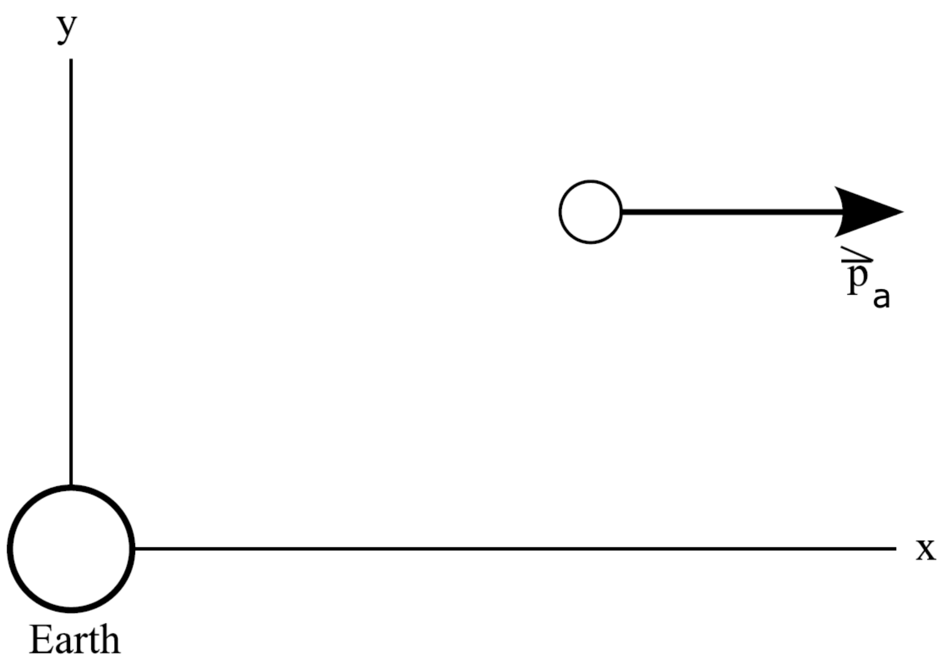
Physics 2211 – Summer GPS Week 6

Problem #1



The diagram above (not to scale) shows an asteroid passing near Earth. At the instant shown, the Earth is at position $\vec{r}_E = < 0, 0, 0 >$ m, the asteroid is at position $\vec{r}_a = < 1.7 \times 10^8, 1.1 \times 10^8, 0 >$m, and the asteroid has a momentum of $\vec{p}_a = < 2.4 \times 10^{16}, 0, 0 >$ kg m/s. The Earth's mass is $M_E = 6 \times 10^{24}$ kg and the asteroid's mass is $m_a = 2 \times 10^{13}$ kg.

(a) On the diagram, draw and label an arrow representing the **gravitational force vector** on the asteroid due to the Earth.

(b) On the diagram, draw and label an arrow representing the component of the gravitational force on the asteroid that is **parallel** to its momentum. This arrow must be drawn to the same scale as the arrow you drew for part a.

(c) On the diagram, draw and label an arrow representing the component of the gravitational force on the asteroid that is **perpendicular** to its momentum. This arrow must be drawn to the same scale as the arrow you drew for part a.

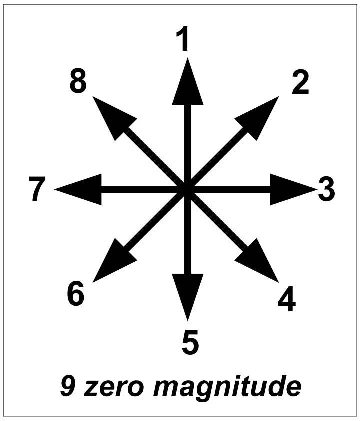
(d) Which of the components of the force, parallel or perpendicular, is responsible for changing the **direction** of the asteroid's momentum?

