DPP – 3 (Circular Motion)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/78

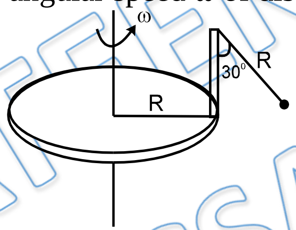
Video Solution on YouTube:- https://youtu.be/8MdMejGsQrQ

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/80

Q 1. A mass is supported on a frictionless horizontal surface. It is attached to a string and rotates about a fixed centre at an angular velocity ω_0. If the length of the string and angular velocity are doubled, the tension in the string which was initially T_0 is now

(a) T_0 (b) $T_0/2$ (c) $4T_0$ (d) $8T_0$

Q 2. A disc of radius R has a light pole fixed perpendicular to the disc at the circumference which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angular speed ω. The string is making an angle 30^0 with the rod. Then the angular speed ω of disc is:

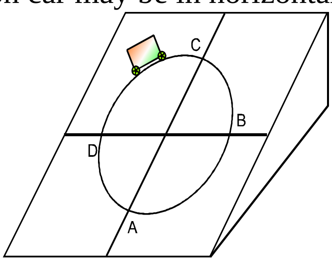


(a) $\left(\frac{\sqrt{3}g}{R}\right)^{1/2}$ (b) $\left(\frac{\sqrt{3}g}{2R}\right)^{1/2}$ (c) $\left(\frac{g}{\sqrt{3}R}\right)^{1/2}$ (d) $\left(\frac{2g}{3\sqrt{3}R}\right)^{1/2}$

Q 3. A motorcycle is going on an overbridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the overbridge, the normal force on it.

(a)Increases (b) Decreases
(c) Remains the same (d) Fluctuates

Q 4. A car is moving along a circle with constant speed on an inclined plane as shown in diagram. Then friction force on car may be in horizontal direction :



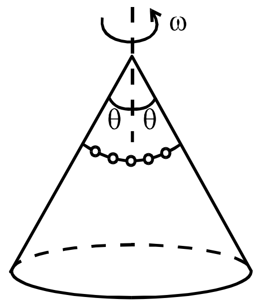
(a) in portion 'AB' including point A and B
(b) in portion 'BC' including point B and C
(c) in portion 'CD' including point C and D
(d) in portion 'DA' including point D and A

Q 5. A uniform circular ring of mass per unit length λ and radius R is rotating with angular velocity ω about its own axis in a gravity free space. Tension in the ring is

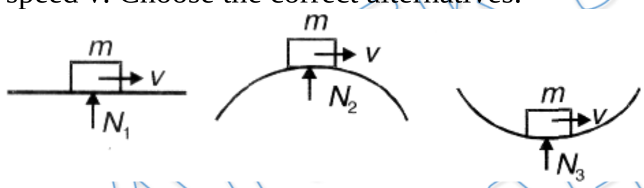
(a) Zero (b) $\frac{\lambda R^2 \omega^2}{2}$

(c) $\lambda R^2 \omega^2$ (d) $\lambda R \omega^2$

Q 6. A chain of mass 'm' and radius 'r' is placed onto a cone of semi vertical angle q. Cone rotated with angular velocity w. Find the tension in the chain if it does not slide on the cone.



Q 7 The figure shows a block of mass m moving without friction along three tracks with same speed v. Choose the correct alternatives.

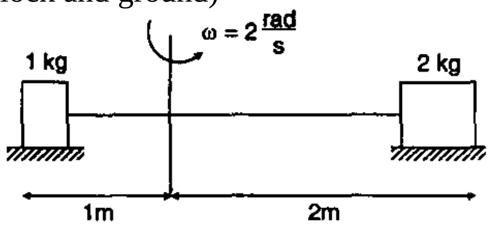


(a) $N_1 > N_2$ (b) $N_2 > N_3$ (c) $N_3 > N_1$ (d) $N_1 = N_2 = N_3$

Q 8. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A plumb bob is suspended from the roof of the car by a light rigid rod. The angle made by the rod with the track is: (g = 10 m/s^2)

(a) zero (b) 30° (c) 45° (d) 60°

Q 9. Two blocks of mass 1 kg and 2 kg are joined by a massless inextensible string of length 3 m. Both blocks are kept on a horizontal table as shown. Friction coefficient between 2 kg block and table is zero. They are rotated about a vertical axis passing at a distance of 1 m from 1 kg. Force of friction on 1 kg block is (assume that there is enough friction between 1 kg block and ground)



(a) 12 N towards centre (b) 20 N towards centre

(c) 20 N away from the centre (d) 12 N away from the centre

Q 10. Three balls each of mass 1kg are attached with three strings each of length l m as shown in figure. They are rotated in a horizontal elide with angular velocity ω = 4 rad/s about point O. Match the following:

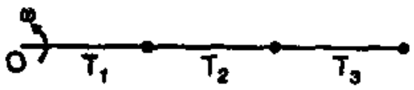


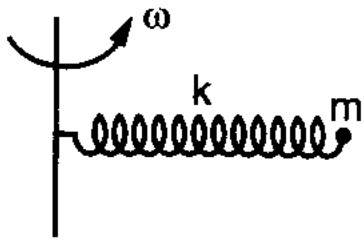
Table-1		Table-2	
(A)	T_1	(P)	**Maximum**
(B)	T_2	(Q)	**Minimum**
(C)	T_3	(R)	**80 N**
		(S)	**48 N**
		(T)	**90 N**

Q 11. A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration α. If the coefficient of friction between the rod and bead is μ, and gravity is neglected, then the time after which the bead starts slipping is.

