Physics 3210

Week 11 clicker questions

Multiplication of a vector by a matrix A is a linear transformation

$$\mathbf{v} \rightarrow A\mathbf{v}$$

What happens to an eigenvector of A under this linear transformation (assuming the corresponding eigenvalue is nonzero)?

A. The magnitude of the vector can change, but not its direction.
B. The direction of the vector can change, but not its magnitude.
C. Both the magnitude and the direction of the vector can change.
D. Neither the magnitude nor the direction of the vector can change.

The eigenvalue equation can be written as

$$(\mathrm{A}-\lambda \mathrm{I})\mathbf{v}=\mathbf{0}$$

What condition must be satisfied for λ to be an eigenvalue of A?

A. $(\mathrm{A}-\lambda \mathrm{I})=0$

B. $\mathrm{A}\mathbf{v}=\mathbf{0}$

C. $\det(\mathrm{A}-\lambda \mathrm{I})=0$

D. $\det(\mathrm{A})=0$

The matrix A has eigenvectors $\mathbf{v}_1, \mathbf{v}_2, \cdots \mathbf{v}_n$
which correspond to eigenvalues $\lambda_1, \lambda_2, \cdots \lambda_n$
The matrix S has the eigenvectors as its columns: $S = \begin{bmatrix} \mathbf{v}_1 & \mathbf{v}_2 & \cdots & \mathbf{v}_n \end{bmatrix}$
What is the product AS?

A. $AS = \begin{bmatrix} A\mathbf{v}_1 & A\mathbf{v}_2 & \cdots & A\mathbf{v}_n \end{bmatrix}$

B. $AS = \begin{bmatrix} \lambda_1\mathbf{v}_1 & \lambda_1\mathbf{v}_2 & \cdots & \lambda_1\mathbf{v}_n \end{bmatrix}$

C. $AS = \begin{bmatrix} \lambda_1\mathbf{v}_1 & \lambda_2\mathbf{v}_2 & \cdots & \lambda_n\mathbf{v}_n \end{bmatrix}$

D. $AS = \begin{bmatrix} \lambda_1\mathbf{v}_1^T \\ \lambda_2\mathbf{v}_2^T \\ \vdots \\ \lambda_n\mathbf{v}_n^T \end{bmatrix}$

Which of the following is the correct description of a cube of constant density?

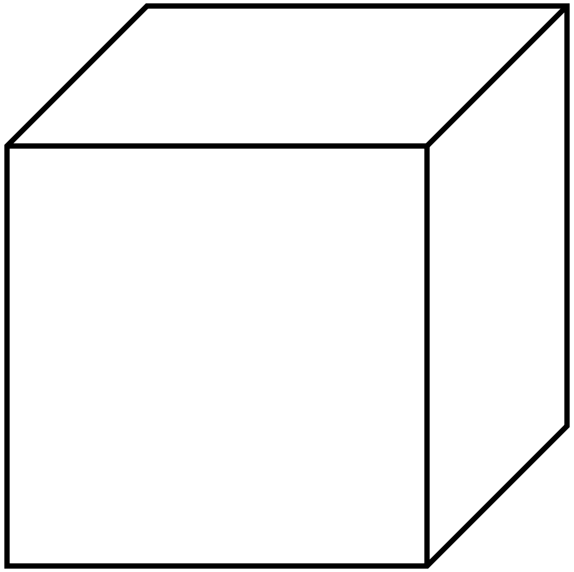
A. Spherical top.

B. Oblate symmetric top.

C. Prolate symmetric top.

D. Asymmetric top.

E. Rotor.



Physics 3210

Wednesday clicker questions

How is the time derivative of a vector **v** in an inertial frame (I) related to the time derivative of the vector in a rotating frame (R), which rotates with angular velocity vector **ω**?

