Physicsaholics

DPP – 4 (Circular Motion)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/39

Video Solution on YouTube:- https://youtu.be/hsCDAjR-KWY

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/42

Q 1. When the string of a conical pendulum makes an angle of 45^0 with the vertical, its time is T_1 when the string makes an angle of 60^0 with the vertical, its time period is T_2 then T_1^2/T_2^2 is:

(a) 2 (b) $\sqrt{2}$

(c) $\frac{1}{2}$ (d) none of these

Q 2. A sphere of mass 200 g is attached to an inextensible string of length 130 cm whose upper end is fixed to the ceiling. The sphere is made to describe a horizontal circle of radius 50 cm Calculate the periodic time of this conical pendulum and the tension in the string: ($g = 10\ m/s^2$)

(a) 2.2 sec, 2.2 N (b) 2 sec, 4 N

(c) 1.6 sec, 2.2 N (d) 2.5 sec, 3N

Q 3. In a well of death, motor cycle rides round the inner wall of a hollow cylindrical chamber. If the radius of the cylindrical chamber is 8 m. What would be minimum speed of the rider to prevent him from sliding down? ($g = 10\ m/s^2$, $\mu = 0.2$)

(a) 10 m/s (b) 20 m/s

(c) 30 m/s (d) 40 m/s

Q 4. A person wants to drive on the vertical surface of a large cylindrical wooden well commonly known as death well in a circus. The radius of the well 2 meter, and the coefficient of friction between the tyers of the motorcycle and the wall of the well is 0.2 the minimum speed the motorcyclist must have in order to prevent slipping should be ($g = 10\ m/s^2$)

(a) 10 m/s (b) 15 m/s

(c) 20 m/s (d) 25 m/s

Q 5. What will be maximum speed of a car on a curved road of radius 30 m. If the coefficient of friction between the tyres and the road is 0.4? ($g = 10\ m/s^2$)

(a) 10.95 m/s (b) 9.87 m/s

(c) 12.13 m/s (d) 4.27 m/s

Q 6. A van moving with a speed of 108 km/h on level road where coefficient of friction between tyres and rod is 0.5. For the safe driving of van the minimum radius of curvature of the rod will be: ($g = 10\ m/s^2$)

(a) 80 m (b) 40 m

(c) 180 m (d) 20 m

Q 7. A car of mass 1000kg negotiates a banked curve of radius 90m on a frictionless road. If the banking angle is 45^0 the speed of the car is: ($g = 10\ m/s^2$)
(a) 10 m/s (b) 20 m/s
(c) 30 m/s (d) 40 m/s

Q 8. A cyclist riding at a speed of $14\sqrt{3}$ m/s takes a turn around a circular road of radius $20\sqrt{3}$ m. What is his inclination with horizontal? ($g = 10\ m/s^2$)
(a) 30^0 (b) 45^0
(c) 60^0 (d) 37^0

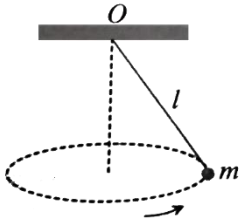
Q 9. A turn of radius 20 m is banked for the vehicles going at a speed of 36km/h. If the coefficient of static friction between the road and the tyre is 0.4, what are the possible speeds of a vehicle so that it neither slips down nor skids up? ($g = 10\ m/s^2$)
(a) $4.08\ \text{m/s} \leq V \leq 15 m/s$
(b) $3.01\ \text{m/s} \leq V \leq 15 m/s$
(c) $4.08\ \text{m/s} \leq V \leq 12 m/s$
(d) $3.01\ \text{m/s} \leq V \leq 12 m/s$

