quizz 8, ME 240 Dynamics, Fall 2017

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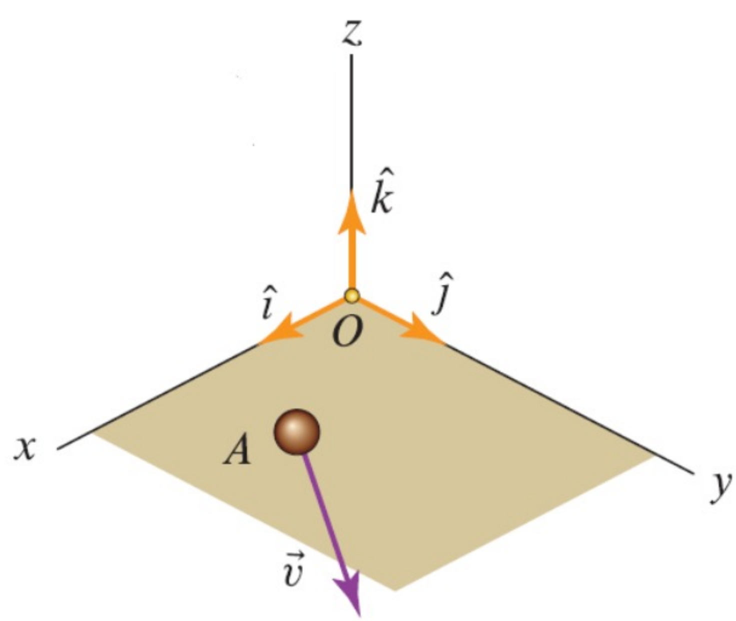
0.1 Problem 1



The particle A, which has mass 3 kg, is moving in the coordinate system shown above. A is currently at position X=1.5, Y=5.8, Z=-1.2 m relative to the origin O, and is moving with velocity $\vec{v}$=4.1i+4.4j+5.3k m/s.

What is the magnitude of the angular momentum of particle A about the origin O (kg*m^2/s)?

Report your answer to the nearest whole number.

Let $\bar{h}_O$ be the angular momentum of A w.r.t to O. Therefore apply the definition

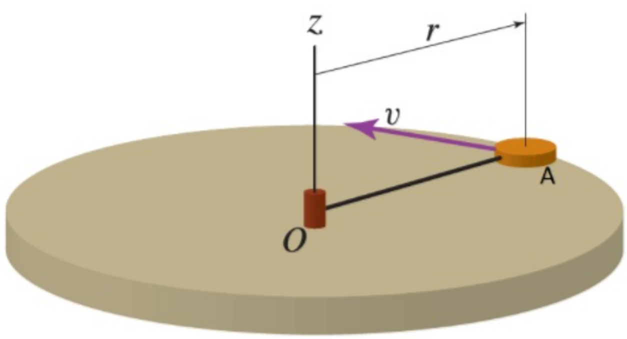
$$
\begin{aligned}
\bar{h}_O &= \bar{r}_{A/O} \times m\bar{v}_A \\
&= 3 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1.5 & 5.8 & -1.2 \\ 4.1 & 4.4 & 5.3 \end{vmatrix} \\
&= 3\left(36.02\hat{\imath} - 12.87\hat{\jmath} - 17.18\hat{k}\right) \\
&= 108.06\hat{\imath} - 38.61\hat{\jmath} - 51.54\hat{k}
\end{aligned}
$$

Hence

$$
\begin{aligned}
\left|\bar{h}_O\right| &= \sqrt{108^2 + 38.61^2 + 51.54^2} \\
&= 125.794 \text{ kg-m}^2/\text{sec}
\end{aligned}
$$

0.2 Problem 2

Question 2 2 pts



Particle A with mass 3.6 kg is attached to the origin O by a string of viscoelastic putty (silly putty) that slowly stretches. Initially A travels at speed V=9.87 m/s and at radius $r = r_0$ m.

What is the speed of A (m/s) when the radius is r =2.29*r_0

Report your answer to two decimal places.

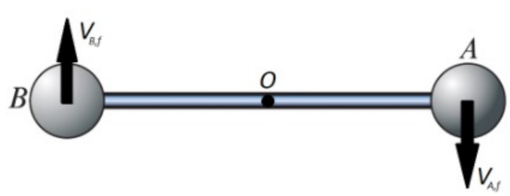
By conservation of angular momentum

$$\begin{aligned} r_0 m v_A &= 2.29 r_0 m v_2 \\ v_2 &= \frac{v_A}{2.29} \\ &= \frac{9.87}{2.29} \\ &= 4.31 \text{ m/s} \end{aligned}$$

0.3 Problem 3

Particles A (mass 9.8 kg) and B (mass 8.3 kg) are on a massless rod with length L=5.0 meters which spins about the origin O. There is a linear motor at the origin that can move the bar back and forth relative to the origin, without applying a moment to the system. Initially particle B is at the origin O and particle A is traveling with a speed of V_A=3.70 m/s (shown above).

The linear motor at O slowly moves the rod, so that A moves toward O and B moves away from O. There are no other forces or moments.



When the rod is centered at O (as seen above), what is the velocity of B (m/s)?

Report your answer to two decimal places.

Angular momentum initially

$$\begin{aligned}\bar{h}_1 &= \bar{r}_{A/O} \times m_A \bar{v}_A \\ &= 9.8 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 5 & 0 & 0 \\ 0 & -3.7 & 0 \end{vmatrix} \\ &= -181.3\hat{k} \qquad (1)\end{aligned}$$

In new state, we first note that $\left|\bar{v}_{A_2}\right| = |\bar{v}_B|$ since both are the same radius from origin. This means $\left|v_{A_y}\right| = \left|v_{B_y}\right|$ since they move only in y direction. Then

$$\begin{aligned}\bar{h}_2 &= \bar{r}_{A/O} \times m_A \bar{v}_{A_2} + \bar{r}_{B/O} \times m_B \bar{v}_B \\ &= 9.8 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2.5 & 0 & 0 \\ 0 & -v_{A_y} & 0 \end{vmatrix} + 8.3 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -2.5 & 0 & 0 \\ 0 & v_{B_y} & 0 \end{vmatrix} \\ &= 9.8 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2.5 & 0 & 0 \\ 0 & -v_{B_y} & 0 \end{vmatrix} + 8.3 \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -2.5 & 0 & 0 \\ 0 & v_{B_y} & 0 \end{vmatrix} \\ &= -46.5 v_{B_y} \hat{k} \qquad (2)\end{aligned}$$

Since (1) and (2) are equal (conservation of angular momentum) then

$$v_{B_y} = \frac{-181.3}{-46.5} = 3.899 \text{ m/s}$$