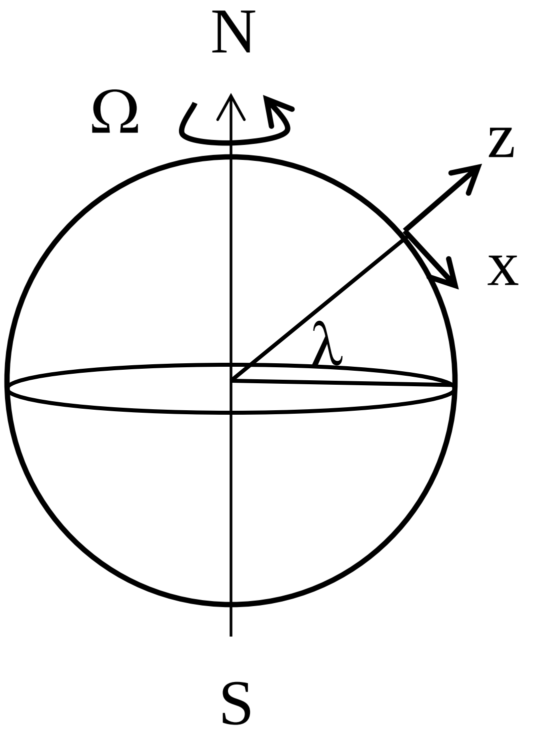
Physics 3210

Week 10 clicker questions

Consider a Foucault pendulum in the northern hemisphere. We derived the motion of the pendulum in the absence of rotation as x'(t), y'(t). When rotation of the earth is included, we find

$$\begin{bmatrix} x(t) \\ y(t) \end{bmatrix} = \begin{bmatrix} \cos\Omega_z t & \sin\Omega_z t \\ -\sin\Omega_z t & \cos\Omega_z t \end{bmatrix} \begin{bmatrix} x'(t) \\ y'(t) \end{bmatrix}$$

What is the effect of multiplying by the matrix?

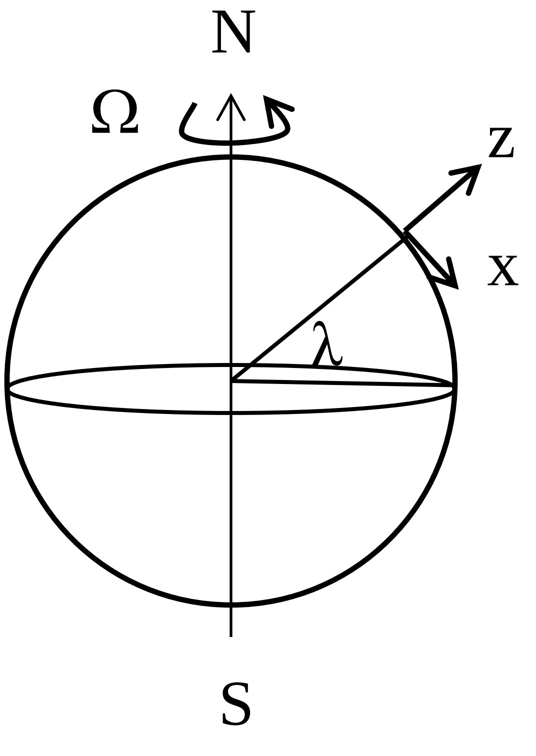


A. The x', y' solution is reflected about a time-dependent axis.
B. The x', y' solution is reflected about a fixed axis.
C. The x', y' solutions is rotated through a fixed angle.
D. The x', y' solution is rotated through a time-dependent angle.

Consider a Foucault pendulum in the northern hemisphere. We derived the motion of the pendulum in the absence of rotation as x'(t), y'(t). When rotation of the earth is included, we find

$$\begin{bmatrix} x(t) \\ y(t) \end{bmatrix} = \begin{bmatrix} \cos\Omega_z t & \sin\Omega_z t \\ -\sin\Omega_z t & \cos\Omega_z t \end{bmatrix} \begin{bmatrix} x'(t) \\ y'(t) \end{bmatrix}$$

What is precession frequency of the pendulum?



A. Ω

B. $\Omega \sin\lambda$

C. $\Omega \cos\lambda$

D. None of the above.

Consider a Foucault pendulum in the northern hemisphere. Where does the pendulum precess most rapidly?

