1. A body is revolving with a uniform speed v in a circle of radius r. The angular acceleration of the body is

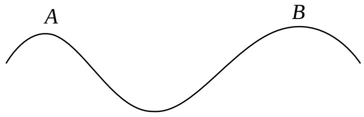
(a) $\frac{v}{r}$

(b) Zero

(c) $\frac{v^2}{r}$ along the radius and towards the centre

(d) $\frac{v^2}{r}$ along the radius and away from the centre

2. A car moves at a constant speed on a road as shown in the figure. The normal force exerted by the road on the car is N_A and N_B when it is at the points A and B respectively



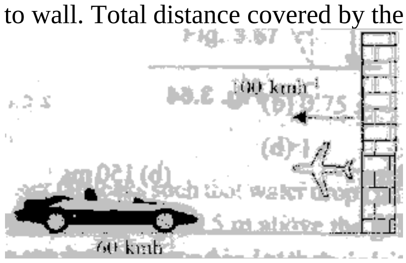
(a) $N_A = N_B$ (b) $N_A > N_B$

(c) $N_A < N_B$ (d) All possibilities are there

3. In the above problem, what is the change in angular velocity in going from P_1 to P_2

(a) Zero (b) $\sqrt{2}\,v/R$ (c) $v/\sqrt{2}\,R$ (d) $2v/R$

4. A jeep moves at uniform speed of 60 kmh^{-1} on a straight road blocked by a wall. The jeep has to take a sharp perpendicular turn along the wall. A rocket flying at uniform speed of 100 kmh^{-1} starts from the wall towards the jeep when the jeep is 30 km away. The rocket reaches the windscreen and returns to wall. Total distance covered by the rocket is



(a) 100 km (b) 50 km (c) 25km (d) 75km

5. A car is moving on a circular track of radius R. The road is banked at θ. μis the coefficient of friction. Find the maximum speed the car can have.

(a) $\left[\frac{Rg(\sin\theta+\mu\cos\theta)}{\cos\theta+\mu\sin\theta}\right]^{1/2}$ (b) $\left[\frac{Rg(\cos\theta+\mu\sin\theta)}{\cos\theta-\mu\sin\theta}\right]^{1/2}$

(c) $\left[\frac{Rg(\sin\theta+\mu\cos\theta)}{\cos\theta-\mu\sin\theta}\right]^{1/2}$ (d) None

6. The minimum velocity (in m/s) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is-

(a) 60 (b) 30 (c) 15 (d) 25

7. A car is travelling along a circular curve that has a radius of 8m. If its speed is 8 m/s and is increasing uniformly at 8 m/s^2, the magnitude of its acceleration at this instant is -

(a) 8 m/s^2 (b) $8\sqrt{2}$ m/s^2 (c) $\frac{8}{\sqrt{2}}$ m/s^2 (d) 16 m/s^2

8. A 500 kg car takes a round turn of radius 50 m with a velocity of 36 km/hr. The centripetal force is-

(a) 250 N (b) 750 N (c) 1000 N (d) 1200 N

9. A wheel covers a distance of 9.5 *km* in 2000 revolutions. The diameter of the wheel is

(a) 15 m (b) 7.5 m (c) 1.5 m (d) 7.5 m

10. The magnitude of displacement of a particle moving in a circle of radius a with constant angular speed ω varies with time t as –

(a) 2a sin ωt (b) $2a \sin\frac{\omega t}{2}$

(c) 2a cosωt (d) $2a \cos\frac{\omega t}{2}$

11. Motion of one projectile as seen by the another projectile is always –

(a) A straight line (b) Circular

(c) Parabolic (d) Elliptical

12. If a cycle wheel of radius 4 m completes one revolution in two seconds. Then acceleration of the cycle will be

(a) $\pi^2 m/s^2$ (b) $2\pi^2 m/s^2$

(c) $4\pi^2 m/s^2$ (d) $8\pi\, m/s^2$

13. A stone is tied to one end of a spring 50 cm long is whirled in a horizontal circle with a constant speed. If the stone makes 10 revolutions in 20 s, what is the magnitude of acceleration of the stone

(a) 493 cm/sec^2 (b) 720 cm/sec^2

(c) 860 cm/sec^2 (d) 990 cm/sec^2

14. A wheel of radius $0.20m$ is accelerated from rest with an angular acceleration of $1\ rad/s^2$. After a rotation of 90^o the radial acceleration of a particle on its rim will be

