

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 .

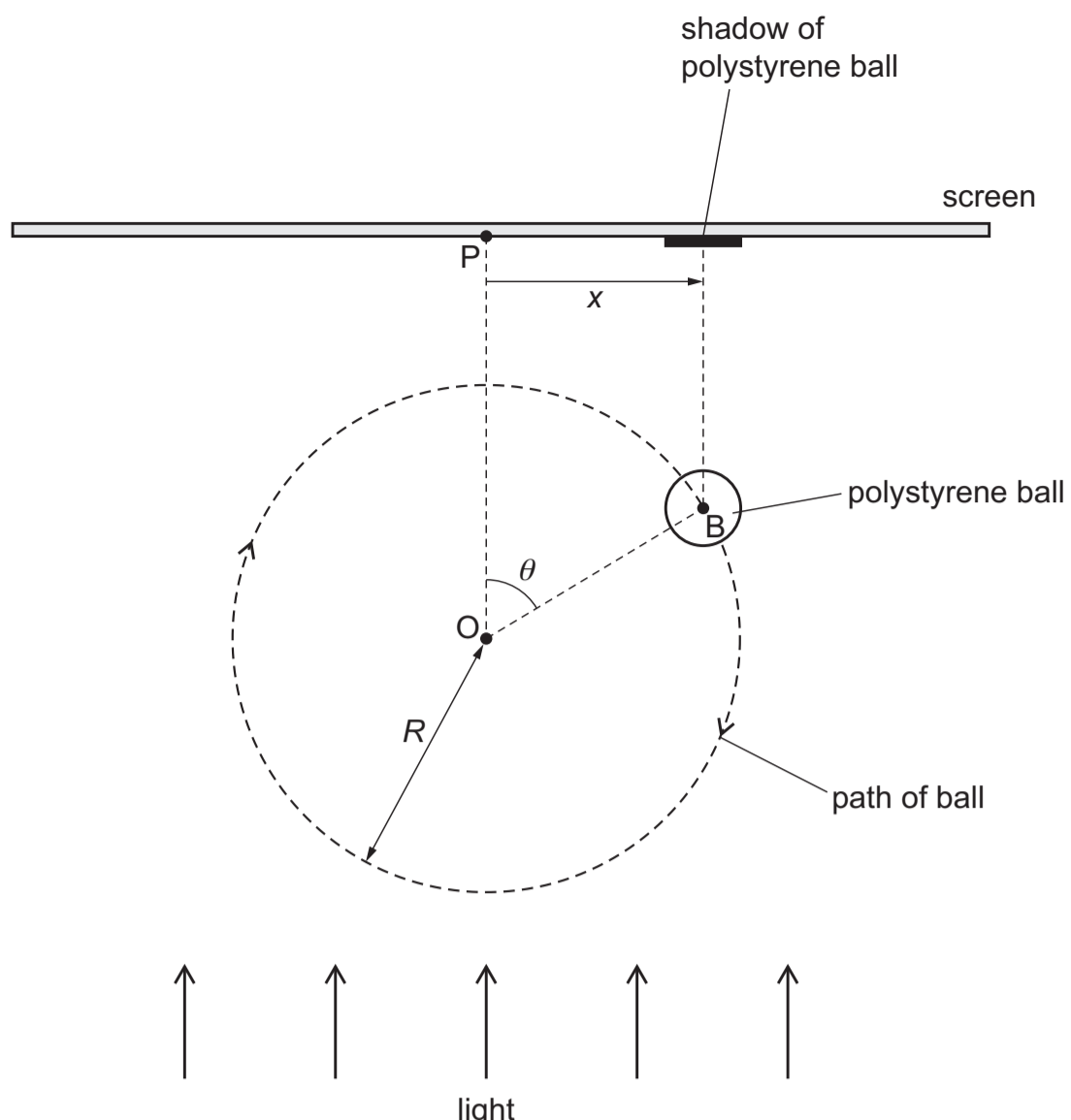


Fig. 1.1

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.

$v = \dots\dots\dots$ [1]

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

centripetal acceleration = $\dots\dots\dots$ [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 .

$x = \dots\dots\dots$ [1]

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

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

$\theta = \dots\dots\dots$ [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.

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 [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 rad s^{-1} .

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

(i) the amplitude

amplitude = $\dots\dots\dots$ m [1]

(ii) the period

period = $\dots\dots\dots$ s [2]

(iii) the maximum acceleration.

maximum acceleration = $\dots\dots\dots$ ms^{-2} [2]