DPP - Daily Practice Problems

Name : 　　　　Date :

Start Time : 　　　　End Time :

PHYSICS 07

SYLLABUS : MOTION IN A PLANE-2 (Horizontal Circular Motion)

Max. Marks : 120 　　　　**Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A particle completes 1.5 revolutions in a circular path of radius 2 cm. The angular displacement of the particle will be – (in radian)

(a) 6π 　(b) 3π 　(c) 2π 　(d) π

Q.2 A particle revolving in a circular path completes first one third of circumference in 2 sec, while next one third in 1 sec. The average angular velocity of particle will be – (in rad/sec)

(a) $2\pi/3$ 　(b) $\pi/3$ 　(c) $4\pi/3$ 　(d) $5\pi/3$

Q.3 The ratio of angular speeds of minute hand and hour hand of a watch is -

(a) 1 : 12 　(b) 6 : 1 　(c) 12 : 1 　(d) 1 : 6

Q.4 The angular displacement of a particle is given by

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$, where ω_0 and α are constant and

$\omega_0 = 1$ rad/sec, $\alpha = 1.5$ rad/sec^2. The angular velocity at time, t = 2 sec will be (in rad/sec) -

(a) 1 　(b) 5

(c) 3 　(d) 4

Q.5 The magnitude of the linear acceleration of the particle moving in a circle of radius 10 cm with uniform speed completing the circle in 4 s, will be -

(a) 5π cm/s^2 　(b) 2.5π cm/s^2

(c) $5\pi^2$ cm/s^2 　(d) $2.5\pi^2$ cm/s^2

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 A cane filled with water is revolved in a vertical circle of radius 4 m and water just does not fall down. The time period of revolution will be –

(a) 1 s (b) 10 s
(c) 8 s (d) 4 s

Q.7 The length of second's hand in a watch is 1 cm. The change in velocity of its tip in 15 second is -

(a) 0 (b) $\frac{\pi}{30\sqrt{2}}$ cm/s
(c) $\frac{\pi}{30}$ cm/s (d) $\frac{\pi\sqrt{2}}{30}$ cm/s

Q.8 An electron is moving in a circular orbit of radius 5.3×10^{-11} metre around the atomic nucleus at a rate of 6.6×10^{15} revolutions per second. The centripetal force acting on the electron will be -
(The mass of the electron is 9.1×10^{-31}kg)

(a) 8.3×10^{-8}N (b) 3.8×10^{-8}N
(c) 4.15×10^{-8}N (d) 2.07×10^{-8}N

Q.9 An air craft executes a horizontal loop of radius 1 km with a steady speed of 900 km/h. The ratio of centripetal acceleration to that gravitational acceleration will be-

(a) 1 : 6.38 (b) 6. 38 : 1
(c) 2.25 : 9.8 (d) 2.5 : 9.8

Q.10 A car driver is negotiating a curve of radius 100 m with a speed of 18 km/hr. The angle through which he has to lean from the vertical will be -

(a) $\tan^{-1}\frac{1}{4}$ (b) $\tan^{-1}\frac{1}{40}$
(c) $\tan^{-1}\left(\frac{1}{2}\right)$ (d) $\tan^{-1}\left(\frac{1}{20}\right)$

Q.11 A particle moves in a circle of radius 20cm with a linear speed of 10m/s. The angular velocity will be -

(a) 50 rad/s (b) 100 rad/s
(c) 25 rad/s (d) 75 rad/s

Q.12 The angular velocity of a particle is given by $\omega = 1.5\,t - 3t^2 + 2$, the time when its angular acceleration decreases to be zero will be -

(a) 25 sec (b) 0.25 sec
(c) 12 sec (d) 1.2 sec

Q.13 A particle is moving in a circular path with velocity varying with time as $v = 1.5t^2 + 2t$. If the radius of circular path is 2 cm, the angular acceleration at t = 2 sec will be -

(a) 4 rad/sec^2 (b) 40 rad/sec^2
(c) 400 rad/sec^2 (d) 0.4 rad/sec^2

Q.14 A grind stone starts from rest and has a constant-angular acceleration of 4.0 rad/sec^2.The angular displacement and angular velocity, after 4 sec. will respectively be -

(a) 32 rad, 16 rad/s (b) 16 rad, 32 rad/s
(c) 64 rad, 32 rad/s (d) 32 rad, 64 rad/s