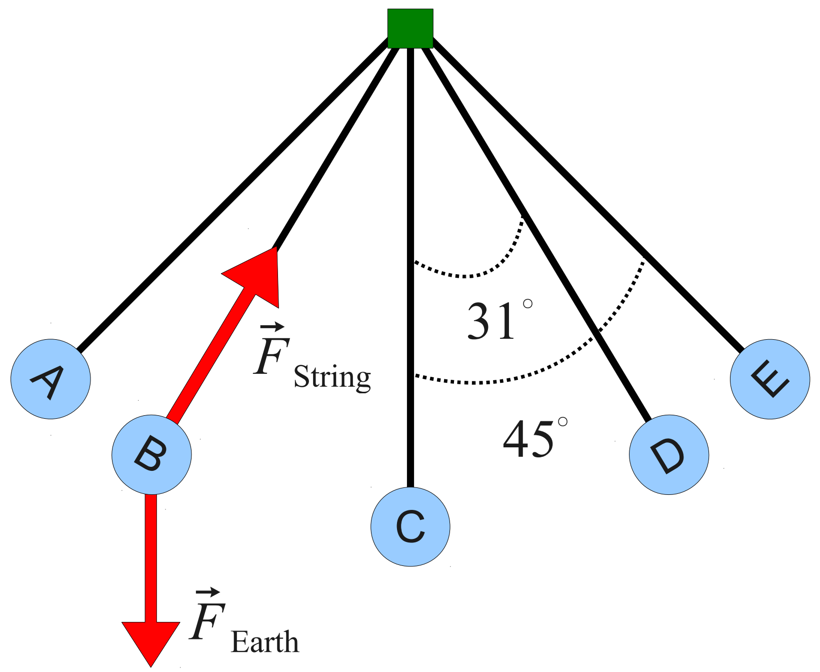
(e) At the instant shown, is the **magnitude** of the asteroid's momentum increasing, decreasing, or not changing?

(f) Determine $(\frac{d\vec{p}}{dt})_{\parallel}$, $(\frac{d\vec{p}}{dt})_{\perp}$, and R, the radius of the kissing circle for the asteroid. Briefly explain your answer.

Problem #2

A 5 kg ball is attached to one end of a string that is 5 m in length; the other end of the string is attached to a fixed support. The ball swings freely in a circular arc from left to right. Figure 1 shows snapshots of the ball at different times. When the ball is at location C, the string is vertical. When the ball is at location A or E, the ball is momentarily at rest and the string makes an of 45 degree angle with the vertical. When the ball is at location B or D, the string make an angle of 31 degrees with the vertical and the ball's speed is 3.83 m/s (air resistance has been neglected).





(a) Using the rosette of arrows shown above, indicate the number of the arrow that best represents the direction of the following quantities at locations A through E:

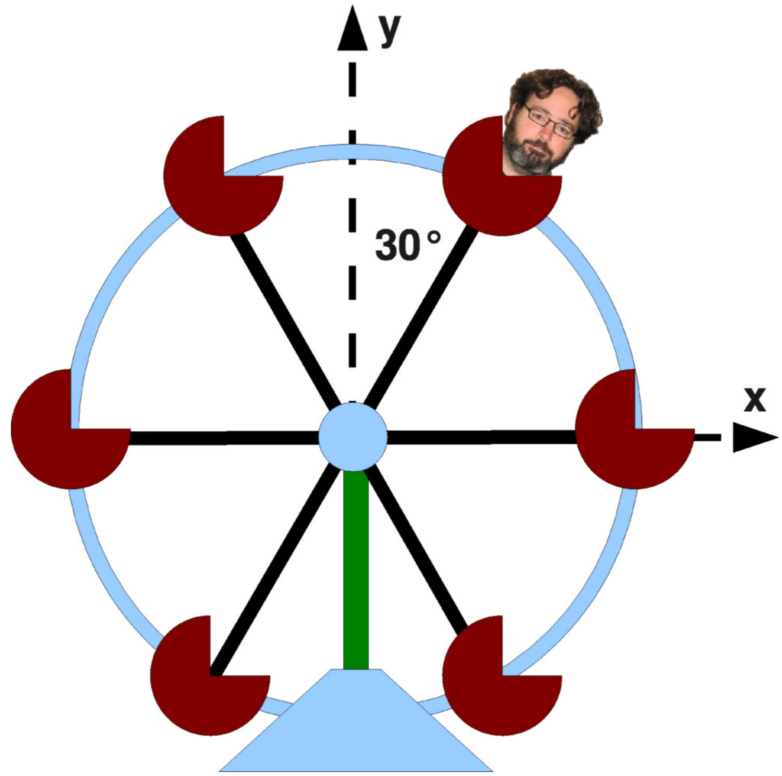
	A	B	C	D	E
$(\frac{d\vec{p}}{dt})_{\parallel}$					
$(\frac{d\vec{p}}{dt})_{\perp}$					
$\vec{F}_{net}$					

