## Additional Problems For Self Practice (APSP)

# PART-I : PRACTICE TEST PAPER

**Max. Marks : 120** **Max. Time : 1 Hr.**

### Important Instructions :

1. The test is of **1 hour** duration and max. marks 120.
2. The test consists **30** questions, **4 marks** each.
3. Only one choice is correct **1 mark** will be deducted for incorrect response. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
4. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 3 above.

**1.** If the radii of circular paths of two particles of same masses are in the ratio of 1 : 2, then in order to have same centripetal force, their speeds should be in the ratio of :

(1) 1 : 4 (2) 4 : 1 (3) 1 : $\sqrt{2}$ (4) $\sqrt{2}$ : 1

**2.** On horizontal smooth surface a mass of 2 kg is whirled in a horizontal circle by means of a string at an initial angular speed of 5 revolutions per minute. Keeping the radius constant the tension in the string is doubled. The new angular speed is nearly:

(1) 14 rpm (2) 10 rpm (3) 2.25 rpm (4) 7 rpm

**3.** A particle is kept fixed on a uniformly rotating turn-table As seen from the ground , the particle goes in a circle, its speed is 10 cm/s and acceleration is 10 cm/s$^2$.The particle is now shifted to a new position to make the radius double of the original value.The new values of the speed and acceleration will be

(1) 20 cm/s, 20 cm/s$^2$ (2) 10 cm/s, 80 cm/s$^2$ (3) 40 cm/s, 10 cm/s$^2$ (4) 40 cm/s,40 cm/s$^2$

**4.** In a circus, stuntman rides a motorbike in a circular track of radius R in the vertical plane. The minimum speed at highest point of track will be :

(1) $\sqrt{2gR}$ (2) 2gR (3) $\sqrt{3gR}$ (4) $\sqrt{gR}$

**5.** A particle is moving in the vertical plane. It is attached at one end of a string of length l whose other end is fixed. The velocity at the lowest point is u. The tension in the string is $\vec{T}$ and acceleration of the particle is $\vec{a}$ at any position. Then, $\vec{T}.\vec{a}$ is zero at the highest point:

(1) only if u ≤ $\sqrt{2g\ell}$ (2) if u = $\sqrt{5g\ell}$ (3) only if u = $\sqrt{2g\ell}$ (4) only if u > $\sqrt{2g\ell}$

**6.** In the above question, $\vec{T}.\vec{a}$ is non-negative at the lowest point for:

(1) u ≤ $\sqrt{2g\ell}$ (2) u = $\sqrt{2g\ell}$ (3) u < $\sqrt{2g\ell}$ (4) any value of u

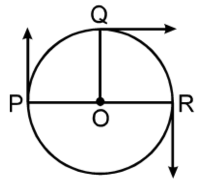
**7.** In the above question, $\vec{T}.\vec{u}$ is zero for:

(1) u ≤ $\sqrt{2g\ell}$ (2) u = $\sqrt{2g\ell}$ (3) u ≥ $\sqrt{2g\ell}$ (4) any value of u

**8.** If the apparent weight of the bodies at the equator is to be zero, then the earth should rotate with angular velocity

(1) $\sqrt{\frac{g}{R}}$ rad/sec (2) $\sqrt{\frac{2g}{R}}$ rad/sec (3) $\sqrt{\frac{g}{2R}}$ rad/sec (4) $\sqrt{\frac{3g}{2R}}$ rad/sec

**9.** Three point particles P, Q, R move in a circle of radius ' r ' with different but constant speeds. They start moving at t = 0 from their initial positions as shown in the figure. The angular velocities (in rad/sec) of P, Q and R are $5\pi$, $2\pi$ & $3\pi$ respectively, in the same sense. The time interval after which they all meet is:

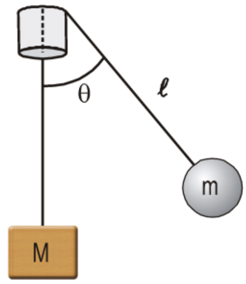



(1) 2/3 sec (2) 1/6 sec
(3) 1/2 sec (4) 3/2 sec

**10.** A particle of mass m begins to slide down a fixed smooth sphere from the top. What is its tangential acceleration when it breaks off the sphere ?

