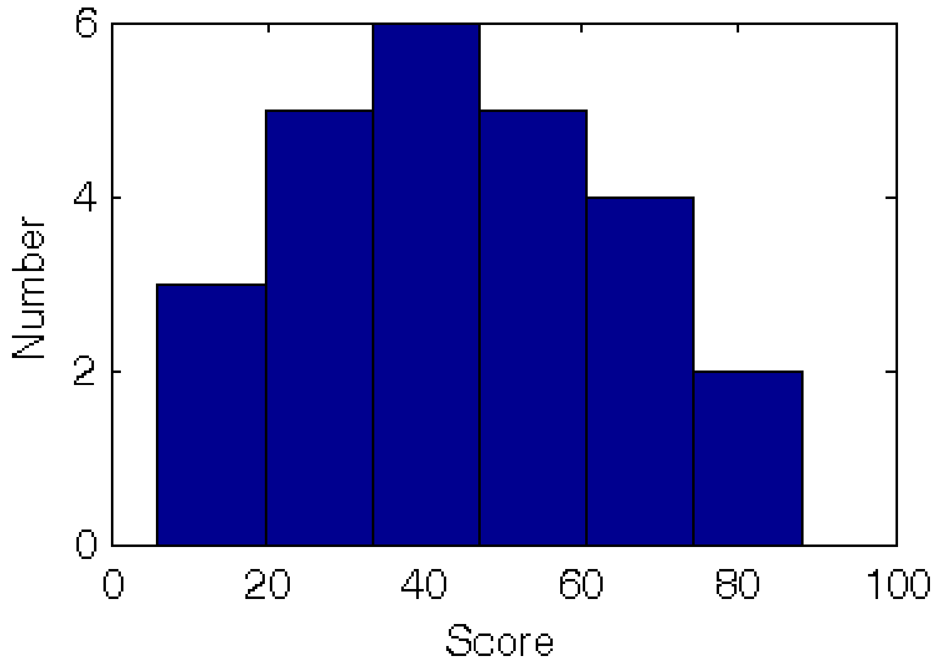
Physics 3210

Week 9 clicker questions

Exam 2 scores



Median=45

Standard deviation=22

Which of the following types of motion lead to fictitious forces (in the moving reference frame)?

1. The frame moves at a constant velocity with respect to an inertial reference frame.
2. The frame rotates at a constant angular velocity with respect to an inertial reference frame.
3. The frame moves at a constant acceleration with respect to an inertial reference frame.
4. The frame rotates at a constant angular acceleration with respect to an inertial reference frame.

A. None
B. Exactly one
C. Exactly two
D. Exactly three
E. All four

For a rotating coordinate frame with the rotation aligned with the z axis, we derived that

$$x\frac{d\hat{x}}{dt}+y\frac{d\hat{y}}{dt}+z\frac{d\hat{z}}{dt}=\left(-x\Omega\sin\theta\sin\Omega t,\, y\Omega\sin\theta\cos\Omega t,\, 0\right)$$

How can this expression be rewritten in vector notation?

A. $\mathbf{r}\cdot\boldsymbol{\Omega}$

B. $(\boldsymbol{\Omega}\times\mathbf{r})\cdot\boldsymbol{\Omega}$

C. $(\boldsymbol{\Omega}\times\mathbf{r})\cdot\mathbf{r}$

D. $\boldsymbol{\Omega}\times\mathbf{r}$

The coriolis and centrifugal “forces” are

$$\mathbf{F}_{\text{coriolis}} = -2m\mathbf{\Omega}\times\mathbf{v}$$

$$\mathbf{F}_{\text{centrifugal}} = -m\mathbf{\Omega}\times(\mathbf{\Omega}\times\mathbf{r})$$

Which force is more important in the limit of slow velocity (in the rotating frame)?

A. Coriolis force

B. Centrifugal force

C. They are equally important

D. Neither is important

E. More information is needed to answer

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$$\mathbf{F}_{\text{coriolis}} = -2m\mathbf{\Omega}\times\mathbf{v}$$

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A disk drive typically rotates at about 3600 rpm = 360 radians/sec. For a dust particle at a radius r=5 cm, how fast must the particle be moving (in the rotating frame) for the coriolis and centrifugal forces to have approximately equal magnitude?