(a) $\pi\ m/s^2$ (b) $0.5\ \pi\ m/s^2$

(c) $2.0\pi\ m/s^2$ (d) $0.2\ \pi\ m/s^2$

15. A body is performing circular motion. An observer O_1 is sitting at the centre of the circle and another observer O_2 is sitting on the body. The centrifugal force is experienced by the observer

(a) O_1 only (b) O_2 only

(c) Both by O_1 and O_2 (d) None of these

16. In the above problem, what is change in velocity in going from P_1 to P_2

(a) Zero (b) $\sqrt{2v}$ (c) $v/\sqrt{2}$ (d) 2 v

17. A car is travelling at a velocity of 10 kmh^{-1} on a straight road. The driver of car throws a parcel with a velocity of $10\sqrt{2}$ kmh^{-1} when car is passing by a man standing on the side of a road. If parcel just reaches the man, the direction of throw makes following angle with the direction of car

(a) 135^0 (b) 45^0 (c) $\tan^{-1}(\sqrt{2})$ (d) $\tan(1/\sqrt{2})$

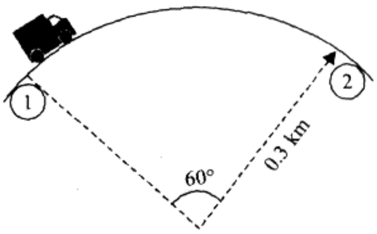
18. A particle starts from the origin of coordinates at time t= 0 and moves in the xyplane with a constant acceleration αin the y-direction. Its equation of motion is $y = \beta x^2$. Its velocity component in the x- direction is

(a) Variable (b) $\sqrt{\frac{2\alpha}{\beta}}$ (c) $\frac{\alpha}{2\beta}$ (d) $\sqrt{\frac{\alpha}{2\beta}}$

19. A circular track of radius 300 m is banked at an angle π/12 radian. If the coefficient of friction between wheel of a vehicle and road is 0.2, the maximum safe speed of vehicle is

(a) 28 ms^{-1} (b) 38ms^{-1} (c) 18ms^{-1} (d) 48ms^{-1}

20. A jeep runs around the curve of radius 0.3 km at a constant speed of 60 ms^{-1}. The resultant change in velocity, instantaneous acceleration and average acceleration over 60^0 arc are



(a) 30 ms^{-1}, 11.5 ms^{-2},12 ms^{-2} (b) 60ms^{-1}, 12 ms^{-2},11.5ms^{-2}
(c) 60ms^{-1}, 11.5 ms^{-2},12ms^{-2} (d) 40 ms^{-1}, 10ms^{-2},8ms^{-2}

21. A motor car is travelling at 30 ms^{-1} on a circular road of radius 500 m. It is increasing speed at the rate of 2 ms^{-2}. The acceleration of car is
(a) 2 ms^{-2} (b) 2.7 ms^{-2} (c) 3ms^{-2} (d) 3.7 ms^{-2}

22. A string of length 1m is fixed at one end and carries a mass of 100 g at the other end. The string makes 2/π revolutions per second around the vertical axis through the fixed end. If angle of inclination of the string with the vertical is $\cos^{-1}5/8$, the linear velocity of the mass is nearly
(a) 1 ms^{-1} (b) 2 ms^{-1} (c) 3 ms^{-1} (d) 4 ms^{-1}

23. A particle of mass m revolves in a circle of radius r with a uniform speed ν, then its velocity vector -
(a) Remains constant
(b) Changes in magnitude
(c) Changes in direction
(d) Changes both in magnitude and direction

24. A non-uniform thin rod of length L is placed along x-axis as such its one of ends is at the origin. The linear mass density of rod is $\lambda = \lambda_0 x$. The distance of centre of mass of rod from the origin is :
(a) $\frac{L}{2}$ (b) $\frac{2L}{3}$ (c) $\frac{L}{4}$ (d) $\frac{L}{5}$

25. An aeroplane is moving in a circular path with a speed 250 km/hr; what is the change in velocity in half revolution -
(a) 500 km/hr (b) 250 km/hr (c) 125 km/hr (d) Zero

26. Consider the following controls in an automobile: gas pedal, brake, steering wheel. The controls in this list that cause an acceleration of the car are –
(a) All three controls (b) The gas pedal and the brake
(c) Only the brake (d) Only the gas pedal