(b) Draw a force diagram showing all of the forces acting in the ball at location E. What is the magnitude of the net force acting on the ball at this location? Please show all of your work in this calculation and put off substituting numerical values into you work until you have a final expression to evaluate.

(c) Draw a force diagram showing all of the forces acting in the ball at location D. What is the magnitude of the tension force acting on the ball at this location? Please show all of your work in this calculation and put off substituting numerical values into you work until you have a final expression to evaluate.

Problem #3

The Singapore Flyer (the world's largest Ferris wheel) has a diameter of 165 m. The wheel rotates counter-clockwise at a *constant rate*, completing a full rotation in 4 minutes. Dr. Greco, a 100 kg passenger, is riding in the gondola at an angle of 30 degrees from the vertical.



(a) Choosing Dr. Greco as your system, which objects in the surroundings exert a force on him.

(b) What is the parallel component of the rate of change of Dr. Greco's momentum? Explain how you know this.

(c) What is the perpendicular component of the rate of change of Dr. Greco's momentum?

(d) What is the magnitude of the parallel component of the contact force exerted by the Ferris wheel on Dr. Greco?

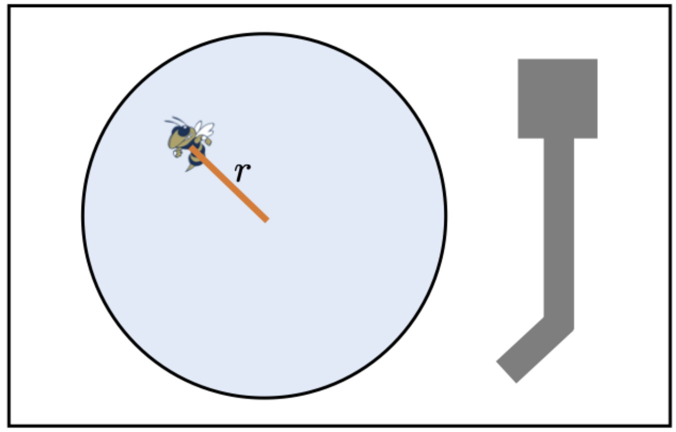
(e) What is the magnitude of the perpendicular component of the contact force exerted by the Ferris wheel on Dr. Greco?

(f) Now consider the instant where Dr. Greco is momentarily at the top of the Ferris wheel. With what speed must Dr. Greco be traveling so that he feels weightless?

(g) Now consider the instant where Dr. Greco is momentarily at the bottom of the Ferris wheel. With what speed must Dr. Greco be traveling so that he feels three times as heavy?

Problem #4

A yellow-jacket with mass $m = 1$ g lands on a motionless disk on a turntable, at a distance $r = 6$ cm from the center of the disk, as shown (top-view) in the figure. When you turn on the turntable, the disk begins rotating clockwise, speeding up as time passes.



You observe that as the disk rotates the yellow-jacket rotates with the disk, remaining in the same spot, at the same distance r from the center. You assume correctly that this is due to the static friction between its legs and the disk ($\mu_s = 0.5$). However, once the disk reaches a certain rotation speed v_c, the yellow-jacket is flung out in a tangential direction.

A. What forces are acting on the yellow-jacket as it rotates along with the disk?

B. Draw the $\hat{p}$ and $\hat{n}$ axes that correspond to the position of the yellow-jacket as shown in the figure.

C. What is the magnitude of the normal force N acting on the yellow-jacket?

D. What is the magnitude of the friction force f acting on the yellow-jacket?

E. Determine the speed v_c above which the yellow-jacket is flung off the disk.