Unit 6 · Circular Motion

HARDER PRACTICE QUESTIONS

Full marks 32

Write your answers on separate paper. Show your working. Take $g = 9.8\ m/s^2$.

1 Spot the error [3]

Find the mistake and correct it.

A fan turns at 60 revolutions per minute, and its blade tip is 0.5 m from the center. Ankit writes: "$\omega = 60$ rad/s, so the tip's speed is $v = r\omega = 0.5 \times 60 = \mathbf{30\ m/s}$."

2 On a Ferris wheel [5]

A Ferris wheel of radius 10 m turns once every 20 s at a steady speed. Sujana, 50 kg, sits on a seat that stays upright.

i. Find her speed and her centripetal acceleration.
ii. Find the push of the seat on her at the top and at the bottom.
iii. What if the wheel turned faster? Find the period at which she would feel weightless at the top.

3 Design a bend [4]

The road and its speed are made up.

A bend on a hill road has a radius of 40 m, and vehicles are meant to take it at 36 km/h.

i. At what angle should it be banked so that no friction is needed at that speed?
ii. A truck takes the bend at 54 km/h on a day when the road is icy (no friction). What happens, and why?

4 Newton's Moon test [4]

Use the numbers given.

The Moon goes round the Earth once in 27.3 days, at a distance of about 3.84×10^8 m, about 60 times the Earth's radius.

i. Find the Moon's centripetal acceleration, $4\pi^2 r/T^2$.
ii. If gravity weakens as $1/d^2$, what should the pull of the Earth give at 60 Earth radii? Compare.
iii. What did this comparison tell Newton?

5 Predict, then explain [4]

Write your prediction first, then explain it.

Three coins lie on a turntable at 5 cm, 10 cm and 20 cm from its center. The turntable is slowly made to spin faster.

i. Which coin slides off first? Explain.
ii. If the coefficient of friction is 0.4 and the turntable turns at 4 rad/s, how far from the center can a coin stay?

6 Read the data [4]

Engineers tested the greatest speed at which a car could take level bends of different radii on the same road surface without skidding:

Radius r (m)	25	50	100
Greatest speed (m/s)	9.9	14.0	19.8

i. Show that $v^2 \propto r$, and find the coefficient of friction.
ii. Predict the greatest speed on a bend of radius 200 m.
iii. Pratiksha says: "Doubling the radius doubles the safe speed." Correct her.

7 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Sandesh wrote: "A car going round a bend at a steady speed has no acceleration. An outward centrifugal force acts on it, which friction balances. If the road were suddenly frictionless, the car would fly straight outward from the center of the bend."

8 Think [3]

A bucket of water swung fast over someone's head in a vertical circle doesn't spill at the top. Asmita says: "At the top, gravity stops acting on the water." Is she right? Explain what really happens.

9 Make your own [2]

A toy car is let go from rest at a height h on a smooth track that runs into a loop of radius r. Choose a loop radius and the least height h that lets the car go safely round the loop. Show that it works.