OBJECTIVE - I

1. When a particle moves in a circle with a uniform speed

(A) its velocity and acceleration are both constant

(B) its velocity is constant but the acceleration changes

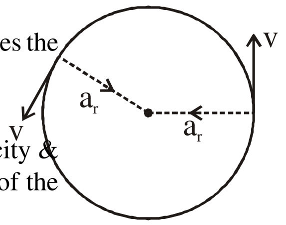
(C) its acceleration is constant but the velocity changes

(D*) its velocity and acceleration both change

Sol. D

Due to centripetal force, particle moves in a circle. Centripetal force provides the centripetal acceleration, direction of centripetal acceleration always applied towards the centre.

Particle moves in a circle with a uniform speed mean magnitude of velocity & centripetal acceleration is constant. Causes of centripetal force direction of the velocity is continuously changes.



2. Two cars having masses m_1 and m_2 move in circles of radil r_1 and r_2 respectively. If they complete the circles in equal time, the ratio of their angular speeds ϖ_1 / ϖ_2 is -

(A) m_1/m_2 (B) $r_1/r2$ (C) m_1r_1/m_2r_2 (D*) 1

Sol. For complete one circle

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

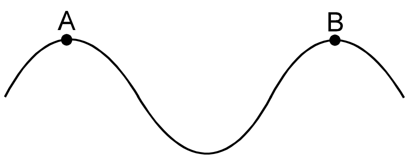
for m_1 car $\quad T_1 = \frac{2\pi}{w_1}$

for m_2 car $\quad T_2 = \frac{2\pi}{w_2}$

Given $\quad T_1 = T_2$

$$\frac{2\pi}{w_1} = \frac{2\pi}{w_2} \quad Þ \quad \frac{w_1}{w_2} = 1$$

3. A car moves at a constant speed on a road as shown in figure (7-Q2). The normal force by the road on the car in N_A and N_B when when it is at the points A and B respectively.

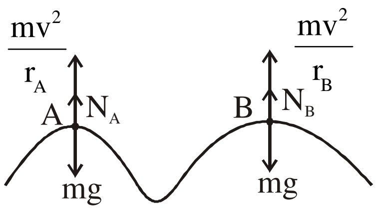


(A) $N_A = N_B$ (B) $N_A > N_B$ (C*) $N_A < N_B$ (D) insufficient

Sol. Here $\quad r_B > r_A$ .... (1)

$$N_A = mg - \frac{mv^2}{r_A} \quad .... (2)$$

$$\& \; N_B = mg - \frac{mv^2}{r_B} \quad .... (3)$$



from equation (1) , (2) & (3) we get

$N_B > N_A$

4. A particle of mass m is observed from an inertial frame of reference and is found to move in a circle of radius r with a unifrom speed v. The centrifugal force on it is

(A) $\frac{mv^2}{r}$ towards the centre (B) $\frac{mv^2}{r}$ away from the centre

(C) $\frac{mv^2}{r}$ along the tangent through the particle (D*) zero k

Sol. D

Centrifugal force is a pseudo force. If we work from an inertial frame, there is no need to apply any pseudo force, centrifugal force acts because we describe the particle from a rotating frame which is non inertial and still use Newton's law.

5. A particle of mass m roatates in a circle of radius a with a uniform angular speed ϖ . It is viewed from a, frames rotating about the z-axis with a uniform angular speed ϖ_0 . The centrifugal force on the particle is -

(A) $m\varpi^2$ (B*) $m\varpi_0{}^2\,a$ (C) $m\left(\frac{\varpi+\varpi_0}{2}\right)^2 a$ (D) $m\varpi\ \varpi_0\,a$.

Sol. B

Centrifugal force on the particle is = mw^2r

Here angular speed is 'w_0'

and radius is 'a'

So centrifugal force is = $mw_0{}^2a$

Centrifugal force is a pseudo force. It is equal to the magnitude of centrifugal force & its direction is opposite to centrifugal force.

6. A particle is kept fixed on a turnatable rotating uniformly. As seen from the ground , the particle goes in a circle , its speed is 20 cm/ss and acceleration is 20 cm/s^2.The particle is now shifted to a new position to make the radius half of the original value.The new values of the speed and acceleration will be

(A*) 10 cm/s, 10 cm/s^2 (B) 10 cm/s, 80 cm/s^2 (C) 40 cm/s, 10 cm/s^2 (D) 40 cm/s,40 cm/s^2

Sol. A

Centripetal acceleration = $\frac{v^2}{r}$ Þ $20 = \frac{(20)^2}{r}$ Þ $r = 20$ cm

angular velocity = $\frac{v}{r} = \frac{20}{20} = 1$ rad./s

The particle is now shifted to a new position to make the radius half of the original value.