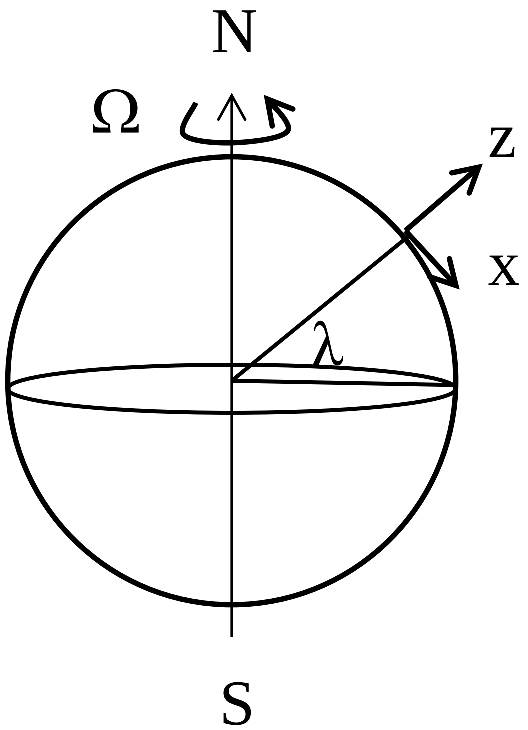
A. At the equator.

B. At 30 degrees N latitude.

C. At 45 degrees N latitude.

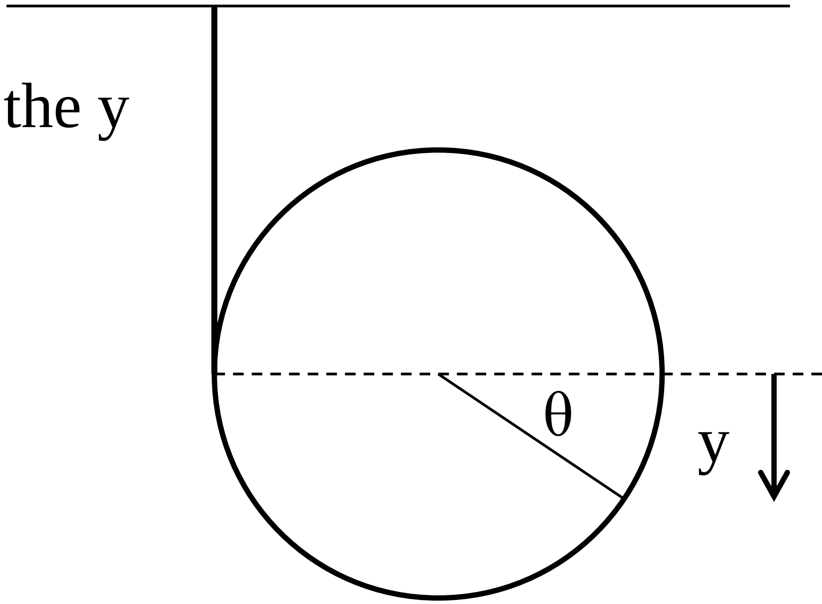
D. At 60 degrees N latitude.

E. At the north pole.



A cylinder (mass M, radius R) is suspended from a string wrapped around its edge. The cylinder is released from rest; it then falls and the string unwraps. The tension in the string has magnitude T.

What is the net force on the cylinder (in the y direction)?



A. $F = Mg$

B. $F = -T$

C. $F = Mg - T$

D. $F = T - Mg$

A cylinder (mass M, radius R) is suspended from a string wrapped around its edge. The cylinder is released from rest; it then falls and the string unwraps. The tension in the string has magnitude T.

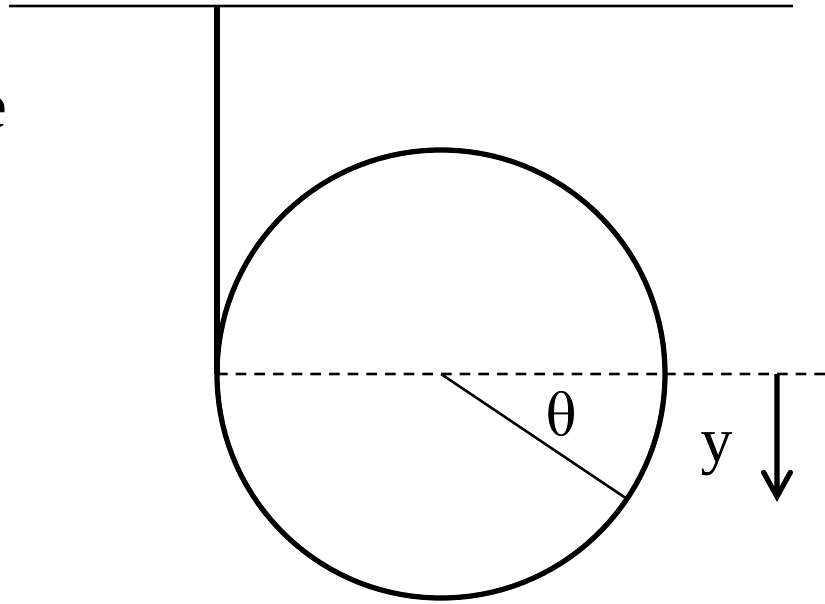
What are the sources of torque about the central axis of the cylinder?