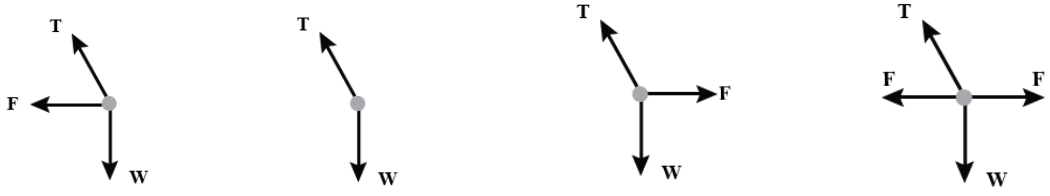
Q 10. A curve in a road forms an arc of radius 800 m. If the road is 19.6 m wide and outer edge is 1m higher than the inner edge, calculate the speed for which it is banked: ($g = 9.8\ m/s^2$)
(a) 10 m/s (b) 12.7 m/s (c) 20 m/s (d) 23.1 m/s

Q 11. A circular road of radius 1000 m has banking angle 45^0. The maximum safe speed of a car having mass 2000 kg will be, if the coefficient of friction between tyre and road is 0.5: ($g = 9.8\ m/s^2$)
(a) 172 m/s (b) 124 m/s (c) 99 m/s (d) 86 m/s

Q 12. Find the maximum velocity for skidding for a car moved on a circular track of radius 100 m. The coefficient of friction between the road and tyre is 0.2: ($g = 9.8\ m/s^2$)
(a) 0.14 m/s (b) 140 m/s (c) 1.4 m/s (d) 14 m/s

Q 13. A point mass m is suspended from a light thread of length l, fixed at O, is whirled in a horizontal circle at constant speed as shown. From your point of view, stationary with respect to the mass, the forces on the mass are:





(a) (b) (c) (d)

Answer Key

Q.1 b	**Q.2 a**	**Q.3 b**	**Q.4 a**	**Q.5 a**
Q.6 c	**Q.7 c**	**Q.8 a**	**Q.9 a**	**Q.10 c**
Q.11 a	**Q.12 d**	**Q.13 c**		

