LAKSHYA

MHTCET 2025

Physics

Lecture - 03

Rotational Dynamics

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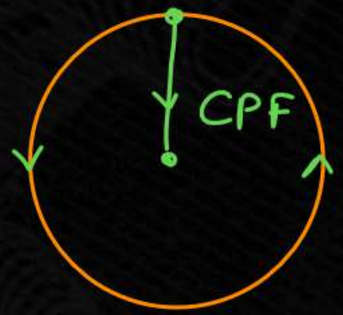
Topics *to be covered*

1. Vehicle Along a Horizontal Circular Track ✓
2. Death Well ✓
3. Vehicle on Banked Road ✓

Revision :

CPF: force in CM directed towards the center of circular track.

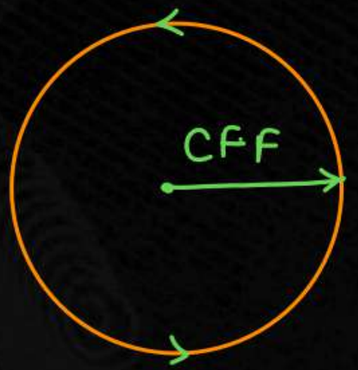


$$\vec{F}_{cp} = -\frac{mv^2}{r}\hat{r}$$

CFF :

force acts on object performing CM directed away from center of circular track.

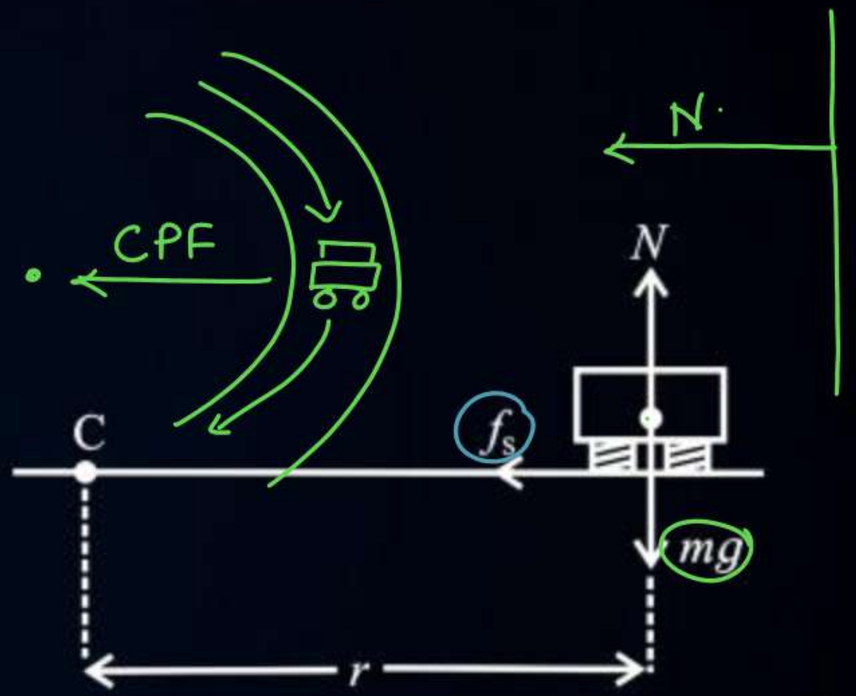
$$\vec{F}_{CF} = \frac{mv^2}{r}\hat{r}$$



Vehicle Along a Horizontal Circular Track

- In the above case frictional force is responsible to keep vehicle on track, meas it is CPF.