A. Gravity.

B. Tension in the string.

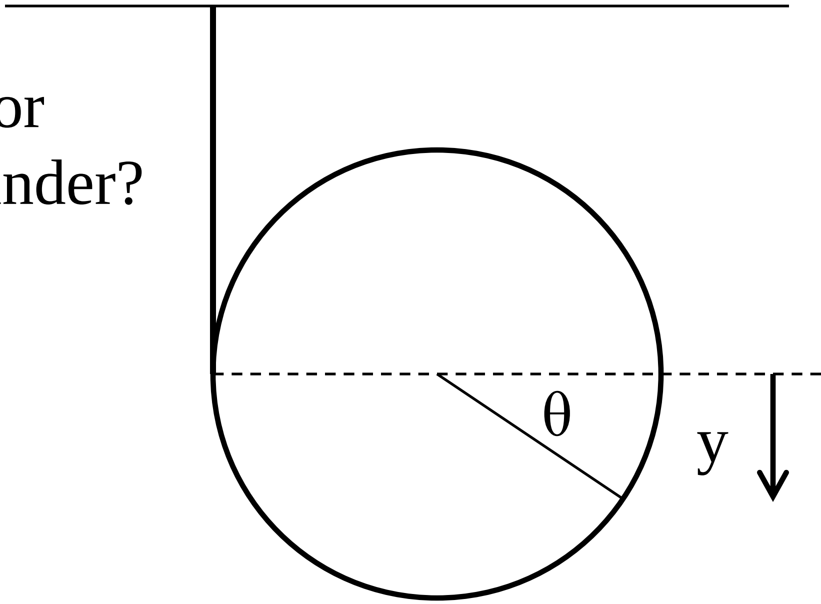
C. Both gravity and tension in the string.

D. Neither gravity nor tension in the string.



A cylinder (mass M, radius R) is suspended from a string wrapped around its edge. The cylinder is released from rest; it then falls and the string unwraps. The tension in the string has magnitude T.

What is the correct equation of motion for rotation about the central axis of the cylinder?



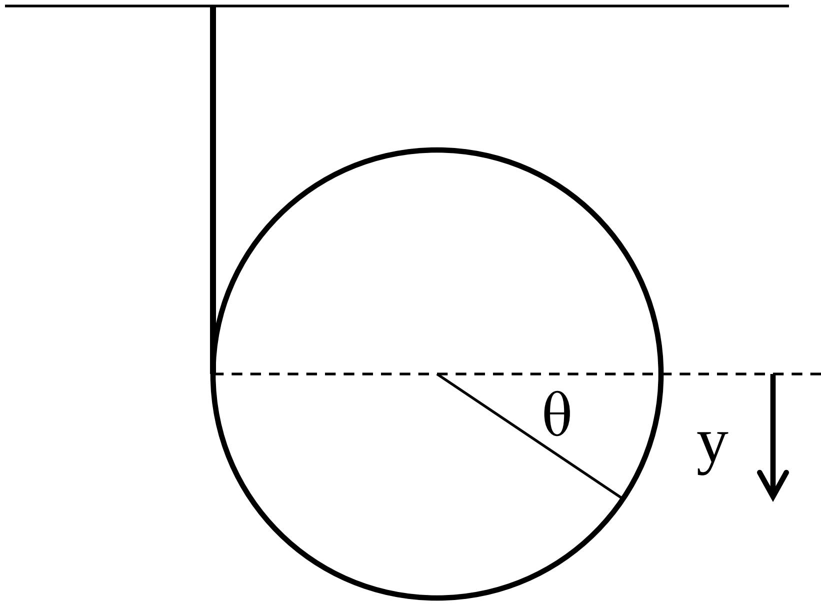
A. $I\ddot{\theta} = T$

B. $I\ddot{\theta} = -T$

C. $I\ddot{\theta} = RT$

D. $I\ddot{\theta} = -RT$

A cylinder (mass M, radius R) is suspended from a string wrapped around its edge. The cylinder is released from rest; it then falls and the string unwraps. The tension in the string has magnitude T.



