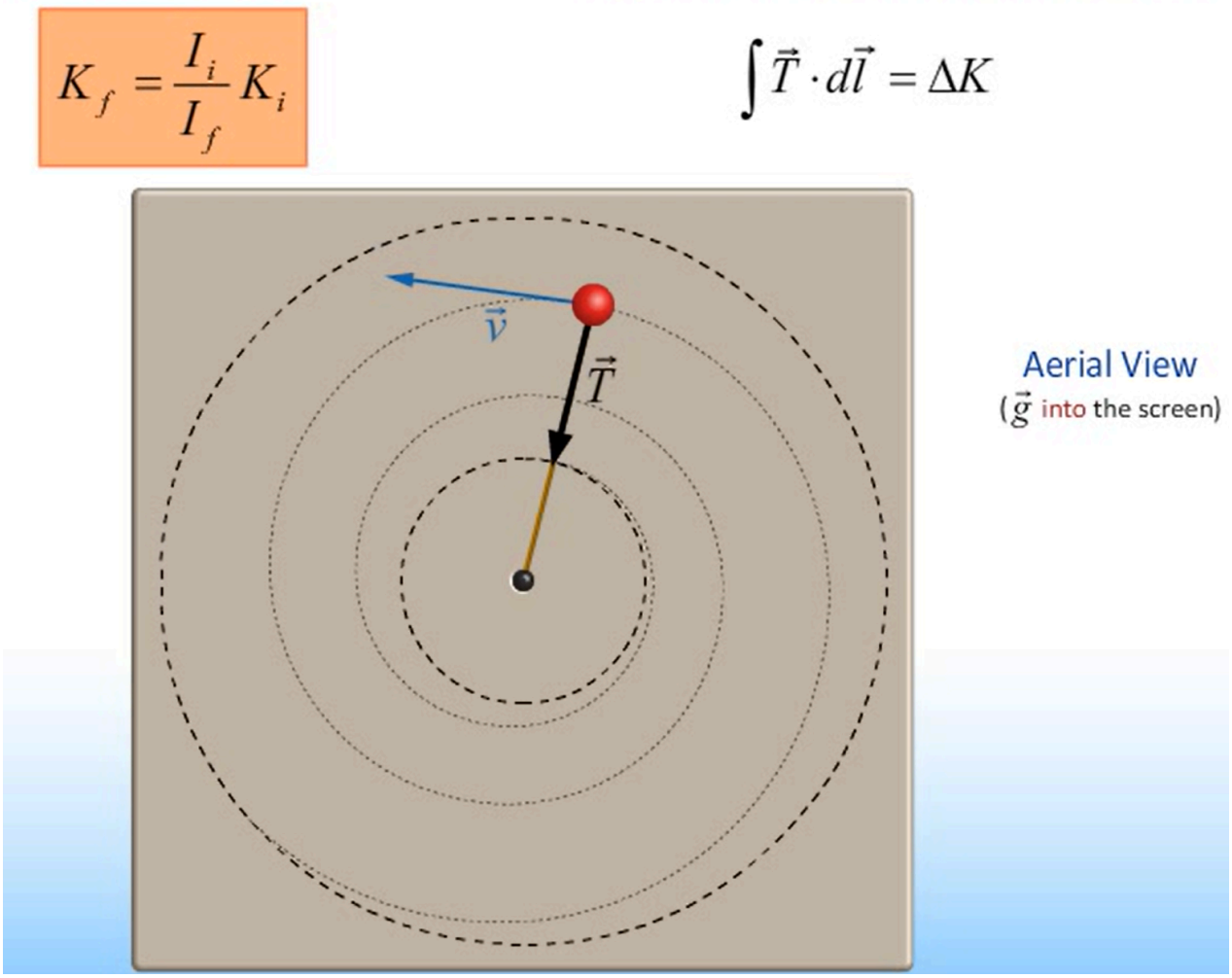
L21_Angular Momentum Vector and Precession

Spinning at a decreasing radius

1. Here the angular momentum is still conservative, as R decreases, I decreases, so ω increases, and Kinematic energy increases, which is caused by the work done by the tension

$$K_f = \frac{I_i}{I_f} K_i$$

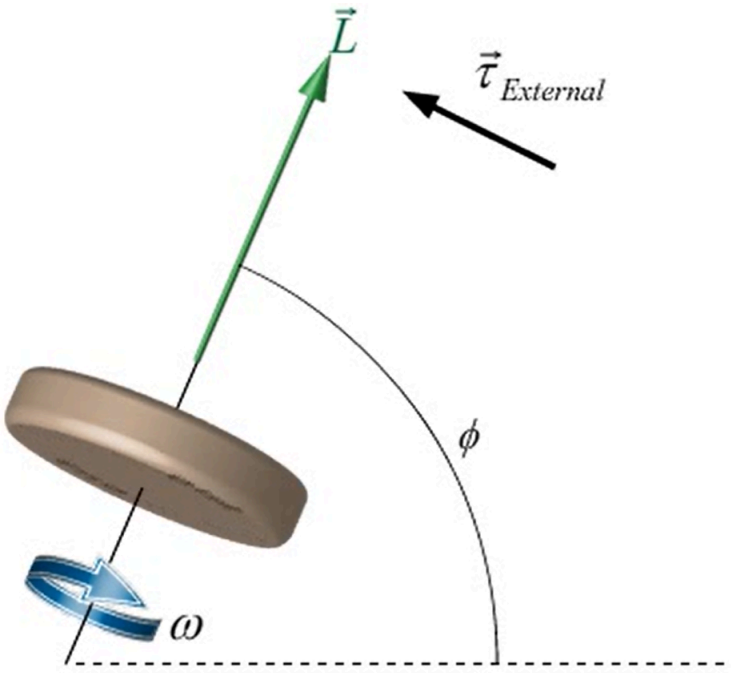
$$\int \vec{T} \cdot d\vec{l} = \Delta K$$



images/image-5.png

Precession

1. If a torque is perpendicular to the symmetric axis, it does not change the magnitude of the angular momentum, it only changes its direction
2. Precession Rate



