# Wednesday Warm Up: Unit 6: Fixed axis rotation

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## 1 Memory Bank

- $\vec{s} = \vec{\theta} \times \vec{r}$ ... Geometric relationship.
- $\vec{v} = \vec{\omega} \times \vec{r}$ ... Geometric relationship.
- $\vec{\tau} = \vec{r} \times \vec{F}$ ... The relationship between *torque*, $\vec{\tau}$, the *moment arm*, $\vec{r}$, and the *force*, $\vec{F}$.
- $\vec{\tau} = I\vec{\alpha}$ ... Newton's 2nd law, in angular form.
- $W = \vec{\tau} \cdot \vec{\theta}$ ... Definition of work, angular form.
- $d\vec{L}/dt = \vec{\tau}$ ... Newton's 2nd law in angular form, with angular momentum.

## 2 Fixed Axis Rotation, Torque, and Kinetic Energy

1. An aircraft is coming in for a landing at 300 meters height when the propeller falls off. When it comes off, the propeller has a rotation rate of 20 rev/s, a moment of inertia of 70.0 kg m$^2$, and a mass of 200 kg. If air resistance is present and reduces the propeller's rotational kinetic energy at impact by 30%, what is the propeller's rotation rate at impact?

2. A neutron star of mass $2 \times 10^{30}$ kg and radius 10 km rotates with a period of 0.02 seconds. (a) What is its rotational kinetic energy? (b) If, 10 years later, a period of 0.04 seconds is observed, what energy was lost? (c) What is loss rate (power) that caused the slowdown?

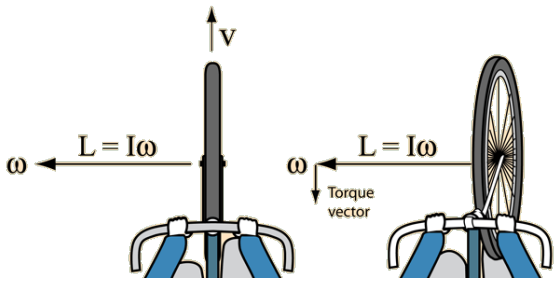


Figure 1: A bicycle turns left if you lean left.

3. Using $d\vec{L}/dt = \vec{\tau}$, show qualitatively that when a bicyclist leans left, he turns left.

4. If $\vec{\tau} = 0$, explain why angular momentum is conserved.