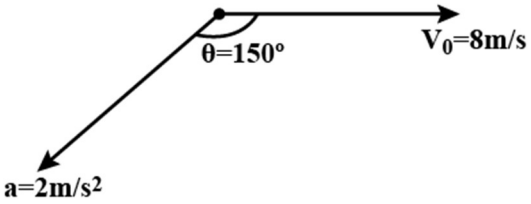
DPT: CIRCULAR MOTION

PHYSICS

1. The figure shows the velocity and acceleration of a point like body at the intial moment of its motion. The acceleration vector of the body remains constant the minimum radius of curvature of the trajectory of the body is.



1) 2m 2) 3m 3) 8m 4) 16m

2. A body moving in a circle with speed of 1m/s. this speed increases at a constant rate of 2m/s every second. Assume that the radius of the circle described is 25m the total acceleration of the body ofter 2s is

1) $2mls^2$ 2) $\sqrt{5}m/s^2$ 3) 25 m/s2 4) $\sqrt{7}m/s^2$

3. The angle made by a motor with the vertical when negotiating a bend along an unbanked road of radius 10m with speed of 27kmph is about $(g = 10m/s^2)$

1) $Tan^{-1}(9/16)$ 2) $Tan^{-1}(5/8)$ 3) $Tan^{-1}(9/8)$ 4) $Tan^{-1}(9/4)$

4. A particle P is moving in a circle of radius 'r' with uniform speed 'V'. 'O' is the centre of circle and AB is a diameter when passing through 'B' the angular velocity of P about A and O in the ratio

1) 1:2 2) 2:1 3) 4:1 4) 1:1

5. When ceiling fan is switched off its angular velocity reduces to 50% while it makes 36 rotations. How many more rotation will it make before coming to rest (Assume uniform angular retardation)

1) 48 2) 36 3)18 4) 12

6. A particle moves in xy plane the position vector at any time 't' is 'r' =$(2ti + 2t^2j)$m. The rate of change of θ at t= 2 second (where θ is angle which its velocity vector makes with positive x - axis) is

1) $\frac{1}{14}$ rad/s 2) $\frac{2}{17}$ rad/s 3) $\frac{4}{7}$ rad/s 4) $\frac{6}{5}$ rad/s

7. A particle is moving at uniform speed 3 m/s along a circle of radius the centripetal acceleration of particle is

1) 8 m/s^2 2) 9 m/s^2 3) 6 m/s^2 4) 3 m/s^2

8. A particle is projected with velocity $20\sqrt{2}m/s$ at angle of 45^0 with horizontal the angular velocity of the particle at highest point of its journey about point of projection is

1) 2 rad/s 2) 1 rad/s 3) 0.5 rad/s 4) 3 rad/s

9. A point traversed half of the circle of radius R in time t the magnitude of the average velocity of the particle in this time interval is