(a) $\sqrt{\frac{\mu}{\alpha}}$ (b) $\frac{\mu}{\sqrt{\alpha}}$ (c) $\frac{1}{\sqrt{\mu\alpha}}$ (d) infinitesimal

Q 12. A particle of mass m is tied to a light string and rotated with a speed v along a circular path of radius r. If T= tension in the string and mg = gravitational force on the particle then the actual forces acting on the particle are
(a) mg and T only
(b) mg, T and an additional force of mv^2/r directed inwards
(c) mg, T and an additional force of mv^2/r directed outwards
(d) only a force mv^2/r directed outwards

Q 13. A particle of mass m is fixed to one end of a light spring of force constant k and unstretched length *l*. The system is rotated about the other end of the spring with an angular velocity ω, in gravity free space. The increase in length of the spring will be



(a) $\frac{m\omega^2 l}{k}$ (b) $\frac{m\omega^2 l}{k-m\omega^2}$ (c) $\frac{m\omega^2 l}{k+m\omega^2}$ (d) none of these

Q 14. A uniform rod of mass m and length *l* rotates in a horizontal plane with an angular velocity ω about a vertical axis passing through one end. The tension in the rod at a distance x from the axis is

(a) $\frac{1}{2}m\omega^2 x$ (b) $\frac{1}{2}m\omega^2\frac{x^2}{l}$

(c) $\frac{1}{2}m\omega^2 l\left(1-\frac{x}{l}\right)$ (d) $\frac{1}{2}\frac{m\omega^2}{l}[l^2 - x^2]$

Q 15. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is then rotates in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

(a) $\frac{1}{2}M\omega^2L$ (b) $M\omega^2L$ (c) $\frac{1}{4}M\omega^2L$ (d) $\frac{1}{2}M\omega^2L^2$

Q 16. The earth rotates from west to east. A wind mass begins moving due north from the equator, along the earth's surface. Neglect all effects other than the rotation of the earth. The wind mass will

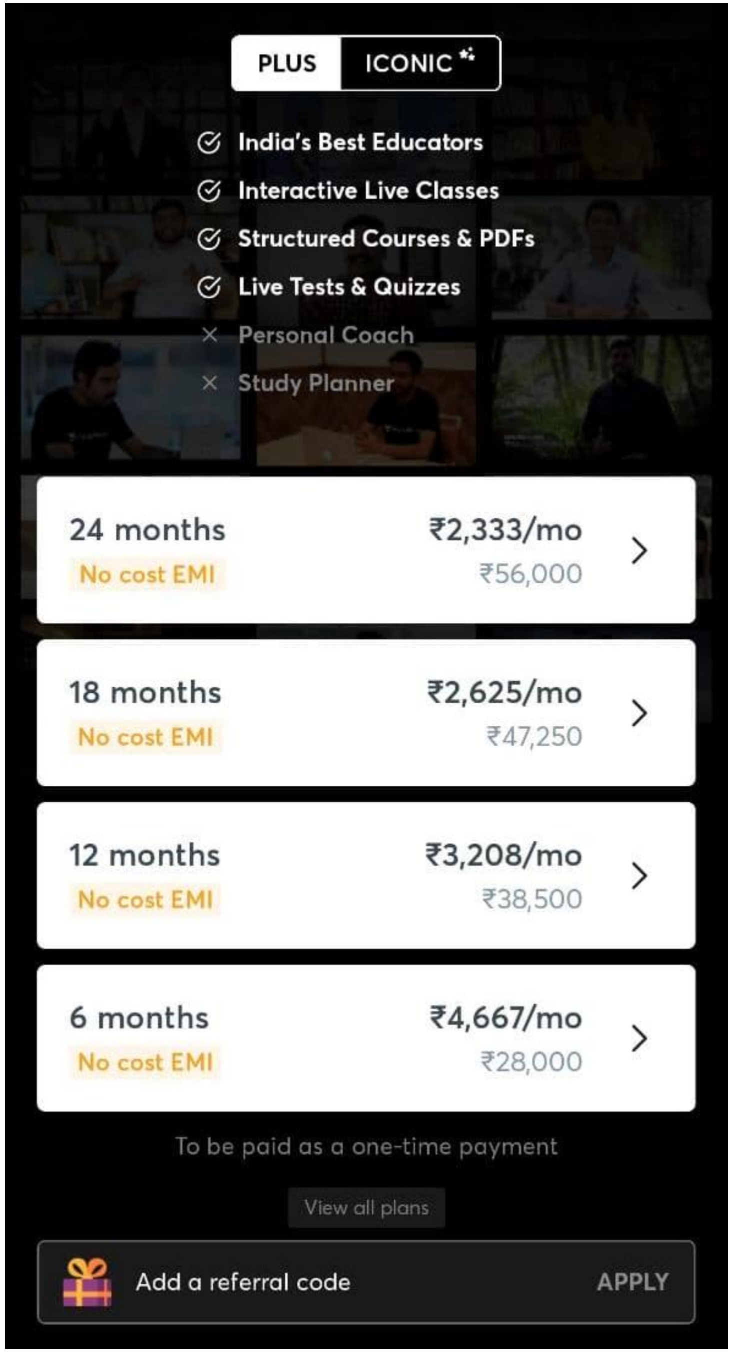
(a) always move due north.
(b) shift a little to the east as it moves to higher latitudes
(c) shift a little to the west as it moves to higher latitudes
(d) move along a loop and return to its starting point on the equator

Q 17. A geostationary satellite S is stationed above a point P on the equator. A particle is fired from S directly towards P.

(a) With respect to the axis of rotation of the earth P and S have the same angular velocity but different linear velocities
(b) The particle will hit P.
(c) The particle will hit the equator east of P.
(d) The particle will hit the equator west of P.

Answer Key

Q.1 d	**Q.2 d**	**Q.3 a**	**Q.4 b, c**	**Q.5 c**
Q.6 $\frac{M}{2\pi}(\omega^2R + g\cot\theta)$	**Q.7 a, c**	**Q.8 c**	**Q.9 d**	**Q.10** A(P), B(R), C(Q,S)
Q.11 a	**Q.12 a**	**Q.13 b**	**Q.14 d**	**Q.15 a**
Q.16 b	**Q.17 a, c**			