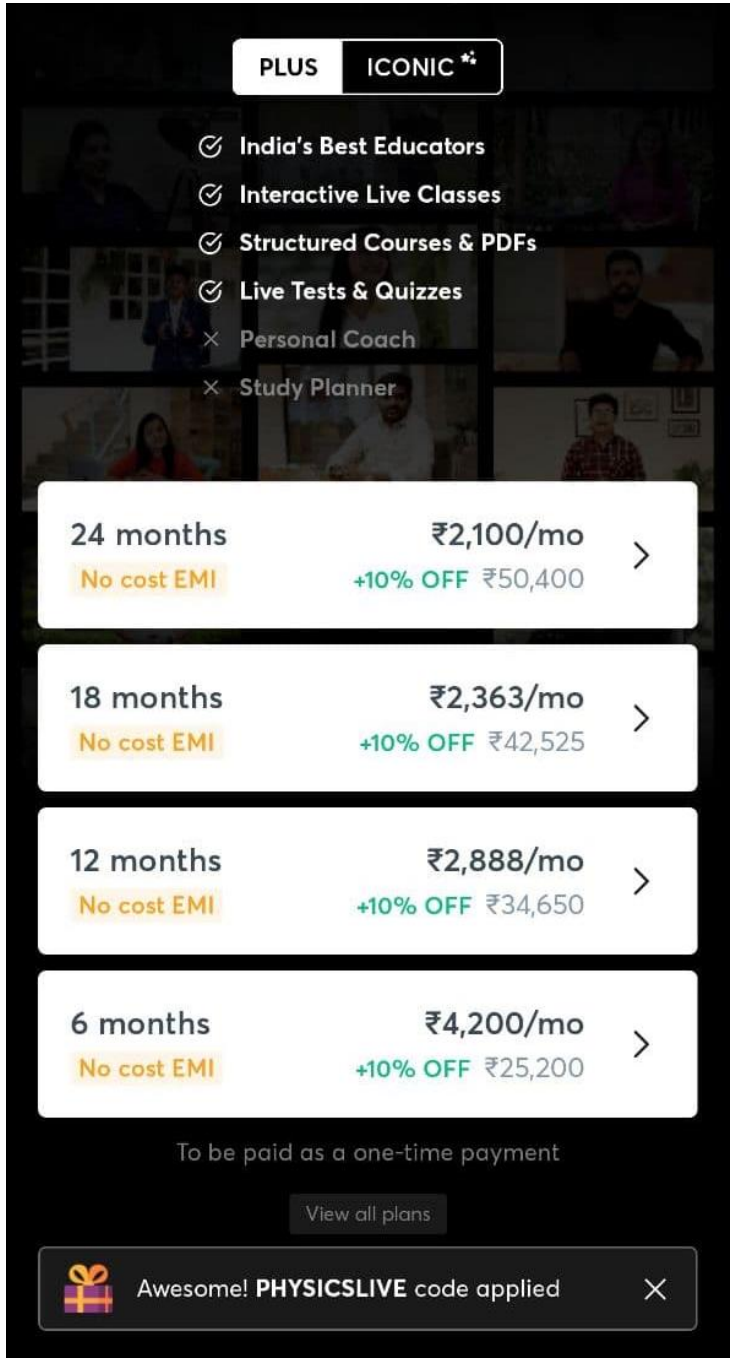
Plus leaderboard

Based on educator activity in last 30 days

1	Prateek Jain	11.4M mins
2	Ajay Mishra (Akm)	6.3M mins
3	Shubh Karan Choudhary (Skc)	5.9M mins
4	Dr Amit Gupta	5.5M mins
5	Ramesh Sharda	4.9M mins
6	Sandeep Nodiyal	4.8M mins
7	Shailendra Tanwar	3.6M mins
8	Vishal Vivek	2.7M mins
9	Garima Goel	2.7M mins
10	Saurabh Sharma	2.6M mins
11	Dr S K Singh	2.6M mins
12	Nishant Varshney	

PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS and learn from India's Top Faculties.

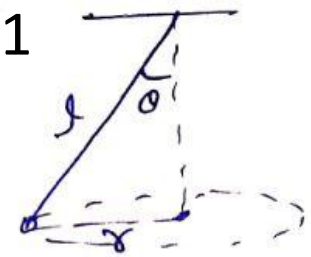


Written Solution

DPP-4 Conical Pendulum, Motion of vehicle on circular path, Banking of roads

By Physicsaholics Team

Solution: 1



$r = l\sin\theta$

$T = \frac{2\pi r}{v}$

$v = r\omega$

$T = \frac{2\pi r}{r\omega} = \frac{2\pi}{\omega}$

$v = \sqrt{rg\tan\theta}$

$v^2 = rg\tan\theta \Rightarrow \omega^2 = \frac{v^2}{r^2} = \frac{rg\tan\theta}{r^2}$

$\omega^2 = \frac{g\tan\theta}{r} = \frac{g\tan\theta}{l\sin\theta}$

$\omega^2 = \left(\frac{g}{l\cos\theta}\right)$

$\omega = \sqrt{\frac{g}{l\cos\theta}}$

$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{l\cos\theta}{g}}$

$T \propto \sqrt{\cos\theta} \Rightarrow T^2 \propto \cos\theta$

$\frac{T_1^2}{T_2^2} = \frac{\cos\theta_1}{\cos\theta_2} = \frac{\cos 45^\circ}{\cos 60^\circ} = \frac{1/\sqrt{2}}{1/2} = \frac{2}{1} \times \frac{1}{\sqrt{2}}$

$$\boxed{\frac{T_1^2}{T_2^2} = \frac{\sqrt{2}}{1}}$$

OR

$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{l\cos\theta}{g}}$

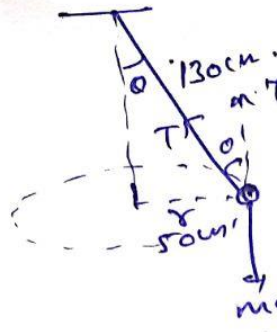
$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{\cos\theta_1}{\cos\theta_2}}$

$\Rightarrow \frac{T_1^2}{T_2^2} = \frac{\cos 45^\circ}{\cos 60^\circ}$

$= \frac{1}{\sqrt{2} \times 1/2} = \sqrt{2}$

Ans. b

Solution: 2



$T\cos\theta = mg$ — (1)