(1) $\frac{2g}{3}$ (2) $\frac{\sqrt{5}g}{3}$ (3) g (4) $\frac{g}{3}$

**11.** A large mass M hangs stationary at the end of a light string that passes through a smooth fixed tube to a small mass m that moves around in a horizontal circular path. If $\ell$ is the length of the string from m to the top end of the tube and $\theta$ is angle between this part and vertical part of the string as shown in the figure, then time taken by m to complete one circle is equal to

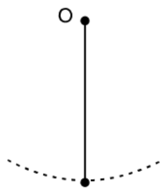


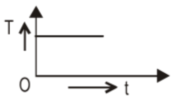

(1) $2\pi\sqrt{\frac{\ell}{g\sin\theta}}$ (2) $2\pi\sqrt{\frac{\ell}{g\cos\theta}}$
(3) $2\pi\sqrt{\frac{m\ell}{gM\sin\theta}}$ (4) $2\pi\sqrt{\frac{\ell m}{gM}}$

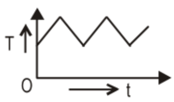
**12.** A stone of mass 1 kg tied to a light inextensible string of length L = 40 cm, whirling in a circular path in a vertical plane. The ratio of maximum tension in the string to the minimum tension in the string is 3, If g is taken to be 10 m/s$^2$, the speed of the stone at the highest point of the circle is :

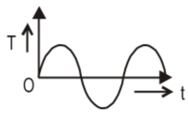
(1) 4 m/s (2) $5\sqrt{2}$ m/s (3) $10\sqrt{3}$ m/s (4) 20 m/s

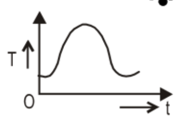
**13.** A particle of mass m is suspended from a fixed point O by a string of length $\ell$.It is displaced by angle $\theta$ ($\theta < 90°$) from equilibrium position and released from there at t = 0 . The graph, which shows the variation of the tension T in the string with time 't', may be :




(1) 

(2) 

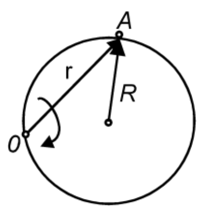
(3) 

(4) 


**14.** A particle moves along an arc of a circle of radius R. Its velocity depends on the distance covered s as $v = a\sqrt{s}$, where a is a constant then the angle $\alpha$ between the vector of the total acceleration and the vector of velocity as a function of s will be

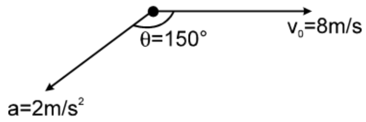
(1) $\tan\alpha = \frac{R}{2s}$ (2) $\tan\alpha = 2s / R$ (3) $\tan\alpha = \frac{2R}{s}$ (4) $\tan\alpha = \frac{s}{2R}$

**15.** A particle A moves along a circle of radius R = 50 cm so that its radius vector r relative to the point O (Fig.) rotates with the constant angular velocity $\omega = 0.40$ rad/s. Then modulus v of the velocity of the particle , and the modulus a of its total acceleration will be



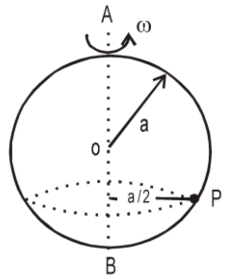

(1) v = 0.4 m/s, a = 0.4 m/s$^2$ (2) v = 0.32 m/s, a = 0.32 m/s$^2$
(3) v = 0.32 m/s, a = 0.4 m/s$^2$ (4) v = 0.4 m/s, a = 0.32 m/s$^2$

**16.** re shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The minimum radius of curvature of trajectory of the body is




(1) 2 meter (2) 4 meter
(3) 8 meter (4) 16 meter.

**17.** A smooth wire bent in the form of circle of radius (a), a pearl moves slowly on circumference, this circle is rotated about diameter AB with speed $\omega$, then pearl reaches a point P it stops sliding then value of $\omega^2$ will be-




(1) 2g/a (2) $\frac{2g}{a\sqrt{3}}$
(3) $\frac{a\sqrt{3}}{g}$ (4) $\frac{2a}{g\sqrt{3}}$

**18.** A stone is tied to a string of length $\ell$ and is whirled in a vertical circle with the other end of the string as the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is :

(1) $\sqrt{2\left(u^2 - g\ell\right)}$ (2) $\sqrt{\left(u^2 - g\ell\right)}$ (3) $u - \sqrt{\left(u^2 - 2g\ell\right)}$ (4) $\sqrt{2g\ell}$

**19.** A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is

(1) Mg ($\sqrt{2}$ +1) (2) Mg $\sqrt{2}$ (3) $\frac{Mg}{\sqrt{2}}$ (4) Mg ($\sqrt{2}$ – 1)

**20.** 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, $\alpha$ . If the coefficient of friction between the rod and the bead is $\mu$, and gravity is neglected, then the time after which the bead starts slipping is-

(1) $\sqrt{\frac{\mu}{\alpha}}$ (2) $\frac{\mu}{\sqrt{\alpha}}$ (3) $\frac{1}{\sqrt{\mu\alpha}}$ (4) Infinitesimal

**21.** A stone is projected from level ground at t = 0 sec such that its horizontal and vertical components of initial velocity are 10 m/s and 20 m/s respectively. Then the instant of time at which tangential and normal components of acceleration of stone are same is : (neglect air resistance) g = 10 m/s$^2$.