A. 9 cm/sec

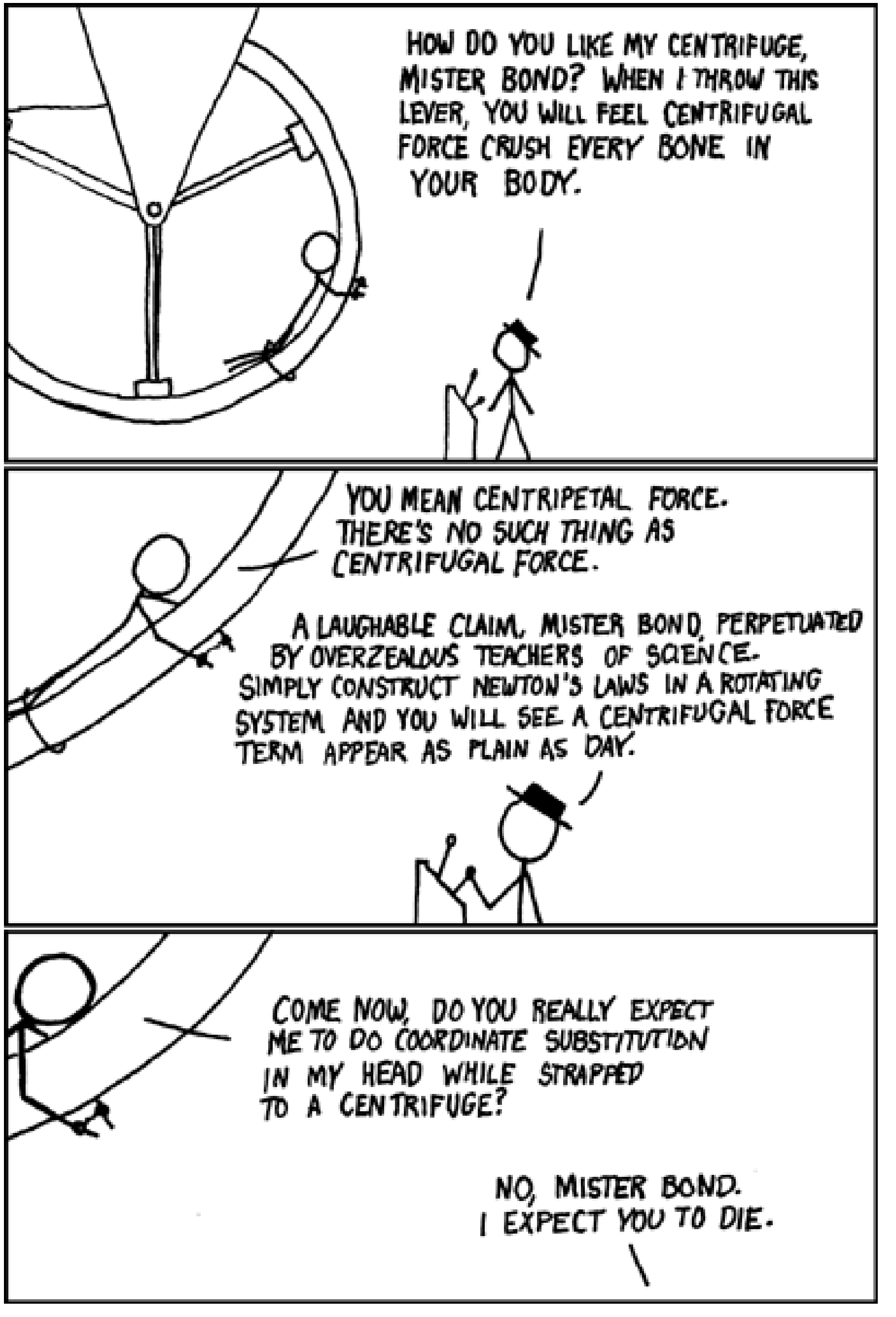
B. 90 cm/sec

C. 900 cm/sec

D. 9000 cm/sec

Physics 3210

Wednesday clicker questions



A bead rests on a wire that extends from the origin at and angle θ to the vertical; the wire rotates with angular velocity Ω about the vertical. In the frame rotating with the wire, what is the magnitude and direction of the centrifugal force when the bead is a distance r from the origin?

A. $m\Omega^2 r \sin\theta$, away from the rotation axis

B. $m\Omega^2 r \sin\theta$, towards from the rotation axis

C. $m\Omega^2 r \cos\theta$, away from the rotation axis

D. $m\Omega^2 r \cos\theta$, towards from the rotation axis

A bucket of water spins about its central axis. After a relaxation time the shape of the water surface reaches a steady state. Where is the water surface highest?