$T\sin\theta = m\omega^2 r$ — (2)

$\frac{(2)}{(1)} = \tan\theta = \frac{\omega^2 r}{g}$

$\tan\theta = ?$

$\sin\theta = \frac{50}{130} = \frac{5}{13}$

$\tan\theta = \frac{5}{12}$

$\therefore \frac{5}{12} = \frac{\omega^2 r}{g} \Rightarrow \omega = \sqrt{\frac{5}{12}\times\frac{10}{50\times10^{-2}}}$

$\omega = \frac{10}{\sqrt{12}} = \frac{5}{\sqrt{3}}$

Time period $t = \frac{2\pi}{\omega} = \frac{2\pi}{5}\times\sqrt{3}$

~~$t = 2.2$ sec~~ $t = 2.2$ sec

~~Let~~ Tension is string $T = ?$

from eqn (1) $[m = 200\text{ gm} = 200\times10^{-3}\text{ kg}]$

$T\cos\theta = mg$

$T\left(\frac{12}{13}\right) = 200\times10^{-3}\times10$

$T = \frac{2\times13}{12}$

$\boxed{T = 2.16\text{ N}}$

Ans. a

Solution: 3

$$\mu = \frac{g}{R\omega^2}$$

$$\omega^2 = \frac{g}{R\mu} \Rightarrow \left(\frac{v}{R}\right)^2 = \frac{g}{R\mu}$$

min; $v = \sqrt{\frac{Rg}{\mu}}$

$$v = \sqrt{\frac{8 \times 10}{0.2}} = \sqrt{400}$$

$$v = 20 \text{ m/s}$$

Ans. b

Solution: 4

$r = 2\,m$,

$\mu = 0.2$

min. $v = \sqrt{\frac{rg}{\mu}} = \sqrt{\frac{2 \times 10}{0.2}} = \sqrt{100}$

$$\boxed{v = 10\ m/s}$$

Ans. a

Solution: 5

$$v_{max} = \sqrt{\mu r g}$$

$$v_{max} = \sqrt{0.4 \times 30 \times 10} = \sqrt{120}$$

$$\boxed{v_{max} = 10.95 \text{ m/s}}$$

Ans. a

Solution: 6

$$V_{max} = \sqrt{T\mu\gamma}$$

$$\gamma = \frac{V^2}{\mu g}$$

$$\gamma = \frac{(30)^2}{0.5 \times 10}$$

$$\boxed{\gamma = 180\ m}$$

$$V = 108\ km/hr$$

$$= 108 \times \frac{5}{18}$$

$$= 30\ m/s$$

Ans. c

Solution: 7

$$\tan\theta = \frac{v^2}{rg}$$

$$\tan 45^\circ = \frac{v^2}{90 \times 10}$$

$$v = 30\sqrt{3}$$

Ans. c

Solution: 8

$$\tan\theta = \frac{v^2}{rg}$$

$$\tan\theta = \frac{(14\sqrt{3})^2}{9.8 \times 20\sqrt{3}} = \frac{196 \times 3}{196 \times \sqrt{3}}$$

$$\tan\theta = \sqrt{3}$$

$$\theta = \tan^{-1}(\sqrt{3})$$

$$\theta = 60^\circ \text{ (with vertical)}$$

from horizontal

$$\alpha = 90 - \theta$$

$$\alpha = 90 - 60^\circ$$

$$\alpha = 30^\circ$$

Ans. a

Solution: 9

for Designed speed

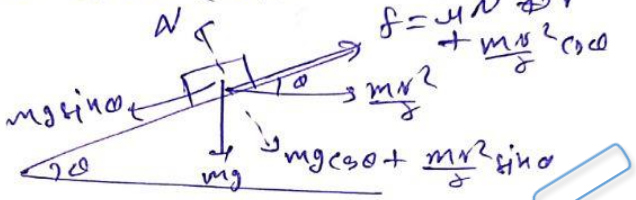
$$\tan\theta = \frac{v_0^2}{rg} = ?$$

$v_0 = 36\ km/hr = 10\ m/s$

$$\tan\theta = \frac{(10)^2}{20\times 10} = \frac{1}{2}$$

$$\Rightarrow \sin\theta = \frac{1}{\sqrt{5}}\ ;\quad \cos\theta = \frac{2}{\sqrt{5}}$$