(1) $\frac{1}{2}$ sec (2) $\frac{3}{2}$ sec (3) 3 sec (4) 4 sec.

**22.** A particle is moving in a circle
(1) The resultant force on the particle must be towards the centre.
(2) The resultant force may be towards the centre.
(3) The direction of the angular acceleration and the angular velocity must be the same.
(4) The cross product of the tangential acceleration and the angular velocity will be zero.

**23.** A ring of mass $2\pi$ kg and of radius 0.25 m is making 300 rpm about an axis through its centre perpendicular to its plane. The tension (in newton's) developed in the ring is (take $\pi^2$ = 10)
(1) 50 (2) 100 (3) 175 (4) 250

**24.** In the motorcycle stunt called "the well of death" the track is a vertical cylindrical surface of 18 m radius. Take the motorcycle to be a point mass and $\mu$ = 0.8. The minimum angular speed of the motorcycle to prevent him from sliding down should be:
(1) 6/5 rad/s (2) 5/6 rad/s (3) 25/3 rad/s (4) none of these

**25.** The driver of a car travelling at full speed suddenly sees a wall at a distance r directly in front of him. To avoid collision,
(1) he should apply brakes sharply
(2) he should turn the car sharply
(3) he should apply brakes and then sharply turn
(4) None of these

**26.** A child is swinging a swing, Minimum and maximum heights of swing from earth's surface are 0.75 m and 2 m respectively. The maximum velocity of this swing is :
(1) 5 m/s (2) 10 m/s (3) 15 m/s (4) 20 m/s

**27.** A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 s, what is the magnitude and direction of acceleration of the stone ?
(1) $\frac{\pi^2}{4}$ $ms^{-2}$ and direction along the radius towards the centre
(2) $\pi^2$ $ms^{-2}$ and direction along the radius away from centre
(3) $\pi^2$ $ms^{-2}$ and direction along the radius towards the centre
(4) $\pi^2$ $ms^{-2}$ and direction along the tangent to the circle

**28.** A particle moves in a circle of radius 5 cm with constant speed and time period 0.2 $\pi$s. The acceleraiton of the particle is :
(1) 15 m/s$^2$ (2) 25 m/s$^2$ (3) 36 m/s$^2$ (4) 5 m/s$^2$

**29.** A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is :
(1) 20 ms$^{-1}$ (2) 30 ms$^{-1}$ (3) 5 ms$^{-1}$ (4) 10 ms$^{-1}$

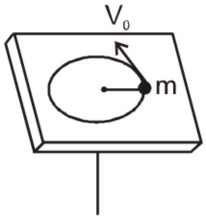
**30.** A car of mass m is moving on a level circular track of radius R. If $\mu_s$ represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by :
(1) $\sqrt{\mu_s mRg}$ (2) $\sqrt{Rg/\mu_s}$ (3) $\sqrt{mRg/\mu_s}$ (4) $\sqrt{\mu_s Rg}$

## Practice Test (JEE-Main Pattern)
**OBJECTIVE RESPONSE SHEET (ORS)**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | | | | | | | | | | |
| Que. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Ans. | | | | | | | | | | |
| Que. | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Ans. | | | | | | | | | | |

## PART - II : PRACTICE QUESTIONS

**1.** A mass m moves in a circle on a smooth horizontal plane with velocity $v_0$ at a radius $R_0$. The mass is attached to string wihich passes through a smooth hole in the plane as shown.
The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is :




(1) $\frac{1}{4}mv_0^2$ (2) $2mv_0^2$
(3) $\frac{1}{2}mv_0^2$ (4) $mv_0^2$

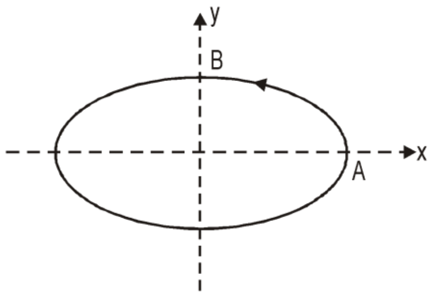
**2.** An automobile moves on a road with a speed of 54 km $h^{-1}$. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kg $m^2$. If the vehicle is brought to rest in 15 sec. the magnitude of average torque transmitted by its brakes to the wheel is :
(1) 8.58 kg $m^2$ $s^{-2}$ (2) 10.86 kg $m^2$ $s^{-2}$ (3) 2.86 kg $m^2$ $s^{-2}$ (4) 6.66 kg $m^2$ $s^{-2}$