A. $\left.\frac{d\mathbf{v}}{dt}\right)_I = \left.\frac{d\mathbf{v}}{dt}\right)_R$

B. $\left.\frac{d\mathbf{v}}{dt}\right)_I = \left.\frac{d\mathbf{v}}{dt}\right)_R + \boldsymbol{\omega}$

C. $\left.\frac{d\mathbf{v}}{dt}\right)_I = \left.\frac{d\mathbf{v}}{dt}\right)_R + \boldsymbol{\omega} \times \mathbf{v}$

D. $\left.\frac{d\mathbf{v}}{dt}\right)_I = \left.\frac{d\mathbf{v}}{dt}\right)_R + \mathbf{v} \times \boldsymbol{\omega}$

What is the first component of $\boldsymbol{\omega} \text{x} \text{I} \boldsymbol{\omega}$?

A. $\omega_2\omega_3\left(I_3 - I_2\right)$

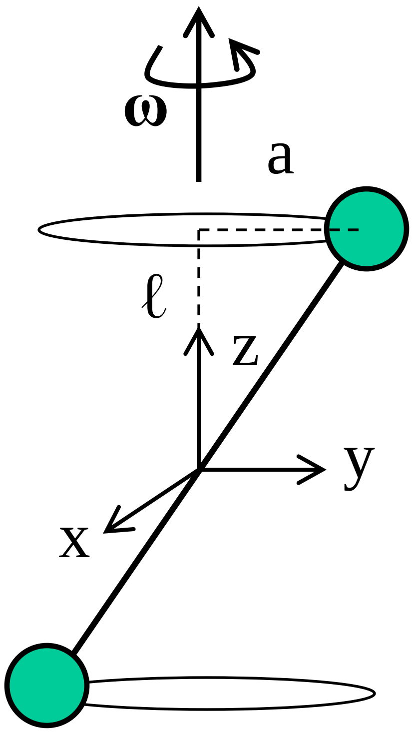
B. $\omega_2\omega_3\left(I_2 - I_3\right)$

C. $\omega_1\omega_3\left(I_3 - I_1\right)$

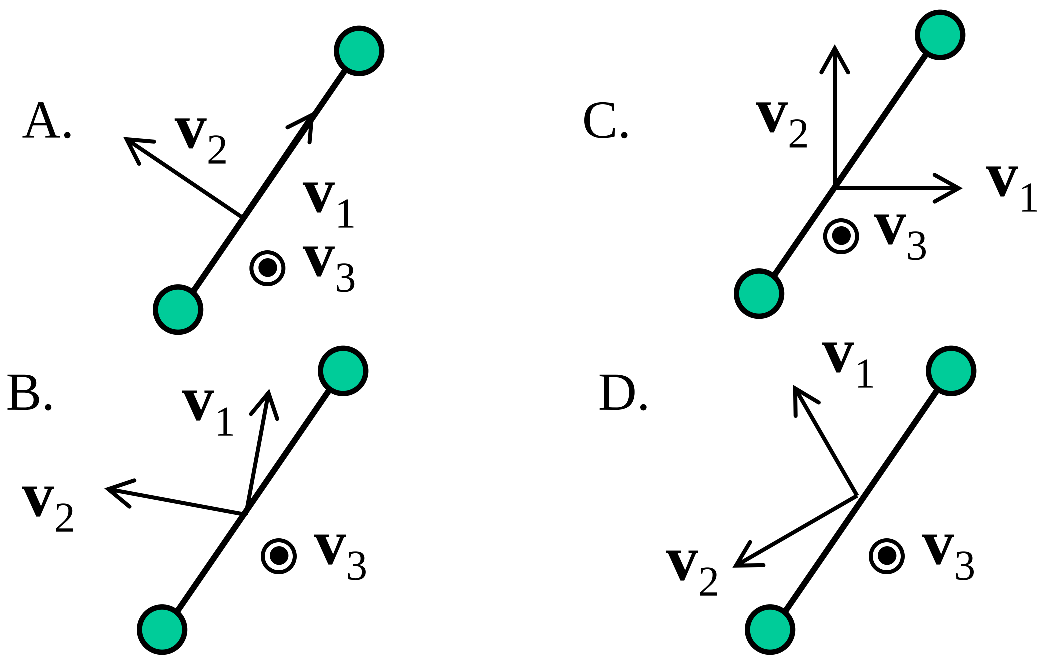
D. $\omega_1\omega_3\left(I_1 - I_3\right)$