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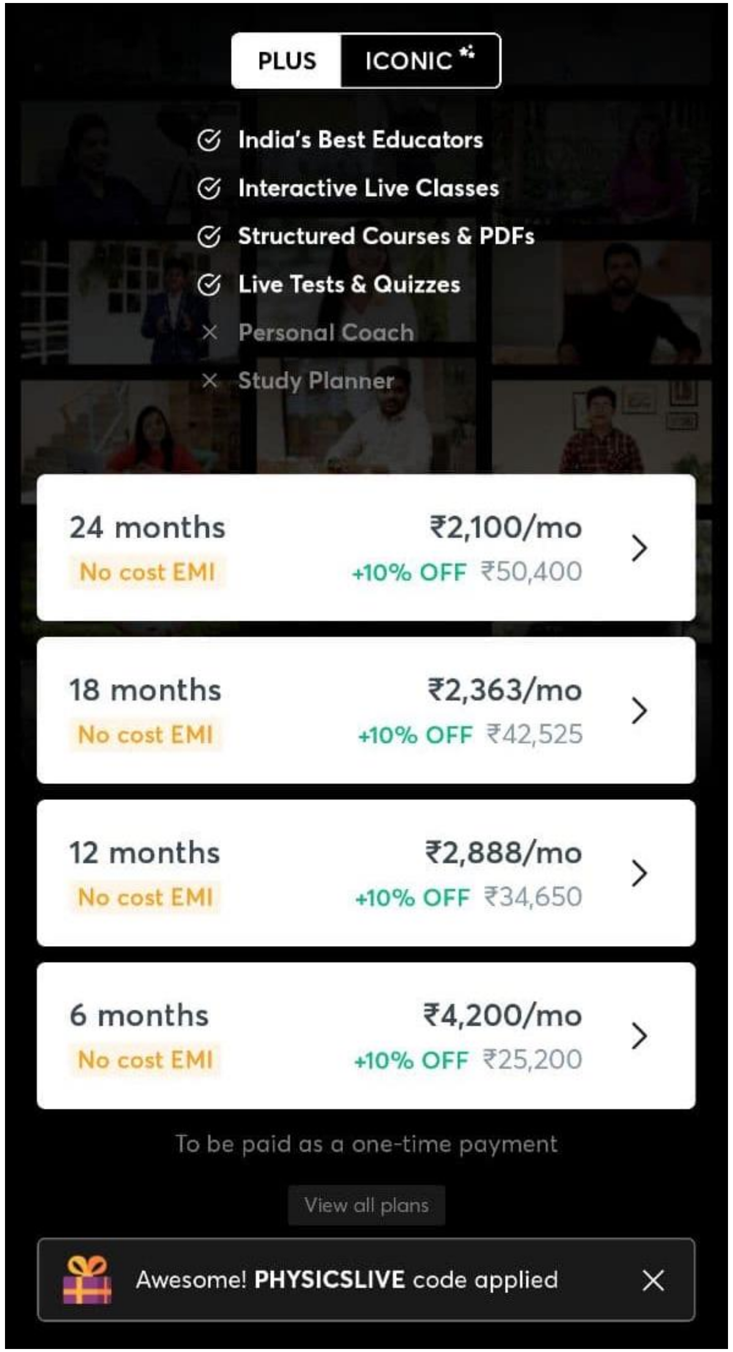
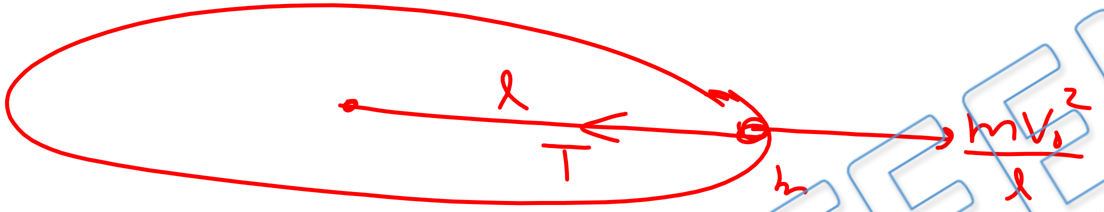


Written Solution

DPP - 3 : Centripetal and Centrifugal Force

By Physicsaholics Team

Q1) A mass is supported on a frictionless horizontal surface. It is attached to a string and rotates about a fixed centre at an angular velocity ω_0. If the length of the string and angular velocity are doubled, the tension in the string which was initially T_0 is now -



(a) T_0 (b) $T_0/2$ (c) $4T_0$ (d) $8T_0$ ✓

$$T = \frac{mv_0^2}{l} = ml\omega_0^2$$

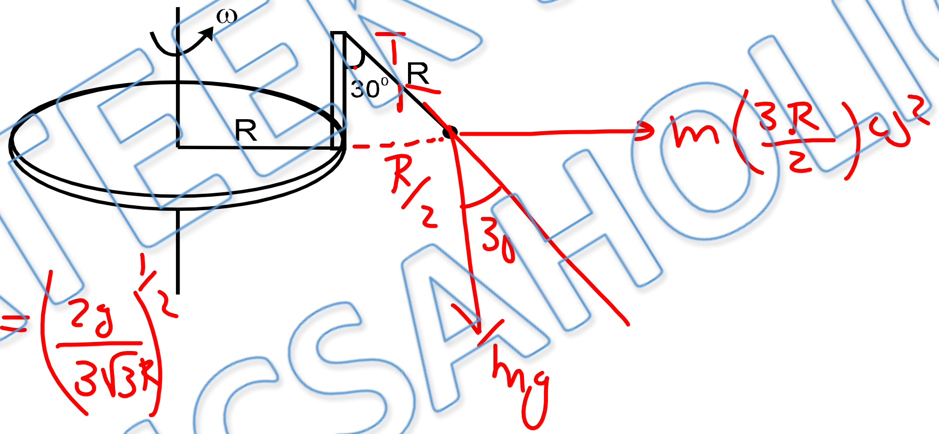
2 times, 4 times, 8 times

Q2) A disc of radius R has a light pole fixed perpendicular to the disc at the circumference which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angular speed ω. The string is making an angle 30^0 with the rod. Then the angular speed ω of disc is:

$R\sin 30 = R/2$

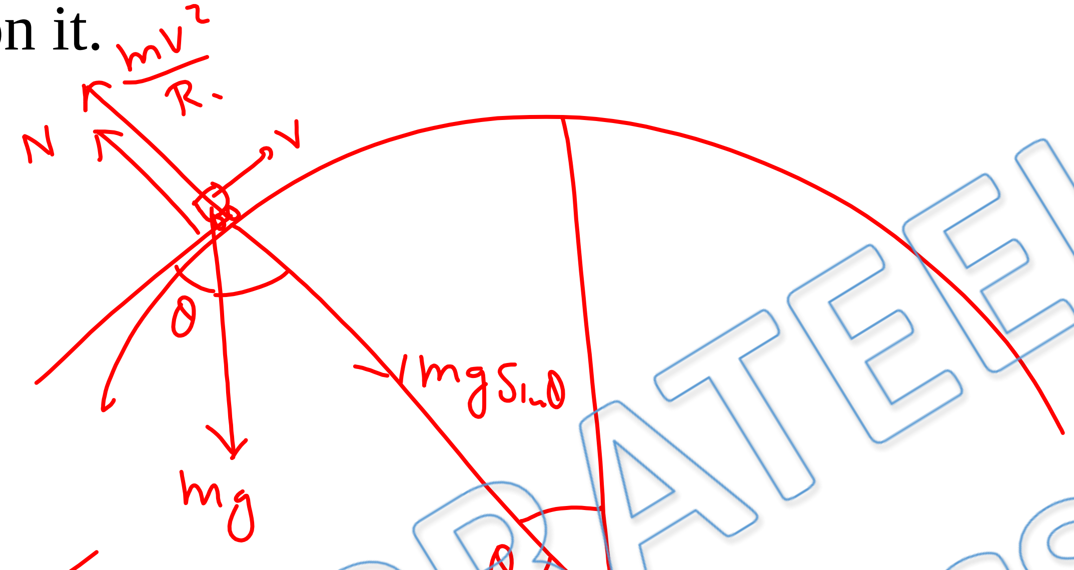
$\tan 30 = \frac{\frac{3}{2} m R\omega^2}{mg} = \frac{1}{\sqrt{3}}$

$\omega^2 = \frac{2g}{3\sqrt{3}R} \Rightarrow \omega = \left(\frac{2g}{3\sqrt{3}R}\right)^{1/2}$



(a) $\left(\frac{\sqrt{3}g}{R}\right)^{1/2}$ (b) $\left(\frac{\sqrt{3}g}{2R}\right)^{1/2}$ (c) $\left(\frac{g}{\sqrt{3}R}\right)^{1/2}$ (d) $\left(\frac{2g}{3\sqrt{3}R}\right)^{1/2}$ ✓

Q3) A motorcycle is going on an overbridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the overbridge, the normal force on it.



$$N + \frac{mv^2}{R} = mg\sin\theta$$

$$N = mg\sin\theta - \frac{mv^2}{R}$$

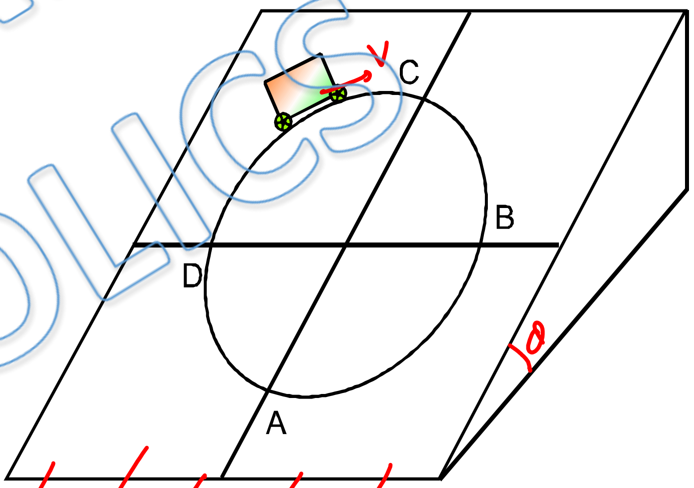
increasing

N → increasing

(a) Increases (b) Decreases

(c) Remains the same (d) Fluctuates

Q4) A car is moving along a circle with constant speed on an inclined plane as shown in diagram. Then friction force on car may be in horizontal direction :



(a) in portion 'AB' including point A and B

(b) in portion 'BC' including point B and C

(c) in portion 'CD' including point C and D

(d) in portion 'DA' including point D and A

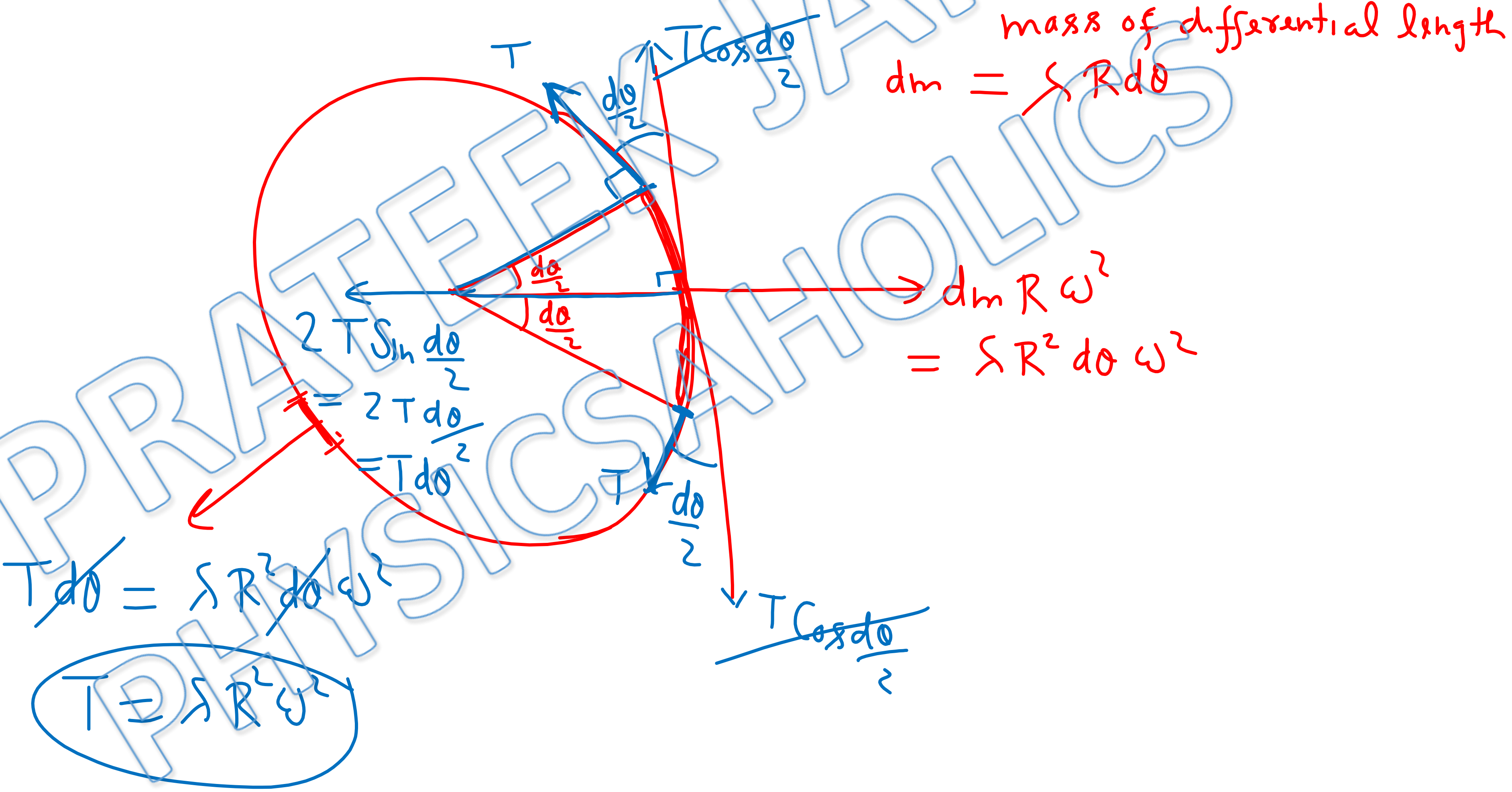
Q5) A uniform circular ring of mass per unit length λ and radius R is rotating with angular velocity ω about its own axis in a gravity free space. Tension in the ring is