1) 2R 2) R/t 3) 2R/t 4) R/2t

10. A car is moving in a circular horizontal track of radius 10m with a constant speed of $10m/s^2$. A plumb bob is suspended from the roof of the car by a string of length 1m the angle made by the string with vertical is ($g = 10m/s^2$)
    1) 0 2) 30 3) 45^0 4) 60
11. A projectile is launched horizontally with 10m/s from some height, radius of curvature of path at t=1sec is ($g = 10m/s^2$)
    1) $40\sqrt{m}$ 2) $20\sqrt{2m}$ 3) 80m 4) 20m
12. If the radius of circular track of two particles are in the ratio of 4:9 then in order to have same centripetal acceleration their speeds should be in the ratio of
    1) 4:9 2) 2:3 3) 3:2 4) 9:4
13. A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a centripetal force F with is inversely proportional to R^3. Its time period of revolution will be given by
    1) $T \propto R^2$ 2) $T \propto R^{3/2}$ 3) $T \propto R^{5/2}$ 4) $T \propto R^{4/3}$
14. A body rotating with an angular speed of 600 rpm is uniform accelerated to 1800 rpm in 10 sec the number of rotations made in the process is
    1) 300 2) 200 3) 100 4) 150
15. A block of 200g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20cm, if block takes 40s to complete one round, the normal force by the side walls of the groove is
    1) 3.14 x 10^{-2}N 2) $9.859x10^{-2}$ 3) $9.859x10^{-4}N$ 4) $6.28x10^{-3}N$
16. A particle is moving along the circumference of a circle subtends an angle of 30^0at its centre in 2s. find its angular velocity __ rad/s
    1) π 2) $\frac{\pi}{3}$ 3) $\frac{\pi}{12}$ 4) 12
17. A ring of mass 2π kg and of radius 0.25m is making 300 rpm about an axis through its centre perpendicular to its plane. The tension (in N) developed in the ring is
    1) 50 2) 100 3) 175 4) 250
18. A particle is projected with velocity 5m/s at angle 60^0 with vertical. Its intial tangential acceleration at the point of landing (in SI units) is (take $g = 9.8ms^2$)
    1) 5.9 m/s^2 2) 9.8 m/s^2 3) 4.9 m/s^2 4) 4 m/s^2
19. The centripetal force acting on a body of mass m revolving in a circle of a radius 'r' and completes n rev/sec is
    1) $4\pi mrn^2$ 2) $4\pi mr^2n^2$ 3) $4\pi^2mr^2n^2$ 4) $4\pi^2mrn^2$

20. The angular speed of a particle moving in a circle of radius 20cm increases from 2 rad/s to 40 rad/s in 9s. The ratio of its centripetal acceleration to tangential acceleration at the end of 19s
    1) 800:1 2) 1:800 3) 400:1 4) 1:400
21. A stone of mass 1kg is attached to a string of the length 4m and whirled in a horizontal circle. If the string can with stand a tension of 9N, the maximum velocity with which the stone can be whirled is __m/s
22. A motor car is travelling at 30m/s on a circular road of radius 500m. It is increasing its speed at the rate of 2 m/s^2. its acceleration is ____m/s^2 (approximately)
23. A stone is tied at the end of a string of 2m length and then rotated with a constant angular velocity of 10 rad/sec the centripetal acceleration of the stone will be ___rad/s^2

24. A boy whirls a stone in a horizontal circle of radius 2m and at height 10m above level ground the string breaks and the stone files off horizontally and strikes the ground after travelling a horizontal distance of 10m. the magnitude of the centripetal acceleration of the stone while in circular motion (g =10)m/s^2 ____m/s^2
25. A car is driven round a curved path of radius 16m without the danger of skidding. The coefficient of friction between the tyres of the car and the surface of curved path is 0.1 what is the maximum speed of the car for safe driving? ($g = 10m/s^2$)_____m/s^2
26. The centripetal required for a 1000kg car travelling at 10m/s to take a turn by 90^0 in travelling along on arc of length 628m is ____N
27. The maximum speed with which a car can be driven safely along a curve road of radius 17.32m and banked at 30^0 with horizontal is ____m/s
28. An empty truck can take certain level turn at a maximum safe speed of 12 m/s without skidding when the truck is carrying a load equal to its own weight. the maximum speed at which the truck safely take the turn is _____m/s
29. A body is tied at the end of a string and whirled round in a horizontal circle. At any instant its kinetic energy is found to be numerically equal to the centripetal force on it. Then the radius of the circle will _____m
30. In death well motor cycle rider drives round the inner wall of a hollow cylindrical chamber. If the radius of the cylindrical chamber is 8m, what would be minimum speed of the rider to prevent him from sliding down? $(g = 10m/s^2, \mu = 0.2)$

KEY

1-10	**3**	**2**	**1**	**1**	**4**	**2**	**2**	**2**	**3**	**3**
11-20	**2**	**2**	**1**	**2**	**3**	**3**	**4**	**3**	**4**	**1**
21-30	**6**	**3**	**200**	**25**	**4**	**250**	**10**	**12**	**2**	**20**

