

6.4 Horizontal circular motion

Name: _____ Class: _____ Date: _____

Total: 20 marks

KEY WORDS angular speed • centripetal acceleration

Horizontal circular motion

Objective

Use angular speed and radial acceleration $r\omega^2 = v^2/r$ with vertical equilibrium for table circles, conical pendulums and similar contexts (objectives 4.1–4.3).

1 Key knowledge and worked examples

Two resolutions. Towards the centre: the net force provides $mr\omega^2$ (or $\frac{mv^2}{r}$). Vertically: no acceleration, so forces balance. The radius is the horizontal distance to the axis, not the string length.

Worked example (WME03 June 2025 Q2). P (mass m) on a smooth table, tethered to O above by a string of length a at 30° to the table, circling with $\omega = \sqrt{\frac{g}{2a}}$. Radius = $a \cos 30^\circ$. Centrewards: $T \cos 30^\circ = m(a \cos 30^\circ)\omega^2 = ma \cos 30^\circ \cdot \frac{g}{2a} \implies T = \frac{mg}{2}$. Vertically: $R = mg - T \sin 30^\circ = mg - \frac{mg}{4} = \frac{3mg}{4}$.

2 Practice

2.1 A particle moves in a circle of radius 0.5 m at 2 revolutions per second. Find ω and the speed. [2]

2.2 A conical pendulum: string length l , angle 45° to the vertical, mass m . Find the angular speed in terms of g and l . [3]

2.3 For that pendulum, find the tension in terms of mg . [2]

3 Exam-style questions

3.1 (*Edexcel IAL WME03 June 2025 Q2.*) One end of a light inextensible string of length a is attached to a fixed point O above a smooth horizontal table; the other end is attached to a particle P of mass m on the table. P moves on the table in a horizontal circle with constant angular speed $\sqrt{\frac{g}{2a}}$, the string taut and making a constant angle of 30° with the table. Find, in terms of m and g , the magnitude of the force exerted on P by the table. [7]

3.2 (*Original.*) A car of mass m travels at speed v round a circular bend of radius r banked at an angle θ to the horizontal, where $\tan \theta = \frac{3}{4}$ and there is no sideways frictional force on the car. (a) Show that $v^2 = \frac{3gr}{4}$. (b) Find the magnitude of the normal reaction in terms of m and g . [6]