E. $\omega_1\omega_2\left(I_2 - I_1\right)$

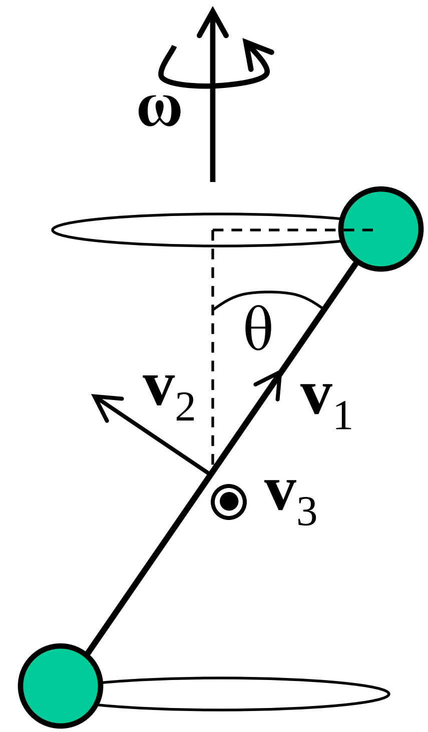
A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and $-\ell$, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega \hat{\mathbf{z}}$



Consider the body frame where the positions of the masses are $(0,a,\ell)$ and $(0,-a,-\ell)$. What are the principle axes of inertia?



A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and -ℓ, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega\hat{\mathbf{z}}$



Consider the body frame aligned with the principle axes of inertia (as sketched). What are the components of the angular velocity vector in this frame?

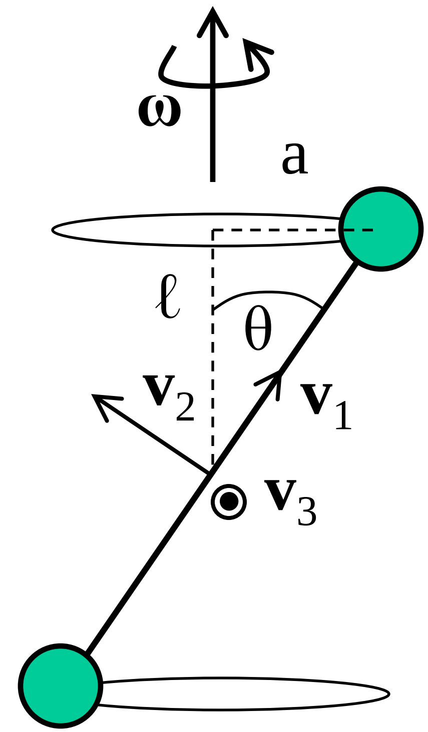
A. $\boldsymbol{\omega} = \begin{bmatrix} \omega\sin\theta \\ \omega\cos\theta \\ 0 \end{bmatrix}$

B. $\boldsymbol{\omega} = \begin{bmatrix} \omega\sin\theta \\ 0 \\ \omega\cos\theta \end{bmatrix}$

C. $\boldsymbol{\omega} = \begin{bmatrix} \omega\cos\theta \\ \omega\sin\theta \\ 0 \end{bmatrix}$

D. $\boldsymbol{\omega} = \begin{bmatrix} \omega\cos\theta \\ 0 \\ \omega\sin\theta \end{bmatrix}$

A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and $-\ell$, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega \hat{\mathbf{z}}$



Consider the body frame aligned with the principle axes of inertia (as sketched). What are Euler's equations in this frame?