Q.15 The shaft of an electric motor starts from rest and on the application of a torque, it gains an angular acceleration given by $\alpha = 3t - t^2$ during the first 2 seconds after it starts after which $\alpha = 0$. The angular velocity after 6 sec will be -

(a) 10/3 rad/sec (b) 3/10 rad/sec
(c) 30/4 rad/sec (d) 4/30 rad/sec

Q.16 Using rectangular co-ordinates and the unit vectors **i** and **j**, the vector expression for the acceleration *a* will be (*r* is a position vector) -

(a) ωr^2 (b) $-\omega^2 r/2$
(c) $-2\omega r^2$ (d) $-\omega^2 r$

Q.17 The vertical section of a road over a canal bridge in the direction of its length is in the form of circle of radius 8.9 metre. Find the greatest speed at which the car can cross this bridge without losing contact with the road at its highest point, the center of gravity of the car being at a height h = 1.1 metre from the ground. (Take g = 10 m/sec^2)

(a) 5 m/s (b) 7 m/s
(c) 10 m/s (d) 13 m/s

Q.18 The maximum speed at which a car can turn round a curve of 30 metre radius on a level road if the coefficient of friction between the tyres and the road is 0.4, will be -

(a) 10.84 m/s (b) 17.84 m/s
(c) 11.76 m/s (d) 9.02 m/s

Q.19 The angular speed with which the earth would have to rotate on its axis so that a person on the equator would weigh $(3/5)^{th}$ as much as present, will be:
(Take the equatorial radius as 6400 km)

(a) 8.7×10^4 rad/sec (b) 8.7×10^3 rad/sec
(c) 7.8×10^4 rad/sec (d) 7.8×10^3 rad/sec

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	

Space for Rough Work

Q.20 A smooth table is placed horizontally and a spring of unstreched length ℓ_0 and force constant k has one end fixed to its centre. To the other end of the spring is attached a mass m which is making n revolution per second around the centre. Tension in the spring will be

(a) $4\pi^2 m k \ell_0 n^2/(k - 4\pi^2 m n^2)$
(b) $4\pi^2 m k \ell_0 n^2/(k + 4\pi^2 m n^2)$
(c) $2\pi^2 m k \ell_0 n^2/(k - 4\pi^2 m n^2)$
(d) $2\pi m k \ell_0 n^2/(k - 4\pi^2 m n^2)$

Q.21 A motor car is travelling at 30 m/s on a circular road of radius 500 m. It is increasing its speed at the rate of 2 m/s^2. Its net acceleration is (in m/s^2) –

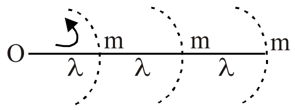
(a) 2 (b) 1. 8
(c) 2.7 (d) 0

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 Three identical particles are connected by three strings as shown in fig. These particles are revolving in a horizontal circle. The velocity of outer most particle is v, then choose correct relation for T_1,T_2 and T_3
(where T_1 is tension in the outer most string etc.)



(1) $T_1 = \frac{mv_A^2}{3\ell}$ (2) $T_2 = \frac{5mv_A^2}{9\ell}$

(3) $T_3 = \frac{6mv_A^2}{9\ell}$ (4) $T_3 = \frac{5mv_A^2}{9\ell}$

Q.23 A particle describes a horizontal circle on the smooth surface of an inverted cone. The height of the plane of the circle above the vertex is 9.8 cm, then choose the correct options

(1) The speed of the particle will be 0.98 m/s
(2) $\tan\theta = \frac{rg}{v^2}$ (θ is semi-apex angle)
(3) The speed of the particle will be 98 m/s
(4) $\tan\theta = \frac{rg}{v}$ (θ is semiapex angle)

Q.24 Choose the correct statements

(1) Centripetal force is not a real force. It is only the requirement for circular motion.
(2) Work done by centripetal force may or may not be zero.
(3) Work done by centripetal force is always zero.
(4) Centripetal force is a fundamental force.

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

The velocity of the particle changes moving on the curved path, this change in velocity is brought by a force known as centripetal force and the acceleration so produced in the body is known as centripetal acceleration. The direction of centripetal force or acceleration is always towards the centre of circular path.

