Physics 3210

Week 12 clicker questions

If $\mathbf{v}$ is a vector in one frame and $\mathbf{v}'$ is the same vector in a rotated frame, we showed that $\mathbf{v}'=A\mathbf{v}$, where A is a rotation matrix (the matrix of direction cosines). This determines $\mathbf{v}'$ given A and $\mathbf{v}$.

If instead we know $\mathbf{v}'$ and A, how can we find $\mathbf{v}$?

A. $\mathbf{v}=A\mathbf{v}'$
B. $\mathbf{v}=A^T\mathbf{v}'$
C. $\mathbf{v}=A^2\mathbf{v}'$
D. We can't determine $\mathbf{v}$ without first determining a different rotation matrix.

For a rotation matrix, $A^T A = I$.

What does this imply about the determinant of A?

A. det A = 1

B. det A = -1

C. det A = 1 or -1

D. det A = 0

E. None of the above.

Which of the following is the correct matrix for a rotation about the x axis?

A. $A_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \sin\theta & \cos\theta \\ 0 & -\cos\theta & \sin\theta \end{bmatrix}$

C. $A_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & \sin\theta \\ 0 & -\sin\theta & \cos\theta \end{bmatrix}$

B. $A_x = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

D. $A_x = \begin{bmatrix} \sin\theta & \cos\theta & 0 \\ -\cos\theta & \sin\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Suppose a book is rotated in two different ways: from the same starting orientation, the book is rotated by 90^o clockwise
(1) about the x axis, then about the y axis, then about the z axis,
or
(2) about the y axis, then about the x axis, then about the z axis.
Note: the axes are in the space frame.

How do the final orientations of the book compare?

A. The orientations are the same.

B. The orientations are different.

Using Euler angles, we wish to construct a rotation matrix that rotates first by angle φ about the z axis (matrix A_φ), then by angle θ about the x′ axis (matrix A_θ), then by angle ψ about the z′′ axis (matrix A_ψ). How should we multiply the three rotation matrices to get the final rotation matrix, $A(\varphi,\theta,\psi)$?

A. $A(\varphi,\theta,\psi)=A_\theta A_\psi A_\varphi$

B. $A(\varphi,\theta,\psi)=A_\varphi A_\theta A_\psi$

C. $A(\varphi,\theta,\psi)=A_\varphi A_\psi A_\theta$

D. $A(\varphi,\theta,\psi)=A_\psi A_\varphi A_\theta$

E. $A(\varphi,\theta,\psi)=A_\psi A_\theta A_\varphi$

Using Euler angles, we constructed a rotation matrix $A(\varphi,\theta,\psi)$ that rotates first by angle φ about the z axis (matrix A_φ), then by angle θ about the x' axis (matrix A_θ), then by angle ψ about the z'' axis (matrix A_ψ). What is the matrix A^{-1} that reverses (or undoes) this series of rotations?

A. $A^{-1}=A(\varphi,\theta,\psi)$

B. $A^{-1}=A^{T}(\varphi,\theta,\psi)$

C. $A^{-1}=A(\theta,\varphi,\psi)$

D. $A^{-1}=A^{T}(\theta,\varphi,\psi)$

E. $A^{-1}=A(\psi,\varphi,\theta)$

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Wednesday clicker questions

What is the relationship between the principle moments of inertia I_1, I_2, and I_3 for a <u>symmetric top</u>?

