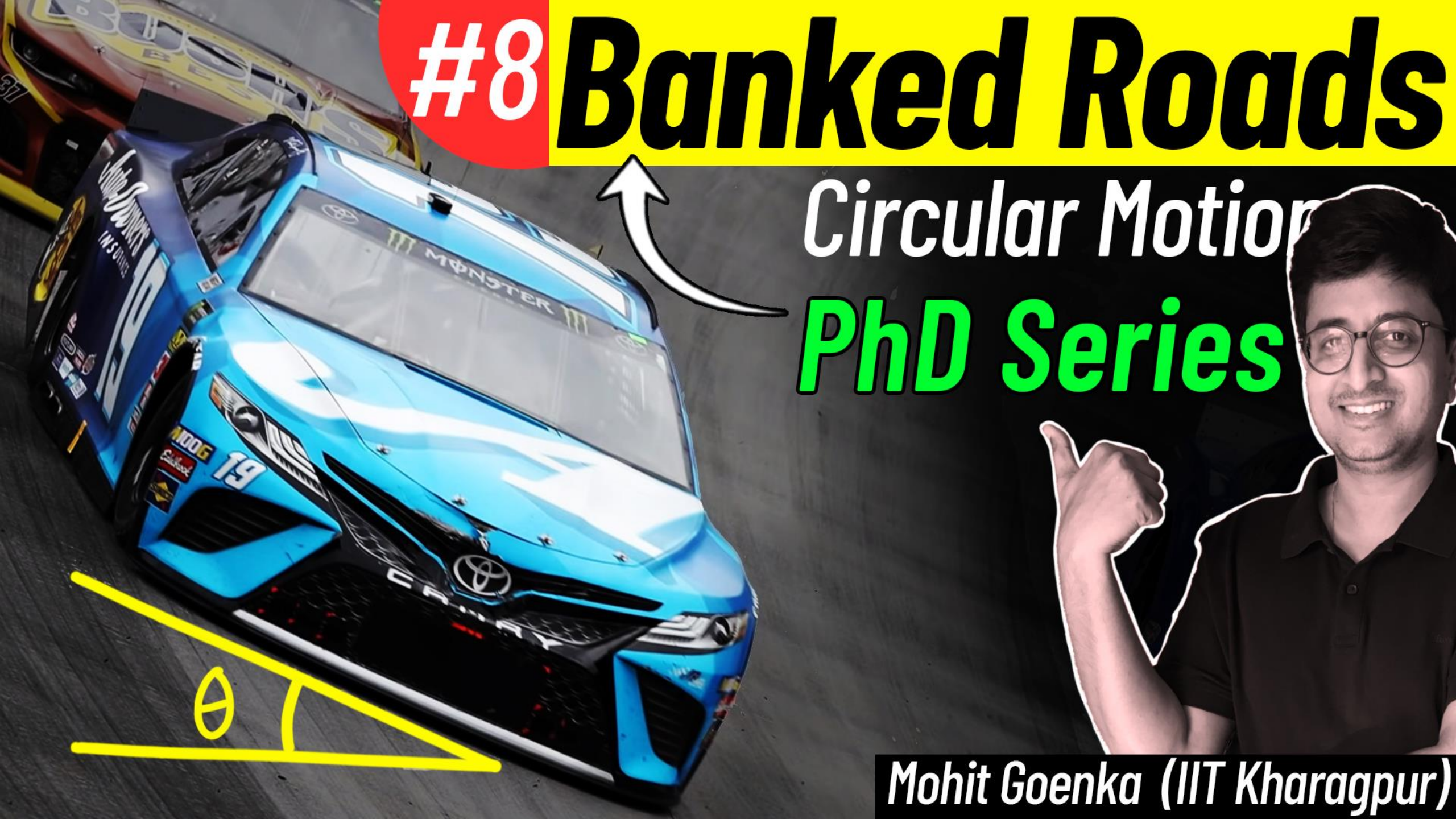
#8 Banked Roads

Circular Motion

PhD Series



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BANKED ROADS

PhD SERIES

1. Lets Understand all Cases