Q.25 A ball is fixed to the end of a string and is rotated in a horizontal circle of radius 5 m with a speed of 10 m/sec. The acceleration of the ball will be -

(a) 20 m/s^2 (b) 10 m/s^2
(c) 30 m/s^2 (d) 40 m/s^2

Q.26 A body of mass 2 kg lying on a smooth surface is attached to a string 3 m long and then whirled round in a horizontal circle making 60 revolution per minute. The centripetal acceleration will be-

(a) 118.4 m/s^2 (b) 1.18 m/s^2
(c) 2.368 m/s^2 (d) 23.68 m/s^2

Q.27 A body of mass 0.1 kg is moving on circular path of diameter 1.0 m at the rate of 10 revolutions per 31.4 seconds. The centripetal force acting on the body is -

(a) 0.2 N (b) 0.4 N
(c) 2 N (d) 4 N

RESPONSE GRID					
	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ
	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ		

Space for Rough Work

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.28 Statement - 1 : In non-uniform circular motion, velocity vector and acceleration vector are not perpendicular to each other.

Statement - 2 : In non-uniform circular motion, particle has normal as well as tangential acceleration.

Q.29 Statement - 1 : A cyclist is cycling on rough horizontal circular track with increasing speed. Then the frictional force on cycle is always directed towards centre of the circular track.

Statement - 2 : For a particle moving in a circle, radial component of net force should be directed towards centre.

Q.30 Statement - 1 : If net force $\vec{F}$ acting on a system is changing in direction only, the linear momentum $(\vec{p})$ of system changes in direction.

Statement - 2 : In case of uniform circular motion, magnitude of linear momentum is constant but direction of centripetal force changes at every instant.

RESPONSE GRID			
	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 7 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	30	Qualifying Score	48
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

07

(1) **(b)** We have angular displacement

$$= \frac{\text{linear displacement}}{\text{radius of path}}$$

$$\Rightarrow \Delta\theta = \frac{\Delta S}{r}$$

Here, $\Delta S = n(2\pi r) = 1.5(2\pi \times 2 \times 10^{-2}) = 6\pi \times 10^{-2}$

$$\therefore \Delta\theta = \frac{6\pi \times 10^{-2}}{2 \times 10^{-2}} = 3\pi \text{ radian}$$

(2) **(a)** We have $\vec{\omega}_{av} = \frac{\text{Total angular displacement}}{\text{Total time}}$

For first one third part of circle,

angular displacement, $\theta_1 = \frac{S_1}{r} = \frac{2\pi r/3}{r}$

For second one third part of circle,

$$\theta_2 = \frac{2\pi r/3}{r} = \frac{2\pi}{3} \text{ rad}$$

Total angular displacement,

$\theta = \theta_1 + \theta_2 = 4\pi/3$ rad

Total time $= 2 + 1 = 3$ sec

$$\therefore \vec{\omega}_{av} = \frac{4\pi/3}{3} \text{ rad/s} = \frac{4\pi}{6} = \frac{2\pi}{3} \text{ rad/s}$$

(3) **(c)** Angular speed of hour hand,

$$\omega_1 = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{12 \times 60} \text{ rad/sec}$$

Angular speed of minute hand,

$$\omega_2 = \frac{2\pi}{60} \text{ rad/sec} \Rightarrow \frac{\omega_2}{\omega_1} = \frac{12}{1}$$

(4) **(d)** We have $\theta = \omega_0 t + \frac{1}{2}\alpha t^2 \Rightarrow \frac{d\theta}{dt} = \omega_0 + \alpha t$

This is angular velocity at time t.

Now angular velocity at t = 2 sec will be

$$\omega = \left(\frac{d\theta}{dt}\right)_{t=2\,sec} = \omega_0 + 2\alpha = 1 + 2 \times 1.5 = 4 \text{ rad/sec}$$

(5) **(d)** The distance covered in completing the circle is $2\pi r = 2\pi \times 10$ cm

The linear speed is $v = \frac{2\pi r}{t} = \frac{2\pi \times 10}{4} = 5\pi$ cm/s