What is the tension in the string?

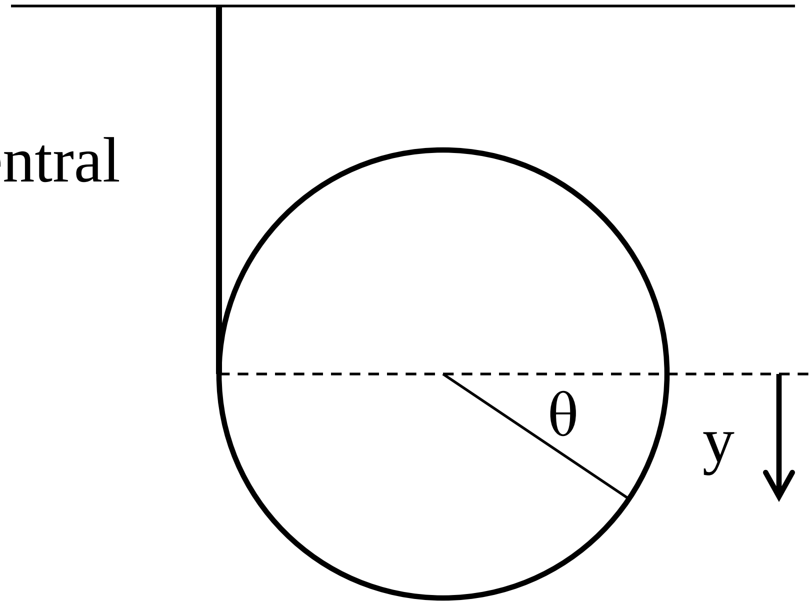
A. $T = \frac{1}{3}Mg$

B. $T = \frac{2}{3}Mg$

C. $T = Mg$

D. $T = \frac{4}{3}Mg$

A cylinder (mass M, radius R) is suspended from a string wrapped around its edge. The cylinder is released from rest; it then falls and the string unwraps. The tension in the string has magnitude T.



What is the angular velocity about the central axis of the cylinder?

A. $\dot{\theta} = \dfrac{gt}{3}$

B. $\dot{\theta} = \dfrac{2gt}{3}$

C. $\dot{\theta} = \dfrac{gt}{3R}$

D. $\dot{\theta} = \dfrac{2gt}{3R}$

Physics 3210

Wednesday clicker questions

A system of n particles is described by the masses and positions of each particle, relative to the center of mass: $m_\alpha, \mathbf{r}_\alpha$

What can you say about the quantity $\sum_\alpha m_\alpha \mathbf{r}_\alpha$?

A. $\sum_\alpha m_\alpha \mathbf{r}_\alpha = 0$

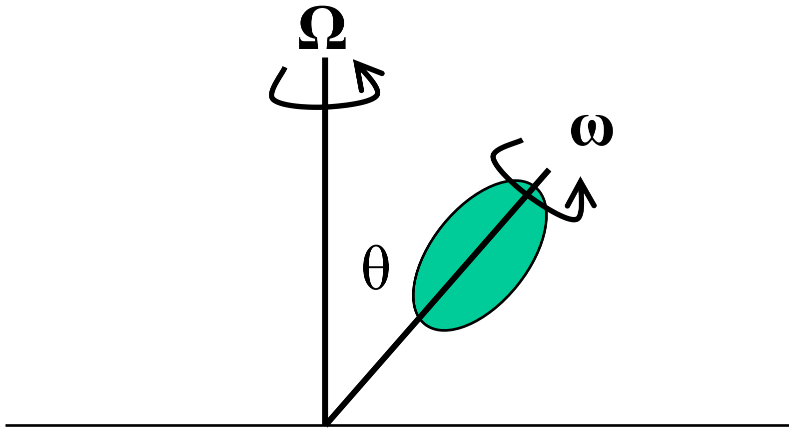
B. $\sum_\alpha m_\alpha \mathbf{r}_\alpha > 0$

C. $\sum_\alpha m_\alpha \mathbf{r}_\alpha < 0$

D. $\sum_\alpha m_\alpha \mathbf{r}_\alpha = \text{the position of the CM}$

A top spins about its own symmetry axis (angular velocity ω) and precesses about the vertical (angular velocity Ω).

