PEN PAPER TEST (MOTION, LAWS OF MOTION) CLASS – IX

1. Prove $v^2 = u^2 + 2as$ graphically where symbols have their usual meaning. A car starting from rest moves with acceleration 0.5 ms^{-2} and travel a distance of 20 m. Calculate the final speed of the car. (3+2)

2. The radius of a wheel is 7 m. What is the displacement of point P, on the wheel (just on the ground) during the half rotation of wheel? The half of the distance travelled by a car with 15 ms^{-1} and the 2nd half with 30 ms^{-1}. Calculate the average speed of the car. (3+2)

3. Show that, if the speed of a car is doubled then the braking distance is four times. If action reaction forces are equal and opposite then why a body moves? An athlete takes 40 s to cover a circular path of radius R. What is the ratio of distance to displacement of him for 2 minutes 20 second? (2+1+2)

4. A ball of mass 100 g rebounds a vertical wall with same speed 100 ms^{-1}. If the time of collision is 0.05 s then calculate the force acting on the ball by the wall. Write two difference between circular motion and rotational motion. Plot displacement versus time graph of a particle freely falling under gravity. (2+2+1)

5. What is the physical quantity is defined by Ns? A body is moving with uniform speed has uniform velocity. Is it true? Explain. A particle starting from rest moving with uniform acceleration and after 5 s it's speed is 10 ms^{-1}. Next 5s it is moving with uniform speed and last 4 s it is moving with uniform acceleration and become finally rest. Plot velocity versus time graph and calculate total distance travelled by it from graph. (1+1+3)

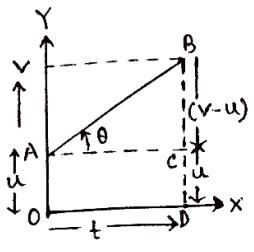
6. State and prove law of conservation of linear momentum. A body of mass m moving with speed u and collides with another stationary body mass M. If m moves with speed v in the same direction, then find the speed of M. (3+2)

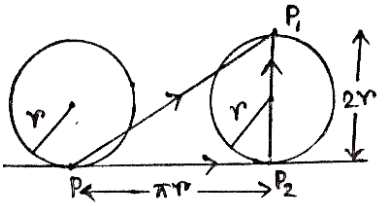
7. A particle is moving along a straight line with initial speed 10 ms^{-1} towards west. It moves with constant acceleration 2 ms^{-2} always acting towards east. Find the distance, displacement and speed of it at 11 s. (5)

8. Give one example that speed of a body remain same but it has acceleration. When a bullet is fired on a glass window it makes a hole but it breaks when a stone is thrown. Explain why? Why a man falling from a certain height receives more injury when he falls on a marble floor than when he falls on a heap of sand? (1+2+2)

9. Is it possible that a particle has velocity in two directions but it has acceleration in one direction? Explain it. A pendulum is suspended from the roof of a car which is moving with constant speed. What change in position of pendulum you observe in this case? Why the centripetal and centrifugal forces are called real and pseudo force respectively? (2+1+2)

10. Which factor provides centripetal force to move a car in circular path? A ball is dropped from a height what is the ratio of distance travelled by it in 1st, 2nd and 3rd second of its motion? In tug of war two person apply T amount of force to each other. What is the tension acting on the rope? (1+3+1)

Q.No.	ANSWER	MARK
1	Let us consider u is the initial velocity of the particle at t = 0 and v is the final velocity of the particle after time t. A and B are the two points on the curve corresponding to t = 0 and t = t respectively. BD is perpendicular on time axis and AC is perpendicular on BD. OA = CD = u, BC = (v - u) and OD = AC = t The distance travelled by it for time t is s = area under the v - t graph s = area of trapezium OABD Or, $s = \frac{1}{2}$[sum of parallel sides × perpendicular distance between parallel sides] Or, $s = \frac{1}{2}[OA + BD] \times AC = \frac{1}{2}[u + v]t$ Or, $2s = \frac{[u+v][v-u]}{a}$ [as v = u + at] 	0.5 0.5 (pic) 0.5 0.5 0.5