(i) for min speed (V_{min})



$$N = mg\cos\theta + \frac{mv_{min}^2}{r}\sin\theta \quad -(1)$$

$$\mu N + \frac{mv_{min}^2}{r}\cos\theta = mg\sin\theta \quad -(2)$$

Put N in eq^n (1)

$$\mu\left(mg\cos\theta + \frac{mv_{min}^2}{r}\sin\theta\right) + \frac{mv^2}{r}\cos\theta = mg\sin\theta$$

$$0.4\left(10\times\frac{2}{\sqrt{5}} + \frac{v_{min}^2}{20}\times\frac{1}{\sqrt{5}}\right) + \frac{v_{min}^2}{20}\times\frac{2}{\sqrt{5}} = 10\times\frac{1}{\sqrt{5}}$$

$$8 + \frac{v_{min}^2}{20}\times 0.4 + \frac{v_{min}^2}{10} = 10$$

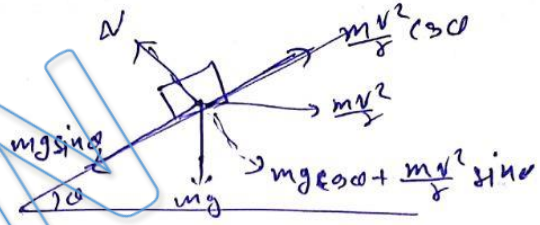
$$0.2\frac{v_{min}^2}{10} + \frac{v_{min}^2}{10} = 2$$

$$1.2\,v_{min}^2 = 20$$

$$v_{min} = \sqrt{\frac{20}{1.2}}$$

$$\boxed{v_{min} = 4.08\ m/s}$$

(ii) for max speed V_{max}



$$N = mg\cos\theta + \frac{mv^2}{r}\sin\theta \quad -(1)$$

$$\mu N + mg\sin\theta = \frac{mv_{max}^2}{r}\cos\theta$$

$$\mu\left(mg\cos\theta + \frac{mv_{max}^2}{r}\sin\theta\right) + mg\sin\theta = \frac{mv^2}{r}\cos\theta$$

$$0.4\left(10\times\frac{2}{\sqrt{5}} + \frac{V_{max}^2}{20}\times\frac{1}{\sqrt{5}}\right) + 10\times\frac{1}{\sqrt{5}} = \frac{V_{max}^2}{20}\times\frac{2}{\sqrt{5}}$$

$$8 + \frac{V_{max}^2}{20}\times 0.4 + 10 = \frac{V_{max}^2}{10}$$

$$18 = \frac{V_{max}^2}{10} - \frac{0.4\times V_{max}^2}{20}$$

$$18 = \frac{V_{max}^2}{10} - \frac{0.2\,V_{max}^2}{10} = \frac{0.8\,V_{max}^2}{10}$$