Here angular velocity is not change r = 10 cm and w = 1 rad/s

Speed = $wr = 1 \times 10 = 10$ cm/s

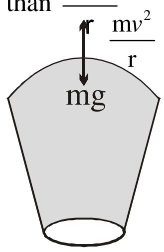
acceleration = $w^2r = 1^2 \times 10 = 10$ cm/s^2.

7. Water in a bucket is whirled in a vertical circle with a string attached to it.The water does not fall down even when the bucket is inverted at the top of its path. We conclude that in this position.

(A) $mg = \frac{mv^2}{r}$ (B) mg is greater than $\frac{mv^2}{r}$

(C*) mg is not greater than $\frac{mv^2}{r}$ (D) mg is not less than $\frac{mv^2}{r}$

Sol. C



When mg > $\frac{mv^2}{r}$

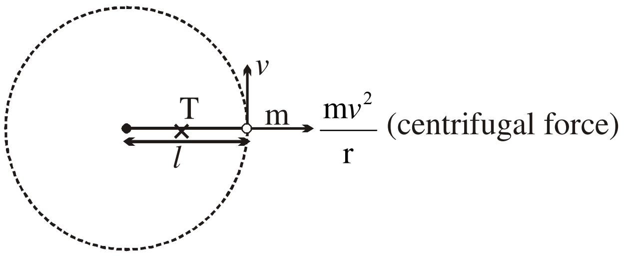
then water doesn't make a vertical circle at the top of bucket.

Position of this only possible when mg < $\frac{mv^2}{r}$.

8. A stone of mass m tied to a string of length l is rotated in a circle with the other end of the string as the centre.The speed of the stone is v. If the string bresks, the stone will move -

(A) towards the centre (B) away from the centre (C*) along a tangent (D) will stop

Sol. C



Due to tension, centripetal force is applied after breaks the string. Tension force is zero that causes centripetal force is also zero. The stone will move along a tangent.

9. A coin placed on a rotating turntable just slips if is placed at a distance of 4 cm from the centre. if the angular velocity of the turntable is doubled , it will just slip at a distance of

(A*) 1 cm (B) 2 cm (C) 4 cm (D) 8 cm

Sol. A

Centrifugal force is same in both cases $mw_1^2r_1 = mw_2^2r_2$ …….(1)

Given, $w_2 = 2w_1$ and $r_1 = 4$ cm

From equation (1)

$mw_1^2 \times 4 = m(2w_1)^2 r_2$ Þ $r_2 = 1$ cm.

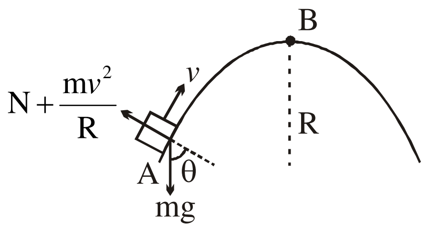
10. A motorcycle is going on an overbridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the overbrdge, the normal force on it -

(A*) increases (B) decreases (C) remains the same (D) flutuates

Sol. A

At point A

$$n + \frac{mv^2}{R} = mg \cos q$$



Þ $$N = mg \cos q - \frac{mv^2}{R}$$

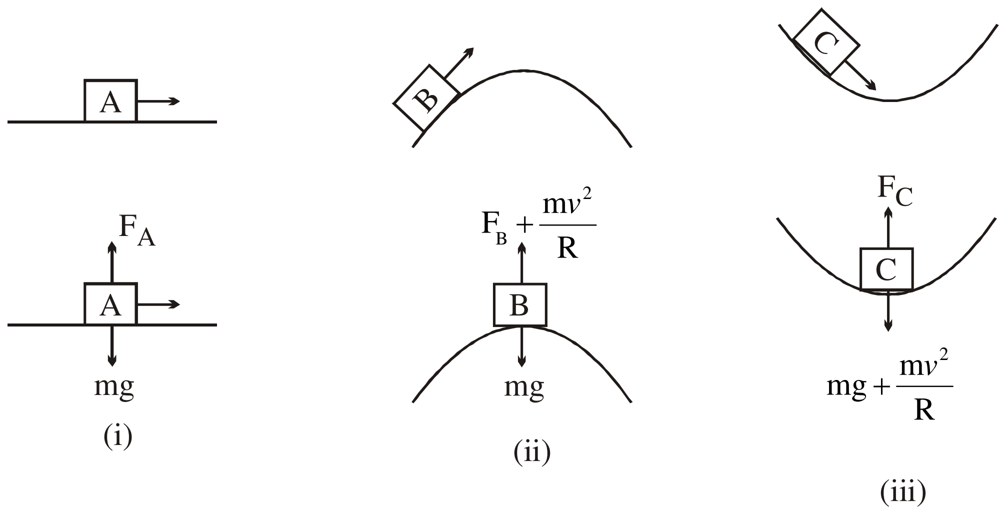
curved path A to B, 'q' is decreases that causes cos q increases and that causes normal force increases.