$$f_s = \frac{mv^2}{r}, \quad N = mg$$



Vehicle on a horizontal road

$$\frac{f_s}{N} = \frac{m v^2/r}{mg}$$

$$\frac{f_s}{N} = \frac{v^2}{rg}.$$

$$f_s = \mu N$$

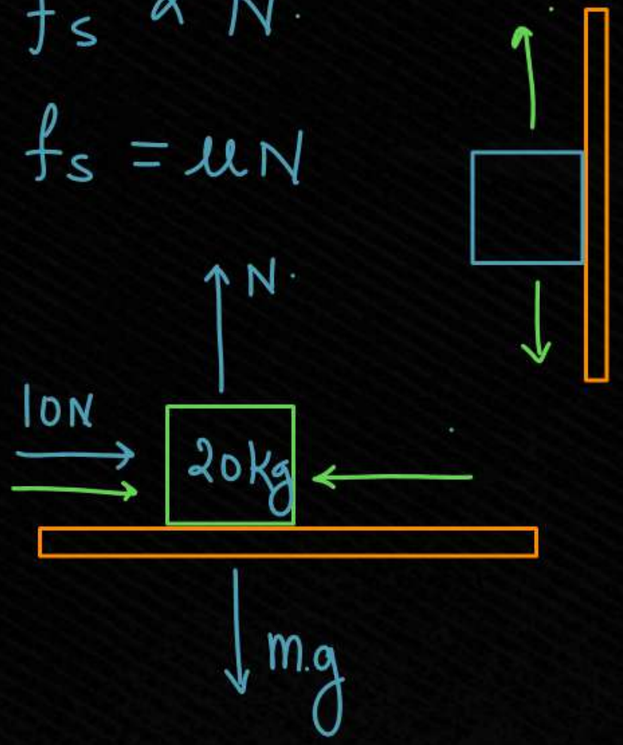
$$\mu = \frac{v^2}{rg}$$

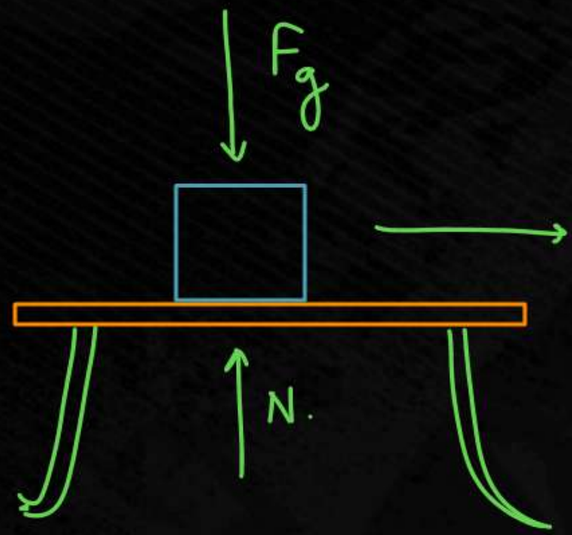
$$\boxed{v = \sqrt{\mu r g}.}$$

– Maximum speed with which vehicle moves along horizontal curved road.

$f_s \propto N$

$f_s = \mu N$





Rest, Balanced force.

Que:

$v_{max} = 60 km/hr.$

$g = 10 m/s^2$

$r = 10 m.$

$\mu = ?$

$v = \sqrt{\mu r g}$

$v^2 = \mu r g$

$\mu = \frac{v^2}{rg}$

$v = 60 km/hr$

$v = (\cancel{60}^{10} \times \frac{5}{\cancel{18}_{3}}) m/s$

$v = 50/3$

$$\therefore \mu = \frac{(50/3)^2}{10 \times 10}$$

$$= \frac{2500/9}{100}$$

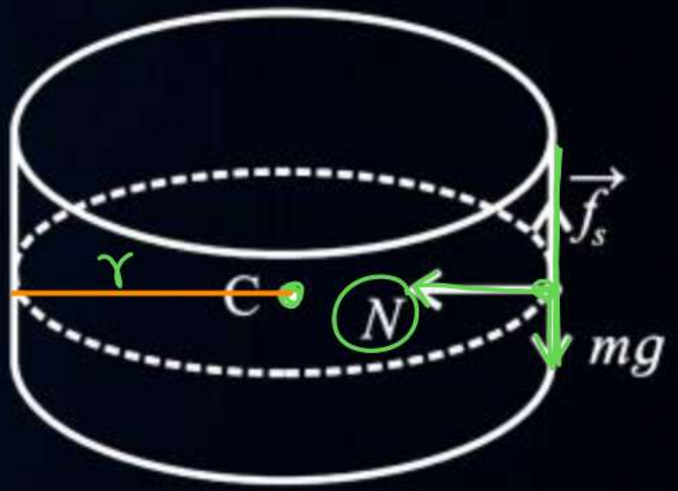
$$\boxed{\mu = 25/9}$$

Well (or Wall) of Death (मौत का कुआँ)

In the above case Normal reaction gives CPF

$$N = \frac{mv^2}{r}, \quad f_s = mg.$$

$$v_{min} = \sqrt{\frac{rg}{\mu}}$$



Well of death.

QUESTION

A motorcyclist rounds a curve of radius 25 m and 36 km/h. The combined mass of the motorcycle and the man is 150 kg. (i) what is the centripetal force exerted on the motorcyclist? (ii) What is the upward force exerted on the motorcyclist? [g = 10 m/s^2]

A. 1500 N

B. 1600 N

C. 1400 N

D. 1450 N

$r = 25\ m$

$v = \frac{36}{18} \times \frac{5}{1} = 10\ m/s$

$m = 150\ kg.$

i)

$F_{cp} = \frac{mv^2}{r}$

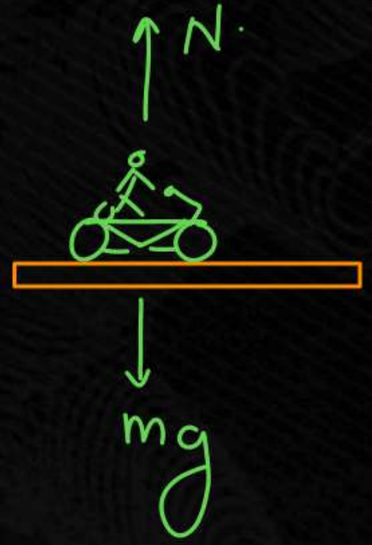
$= \frac{150 \times 100}{25}$

$F_{cp.} = 600\ N.$

ii) Upward force acting on motorcyclist is N - Normal Reaction.