$$V_{max}^2 = \frac{18\times 10}{0.8}$$

$$V_{max} = \sqrt{\frac{18\times 10}{0.8}}$$

$$\boxed{V_{max} = 15\ m/s}$$

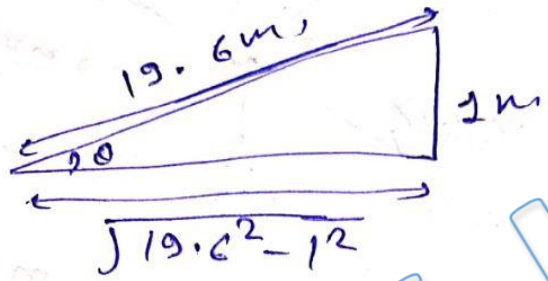
$\therefore V_{min} \le V \le V_{max}$

$$\boxed{4.08\ m/s \le V \le 15\ m/s}$$

Ans. a

Solution: 10

$r = 800\ m$



$$\tan\theta = \frac{1}{\sqrt{19.6^2 - 1}} = \frac{1}{19.57} = \frac{1}{19.6}$$

$$\tan\theta = \frac{v^2}{rg}$$

$$\frac{1}{19.57} = \frac{v^2}{800 \times 9.8}$$

$$\frac{1}{2 \cancel{19.6}} = \frac{v^2}{\cancel{800 \times 9.8}}$$

$$v^2 = \frac{800}{2}$$

$$v^2 = 400$$

$$\boxed{v = 20\ m/s}$$

Ans. c

Solution: 11

max safe speed

$$V_{max} = \sqrt{rg\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)}$$

$$V_{max} = \sqrt{1000 \times 9.8\left(\frac{0.5 + \tan 45^\circ}{1 - 0.5\tan 45^\circ}\right)}$$

$$V_{max} = \sqrt{9800\left(\frac{1/2 + 1}{1 - \frac{1}{2}\times 1}\right)}$$

$$= \sqrt{9800\left(\frac{3/2}{1/2}\right)}$$

$$= \sqrt{9800 \times 3}$$

$$V_{max} = \sqrt{29400}$$

$$\boxed{V_{max} \simeq 172 \text{ m/s}}$$

Ans. a

Solution: 12

$$V_{max} = \sqrt{\mu r g}$$

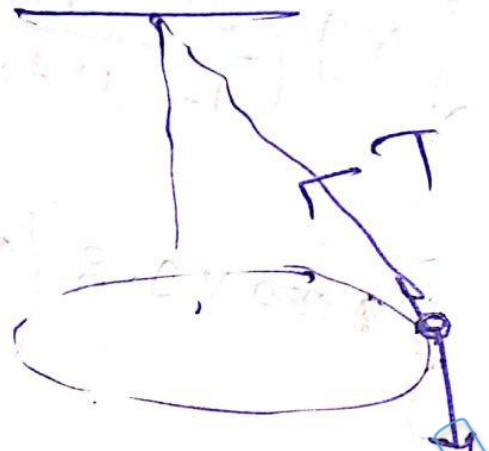
$$= \sqrt{0.2 \times 9.8 \times 100}$$

$$= \sqrt{196}$$

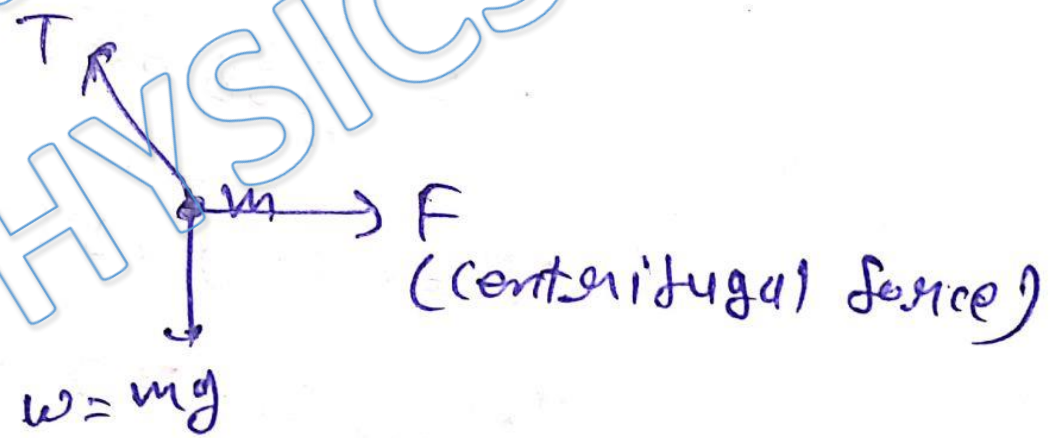
$$\boxed{V_{max} = 14 \text{ m/s}}$$

Ans. d

Solution: 13



w.r.t. rest (Non inertial frame)
centrifugal force will also be there



Ans. c

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/39

Video Solution on YouTube:- https://youtu.be/hsCDAjR-KWY

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/42

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

Unacademy

CLICK

Chalo Niklo