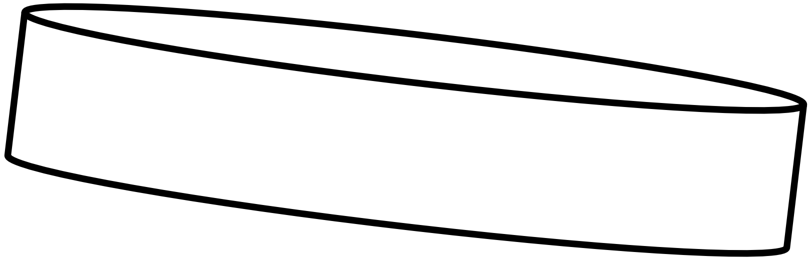
A. $I_1 = I_2 = I_3$

B. $I_1 \neq I_2 = I_3$

C. $I_1 \neq I_2 \neq I_3$

D. The answer depends on the choice of axes.

For a symmetric top with $I_2=I_3$, we defined $\varepsilon=(I_1-I_2)/I_2$.What is the sign of ε for an oblate object such as a coin?



A. $\varepsilon>0$

B. $\varepsilon=0$

C. $\varepsilon<0$

D. The answer depends on the choice of axes.

We showed that for force-free motion of a symmetric top, the angular momentum vector is given by

$$\mathbf{L} = \left(I_1 - I_2\right)\omega_1 \mathbf{e}_1 + I_2 \boldsymbol{\omega}$$

What does this imply about the geometry of the three vectors?

A. $\mathbf{L}$, $\mathbf{e}_1$, and $\boldsymbol{\omega}$ are orthogonal to each other.

B. $\mathbf{L}$ and $\mathbf{e}_1$ are orthogonal to each other.

C. $\mathbf{L}$ and $\boldsymbol{\omega}$ are orthogonal to each other.

D. $\mathbf{L}$, $\mathbf{e}_1$, and $\boldsymbol{\omega}$ lie in the same plane.

E. $\mathbf{L}$, $\mathbf{e}_1$, and $\boldsymbol{\omega}$ are parallel.

For force-free motion of a symmetric top <u>in the body frame</u>, $\boldsymbol{\omega}$ precesses about the $\mathbf{e}_1$ axis with angular velocity $\boldsymbol{\Omega}$, and the angular momentum $\mathbf{L}$ lies in the same plane as $\boldsymbol{\omega}$ and $\mathbf{e}_1$.
What does this imply about the motion of the angular momentum vector $\mathbf{L}$ in the body frame?

A. $\mathbf{L}$ is constant.

B. $\mathbf{L}$ precesses about the $\boldsymbol{\omega}$ axis with angular velocity $\boldsymbol{\Omega}$.

C. $\mathbf{L}$ precesses about the $\boldsymbol{\omega}$ axis an angular velocity different from $\boldsymbol{\Omega}$.

D. $\mathbf{L}$ precesses about the $\mathbf{e}_1$ axis with angular velocity $\boldsymbol{\Omega}$.

E. $\mathbf{L}$ precesses about the $\mathbf{e}_1$ axis an angular velocity different from $\boldsymbol{\Omega}$.

For force-free motion of a symmetric top <u>in the space frame</u>, we showed that

$$\dot{\boldsymbol{\omega}} = \frac{\mathbf{L}}{I_2} \times \boldsymbol{\omega}$$

.

What does this imply about the motion?

A. The vector $\boldsymbol{\omega}$ precesses about the $\mathbf{L}$ axis with angular velocity $\boldsymbol{\omega}_p = \mathbf{L}/(2I_2)$

B. The vector $\boldsymbol{\omega}$ precesses about the $\mathbf{L}$ axis with angular velocity $\boldsymbol{\omega}_p = \mathbf{L}/I_2$

C. The vector $\mathbf{L}$ precesses about the $\boldsymbol{\omega}$ axis with angular velocity $\boldsymbol{\omega}_p = \mathbf{L}/I_2$

D. The vector $\mathbf{L}$ precesses about the $\boldsymbol{\omega}$ axis with angular velocity $\boldsymbol{\omega}_p = \mathbf{L}/(2I_2)$

E. The vector $\boldsymbol{\omega}$ precesses about the $\mathbf{e}_1$ axis with angular velocity $\boldsymbol{\omega}_p = \mathbf{L}/I_2$

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Friday clicker questions