(a) Zero

(b) $\frac{\lambda R^2 \omega^2}{2}$

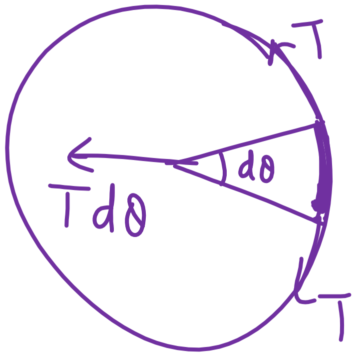
(c) $\lambda R^2 \omega^2$

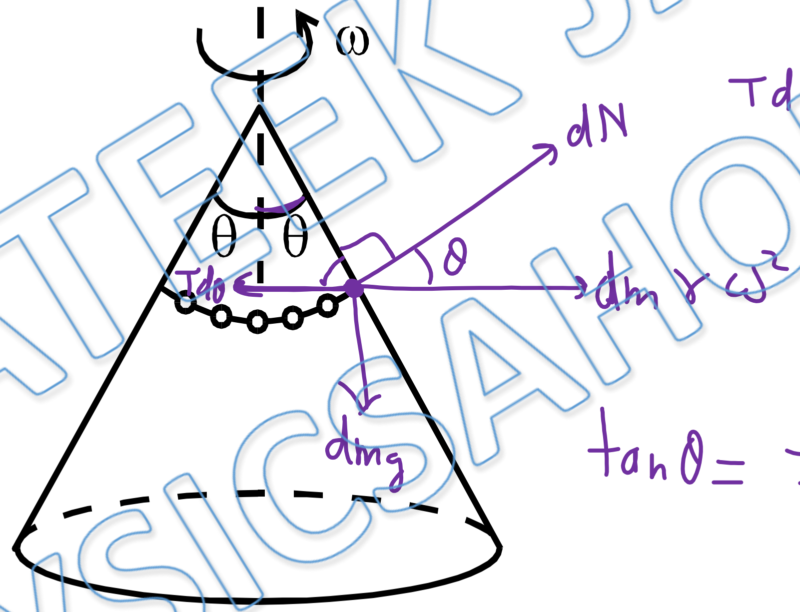
(d) $\lambda R \omega^2$

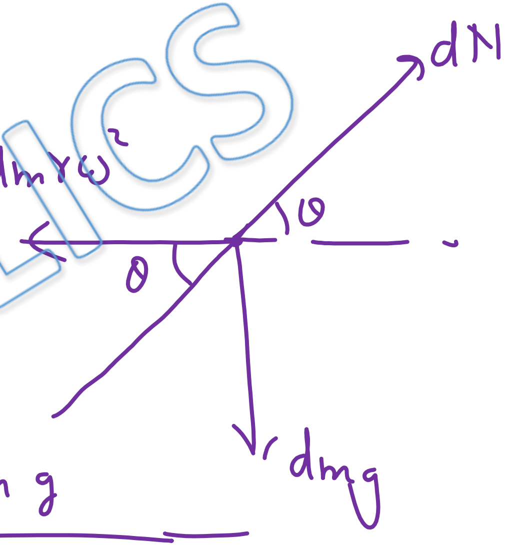


Q6) A chain of mass ' m ' and radius ' r ' is placed onto a cone of semi vertical angle q. Cone rotated with angular velocity w. Find the tension in the chain if it does not slide on the cone.