HINTS

1. $R = \frac{V_0^2}{a}$

$a_c = \frac{v^2}{R} \Rightarrow \frac{v_x^2 + v_y^2}{R}$

$a_c = \frac{v\cos\theta + (v\sin\theta - gt)^2}{R}$

$R = \frac{v\cos\theta + (v\sin\theta - gt)^2}{C}$

$R_{\min} = \frac{(v\cos\theta)^2}{a_c}$

$$R_{\min} = \frac{(8 \times \frac{1}{2})^2}{2}$$

$$R_{\min} = \frac{16}{2} = 8m$$

2. $a_t = 2m/s^2 \qquad v = u + at$

$$v = 1 + 2 \times 2$$

$$v = 5m/s$$

$$a_c = \frac{v^2}{r} = \frac{25}{25} = 1m/s^2$$

$$a = \sqrt{a_c^2 + a_t^2} = \sqrt{2^2 + 1^2}$$

$$= \sqrt{5}m/s^2$$

3. $Tan\theta = \frac{v^2}{rg} \qquad V = 27x\frac{5}{18} \qquad V = \frac{15}{3}m/s$

$$Tan\theta = \frac{9}{16}$$

4. $\omega_A = \frac{V}{2r}$

$$\omega_0 = \frac{V}{r}$$

$$\frac{\omega_A}{\omega_0} = \frac{1}{2}$$

5. $\omega = \frac{\omega_0}{2} \quad \theta = 2\pi N$

$$\frac{\omega_0^2}{4} - \omega_0^2 = 2\alpha(72\pi)$$

$$\alpha = \left(\frac{-\omega_0^2}{192\pi}\right)$$

$$\theta - \frac{\omega_0^2}{4} = 2\left(\frac{-\omega_0^2}{192\pi}\right)^{\theta}$$

$$\theta = \frac{192\pi}{8}$$

$$\theta = 24\pi$$

$$2\pi N = 24\pi$$

$$N = 12$$

6. $V_x = 2 \qquad v_y = 4t$

$$\tan\theta = \frac{v_y}{v_x} = \frac{4t}{\alpha} = 2t$$

$$\frac{d}{dt}=(\tan\theta)=\frac{d}{dt}(2t)$$

$$\sec^2\theta\frac{d\theta}{dt}=2$$

$$\frac{d\theta}{dt}=\frac{2}{\sec^2}$$

$$\frac{d\theta}{dt}=\frac{2}{1+\tan^2\theta}$$

$$\frac{d\theta}{dt}=\frac{2}{1+4t^2}=\frac{2}{17}\ \text{rad/s}$$

7. $a=\frac{v^2}{r}$

$$a=\frac{9}{1}=9m/s^2$$

8. $\theta=30^0$

$V=r\omega \qquad r=\mu$

$$\omega=\frac{v}{r}$$

$$\mu=\frac{4^2\sin^2\theta}{2g}\ \mu=\frac{4^2\sin^2\theta}{2g}$$

$$\mu=20m$$

$$\omega=\frac{20}{20}$$

$=1\text{rad/s}$

9. A $V_{avg}=$ Total displacement / total line

$$V_{avg}=\frac{2R}{t}$$

10. $\tan\theta=\frac{v^2}{rg}=\frac{100}{10\times10}=1$

$$\theta=45^0$$

11.