The linear acceleration is,

$$a = \frac{v^2}{r} = \frac{(5\pi)^2}{10} = 2.5\,\pi^2 \text{ cm/s}^2$$

This acceleration is directed towards the centre of the circle

(6) **(d)** We know that

$$\text{Time period} = \frac{\text{Circumference}}{\text{Critical speed}} = \frac{2\pi r}{\sqrt{gr}}$$

$$= \frac{2 \times 22 \times 4}{7 \times \sqrt{10 \times 4}} = 4 \text{ sec}$$

(7) **(b)** $\text{Velocity} = \frac{\text{Circumference}}{\text{Time of revolution}} = \frac{2\pi r}{60}$

$$= \frac{2\pi \times 1}{60} = \frac{\pi}{30} \text{ cm/s}$$

$$\text{Change in velocity } \Delta v = \sqrt{\left(\frac{\pi}{30}\right)^2 + \left(\frac{\pi}{30}\right)^2}$$

$$= \frac{\pi}{30}\sqrt{2} \text{ cm/s}$$

(8) **(a)** Let the radius of the orbit be r and the number of revolutions per second be n. Then the velocity of electron is given by $v = 2\pi nr$,

$$\therefore \text{Acceleration } a = \frac{v^2}{r} = \frac{4\pi^2 r^2 n^2}{r} = 4\pi^2 r n^2$$

Substituting the given values, we have

$a = 4 \times (3.14)^2 \times (5.3 \times 10^{-11})(6.6 \times 10^{15})^2$

$= 9.1 \times 10^{22}$ m/s^2 towards the nucleus.

The centripetal force is

$F_C = ma = (9.1 \times 10^{-31})(9.1 \times 10^{22})$

$= 8.3 \times 10^{-8}$ N towards the nucleus.

(9) **(b)** Given that radius of horizontal loop

r = 1 km = 1000 m

$$\text{Speed } v = 900 \text{ km/h} = \frac{9000 \times 5}{18} = 250 \text{ m/s}$$

$$\text{Centripetal acceleration } a_c = \frac{v^2}{r} = \frac{250 \times 250}{1000} = 62.5 \text{ m/s}^2$$

$$\therefore \frac{\text{Centripetal acceleration}}{\text{Gravitational acceleration}} = \frac{a_c}{g} = \frac{62.5}{9.8} = 6.38 : 1$$

(10) **(b)** We know that, $\tan\theta = \frac{v^2}{rg} = \frac{\left(18 \times \frac{5}{18}\right)^2}{100 \times 10}$

$$= \frac{1}{40} \Rightarrow \theta = \tan^{-1}\frac{1}{40}$$

(11) **(a)** The angular velocity is $\omega = \frac{v}{r}$

Hence, v = 10 m/s

r = 20 cm = 0.2 m $\therefore \omega = 50$ rad/s

(12) **(b)** Given that $\omega = 1.5t - 3t^2 + 2$

$$\alpha = \frac{d\omega}{dt} = 1.5 - 6t$$

When, $\alpha = 0$

$\Rightarrow 1.5 - 6t = 0$

$$\Rightarrow t = \frac{1.5}{6} = 0.25 \text{ sec}$$

(13) **(c)** Given $v = 1.5\,t^2 + 2t$

Linear acceleration $a = dv/dt = 3t + 2$

This is the linear acceleration at time t

Now angular acceleration at time t

$$\alpha = \frac{a}{r} \Rightarrow \alpha = \frac{3t + 2}{2 \times 10^{-2}}$$

Angular acceleration at t = 2 sec

$$(\alpha)_{at\ t = 2sec} = \frac{3 \times 2 + 2}{2 \times 10^{-2}} = \frac{8}{2} \times 10^2$$

$$= 4 \times 10^2 = 400 \text{ rad/sec}^2$$

(14) **(a)** Angular displacement after 4 sec is

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = \frac{1}{2}\alpha t^2 = \frac{1}{2} \times 4 \times 4^2 = 32 \text{ rad}$$

Angular velocity after 4 sec

$\omega = \omega_0 + \alpha t = 0 + 4 \times 4 = 16$ rad/sec

(15) **(a)** Given $\alpha = 3t - t^2$

$$\Rightarrow \frac{d\omega}{dt} = 3t - t^2 \Rightarrow d\omega = (3t - t^2)dt$$

$$\Rightarrow \omega = \frac{3t^2}{2} - \frac{t^3}{3} + c$$

At $t = 0, \omega = 0$

$$\therefore\ c = 0, \quad \omega = \frac{3t^2}{2} - \frac{t^3}{3}$$

Angular velocity at $t = 2$ sec, $(\omega)_{t = 2\ sec}$

$$= \frac{3}{2}(4) - \frac{8}{3} = \frac{10}{3} \text{ rad/sec}$$

Since there is no angular acceleration after 2 sec

$\therefore$ The angular velocity after 6 sec remains the same.