Precession Rate

$$\frac{\tau_{Net,External}}{L} = \Omega$$

where $\Omega \equiv \frac{d\phi}{dt}$

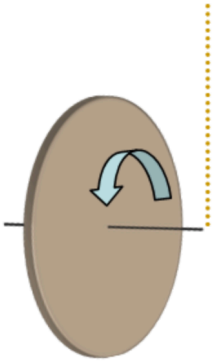
$$[\Omega] = \frac{\text{radians}}{\text{second}}$$

images/image-6.png

3. Period= $\frac{2\pi}{\Omega}$

Good Questions

1. The application of right hand rule



A disk with mass m = 6.6 kg and radius R = 0.42 m hangs from a rope attached to the ceiling. The disk spins on its axis at a distance r = 1.46 m from the rope and at a frequency f = 19.7 rev/s (with a direction shown by the arrow).

image-65.png

4) What is the direction of the angular momentum of the spinning disk at the instant shown in the picture?

- up
- down
- left
- right

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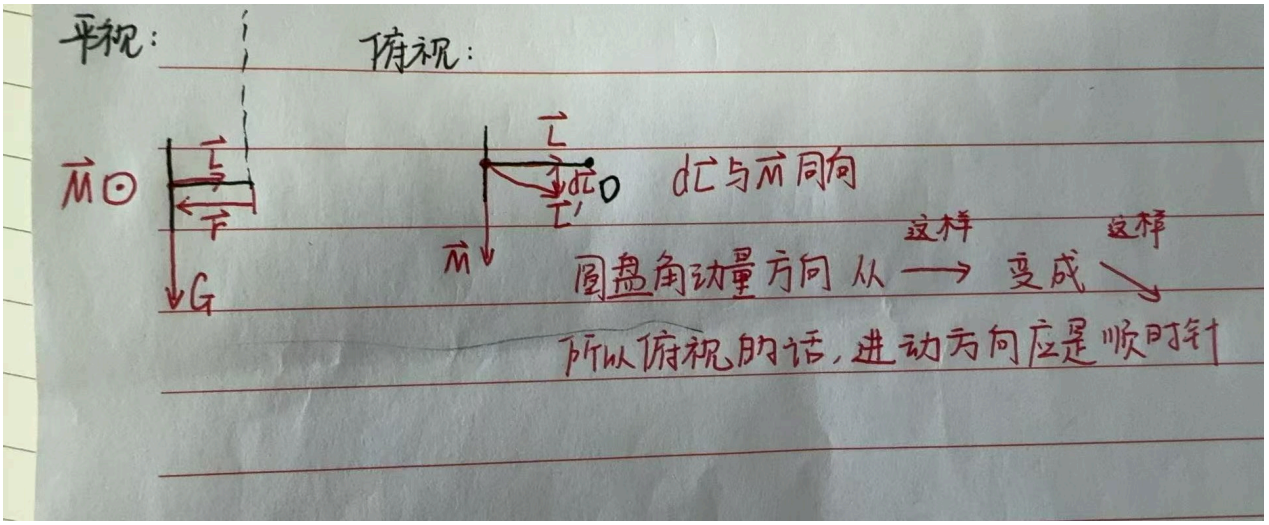
5) What is the direction of the precession of the gyroscope?

- it does not precess
- clockwise as seen from above (looking down the rope)
- counterclockwise as seen from above (looking down the rope)

Submit

image-66.png



993e6395f75761979b104206fdb4efa.jpg

2. A quick summary of right hand rule:
    1. To tell the direction of ω, curl the fingers as the direction of rotation, the direction of the thumb is the answer
    2. To tell the direction of the angular momentum L, same as the ω ,so curl the fingers as the direction of rotation, the direction of the thumb is the answer
    3. To tell the direction of the angular accleration α, if the ω is increasing, then α is to the same direction of ω
    4. To tell the direction of the torque τ , point the fingers from the axis to the action point, curl the fingers in the direction of the force, the direction of the thumb is the answer
    5. To tell the direction of the `precession` , tell by how the angular momentum changes, as shown in the image.
3. Another example of the use of right hand rule: Here the torque points out of the page

A space probe is motionless in interstellar space. It contains a massive disk rotating rapidly around the central axis of the probe. The direction of rotation of the disk, as indicated by the black arrows in the diagram, is counter-clockwise as viewed from the back of the probe.

At time t = 0 a pair of small identical thrusters begin firing, pushing down on the back side of the probe and up on the front side of the probe. The forces provided by the two thrusters are always equal in magnitude and opposite in direction.

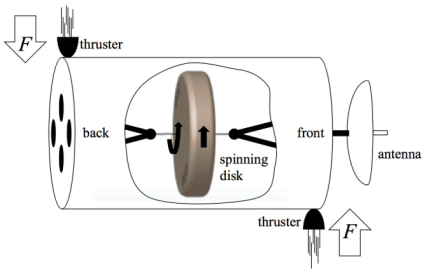


image-75.png

2) After the thrusters have been firing for several minutes, the probe has rotated by approximately 90 degrees. As a result, the antenna at the front of the probe (which was initially pointing towards the right side of the page) is now pointing

- (●) into the page.
- ( ) towards the top of the page.
- ( ) towards the bottom of the page.
- ( ) out of the page.
- ( ) towards the left side of the page.

image-74.png