11. Three identical cars, A, B and C are moving at the same speed on three bridges.The car A goes on a plane bridge B on a bridge convex upward and C goes on a bridge concave upward. Let F_A, F_B and F_C be the normal forces exerted by the cars on the bridges when they are at the middle of bridges.

(A) F_A is maximum of the three forces. (B) F_B is maximum of the three forces.

(C*) F_C is maximum of the three forces (D) $F_A = F_B = F_C$

Sol. C



From diagram (i) Þ $F_A = mg$ …….(1)

From diagram (ii) Þ $F_B = mg - \dfrac{mv^2}{R}$ …….(2)

From diagram (iii) Þ $F_C = mg + \dfrac{mv^2}{R}$ …….(3)

Equation (1), (2) and (3) we get $F_C > F_A > F_B$.

12. A train A runs from east to west and another train B of the same mass runs from west to east at the same speed along the equator. A presses the track with a force F_1 and B presses the track with a force F_2.

(A*) $F_1 > F_2$

(B) $F_1 < F_2$

(C) $F_1 = F_2$

(D) the information is insufficient to find the relation between F_1 and F_2.

Sol. A

Earth rotates from west to east.

Train 'A' runs from east to west and train 'B' runs from west to east. Train 'A' is run in opposite direction of earth rotation. So, we conclude that train 'A' presses the track with a force F_1 is greater than the train 'B' press the track with a force F_2.

So, $F_1 > F_2$.

13. If the earth stops , rotating the apparent value of g on its surface will

(A) increase everywhere

(B) decrease everywhere

(C) remain the same everywhere

(D*) increase at some places and remain the same at some other places

Sol. D

Apparent value of g Þ

$$g' = \sqrt{g^2 - w^2 R \sin^2\theta\left(2g - w^2 R\right)} \quad \text{............. (1)}$$

At equator, $q = 90°$

$g' = g - w^2 R$ .... (2)

At pole, $q = 0°$

$g' = g$ .... (3)

If the earth stops rotating Þ

$w = 0$

From equation (1), (2) & (3) we canclude that

apparent value of g increase at same places and remain the same at pole.

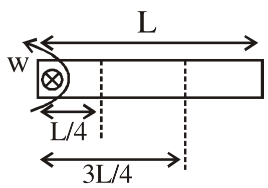
14. A rod of length L is pivoted at one end and is rotated with a uniform angular velocity in a horizontal plane . Let T_1 and T_2 be the tensions at the points L/4 and 3L/4 away from the pivoted ends. **[Q. 14, HCV (obje-1)]**

(A*) $T_1 > T_2$ (B) $T_2 > T_1$ (C) $T_1 = T_2$

(D) The relation between T_1 and T_2 depends on whether the rod rotates clockwise or anticlockwise

Sol. A

Total mass of rod is 'm'



$T_2 = F_C$ .... (1) (F_C = +ve)

$T_1 = T_2 + F_C'$ .... (2) (F_C' = +ve)

from equation (2) we conclude

$T_1 > T_2$

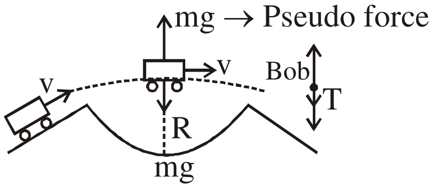
15. A simple pendulum having a bob of mass m is suspended from the ceiling of a car used in a stunt film shotting . The car moves up along an inclined cliff at a speed v and makes a jump to leave the cliff and lands at some distance . Let R be the maximum height of the car from the top of the cliff. The tension is the string when the car is in air is

(A) mg (B) $mg - \frac{mv^2}{r}$ (C) $mg + \frac{mv^2}{r}$ (D*) zero

Sol. D

When car in air $\frac{mv^2}{R} = mg$

At that time string is losse and tension in the string is zero.



16. Let θ doenote the angular displacement of a simple pendulam oscillating in a vertical plane. If the mass of the bob is m, the tension in the string is $mg\cos\theta$

(A) always

(B) never

(C*) at the extereme positions

(D) at the mean position

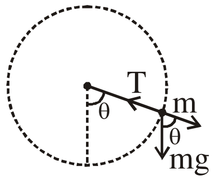
Sol. C

Here $T = \frac{mv^2}{r} + mg \cos q$

If $T = mg \cos q$

$v = 0$

If posible at extreme positions.