27. Two bullets are fired simultaneously uphill parallel to an inclined plane. The bullets have different masses and different initial velocities. Which will strike the plane first?
(a) The fastest one
(b) The heaviest one
(c) The lightest one
(d) They strike the plane at the same time

28. A particle having a mass of 0.5 kg is projected under gravity with a speed of 98 ms^{-1} at an angle of 60°. The magnitude of the change of momentum of the particle after 10 s is -
(a) 0.5 N s (b) 49 N s (c) 98 N s (d) 490 N s

29. A bucket tied at the end of a 1.6 m long string is whirled in a vertical circle with a constant speed. What should be the minimum speed so that the water from the bucket does not spill out during rotation (g= 10 ms^2)?
(a) 9 ms^{-1} (b) 6.25 ms^{-1} (c) 16 ms^{-1} (d) None of these

30. A body is projected horizontally with speed 20 m/s. What will be its speed nearly after 5 sec?

(a) 54 m/s (b) 20 m/s (c) 50 m/s (d) 70 m/s

1. (b)

In uniform circular motion ω constant so $\alpha = \frac{d\omega}{dt} = 0$

2. (c)

From the formula $N = mg - \frac{mv^2}{r}$ $\therefore N \propto r$

As $r_A < r_B$ $\therefore$ $N_A < N_B$

3. (a)

Angular velocity remains constant, so change in angular velocity = Zero.

4. (b)

The time taken by jeep to cover a distance of 30 km = Distance/Speed = 30/60 = 1/2 hr.

Total distance covered by rocket in this duration = speed × time

= 100 × ½ = 50 km

5. (c)

$v_{max} = \left[\frac{Rg(\tan\theta + \mu)}{1 - \mu\tan\theta}\right]^{1/2} = \left[\frac{Rg(\sin\theta + \mu\cos\theta)}{\cos\theta - \mu\sin\theta}\right]^{1/2}$

6. (b)

$\frac{mv^2}{r} = \mu\, mg \Rightarrow v = \sqrt{\mu rg}$

7. (b)

$a = \sqrt{a_r^2 + a_t^2}$

$a_r = \frac{v^2}{r} = \frac{8^2}{8} = 8 m/s^2 \Rightarrow a_t = 8\ m/s^2$

$\therefore$ $a = 8\sqrt{2}\ m/s^2$

8. (c)

$F_C = \frac{Mv^2}{r}$

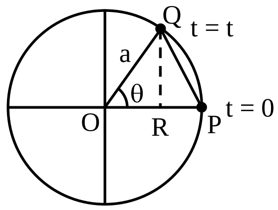
9. (c)

Distance $= n(2\pi r) \Rightarrow 9.5 \times 10^3 = 2000 \times (\pi D) \Rightarrow$

$D = \frac{9.5 \times 10^3}{2000 \times \pi} = 1.5\, m.$

10. (b)

In time t particle has rotated an angle θ = ωt. Displacement



$s = PQ = \sqrt{QR^2 + PR^2}$

$= \sqrt{(a\sin\omega t)^2 + (a - a\cos\omega t)^2}$

$s = 2a\sin\frac{\omega t}{2}$

11. (a)

$\because$ Relative Acceleration is zero

$\therefore$ Relative velocity is constant

Thus Relative path is straight line.

12. (c)

Given $r = 4\,m$ and $T = 2$ seconds.

$\therefore a_c = \frac{4\pi^2}{T^2}r = \frac{4\pi^2}{(2)^2}4 = 4\pi^2\,m/s^2$

13. (a)

Time period $= \frac{\text{Total time}}{\text{No. of revolution}} = \frac{20}{10} = 2\,sec$

$\therefore a_c = \frac{4\pi^2}{T^2}.r = \frac{4\pi^2}{(2)^2}\times(1/2)m/s^2 = 4.93\,m/s^2$

$= 493\,cm/s^2$

14. (d)

From the equation of motion

Angular speed acquired by the wheel, $\omega_2^2 = \omega_1^2 + 2\alpha\theta = 0 + 2\times1\times\frac{\pi}{2} \Rightarrow \omega_2^2 = \pi$

Now radial acceleration $\omega^2 r = \pi\times0.2 = 0.2\pi\,m/s^2$

15. (b)

Centrifugal force is a pseudo force, which is experienced only by that observer who is attached with the body performing circular motion.