2. *V* minimum
3. *V* maximum
4. Conclusion
5. 2021 PYQs

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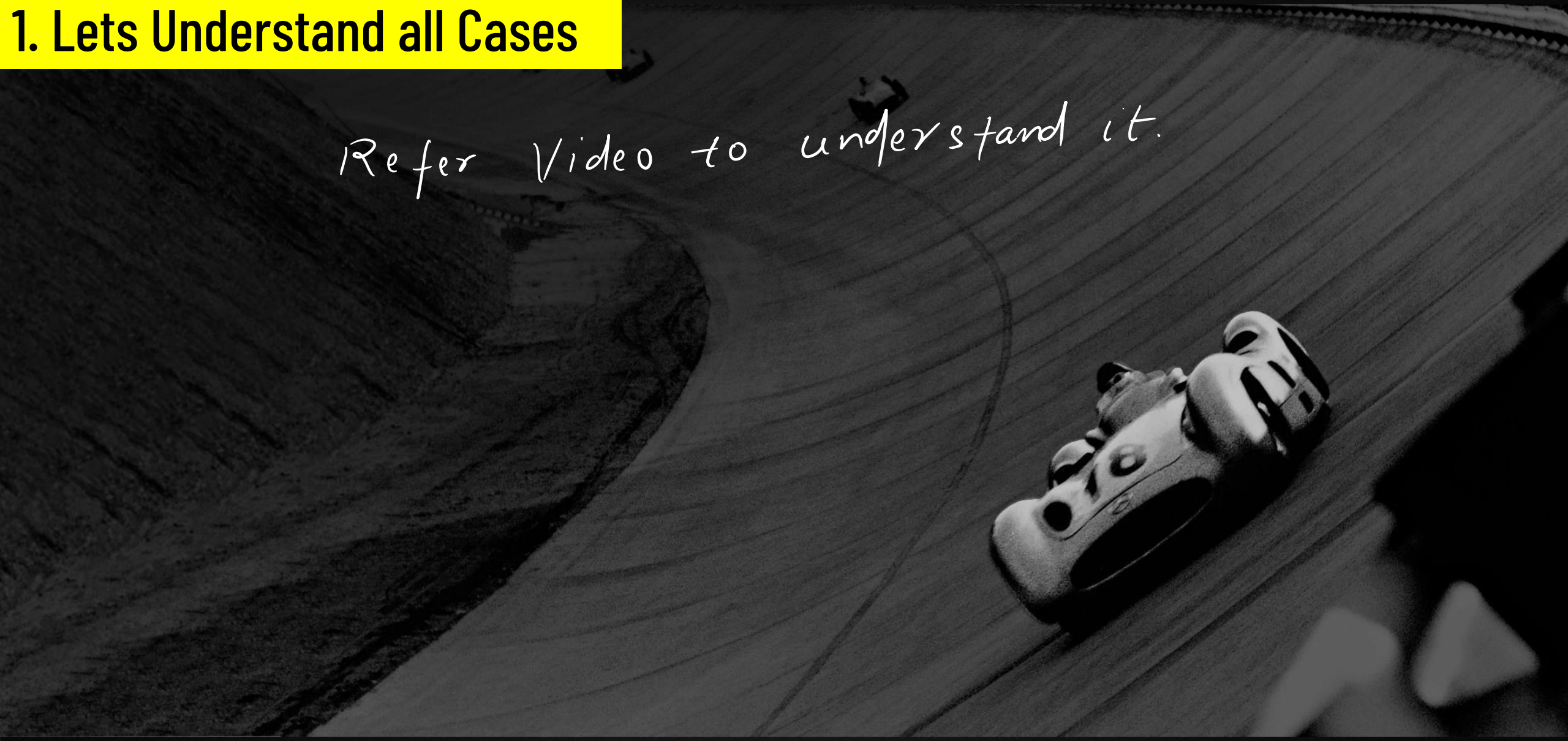
1. Lets Understand all Cases