A. The water is highest at the center of the bucket.

B. The water is highest at a point intermediate between the center and edge of the bucket.

C. The water is highest at the edge of the bucket.

D. The answer depends on the rotation rate.

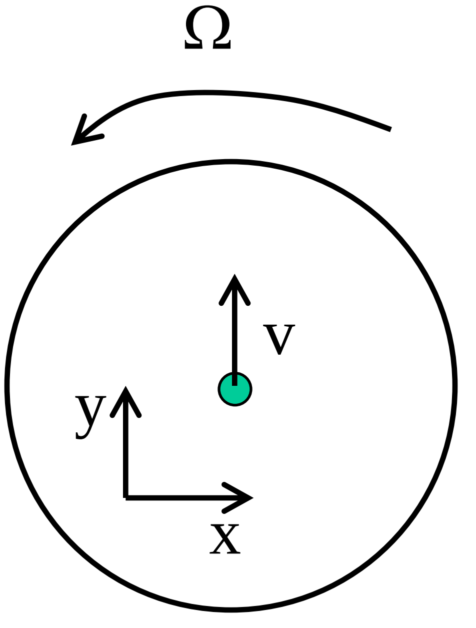
A hockey puck slides from the center towards the edge of a frictionless, rotating merry-go-round. The merry-go-round has angular velocity Ω and rotates CCW when viewed from above. In the rotating frame, the initial velocity is in the positive y direction. In the <u>inertial</u> frame, which way does the path of the puck bend?

A. The path curves to the right when viewed from above (towards positive x).

B. The path doesn't curve.

C. The path curves to the left when viewed from above (towards negative x).

D. The answer depends on the rotation rate.



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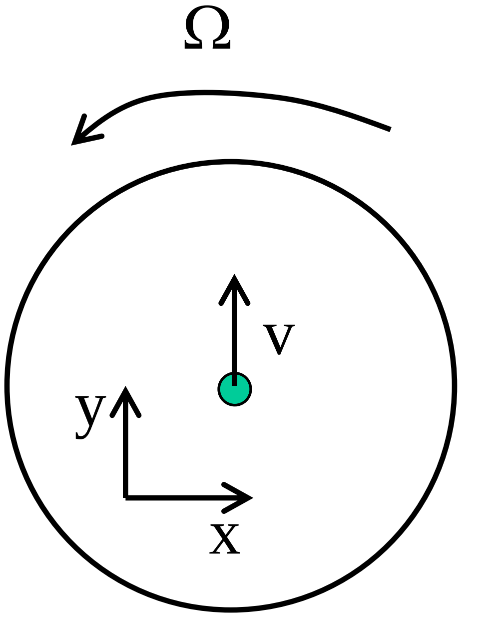
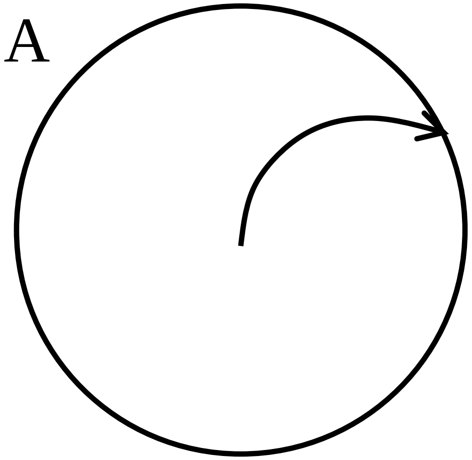


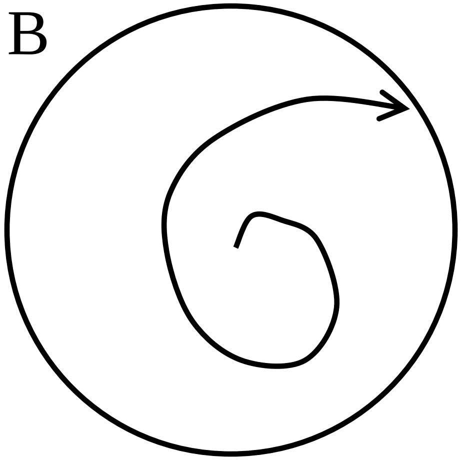
A hockey puck slides from the center towards the edge of a frictionless, rotating merry-go-round. The merry-go-round has angular velocity Ω and rotates CCW when viewed from above. In the rotating frame, the initial velocity is in the positive y direction.

Below are two different paths taken by the puck in the rotating frame. Which correspond to motion with a larger initial velocity?