$$v_x=u_x=u=10m/s$$

$$V_y=u_y+gt=10m/s$$

$$V=\sqrt{v_x^{\ 2}+v_y^{\ 2}}=10\sqrt{2}$$

$$R=\frac{v^2}{g\cos\theta}=\frac{(10\sqrt{2})^2}{10\cos45^0}$$

$$R=20\sqrt{2}m$$

12. $\frac{r_1}{r_2}=\frac{4}{9}$ $\qquad a_1=a_2$

$$\frac{V_1^2}{r_1}=\frac{V_1^2}{r_2}$$

$$\frac{V_1}{V_1}=\sqrt{\frac{r_1}{r_2}}=\frac{2}{3}$$

13. $F\alpha\frac{1}{R^3}$

$$\frac{K}{R^3}=m\omega^2R$$

$$\omega^2=\frac{K}{mR^4}$$

$$\left(\frac{2\pi}{T}\right)^2=\frac{K}{mR^4}$$

$$T^2\alpha R^4\rightarrow T\alpha R^2$$

14. $\omega=\omega o+\alpha t$

$$\alpha=\frac{\omega-\omega_0}{t}=\frac{60\pi-20\pi}{10}$$

$$\alpha=4\pi$$

$$\theta=\omega_0t+\frac{1}{\alpha}\alpha t^2$$

$$\theta=(20\pi)(10)+\frac{1}{\cancel{2}}(\cancel{4}\pi)(100)$$

$\cancel{2\pi}N=\cancel{400\pi}$ $\qquad N=200$

15. $N=F_c=mrw^2$

$$N=0.2\times0.2\times\left(\frac{2\pi}{40}\right)^2$$

$$N=9.859x10^{-4}N$$

16. $\theta=30^0\times\frac{\pi}{180}=\frac{\pi}{6}rad$

$$\omega=\frac{\theta}{t}=\frac{\pi/6}{2}$$

$$\omega=\frac{\pi}{12}rad/s$$

17. $T=\frac{mv^2}{r}$ $\qquad V=r\omega$

$$T=mr\omega^2\Rightarrow$$

18. $a_t=g\sin\theta$

$$\theta=30^0$$

$a_t = 9.8 \times 1/2$

$a_t = 4.9 m/s^2$

19. $F = mrw^2$

$F = mr(2\pi r)^2$

$F = 4\pi^2 mrn^2$

20. $a_c = \omega^2 r$

$a_c = 320 m/s^2$

$\alpha = \frac{\omega - \omega_o}{t} = \frac{40-2}{19}$

$\alpha = 2 rad/s^2$

$a_t = r\alpha = 2 \times 2 \times 10^{-2}$

$a_t = 0.4 m/s^2$

$\frac{a_c}{a_t} = \frac{320}{0.4} = \frac{800}{1}$

21. $F = T = \frac{mv^2}{r}$

$\frac{1 \times v^2}{4} = 9 \qquad V^2 = 36$

$V = 6 m/s$

22. $a_t = \frac{dv}{dt} = 2 m/s^2$

$a_r = \frac{v^2}{r} = \frac{30x30}{500} = 1.8 m/s^2$

$a = \sqrt{a_c^2 + a_t^2} \qquad = \sqrt{(1.8)^2 + 2^2}$

$a = 2.7 m/s^2 \simeq 3 m/s^2$

23. $a = r\omega^2$

$a = 2(10)^2$

$a = 200 rad/s^2$

24. $V = \frac{s}{t}$

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 + \cancel{10}}{\cancel{10}}}$

$t = \sqrt{2}$

$V = \frac{10}{\sqrt{2}} \Rightarrow 5\sqrt{2} m/s$

$a_c = \frac{V^2}{R} = \frac{25x2}{2} = 25 m/s^2$

25. Maximum speed $V = \sqrt{\mu_s gr}$

$V = \sqrt{0.1 \times 10 \times 16}$

$= 4m/s$

26. $F = \frac{mv^2}{R} \times \frac{\pi}{2}$

$= \frac{1000 \times 100 \times \pi}{628 \times 2}$

$= 250N$

27. $V = \sqrt{rg \tan\theta}$

$V = \sqrt{17.32 \times 10 \times \frac{1}{\sqrt{3}}}$

$V = \sqrt{100} = 10m/s$

28. $12m/s$

29. $\frac{1}{2}mv^2 = \frac{mv^2}{r}$

$r = 2m$

30. $N = \frac{mv^2}{r}$ $F = \mu N = mg\mu$

$N = f$ $\frac{mv^2}{r} = \mu mg$

$V = \sqrt{\frac{rg}{m}}$

$V = \sqrt{\frac{8x10}{0.2}}$

$V = \sqrt{400}$ $V = 20m/s$