How does the precession rate depend on the rotation rate?



A. Ω increases as ω increases.

B. Ω is independent of ω.

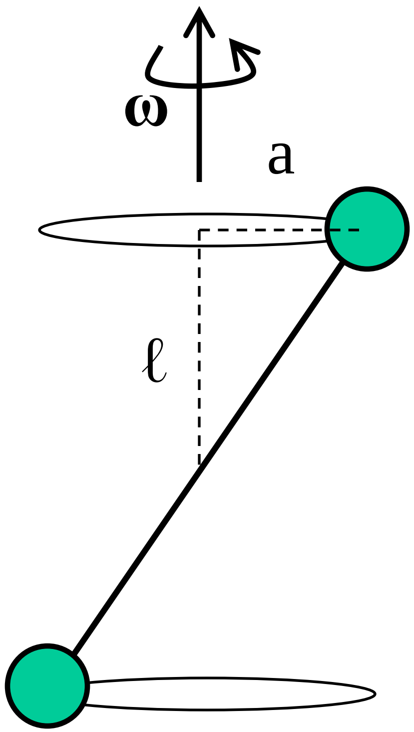
C. Ω decreases as ω increases.

D. It depends on the angle.

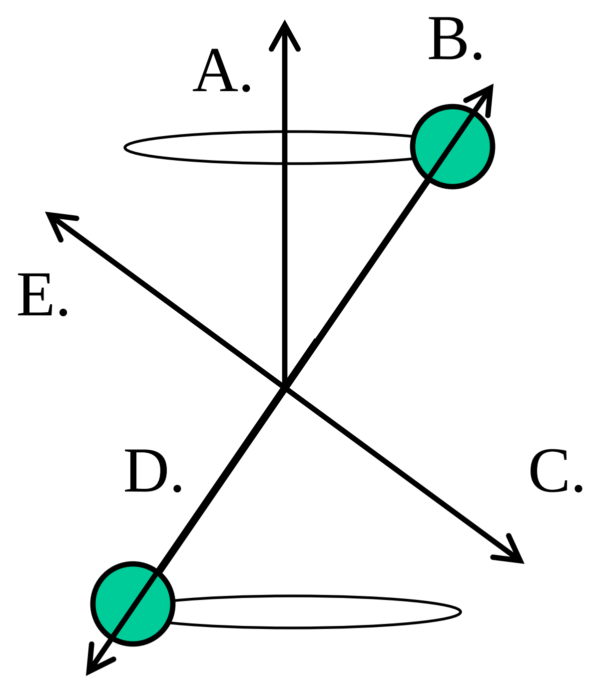
Physics 3210

Friday clicker questions

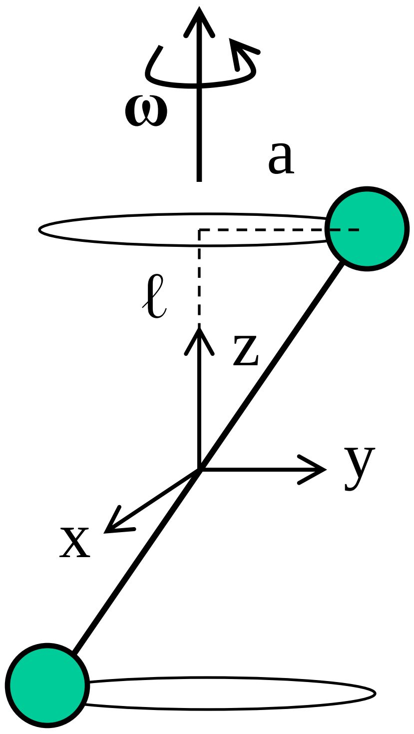
A rotating dumbbell consists of two masses (mass m) which move in circles (radius a) at z displacement ℓ and $-\ell$, joined by a massless rod. The angular velocity vector $\boldsymbol{\omega} = \omega\hat{\mathbf{z}}$



What is the direction of the angular momentum vector **L**?



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 is the I_{33} component of the inertia tensor?

