Gyroscope Mini-Lab Group Worksheet

Names _____ Section _____

Recall : $\overrightarrow{\Delta L} = \vec{\tau}\Delta t,$ *and* $\overrightarrow{L_f} = \overrightarrow{L_o} + \overrightarrow{\Delta L}$

For EVERY exercise. Please make a drawing indicating the direction of the initial angular momentum of the wheel, also the direction of the applied torque, which adds a change in angular momentum. Add the two vectors to get the final angular momentum. Then predict what will happen. Document this with a drawing. ONLY AFTER YOU'VE FINISHED THIS, can you do the exercise!! *(please)*

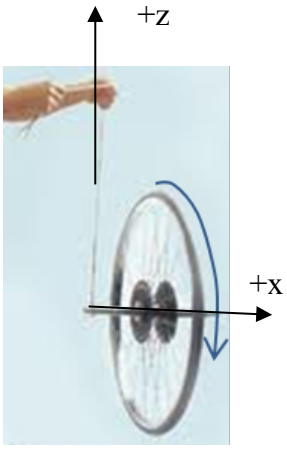
WHEEL STATION

Gyroscopic Bicycle Wheel

1a) If the bike wheel is spinning about the axis shown (right handed system). If you are just holding the rope, about which axis will the wheel rotate (precess)? The +y direction is into the paper.

___ +y ___ +z ___ -y ___ -z

___ it won't rotate except in the spin direction



explain what happens and why. Explain your answer using a sketch of the vectors, words, and equations. That is:

1) Identify the angular momentum and label it $\overrightarrow{L_o}$. Then identify any torque on the system, and the direction. Please label it $\vec{\tau}$. Understand that this torque produces a change in angular momentum, $\overrightarrow{\Delta L}$. What do we do with this little extra angular momentum?

Now, spin the wheel with the string attached onto a side handle (like the figure at right). Then hold onto the string and watch what happens to the wheel "gyroscope". *Were you right in your prediction?*

1b) Spin the wheel faster. How will this change the outcome? Again*, explain your answer using a sketch of the vectors and equations.*

Try it! *Were you right?*

1c) Change the direction of the wheel's rotation. How will this change the outcome? Again*, explain your answer using a sketch of the vectors and equations.*

Try it! *Were you right?*

1d) Move the point of contact of the supporting string closer to the center of the wheel's hub. How will this change the outcome? Again*, explain your answer using a sketch of the vectors and equations.*

Try it! *Were you right?*

1e) While the wheel is precessing, get in the way of the outer end of the axis, preventing it from precessing. How will this change the outcome? Again*, explain your answer using a sketch of the vectors and equations.*

Try it! *Were you right?*

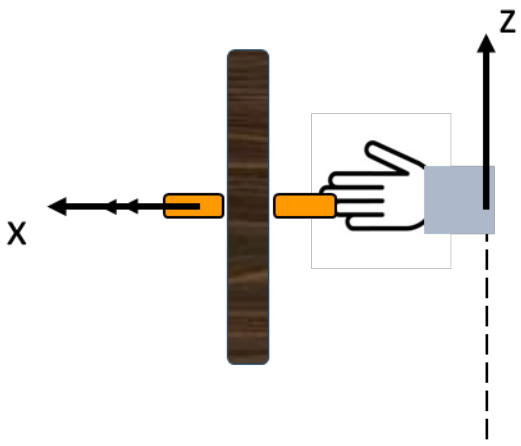
(2) Hold one of the wheel handles with one hand, so the other handle pointing straight away from you. As you look out from your body/arm, spin the wheel CW, or in the drawing below, spin the wheel in the + *x* direction. Then rotate your arm and body to the right, rotating your body in the positive *z* direction. The +y axis is coming out of the paper at you.

About which axis does the wheel try to rotate?

___ +y ___ +z ___ -y ___ -z

___ it won't rotate except in the spin direction

explain your answer using a sketch of the vectors and equations.



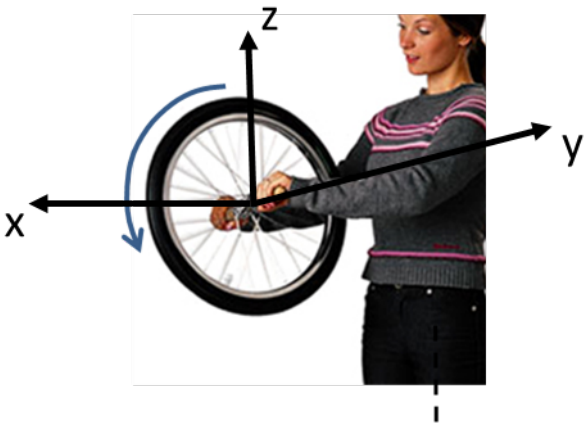
Now run the activity, show why this happens using a sketch and appropriate equations. Make sure everyone does it.

(3) Counter Steering: The wheel is spinning about the y axis as shown, just like you're riding down the street. Pull in on you right hand and push out on your left hand, as if you're turning the handlebars to the right. In which direction will the wheel turn?

___ +x ___ +z ___ -x ___ -z

___ it won't rotate except in the spin direction

explain your answer using a sketch of the vectors and equations.



Let everyone on the team do this.

If you're riding a motorcycle down the street and you want to lean the bike over to the right, which way do you turn the handlebars?