A



B



C. It cannot be determined from the information given.

D. The answer depends on the rotation rate Ω.

A hockey puck slides from the center towards the edge of a frictionless, rotating merry-go-round. The merry-go-round has angular velocity Ω and rotates CCW when viewed from above. In the rotating frame, the initial velocity is in the positive y direction.

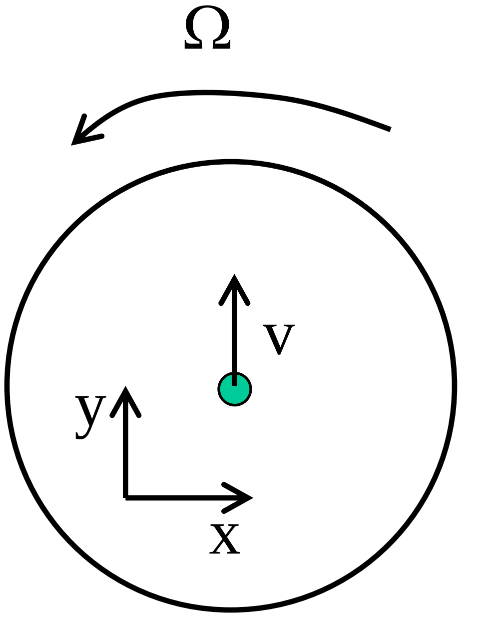
What effect does the Coriolis force have on the velocity of the puck?

A. The Coriolis force changes the magnitude of the velocity, but not the direction.

B. The Coriolis force changes the direction of the velocity, but not the magnitude.

C. The Coriolis force changes both the magnitude and the direction of the velocity.

D. The answer depends on the rotation rate.



Physics 3210

Friday clicker questions

A hockey puck slides from the center towards the edge of a frictionless, rotating merry-go-round. The merry-go-round has radius a, angular velocity Ω and rotates CCW when viewed from above. In the rotating frame, the initial velocity is in the positive y direction; neglect the centrifugal force.

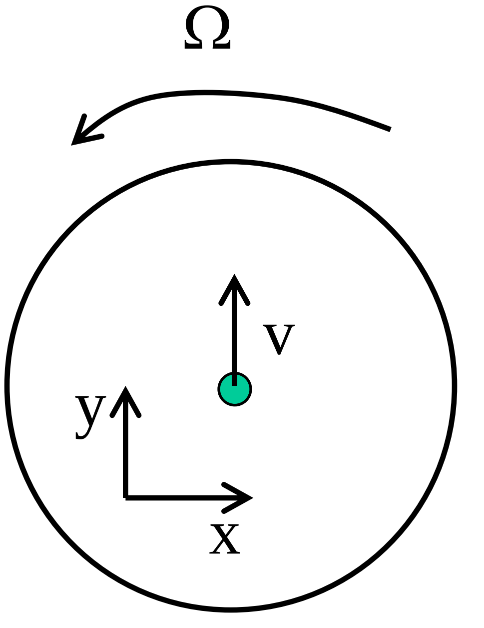
How many rotations does the merry-go-round make before the puck slides off the edge?

A. $\frac{a\Omega}{\pi v}$

B. $\frac{a\Omega}{2\pi v}$

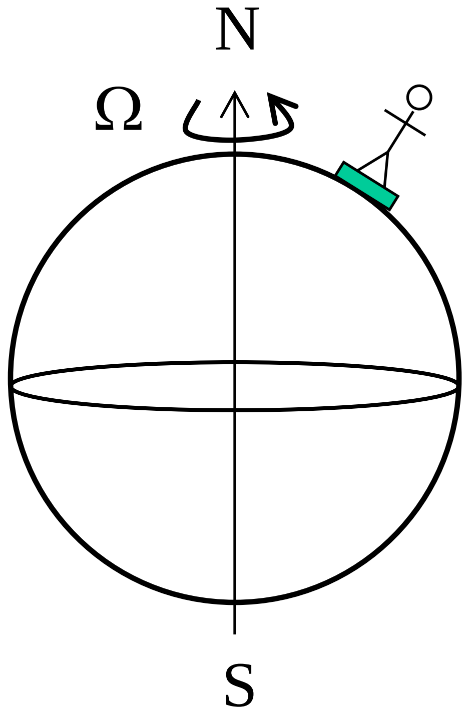
C. $\frac{\pi v}{a\Omega}$

D. $\frac{2\pi v}{a\Omega}$



At which of these points will a person's measured weight be <u>largest</u>?