(16) **(d)** $\hat{i}x + \hat{y}j$, $x = r\cos\theta$,

$y = r\sin\theta$ where $\theta = \omega t$

$r = \hat{i}\,(r\cos\omega t) + \hat{j}\,(r\sin\omega t)$

$v = dr/dt = -\hat{i}\,(\omega r\sin\omega t) - \hat{j}\,(\omega r\cos\omega t)$

$a = d^2r/dt^2 = -\omega^2 r$

(17) **(c)** Let R be the normal reaction exerted by the road on the car. At the highest point, we have

$$\frac{mv^2}{(r + h)} = mg - R, \text{ R should not be negative.}$$

Therefore $v^2 \le (r + a)g = (8.9 + 1.1) \times 10$

or $v^2 \le 10 \times 10 v \le 10$ m/sec

$\therefore\ v_{max} = 10$ m/sec

(18) **(a)** Let W = Mg be the weight of the car. Friction force = 0.4 W

$$\text{Centripetal force} = \frac{Mv^2}{r} = \frac{Wv^2}{gr}$$

$$0.4\,W = \frac{Wv^2}{gr}$$

$\Rightarrow v^2 = 0.4 \times g \times r = 0.4 \times 9.8 \times 30 = 117.6$

$\Rightarrow v = 10.84$ m/sec

(19) **(c)** Let v be the speed of earth's rotation.

We know that $W = mg$

$$\text{Hence } \frac{3}{5}W = mg - \frac{mv^2}{r}$$

$$\text{or } \frac{3}{5}mg = mg - \frac{mv^2}{r}$$

$$\therefore\ \frac{2}{3}mg = \frac{mv^2}{r} \text{ or } v^2 = \frac{2gr}{5}$$

$$\text{Now } v^2 = \frac{2 \times 9.8 \times (6400 \times 10^3)}{5}$$

Solving, we get $v = 5 \times 10^9$ m/sec,

$$\omega = \sqrt{\left(\frac{2g}{5r}\right)} = 7.8 \times 10^4 \text{ radian/sec.}$$

(20) **(a)** Let T be the tension produced in the stretched string. The centripetal force required for the mass m to move in a circle is provided by the tension T. The stretched length of the spring is r (radius of the circle). Now,

Elongation produced in the spring = $(r - \ell_0)$

Tension produced in the spring,

$T = k(r - \ell_0)$ .... (1)

Where k is the force constant

Linear velocity of the motion $v = 2\pi r n$

$$\therefore \text{Centripetal force} = \frac{mv^2}{r} = \frac{m(2\pi rn)^2}{r}$$

$$= 4\pi^2 r n^2 m \quad \text{........ (2)}$$

Equating equation. (1) and (2), we get

$k(r - \ell_0) = 4\pi^2 r n^2 m$ $(\because T = mv^2/r)$

$\Rightarrow kr - k\ell\ell_0 = 4\pi^2 r n^2 m$

$r(k - 4\pi^2 n^2 m) = k\ell_0$

$$\Rightarrow r = \frac{k\ell_0}{(k - 4\pi^2 n^2 m)} \quad \text{........(3)}$$

Substituting the value of r in eqn. (1) we have

$$T = k\left[\frac{k\ell_0}{(k - 4\pi^2 n^2 m)} - \ell_0\right] \text{ or } T = \frac{4\pi^2 n^2 m\ell_0 k}{(k - 4\pi^2 n^2 m)}$$

(21) **(c)** Two types of acceleration are experienced by the car

(i) Radial acceleration due to circular path,

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

(ii) A tangential acceleration due to increase of tangential speed given by

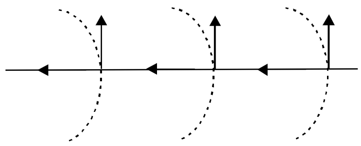
$a_t = \Delta v/\Delta t = 2\ m/s^2$

Radial and tangential acceleration are perpendicular to each other.