2. V minimum

$f = \mu N$

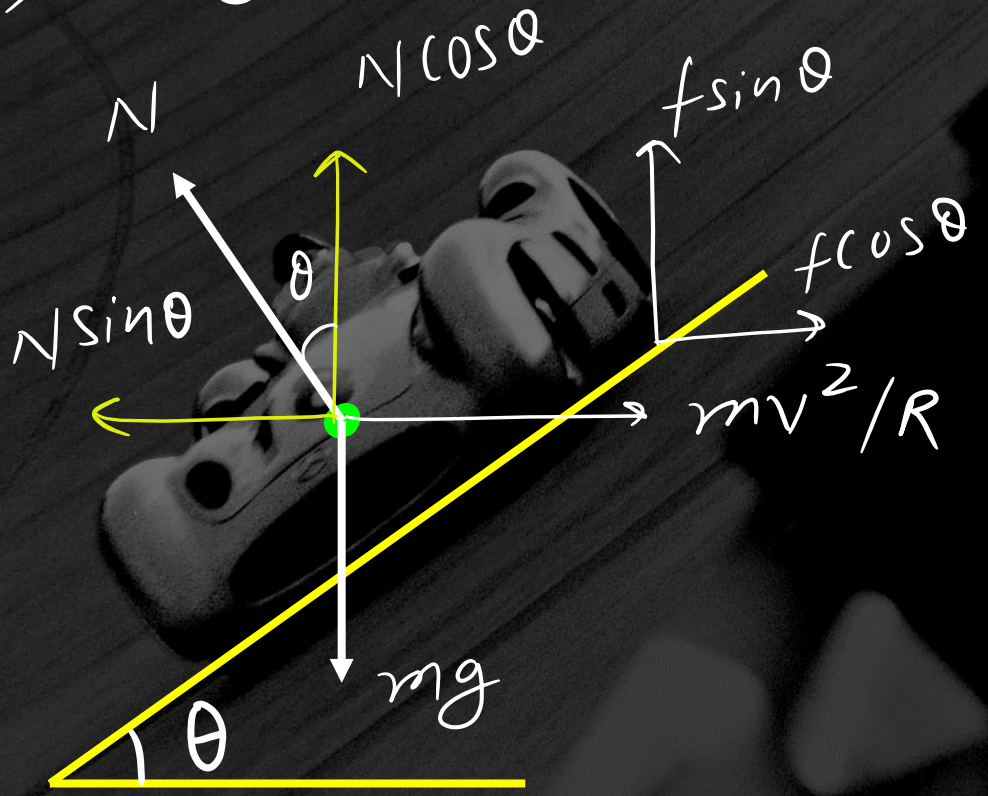
$N\sin\theta = \frac{mv^2}{R} + f\cos\theta \Rightarrow N(\sin\theta - \mu\cos\theta) = \frac{mv^2}{R}$ — (1)

$N\cos\theta + f\sin\theta = mg \Rightarrow N(\cos\theta + \mu\sin\theta) = mg$ — (2)

(1) / (2)

$$\frac{\sin\theta - \mu\cos\theta}{\cos\theta + \mu\sin\theta} = \frac{v^2}{Rg}$$

$$\Rightarrow V_{min} = \sqrt{Rg\left(\frac{\tan\theta - \mu}{1 + \mu\tan\theta}\right)}$$



