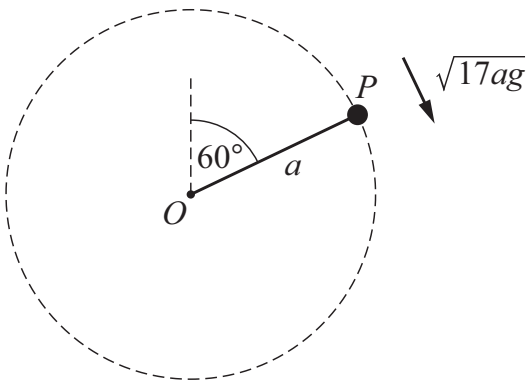
6



A particle P of mass m is attached to one end of a light inextensible string of length a. The other end of the string is attached to a fixed point O. Initially P is held with the string taut and making an angle of 60° with the upward vertical through O. The particle P is projected perpendicular to the string in a downwards direction with speed $\sqrt{17ag}$. It then starts to move along a circular path in a vertical plane with centre O (see diagram). At the lowest point of its path, vertically below O, the particle P collides with a stationary particle Q.

(a) Find, in terms of a and g, an expression for the speed of P immediately before the collision with Q. [2]

As a result of the collision, P rebounds and moves back along a circular path with centre O. The string becomes slack when P reaches the point on the circle vertically above O.

(b) Find, in terms of a and g, an expression for the speed of P immediately after the collision with Q. [3]

The mass of particle Q is km and the collision between P and Q is perfectly elastic.

(c) Find the value of k. [3]