16. (b)

Change in velocity $= 2v\sin(\theta/2) = 2v\sin\left(\frac{90}{2}\right) = 2v\sin45 = \frac{2v}{\sqrt2} = \sqrt2\,v$

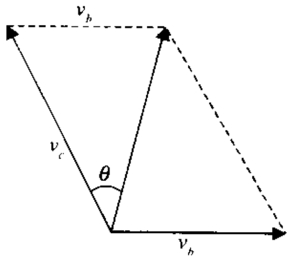
17. (a)

When the car is exactly opposite, the man at least distance, the bag will reach him when thrown with velocity v_0.

$\sin\theta = \frac{v_b}{v_c} = \frac{10}{10\sqrt2} = \frac{1}{\sqrt2}$

or $\theta = 45^0$

$\therefore$ total angle between v_c and v_b is $90 + 45 = 135^0$



18. (d)

$y = \beta x^2$ or $y = 2\beta x\,\dot{x}$

or $\ddot{y} = 2\beta(\dot{x})^2 = \alpha$

or $\dot{x} = \sqrt{\frac{\alpha}{2\beta}}$

[$\ddot{x} = 0$ as it has acceleration only in the y – direction.]

19. (b)

Maximum velocity,

$$v_{max} = \left[\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)rg\right]^{1/2}$$

$$= \left[\left(\frac{0.2 + \tan 15^o}{1 - 0.2\tan 15^o}\right)300 \times 9.8\right]^{1/2} = 38\,ms^{-1}$$

20. (b)

$\Delta\vec{v} = 2v\sin\left(\frac{\theta}{2}\right) = 2 \times 60 \sin 30 = 60\ ms^{-1}$

Instantaneous acceleration

$= \frac{v^2}{r} = \frac{60^2}{0.3 \times 1000} = 12ms^{-2}$

Time taken to cover the arc

$= t = \frac{\pi}{3} \times \frac{300}{60}$

using $\Delta t = \frac{S}{v} = \frac{rd\theta}{v}$

$\therefore$ average acceleration $a = \frac{\Delta v}{t} = \frac{60}{\frac{\pi}{3} \times \frac{300}{60}} = 11.5ms^{-2}$

21. (b)

Given $a_T = 2\ ms^{-2}$

and $a_r = \frac{v^2}{r} = \frac{30 \times 30}{500} = 1.8ms^{-2}$

$\therefore\ a = \sqrt{a_r^2 + a_t^2} = \sqrt{1.8^2 + 2^2} = 2.7\ ms^{-2}$

22. (c)

Using $u = r\omega = r \times 2\pi f$

$= 1 \sin\theta \times 2\pi f$, we get

($\because$ $r = 1 \sin\theta$)

$u = 1 \times 0.78 \times 2\pi \times \frac{2}{\pi} = 3.12\ ms^{-1}$

23. (c)
Changes in direction.

24. (b)

$$x_{cm} = \frac{\int_0^L \lambda x dx}{\int_0^L \lambda dx} = \frac{\lambda_0 \int x^2 dx}{\lambda_0 \int x dx} = \frac{[x^3/3]_0^L}{[x^2/2]_0^L} = \frac{2}{3}L$$

25. (a)

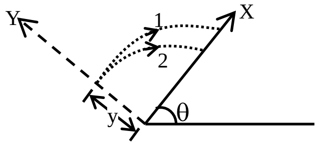
$\Delta\vec{V} = \vec{V}_f - \vec{V}_i$

$|\Delta\vec{V}| = |\vec{V}_f - \vec{V}_i| = 500$ km/hr

[$\because$ $V_f = V_i = 250$ km/hr and $\theta = 180^0$

26. (a)
Because acceleration occurs whenever the velocity changes in any way – with an increase or decrease in speed, a change in direction, or both – all three controls are accelerators. The gas pedal causes the car to speed up; the brake pedal causes the car to slow down. The steering wheel changes the direction of the velocity vector.

27. (d)



Since $v_{1Y} = v_{2Y} = 0$

And $Y_1 = Y_2 = -Y$

$(a_{1Y} = a_{2Y} = -g\cos\theta)$

Hence from, $y = vt + \frac{1}{2}at^2$

Time taken for both the bullets will be same.

28. (b)
Change in momentum = mgt

29. (a)
$v = \sqrt{5rg} = \sqrt{5 \times 1.6 \times 10} = 9ms^{-1}$.

30. (a)

$v_x = u = 20$ m/s

$v_y = u_y + gt = 0 + 10 \times 5 = 50$ m/s

$v = \sqrt{u_x^2 + u_y^2} = \sqrt{(20)^2 + (50)^2}$