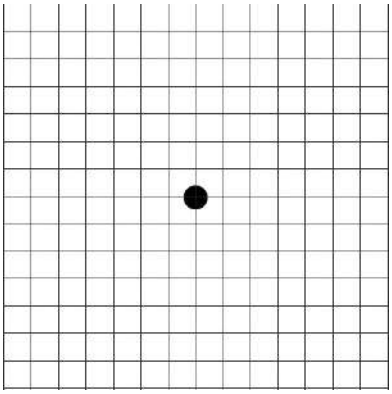
NAME _____ DATE _____

Scenario

Consider a ball of mass M *connected to a string of length* L. *A student holding the free end of the string whirls the ball in a horizontal circle with constant speed. The angle between the string and the vertical is* θ. *The student attempts to whirl the ball faster and faster in order to make the string become horizontal. No matter how fast the student whirls the ball, the string is never exactly horizontal.*

Using Representations

PART A: i. The dot below represents the ball at the instant it appears in the diagram. Draw a free-body diagram showing and labeling the forces (not components) exerted on the ball. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces.



ii. By discussing specific features of your force diagram, explain why the rope cannot become completely horizontal no matter how fast the ball is whirled.

Create an Equation

PART B: i. Derive an equation that relates the speed v of the ball in its circle to the string length L and angle θ. [Hint: What force component provides the centripetal acceleration? How can you find the radius of the circle in terms of L and θ?]

ii. How does your equation in Part B (i) show that the rope cannot become horizontal no matter how fast the ball is whirled?