OBJECTIVE - II

1. An object follows a curved path. The following quantities may remain during the motion -

(A*) speed (B) velocity (C) acceleration (D*) magnitude of acceleration

Sol. AD

An object follows a curved path, magnitude of acceleration & magnitude of velocity is remain same

Q $|\vec{v}|$ = speed

2. Assume that the earth goes round the sun in a circular orbit with a constant speed of 30 km/s.

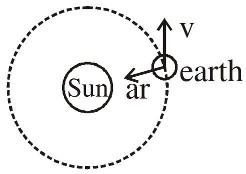
(A) The average velocity of the earth from 1st Jan , 90 to 30th June , 90 is zero

(B) The average acceleration during the above period is 60 km/s^2.

(C) The average speed from 1st Jan , 90 to 31st Dec, 90 is zero.

(D*) The instantaneous acceleration of the earth points towards the sun.

Sol. D



Earth goes round the sun in a circular orbit with a constant speed means tangential acceleration is zero.

And direction of centripetal acceleration always towards to centre.

So total acceleration is equal to centripetal acceleration and its tantaneous acceleration of the earth points towards the sun.

3. The position vector of a particle in a circular motion about the origin sweeps out equal area in equal time. Its

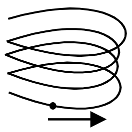
(A) velocity remains constant (B*) speed remains constant

(C) acceleration remains constant (D*) tangential acceleration remains constant

Sol. BD

It is only posible when magnitude of velocity or tangetial acceleration remains constant.

4. A particle is going in a spiral path as shown in figure (7-Q3) with constant speed.



(A) The velocity of the particle is constant

(B) The acceleration of the particle is constant

(C*) The magnitude of accleration is constant

(D) The magnitude of accleration is decreasing continuously.

Sol. C

Magnitude of accleration is constant.

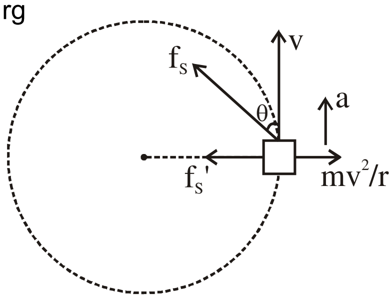
5. A car of mass M is moving on a horizontaly on a circular path of radius r. At an instant its speed is v and is increasing at a rate a.

(A) The acceleration of the car is towards the centre of the path

(B*) The magnitude of the frictional force on the car is greater than $\frac{mv^2}{r}$

(C*) The friction coefficient between the ground and the car is not less than a/g.

(D) The friction coefficient between the ground and the car is $\mu = \tan^{-1}\frac{v^2}{rg}$



Sol. BC

Here friction force provide the centripetal force and also provide the acceleration 'a'.

f_S £ mN

Þ f_S £ mmg

f_S cos q = ma .... (1)

f_S sin q = $\frac{mv^2}{r}$ .... (2)

from equation (1) & (2)

$f_S = \sqrt{(ma)^2 + \left(\frac{mv^2}{r}\right)^2}$ {The magnetude of the friction force on the car is greater the $\frac{mv^2}{r}$ }

f_S £ mmg

So $\quad mmg\ ³ \sqrt{(ma)^2 + \left(\frac{mv^2}{r}\right)^2}$

$\quad m\ ³ \sqrt{\left(\frac{a}{g}\right)^2 + \left(\frac{v^2}{rg}\right)^2}$

The friction coefficient between the ground and the car is not lessthan $\frac{a}{g}$.

6. A circular road of radius r is banked for a speed v = 40 km/hr. A car of mass attempts to go on the circular road. The friction coefficient between the tyre and the road is negligible.

(A) The car cannot make a turn without skidding.

(B*) If the car turns at a speed less than 40 km/hr, it will slip down

(C) If the car turns at the current speed of 40 km/hr, the force by the road on the car is equal $\frac{mv^2}{r}$

(D*) If the car turns at the correct speed of 40 km/hr, the force by the road on the car is greater than mg as well as greater than $\frac{mv^2}{r}$

Sol. BD

Condition of bonking equation

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

Þ If speed less than 40 km/hr it will slip down.

Þ Normal force applied by the road on the car is

$$N = \sqrt{(mg)^2 + \left(\frac{mv^2}{r}\right)^2}$$

$N > mg \qquad \& \qquad N > \frac{mv^2}{r}$

7. A person applies a constant force $\vec{F}$ on a particle of mass m and finds that the particle moves in a circle of radius r with a uniform speed v as seen from an inertial frame of reference.

(A) This is not possible.

(B*) There are other forces on the particle

(C) The resultant of the other forces is $\frac{mv^2}{r}$ towards the centre.

(D*) The resultant of the other forces varies in magnitude as well as in direction.

Sol. BD

Applied constant force $\vec{F}$, provides the centripetal force that causes particle move in a circle. It also varies in magnitude as well as in direction by the external agent.