$$dm = \frac{m}{2\pi} d\theta$$





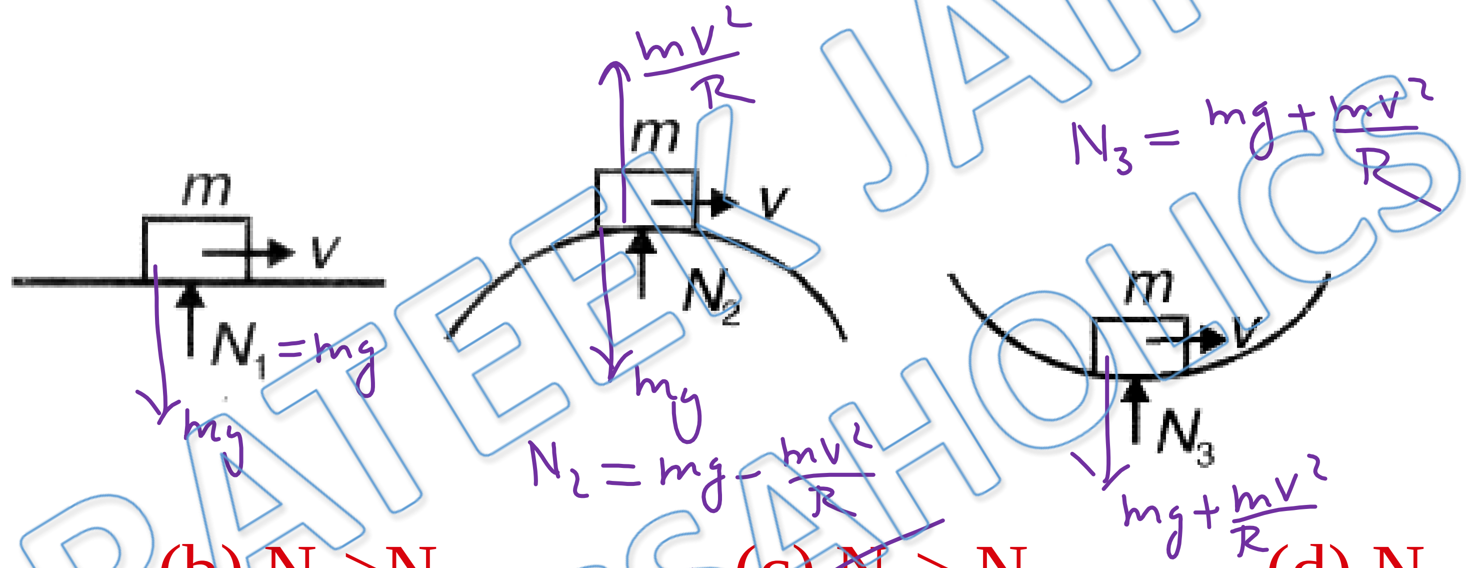


$$\tan\theta = \frac{dm\, g}{T d\theta - dm\, r\omega^2}$$

$$\Rightarrow \tan\theta = \frac{mg/2\pi}{T - \frac{m r \omega^2}{2\pi}} \Rightarrow T - \frac{m\, r\omega^2}{2\pi} = \frac{mg \cot\theta}{2\pi}$$

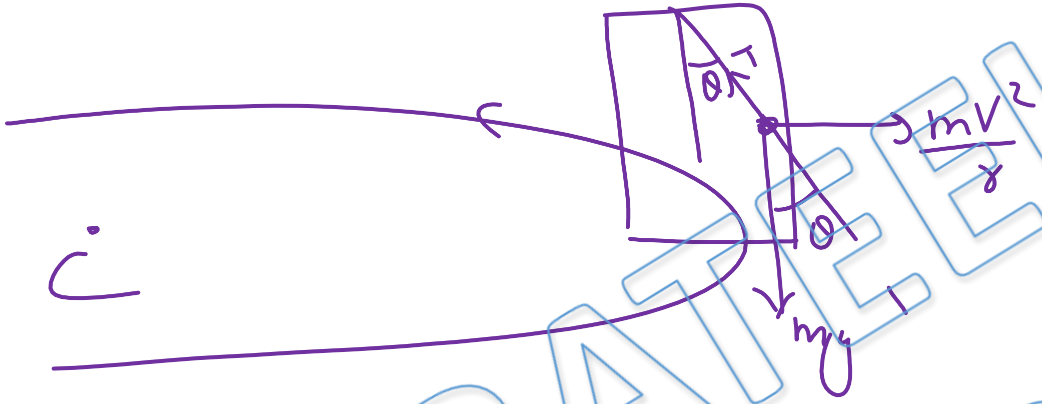
$$T = \frac{m\, r\omega^2}{2\pi} + \frac{mg \cot\theta}{2\pi}$$

Q7) The figure shows a block of mass m moving without friction along three tracks with same speed v. Choose the correct alternatives.



(a) $N_1 > N_2$ (b) $N_2 > N_3$ (c) $N_3 > N_1$ (d) $N_1 = N_2 = N_3$

Q8) A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A plumb bob is suspended from the roof of the car by a light rigid rod. The angle made by the rod with the track is: ($g = 10\ m/s^2$)

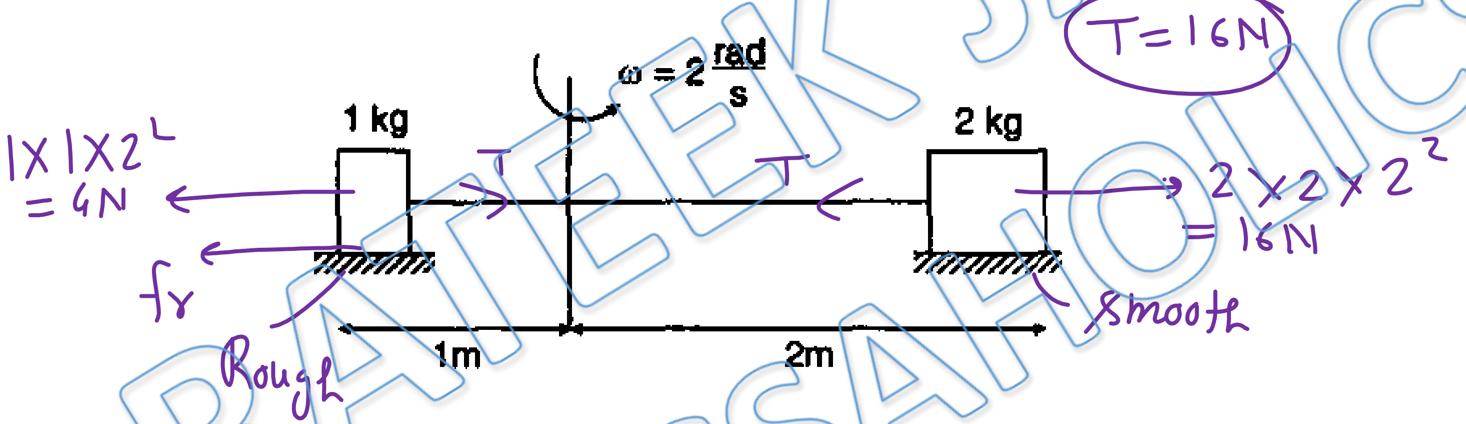


(a) zero (b) 30° (c) 45° (d) 60°

$$\tan\theta = \frac{mv^2/r}{mg} = \frac{10\times10}{10\times10} = 1$$

$\theta = 45°$

Q9) Two blocks of mass 1 kg and 2 kg are joined by a massless inextensible string of length 3 m. Both blocks are kept on a horizontal table as shown. Friction coefficient between 2 kg block and table is zero. They are rotated about a vertical axis passing at a distance of 1 m from 1 kg. Force of friction on 1 kg block is (assume that there is enough friction between 1 kg block and ground)