A. $I_{33} = \frac{1}{2}ma^2$

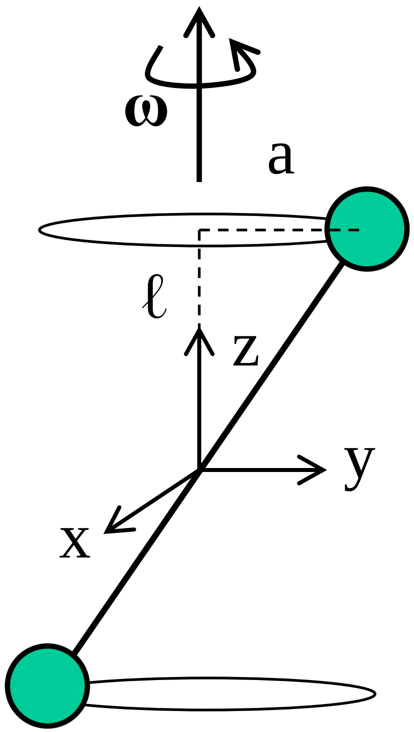
B. $I_{33} = ma^2$

C. $I_{33} = 2ma^2$

D. $I_{33} = m\ell^2$

E. $I_{33} = 2m\ell^2$

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 is the I_{13} component of the inertia tensor?

A. $I_{13} = 2ma\ell$

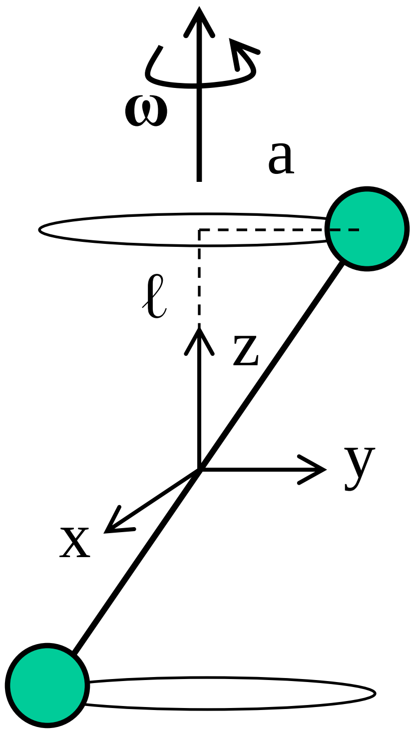
B. $I_{13} = ma\ell$

C. $I_{13} = -2ma\ell$

D. $I_{13} = -ma\ell$

E. $I_{13} = 0$

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 is the I_{23} component of the inertia tensor?

A. $I_{23} = 2ma\ell$

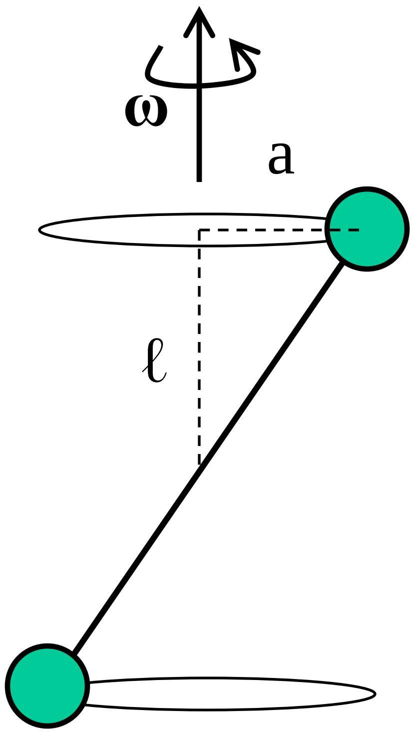
B. $I_{23} = ma\ell$

C. $I_{23} = -2ma\ell$

D. $I_{23} = -ma\ell$

E. $I_{23} = 0$

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 $\boldsymbol{\omega} = \omega\hat{\mathbf{z}}$



What is the kinetic energy of the system?

A. $T = 2ma^2\omega^2$

B. $T = ma^2\omega^2$

C. $T = \frac{1}{2}ma^2\omega^2$

D. $T = -2ma^2\omega^2$

E. $T = 0$

The inertia tensor is a 3-by-3 matrix with real positive eigenvalues and orthogonal eigenvectors.
As a result, how many of the following statements are true?

1. The matrix can be diagonalized.
2. The matrix of eigenvectors is an orthogonal matrix.
3. The matrix of eigenvectors is a rotation matrix (if properly normalized).
4. In the coordinate system aligned with the eigenvectors, the inertia tensor is diagonal.

A. None are true.

B. Exactly one is true.

C. Exactly two are true.

D. Exactly three are true.

E. All four are true.