NAME _____ DATE _____

Scenario

A teacher wishes to set up a demonstration that involves connecting a bowling ball of mass M to a fixed-point O on the ceiling by a string. The distance between O and the center of the bowling ball is L. The teacher plans to exert a horizontal force to pull the bowling ball to position P, where the string makes a $60°$ angle to the vertical (holding the ball in place at time T_1). The teacher then plans to release the ball from rest so that the ball swings down to point Q, where the string is vertical (time T_2). However, the teacher is concerned that the tension will be too great at point Q, and the string will break at time T_2 and the bowling ball will become a projectile.

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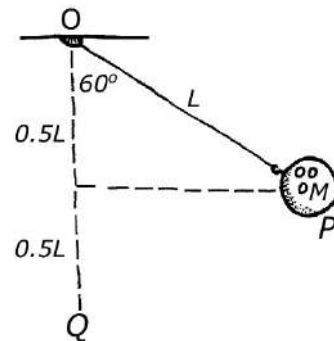
PART A: The dots below represent the bowling ball at the locations and moments indicated. Draw free-body diagrams showing and labeling the forces (not components) exerted on each ball. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces.

The ball is at rest at point P as the teacher exerts a horizontal force to keep the ball in place (time T_1).
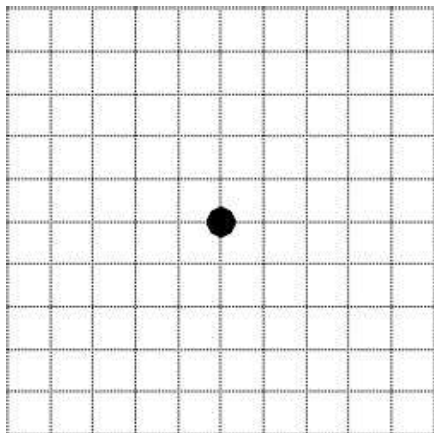
The ball has been released and at this instant is passing through point Q (time T_2).
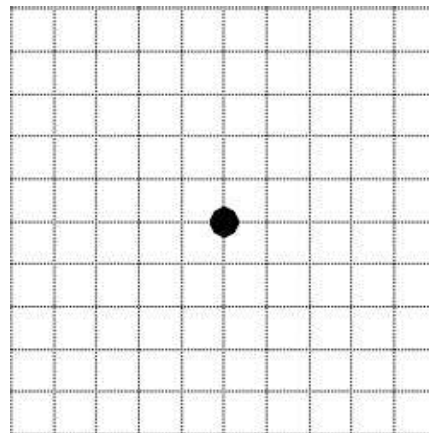
PART B: Use conservation of energy to derive an expression for the speed of the ball at point Q in terms of g and L.

PART C: Determine the tension in the rope at the two moments in time indicated in terms of m and g.

i. Time T_1

ii. Time T_2

Argumentation

PART D: If the string does not break at time T_1, then the teacher does not need to worry about letting go of the ball. Explain why using your answers to Part C.

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