3. V maximum

$f = \mu N$

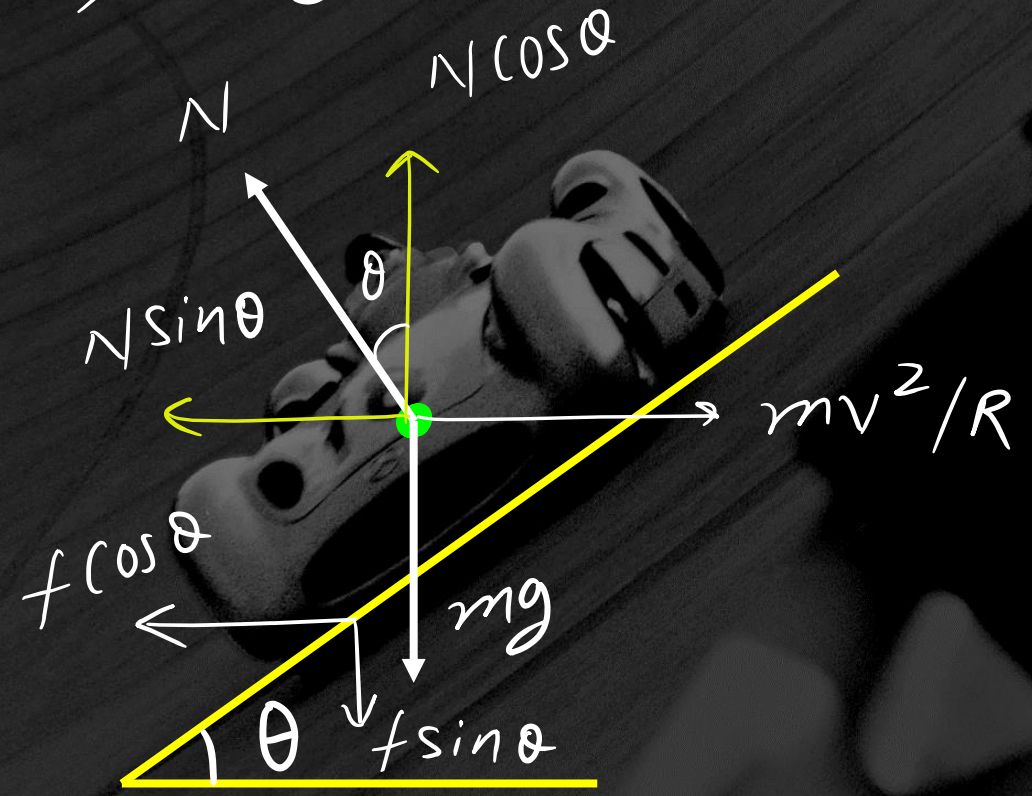
$N\sin\theta + f\cos\theta = \frac{mv^2}{R} \Rightarrow N(\sin\theta + \mu\cos\theta) = \frac{mv^2}{R}$ — (1)

$N\cos\theta = mg + f\sin\theta \Rightarrow N(\cos\theta - \mu\sin\theta) = mg$ — (2)

(1) / (2)

$$\frac{\sin\theta + \mu\cos\theta}{\cos\theta - \mu\sin\theta} = \frac{v^2}{Rg}$$

$$\Rightarrow V_{min} = \sqrt{Rg\left(\frac{\tan\theta + \mu}{1 - \mu\tan\theta}\right)}$$



4. CONCLUSION

1. For no slipping $\sqrt{Rg\left(\frac{\tan\theta-\mu}{1+\mu\tan\theta}\right)} \leq v \leq \sqrt{Rg\left(\frac{\tan\theta+\mu}{1-\mu\tan\theta}\right)}$

2. If $v=\sqrt{Rg\tan\theta}$, $f=0$ (car can turn on slippery road + no wear & tear of tyres)

3. If $v>\sqrt{Rg\tan\theta}$, f acts down the slope
   & $v<\sqrt{Rg\tan\theta}$, f acts up the slope

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The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _____ $\times 10^3$ kg m/s^2. ($\cos 30^\circ = 0.87$, $\mu_s = 0.2$)

(1) 10.2 (2) 7.2 (3) 12.4 (4) 6.96

Q1 2021 July

https://youtu.be/hCShMjLXnFo

5. 2021 PYQs

Statement I : A cyclist is moving on an unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of 2m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve (g = 9.8 m/s^2)

Statement II : If the road is banked at an angle of 45°, cyclist can cross the curve of 2m radius with the speed of 18.5 kmh^{-1} without slipping.

In the light of the above statements, choose the correct answer from the options given below.

(1) Statement I is incorrect and statement II is correct 2021 March

(2) Statement I is correct and statement II is incorrect

(3) Both statement I and statement II are false

(4) Both statement I and statement II are true

Q3

https://youtu.be/zUu5ccnsB_4

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PYQs (2020, 2021)

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