(a) 12 N towards centre

(b) 20 N towards centre

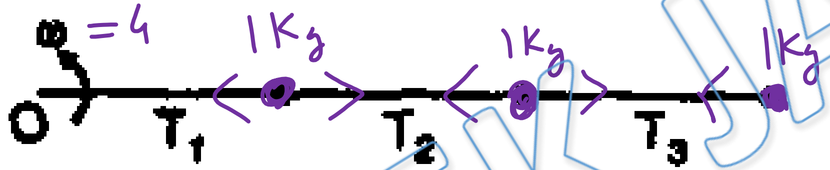
(c) 20 N away from the centre

(d) 12 N away from the centre

$f_r + 4 = T = 16$

$f_r = 12N.$

Q10) Three balls each of mass 1kg are attached with three strings each of length l m as shown in figure. They are rotated in a horizontal elide with angular velocity ω = 4 rad/s about point O. Match the following:



$T_3 = 1(3)4^2 = 48N$

$T_2 = T_3 + 1(2)4^2$

$= 48 + 32 = 80N$

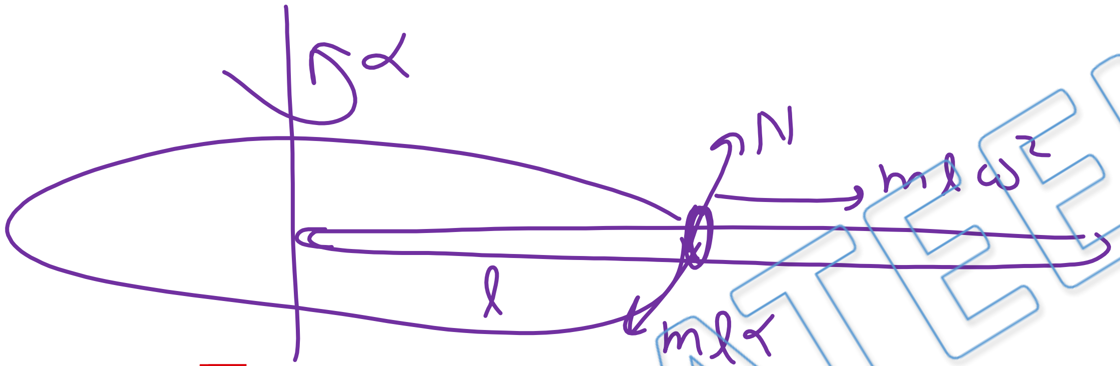
$T_1 = T_2 + 1 \times 1 \times 4^2$

$= 80 + 16$

$= 96N$

Table-1		Table-2	
(A)	T_1	(P)	**Maximum**
(B)	T_2	(Q)	**Minimum**
(C)	T_3	(R)	**80 N**
		(S)	**48 N**
		(T)	**90 N**

Q11) A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration α. If the coefficient of friction between the rod and bead is μ, and gravity is neglected, then the time after which the bead starts slipping is.



(a) $\sqrt{\frac{\mu}{\alpha}}$ (b) $\frac{\mu}{\sqrt{\alpha}}$ (c) $\frac{1}{\sqrt{\mu\alpha}}$ (d) infinitesimal

To just start sliding.

$m\ell\omega^2 = \mu m\ell\alpha$

$\alpha^2 t^2 = \mu\alpha$

$t = \sqrt{\frac{\mu}{\alpha}}$

$N = m\ell\alpha$

$f_{max} = \mu N = \mu m\ell\alpha$

Q12 A particle of mass m is tied to a light string and rotated with a speed v along a circular path of radius r. If T= tension in the string and mg = gravitational force on the particle then the actual forces acting on the particle are

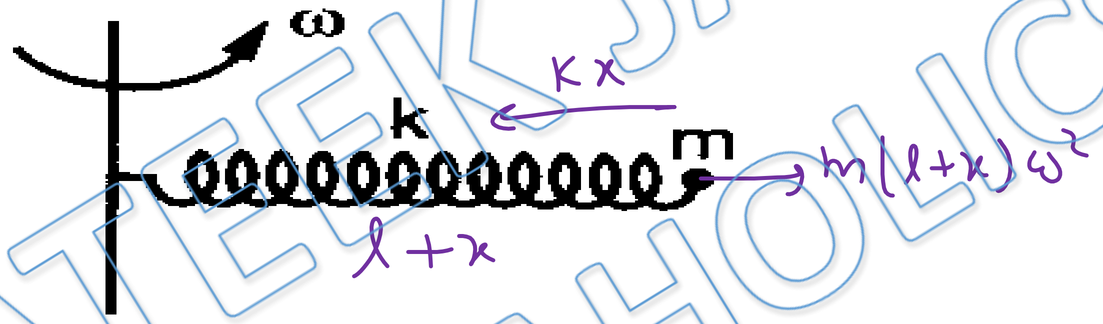
(a) mg and T only

(b) mg, T and an additional force of mv^2/r directed inwards

(c) mg, T and an additional force of mv^2/r directed outwards

(d) only a force mv^2/r directed outwards

Q13) A particle of mass m is fixed to one end of a light spring of force constant k and unstretched length *l*. The system is rotated about the other end of the spring with an angular velocity ω, in gravity free space. The increase in length of the spring will be



(a) $\frac{m\omega^2 l}{k}$ (b) $\frac{m\omega^2 l}{k-m\omega^2}$ (c) $\frac{m\omega^2 l}{k+m\omega^2}$ (d) none of these

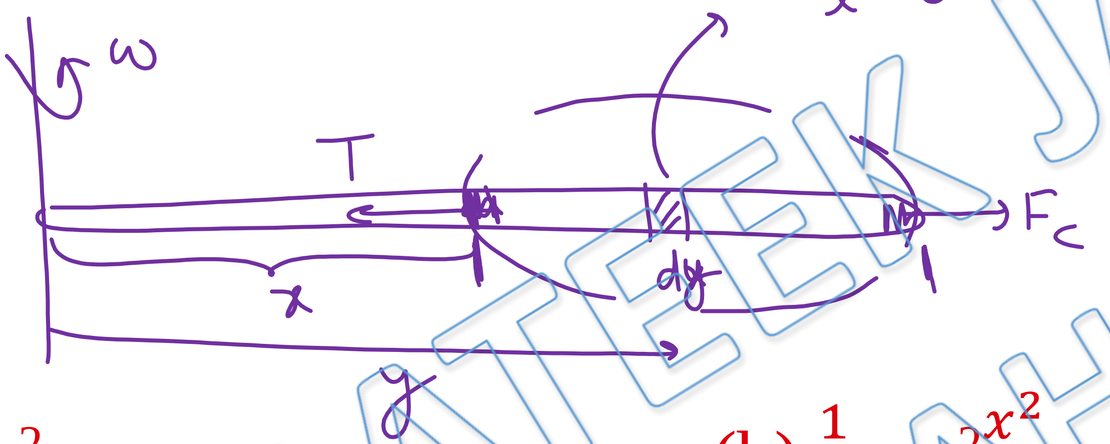
$Kx = ml\omega^2 + mx\omega^2$

$x(K - m\omega^2) = ml\omega^2$

$x = \frac{ml\omega^2}{k - m\omega^2}$

Q14) A uniform rod of mass m and length *l* rotates in a horizontal plane with an angular velocity ω about a vertical axis passing through one end. The tension in the rod at a distance x from the axis is