A. $\tau_1 = 0$, $\tau_2 = 0$, $\tau_3 = 0$

$$\tau_1 = 0 \quad \tau_2 = 0 \quad \tau_3 = 0$$

B.

$$\tau_1 = 0 \quad \tau_2 = 0 \quad \tau_3 = 2m\left(a^2 + \ell^2\right)\omega^2 \sin\theta\cos\theta$$

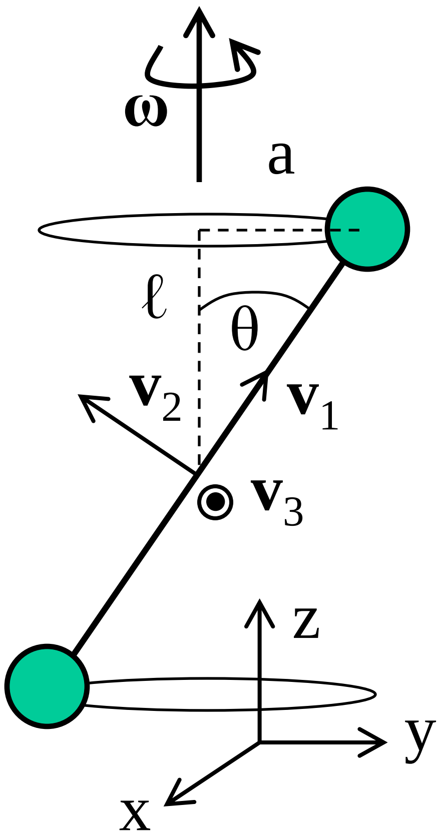
C.

$$\tau_1 = 0 \quad \tau_2 = 2ma\ell\omega^2 \quad \tau_3 = 2m\left(a^2 + \ell^2\right)\omega^2 \sin\theta$$

D.

$$\tau_1 = 0 \quad \tau_2 = 0 \quad \tau_3 = 2m\left(a^2 + \ell^2\right)\omega^2 \sin\theta$$

A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and -ℓ, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega\hat{\mathbf{z}}$



Consider the body frame aligned with the principle axes of inertia (as sketched). In this frame, the torque is constant in the 3 direction (out of the page). How can you describe the torque in the space frame?

A. The torque is zero.

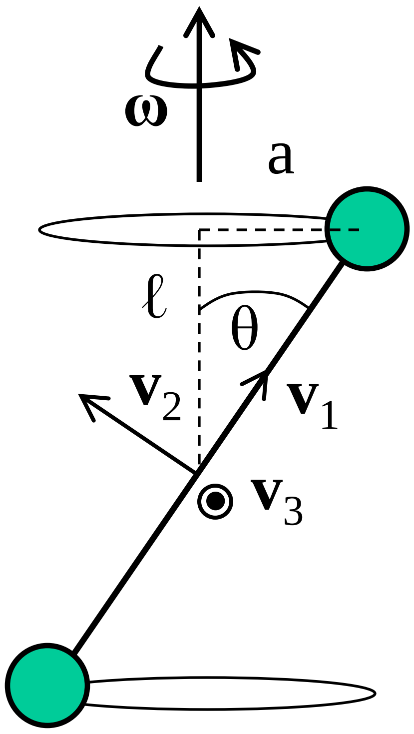
B. The torque is constant, in the same direction as in the body frame.

C. The torque rotates with a constant angular velocity about the z axis.

D. The torque rotates with a constant angular velocity about the x axis.

E. The torque rotates alternately about the z and x axes.

A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and -ℓ, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega\hat{\mathbf{z}}$



Consider the body frame aligned with the principle axes of inertia (as sketched). What is the angular momentum in this frame?

A. $\mathbf{L} = \begin{bmatrix} 0 \\ 2m\left(a^2 + \ell^2\right)\omega\sin\theta \\ 0 \end{bmatrix}$

B. $\mathbf{L} = \begin{bmatrix} 2m\left(a^2 + \ell^2\right)\omega\sin\theta \\ 0 \\ 0 \end{bmatrix}$

C. $\mathbf{L} = \begin{bmatrix} 0 \\ 2ma\ell\omega\sin\theta \\ 0 \end{bmatrix}$

D. $\mathbf{L} = \begin{bmatrix} 2ma\ell\omega\sin\theta \\ 0 \\ 0 \end{bmatrix}$

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Friday clicker questions