$N = mg = 150 \times 10$

$= 1500N.$



QUESTION

Find the maximum speed with which a car can be safely driven along a curve of radius 100 m, if the coefficient of friction between its tyres and the road is 0.2.

$g = 9.8\ m/s^2$

A. 14 m/s

B. 13 m/s

C. 15 m/s

D. 12 m/s

$r = 100\ m$

$\mu = 0.2$

$V = \sqrt{\mu r g}$

$= \sqrt{0.2 \times 100 \times 9.8}$

$= \sqrt{2 \times 98}$

$= \sqrt{196}$

$V_{max.} = 14\ m/s.$

QUESTION

A flat curve on a highway has a radius of curvature 400 m. A car goes around the curve at a speed of 28 m/s. What is the minimum value of the coefficient of friction that will ~~present~~ prevent the car from sliding?

A. 0.2

B. 0.1

C. 0.3

D. 0.5

$r = 400\ m$

$v = 28\ m/s$

$\mu = ?$

$g = 9.8\ m/s^2$

$\mu = \frac{v^2}{rg}$

$\mu = \frac{28 \times 28}{400 \times 9.8}$

$\mu = 0.2$

$\mu = \frac{7 \times 28}{980} = 0.2$

$980 \quad 1405$

QUESTION

A car can be driven on a flat circular road of radius r at a maximum speed v without skidding. The same car is now driven on another flat circular road of radius 2r on which the coefficient of friction between its tyres and the road is the same as on the first road. What is the maximum speed of the car on the second road such that it does not skid?

A. $\sqrt{2}\,v$

B. $\sqrt{1}\,v$

C. $\sqrt{3}\,v$

D. $\sqrt{4}\,v$

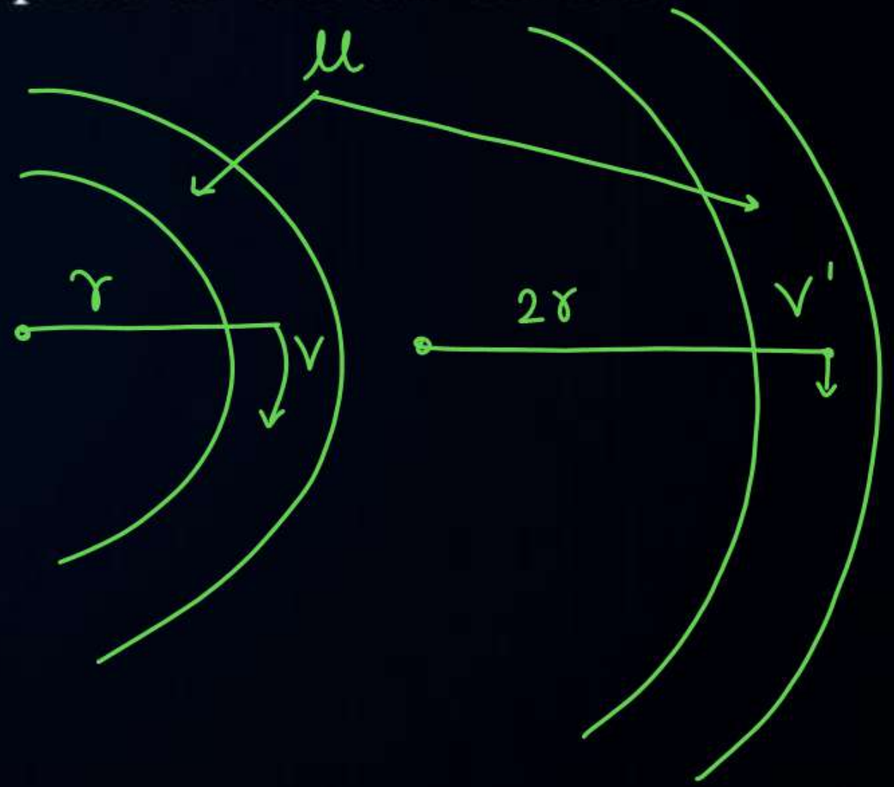
$v = \sqrt{\mu r g}$.

$v \propto \sqrt{r}$

$v' \propto \sqrt{2r}$

$\frac{v'}{v} = \frac{\sqrt{2r}}{\sqrt{r}}$

$v' = \sqrt{2}\,v$.



Summary

1) Vehicle moving on horizontal curved road $v = \sqrt{\mu r g}$.

2) Death well

$$v_{min} = \sqrt{\frac{rg}{\mu}}$$

Homework

1) Revise lecture

2) Practise more questions.


धन्यवाद