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.



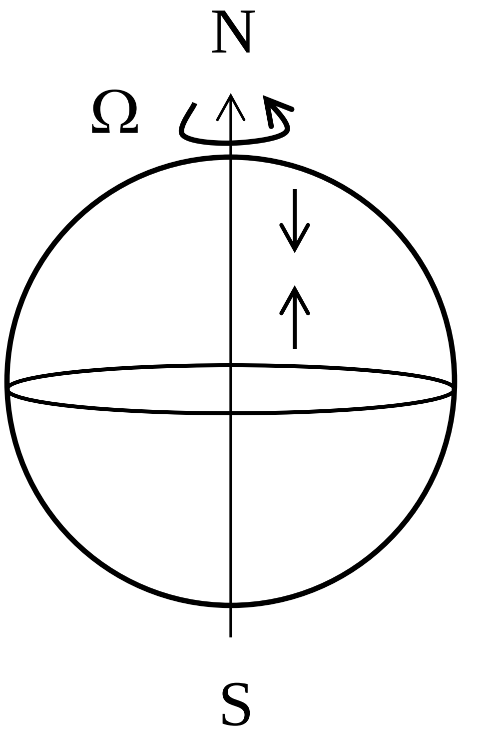
In the <u>northern</u> hemisphere, what direction are winds from the north and south deflected by the Coriolis force?

A. Winds from the N are deflected E and winds from the S are deflected W.

B. Winds from the N are deflected E and winds from the S are deflected E.

C. Winds from the N are deflected W and winds from the S are deflected W.

D. Winds from the N are deflected W and winds from the S are deflected E.



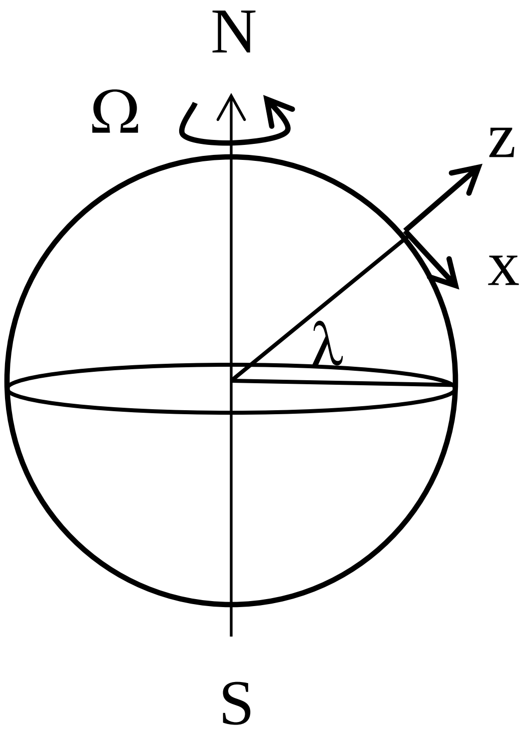
Consider a Foucault pendulum in the northern hemisphere. The latitude is λ and we are using coordinates where x points towards the equator, y points parallel to a latitude line, and z points away from the center of the earth. What is the rotation vector in this coordinate system?

A. $\mathbf{\Omega} = \Omega \begin{bmatrix} -\cos\lambda \\ 0 \\ \sin\lambda \end{bmatrix}$

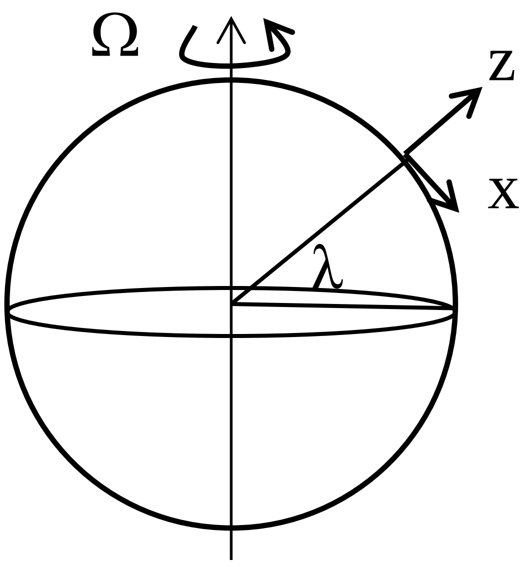
B. $\mathbf{\Omega} = \Omega \begin{bmatrix} \cos\lambda \\ 0 \\ \sin\lambda \end{bmatrix}$

C. $\mathbf{\Omega} = \Omega \begin{bmatrix} -\sin\lambda \\ 0 \\ \cos\lambda \end{bmatrix}$

D. $\mathbf{\Omega} = \Omega \begin{bmatrix} \sin\lambda \\ 0 \\ \cos\lambda \end{bmatrix}$



Consider a Foucault pendulum in the northern hemisphere. The latitude is λ and we are using coordinates where x points towards the equator, y points parallel to a latitude line, and z points away from the center of the earth. What is the cross product of the rotation and velocity vectors in this coordinate system?