**3.** Two stones of masses m and 2 m are whirled in horizontal circles the heavier one in radius $\frac{r}{2}$ and the lighter one in radius r. The tangential speed of lighter stone is n times that of the value of heavier stone when they experience same centripetal forces. The value of n is :
(1) 3 (2) 4 (3) 1 (4) 2

**4.** A spaceman in training is rotated in a seat at the end of a horizontal arm of length 5m. If he can withstand acceleration upto 9 g then what is the maximum number of revolutions per second permissible ? (Take g = 10 m/$s^2$)
(1) 13.5 rev/s (2) 1.35 rev/s (3) 0.675 rev/s (4) 6.75 rev/s

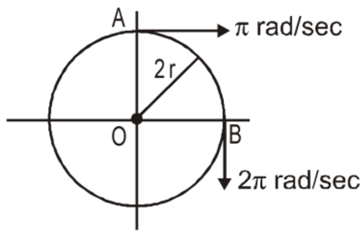
**5.** A particle is moving with constant angular acceleration ($\alpha$) in a circular path of radius $\sqrt{3}$m. At t = 0, it was at rest and at t = 1 sec, the magnitude of its acceleration becomes $\sqrt{6}$ m/$s^2$, then $\alpha$ is :
(1) 2 rad/$s^2$ (2) $\sqrt{3}$ rad/$s^2$ (3) $\sqrt{2}$ rad/$s^2$ (4) 1 rad/$s^2$

**6.** A particle is moving along an elliptical path with a constant speed. As it moves from A to B, magnitude of its acceleration :
(1) continuously increases
(2) continuously decreases
(3) Remains constant
(4) first increases and then decreases




**7.** A particle moves in a circle of radius r with angualr velocity $\vec{\omega}$. At some instant its velocity $\vec{v}$ and radius vector with respect to centre of the circle is $\vec{r}$. At this instant centripetal acceleration $\vec{a}_c$ will be :
(1) $\vec{\omega}\times\vec{v}$ (2) $\vec{v}\times\vec{\omega}$ (3) $\vec{\omega}\times(\vec{\omega}\times\vec{r})$ (4) $\vec{v}\times(\vec{r}\times\vec{\omega})$

**8.** Two particles A and B are moving in a circle with angular velocities $\omega_A = \pi$ rad/sec, $\omega_B = 2\pi$ rad/sec. Initial positions of both the particles are shown in figure. Find the time after which A and B will collide




(1) $\frac{1}{2}$ sec (2) $\frac{3}{2}$ sec
(3) 1 sec (4) 2 sec

**9.** A particle is moving in a circle of radius $\pi$ m in such a way that at any instant the net acceleration makes an angle of 45° with radius. If initial speed is $\frac{\pi}{2}$ m/s, the time taken to complete the first revolution is :

(1) less than 2 sec (2) more than 2 sec (3) exactly 2 sec (4) None of these

**10.** An aeroplane flying at constant speed 115 m/s towards east, makes a gradual turn following a circular path to fly south. The turn takes 15 seconds to complete. The magnitude of the centripetal acceleration during the turn, is

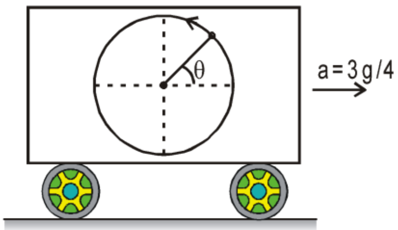
(1) $\frac{23\pi}{8}$ m/s2 (2) $\frac{46\pi}{3}$ m/s2 (3) $\frac{23\pi}{6}$ m/s2 (4) none of these

**11.** A particle is projected horizontaly with speed 10m/s from a certain point above ground. Find the tangential acceleration of particle at t = 2 sec. (Take g = 10 m/s$^2$).