Net acceleration of car

$$a = \sqrt{a_r^2 + a_t^2} = \sqrt{(1.8)^2 + (2)^2} = 2.7\ m/s^2$$

(22) **(a)** For A :



Required centripetal force $= \dfrac{mv_A^2}{3\ell}$

(net force towards centre $= T_1$)

This will provide required centripetal force

particle at A, $\therefore T_1 = \dfrac{mv_A^2}{3\ell}$

For B : Required centripetal force $= \dfrac{m(v_B^2)}{2\ell}$

Remember ω i.e. angular velocity, of all the particles is same

$$\therefore \omega = \frac{v_A}{3\ell} = \frac{v_B}{2\ell} = \frac{v_C}{\ell}$$

When a system of particles rotates about an axis, the angular velocity of all the particles will be same, but their linear velocity will be different, because of different distances from axis of rotation i.e. $v = r\omega$.

Thus for B, centripetal force $= \dfrac{2mv_A^2}{9\ell}$

Net force towards the centre $T_2 - T_1 = \dfrac{2mv_A^2}{9\ell}$

$\Rightarrow T_2 = \dfrac{2mv_A^2}{9\ell} + T_1 = \dfrac{5mv_A^2}{9\ell}$ (Putting value of T_1)

For C :

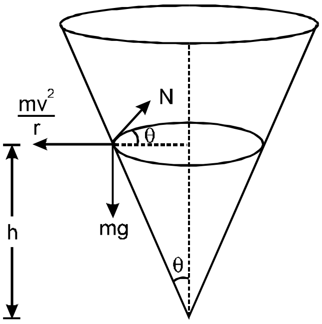
Centripetal force. $\dfrac{mv_C^2}{3\ell} = \dfrac{mv_A^2}{9\ell}$

Net force towards centre $= T_3 - T_2$

$$\therefore T_3 - T_2 = \frac{mv_A^2}{9\ell} \Rightarrow T_3 = \frac{mv_A^2}{9\ell} + T_2$$

$T_3 = \dfrac{6mv_A^2}{9\ell}$ (on putting value of T_2)

(23) **(b)** $N\cos\theta = \dfrac{mv^2}{r}$ and $N\sin\theta = mg$



$$\Rightarrow \frac{N\sin\theta}{N\cos\theta} = \frac{mg}{mv^2/r} \Rightarrow \tan\theta = \frac{rg}{v^2}$$

But $\tan\theta = \dfrac{r}{h}$ $\therefore$ $\dfrac{r}{h} = \dfrac{rg}{v^2}$

$$\Rightarrow v = \sqrt{hg} = \sqrt{9.8 \times 9.8 \times 10^{-2}} = 0.98\ m/s$$

(24) **(d)** (1) Centripetal force is not a real force. It is only the requirement for circular motion. It is not a new kind of force. Any of the forces found in nature such as gravitational force, electric friction force, tension in string, reaction force may act as centripetal force.

(3) Work done by centripetal force is always zero.

(25) **(a)** We know, $a = \dfrac{v^2}{r}$

Hence $v = 10\ m/s, r = 5\ m \therefore a = \dfrac{(10)^2}{5} = 20\ m/s^2$

(26) **(a)** Given that the mass of the particle, m = 2 kg

Radius of circle = 3 m

Angular velocity = 60 rev/minute

$$= \frac{60 \times 2\pi}{60}\ rad/sec = 2\pi\ rad/sec$$

Because the angle described during 1 revolution is 2π radian

The linear velocity $v = r\omega = 2\pi \times 3\ m/s = 6\pi\ m/s$

The centripetal acceleration $= \dfrac{v^2}{r} = \dfrac{(6\pi)^2}{3}\ m/s^2$

$= 118.4\ m/s^2$

(27) **(a)** $F = \dfrac{mv^2}{r} = mr\omega^2$

Here $m = 0.10\ kg, r = 0.5\ m$

and $\omega = \dfrac{2\pi n}{t} = \dfrac{2 \times 3.14 \times 10}{31.4} = 2\ rad/s$

$F = 0.10 \times 0.5 \times (2)^2 = 0.2$

(28) **(a)** In non-uniform circular motion acceleration vector makes some angle with radius hence it is not perpendicular to velocity vector.

(29) **(c)** If speed is increasing there is a tangential acceleration. Net acceleration is not pointing towards centre.

(30) **(b)** Both statements are true but statement-2 is not correct explanation for statement-1.