A. $$\mathbf{\Omega}\times\mathbf{v}=\begin{bmatrix}-\dot{x}\Omega\sin\lambda\\ \dot{y}\Omega\sin\lambda\\ -\dot{x}\Omega\cos\lambda\end{bmatrix}$$

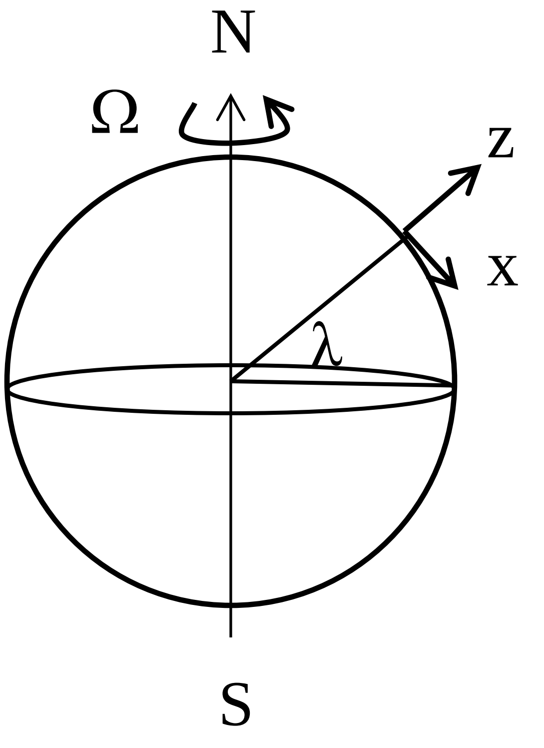
B. $$\mathbf{\Omega}\times\mathbf{v}=\begin{bmatrix}-\dot{x}\Omega\cos\lambda\\ \dot{y}\Omega\cos\lambda\\ -\dot{x}\Omega\sin\lambda\end{bmatrix}$$

C. $$\mathbf{\Omega}\times\mathbf{v}=\begin{bmatrix}-\dot{y}\Omega\sin\lambda\\ \dot{x}\Omega\sin\lambda\\ -\dot{y}\Omega\cos\lambda\end{bmatrix}$$

D. $$\mathbf{\Omega}\times\mathbf{v}=\begin{bmatrix}-\dot{y}\Omega\cos\lambda\\ \dot{x}\Omega\cos\lambda\\ -\dot{y}\Omega\sin\lambda\end{bmatrix}$$

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.

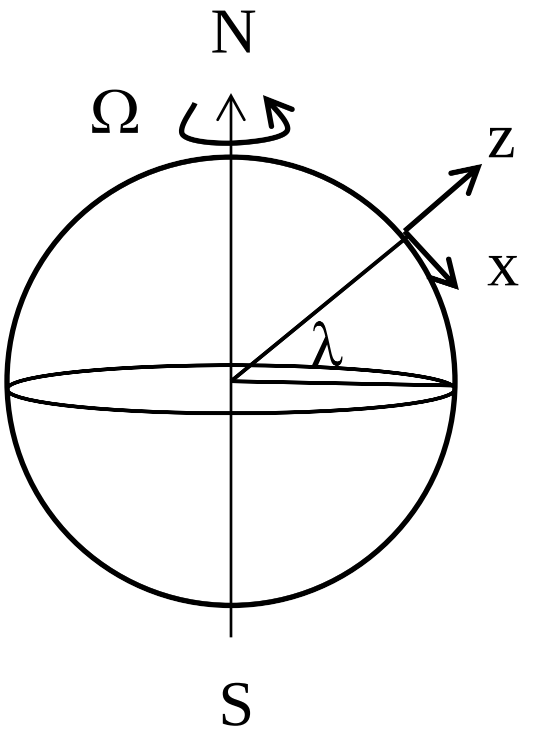
C. The x', y' solutions is rotated through a fixed angle.

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. Ω sinλ
C. Ω cosλ
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.