(1) $\frac{10}{\sqrt{5}}$ (2) $\frac{25}{\sqrt{5}}$ (3) $4\sqrt{5}$ (4) $10\sqrt{5}$

**12.** A particle is tied to one end of a light inextensible string and is moving in a vertical circle, the other end of string is fixed at the centre. Then for complete motion in circle, which is **correct**. (air resistance is negligible)
(1) Acceleration of the particle is directed towards the centre.
(2) Total mechanical energy of the particle and earth remains constant
(3) Tension in the string remains constant
(4) Acceleration of the particle remains constant

**13.** A bus is moving with a constant acceleration a = 3g/4 towards right. In the bus, a ball is tied with a rope and is rotated in vertical circle as shown. The tension in the rope will be minimum, when the rope makes an angle $\theta$ = ______ .



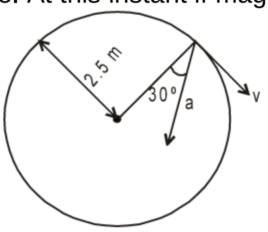

(1) 53° (2) 37°
(3) 180 – 53° (4) 180 + 37°

**14.** A stone of mass M is tied at the end of a string, is moving in a circle of radius R, with a constant angular velocity $\omega$. The total work done on the stone, in any half circle, is:

(1) $\pi MR^2\omega^2$ (2) $2MR^2\omega^2$ (3) $MR^2\omega^2$ (4) 0

**Comprehension # 1**

Figure shows the direction of total acceleration and velocity of a particle moving clockwise in a circle of radius 2.5 m at a given instant of time. At this instant if magnitude of net acceleration is 25 m/sec$^2$ , find




**15.** The radial acceleration

(1) $25\frac{\sqrt{3}}{2}$ m/s$^2$ (2) $25\frac{\sqrt{2}}{3}$ m/s$^2$ (3) $35\frac{\sqrt{2}}{3}$ m/s$^2$ (4) $35\frac{\sqrt{3}}{2}$ m/s$^2$

**16.** The speed of the particle

(1) $\left(125\frac{\sqrt{3}}{4}\right)^{1/3}$ (2) $\left(125\frac{\sqrt{3}}{4}\right)^{1/2}$

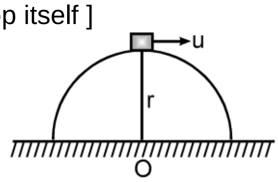
(3) $\left(125\frac{\sqrt{3}}{4}\right)$ (4) None of these

**17.** its tangential acceleration

(1) $\frac{35}{2}$ m/s$^2$ (2) $\frac{25}{3}$ m/s$^2$ (3) $\frac{25}{2}$ m/s$^2$ (4) $\frac{35}{3}$ m/s$^2$

**Comprehension # 2✍**

A small block of mass m is projected horizontally from the top of the smooth and fixed hemisphere of radius r with speed u as shown. For values of $u \geq u_0$, ($u_0 = \sqrt{gr}$) it does not slide on the hemisphere. [ i.e. leaves the surface at the top itself ]




**18.✍** For $u = 2u_0$, it lands at point P on ground. Find OP.

(1) $\sqrt{2}$ r (2) 2r (3) 4r (4) $2\sqrt{2}$ r

**19.✍** For $u = u_0/3$, find the height from the ground at which it leaves the hemisphere.

(1) $\frac{19r}{9}$ (2) $\frac{19r}{27}$ (3) $\frac{10r}{9}$ (4) $\frac{10r}{27}$

**20.✍** Find its net acceleration at the instant it leaves the hemisphere.

(1) g/4 (2) g/2 (3) g (4) g/3

## APSP Answers

**PART - I**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | (3) | **2.** | (4) | **3.** | (1) | **4.** | (4) | **5.** | (2) | **6.** | (4) | **7.** | (4) |
| **8.** | (1) | **9.** | (4) | **10.** | (2) | **11.** | (4) | **12.** | (1) | **13.** | (4) | **14.** | (2) |
| **15.** | (4) | **16.** | (3) | **17.** | (2) | **18.** | (1) | **19.** | (4) | **20.** | (1) | **21.** | (3) |
| **22.** | (2) | **23.** | (4) | **24.** | (2) | **25.** | (1) | **26.** | (1) | **27.** | (3) | **28.** | (4) |
| **29.** | (2) | **30.** | (4) | | | | | | | | | | |

**PART – II**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | (2) | **2.** | (4) | **3.** | (4) | **4.** | (3) | **5.** | (4) | **6.** | (2) | **7.** | (1) |
| **8.** | (2) | **9.** | (1) | **10.** | (3) | **11.** | (3) | **12.** | (2) | **13.** | (1) | **14.** | (4) |
| **15.** | (1) | **16.** | (2) | **17.** | (3) | **18.** | (4) | **19.** | (2) | **20.** | (3) | | |