$dm = \frac{m}{l}dy$



(a) $\frac{1}{2}m\omega^2 x$

(b) $\frac{1}{2}m\omega^2\frac{x^2}{l}$

(c) $\frac{1}{2}m\omega^2 l\left(1-\frac{x}{l}\right)$

(d) $\frac{1}{2}\cdot\frac{m\omega^2}{l}[l^2-x^2]$

$T = F_c$

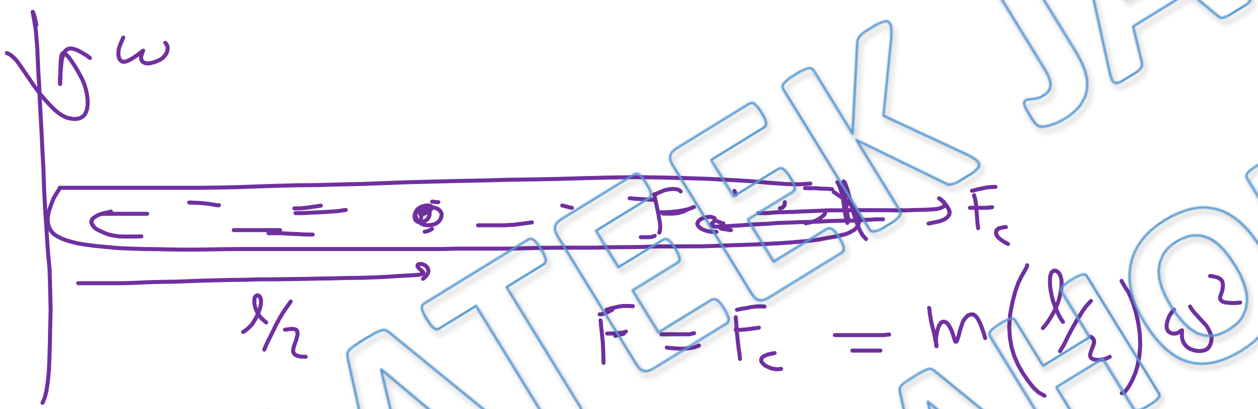
$= \int_x^l \left(\frac{m}{l}dy\right) y\omega^2$

$= \frac{m\omega^2}{l}\int_x^l y\,dy$

$= \frac{m\omega^2}{2l}\left[y^2\right]_x^l$

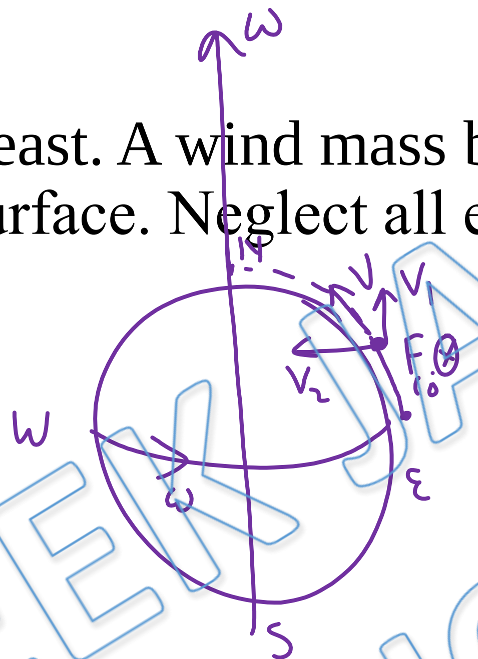
$= \frac{m\omega^2(l^2-x^2)}{2l}$

Q15) A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is then rotates in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is



(a) $\frac{1}{2}M\omega^2 L$ (b) $M\omega^2 L$ (c) $\frac{1}{4}M\omega^2 L$ (d) $\frac{1}{2}M\omega^2 L^2$

Q16) The earth rotates from west to east. A wind mass begins moving due north from the equator, along the earth's surface. Neglect all effects other than the rotation of the earth. The wind mass will



$$F_{cori} = -2m(\vec{\omega} \times \vec{V}) = 2m(\vec{V} \times \vec{\omega})$$

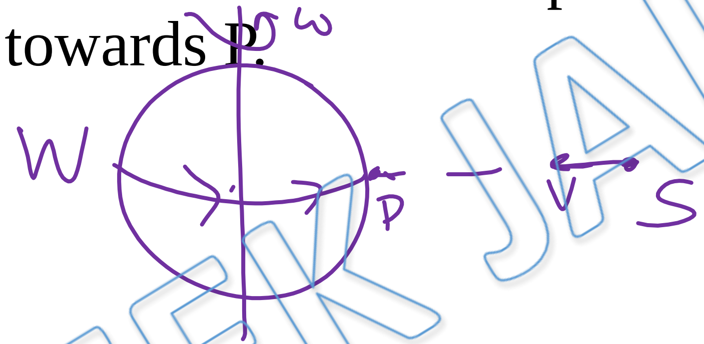
(a) always move due north

(b) shift a little to the east as it moves to higher latitudes

(c) shift a little to the west as it moves to higher latitudes

(d) move along a loop and return to its starting point on the equator

Q17) A geostationary satellite S is stationed above a point P on the equator. A particle is fired from S directly towards P.



(a) With respect to the axis of rotation of the earth P and S have the same angular velocity but different linear velocities

(b) The particle will hit P.

(c) The particle will hit the equator east of P.

(d) The particle will hit the equator west of P.

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Chalo Niklo