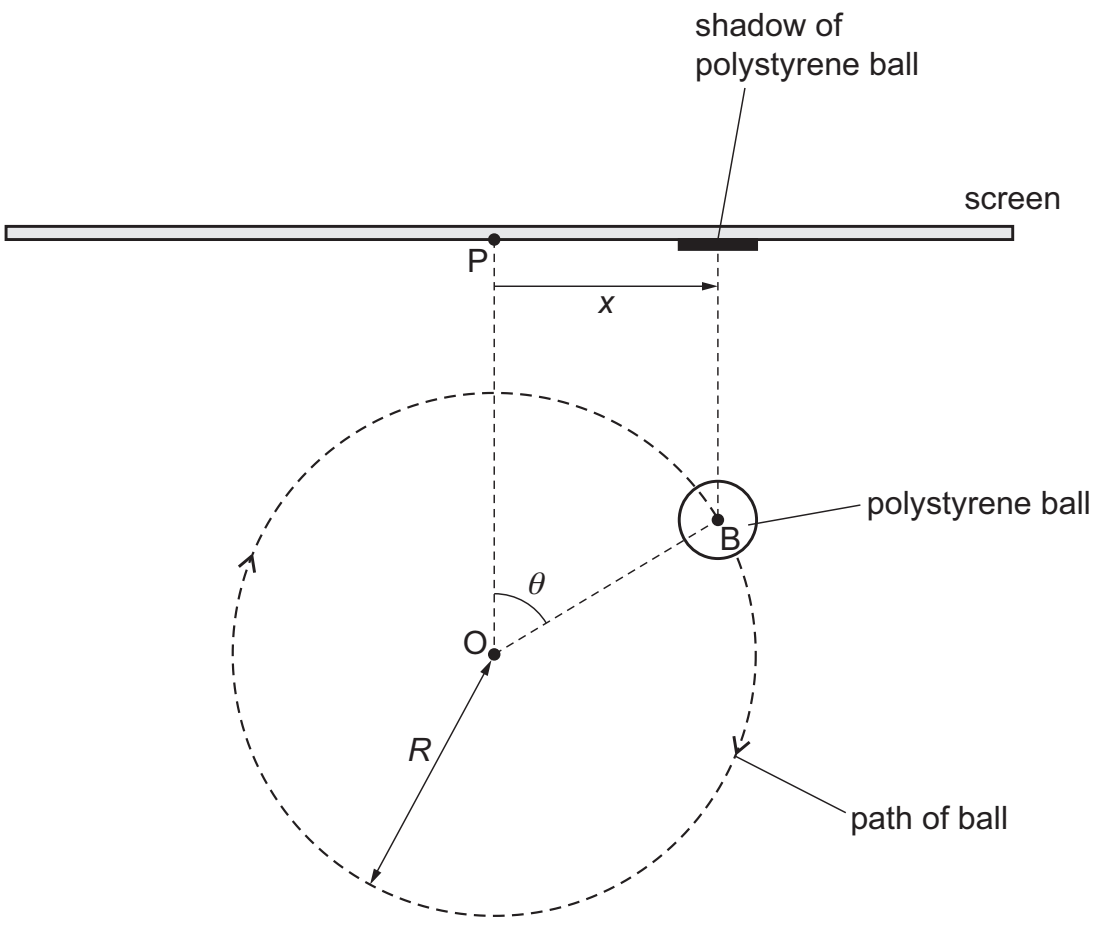
1 **(a)** In terms of velocity and acceleration, describe uniform circular motion of an object.

.....

.....

..... [2]

(b) Fig. 1.1 shows the view from above of a polystyrene ball undergoing horizontal circular motion of radius *R*.



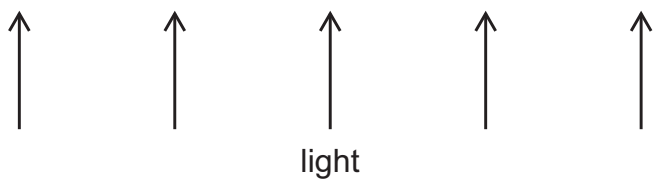


Fig. 1.1

The ball is illuminated by parallel light so that a shadow of the ball forms on a screen placed on the opposite side of the ball from the light source.

The line joining points O and P is perpendicular to the screen.

The angular speed of the circular motion is ω.

(i) State an expression, in terms of *R* and ω, for the speed *v* of the ball.

v = ... [1]

(ii) Determine an expression, in terms of *v* and ω, for the centripetal acceleration of the ball.

centripetal acceleration = ... [2]

(c) The ball in **(b)** is in the position shown in Fig. 1.1, such that line OB is at an angle θ to the line OP.

(i) Determine an expression, in terms of *R* and θ, for the displacement *x* of the shadow from P.

x = ... [1]

(ii) The value of θ is zero at time $t = 0$.

State an expression for θ in terms of ω and *t*.

θ = ... [1]

(iii) Use your answers in **(c)(i)** and **(c)(ii)** to show that *x* is given by

$$x = R\sin\omega t.$$

[1]

(iv) Explain, with reference to the equation in **(c)(iii)**, why the motion of the shadow of the ball on the screen may be modelled as simple harmonic.

.....

..... [1]

(d) The circular motion of the ball in Fig. 1.1 has a diameter of 0.46 m and an angular speed of $1.9\,\text{rad}\,\text{s}^{-1}$.

For the simple harmonic motion of the shadow of the ball in Fig. 1.1, calculate:

(i) the amplitude

amplitude = ... m [1]

(ii) the period

period = ... s [2]

(iii) the maximum acceleration.

maximum acceleration = ... $\text{m}\,\text{s}^{-2}$ [2]