	Or, $2as = v^2 - u^2$ $\therefore v^2 = u^2 + 2as$. U = 0, s = 20 m, a = 0.5 ms^{-2} v =? $V^2 = u^2 + 2as = 2 \times 0.5 \times 20 = 20$ $\therefore v = \sqrt{20} = 2\sqrt{5}\ ms^{-1}$.	0.5 1 1
2	Let us consider a point P of wheel touches the surface and after half rotation of the wheel that point (P) moves to P_1 and the point which touches the surface at that instant is P_2. So, the horizontal displacement of the point P is $PP_2 = \pi r = \frac{22\times7}{7} = 22$ m. Vertical displacement of the point P is $P_1P_2 = 2r = 2\times 7 = 14$ m. So, net displacement of the point P is $PP_1 = \sqrt{{PP_2}^2 + {P_1P_2}^2} = \sqrt{22^2 + 14^2} = 26.1$ m.  Time taken to travel 1st half distance $t_1 = \frac{s}{15}$ s. Time taken to travel 2nd half distance $t_2 = \frac{s}{30}$ s. Average speed $v = \frac{s+s}{\frac{s}{15}+\frac{s}{30}} = \frac{30\times2}{3} = 20\ ms^{-1}$.	0.5 0.5 0.5 0.5 (pic) 1 0.5 0.5 1
3	A car is moving with speed v and it travels s distance before stop. So, $v^2 = 2as$ If the speed is 2v then travel distance is x before stop. So, $(2v)^2 = 2ax$ Or, $4v^2 = 2ax$ Or, $4\times2as = 2ax$ $\therefore x = 4s$ As action reaction forces are acting on different bodies so they are not cancelled each other. In 2 minute 20 second he covers $\frac{140}{40} = 3.5$ rotation. So displacement of the athletes is 2R. The distance travelled for 3.5 rotation is $3.5\times 2\pi R$ The ratio of distance to displacement is $3.5\pi:1 = 11:1$.	0.5 0.5 0.5 0.5 1 0.5 0.5 0.5 0.5
4	M = 0.1 kg v = 100 ms^{-1} change in momentum P = Mv – M(-v) = 2Mv The force acting on the ball by the wall is $F = \frac{P}{t} = \frac{2Mv}{t} = \frac{2\times0.1\times100}{0.05} = 400$ N. | Rotational motion	circular motion
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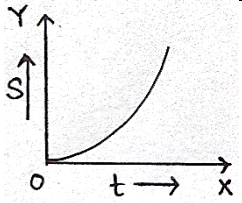
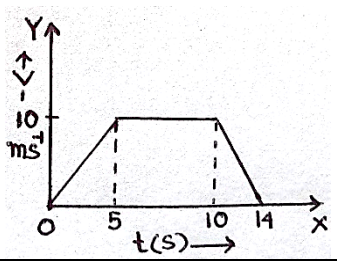
When a body revolves around its own axis of rotation in a circular path is called rotational motion.	When a body revolves around a fixed line called axis of rotation or a fixed point in a circular path is called circular motion.
In this case the position of the body with respect to the rotating axis doesn't change.	In this case the position of the body changes with time. |  	1 1 1 1 1
5	Momentum or impulse When the body moves in a straight line then only it is true otherwise not. distance travelled = area under the graph $= \frac{1}{2}(5 + 14)10$ = 95 ms^{-1}.  	1 1 1 1 1 (pic)
6	If the vector sum of the external forces acting on a system is zero, then the total momentum of the system is conserved i.e. remain constant.	0.5

	Let us consider two bodies A and B of masses m_1 and m_2 are moving with initial velocity $\vec{u}_1$ and $\vec{u}_2$ ($\vec{u}_1 > \vec{u}_2$) in the same direction and after some time they collide and move in the same direction with final velocity $\vec{v}_1$ and $\vec{v}_2$ ($\vec{v}_1 < \vec{v}_2$) respectively. The change in momentum of the body A = $m_1(\vec{v}_1 - \vec{u}_1)$ and the change in momentum of the body B = $m_2(\vec{v}_2 - \vec{u}_2)$. If the collision time is t, and $\vec{F}_1$ is the action of B on A and $\vec{F}_2$ is the action of A on B, then from Newton's third law, $\vec{F}_1 = -\vec{F}_2$ Or, $\vec{F}_1 t = -\vec{F}_2 t$ -----(1). The impulse of body A = $\vec{F}_1 t = m_1(\vec{v}_1 - \vec{u}_1)$ and impulse of body B = $\vec{F}_2 t = m_2(\vec{v}_2 - \vec{u}_2)$. Then from equation (1) we get, $m_1(\vec{v}_1 - \vec{u}_1) = -m_2(\vec{v}_2 - \vec{u}_2)$ Or, $m_1\vec{v}_1 - m_1\vec{u}_1 = -m_2\vec{v}_2 + m_2\vec{u}_2$ Or, $m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$. So, the momentum of the system before collision = the momentum of the system after collision. Using conservation of linear momentum we get, $mu + M\times 0 = mv + MV$ $\therefore V = \frac{mu-mv}{M}$.	0.5 0.5 0.5 0.5 0.5 1 1
7	As the initial speed of the particle is towards west and acceleration is toward east, so after some time it comes to rest and again moves with acceleration. $V = u + at$ or, $0 = 10 - 2t$ or, $t = 5$ s. (after 5 s it comes to rest) Distance travelled for 5 s (toward west) $s = ut + \frac{1}{2}at^2 = 10\times 5 - \frac{1}{2}\times 2 \times 5^2 = 25$ m. Distance travelled for (11-5) = 6 s (toward east) $s = \frac{1}{2}at^2 = \frac{1}{2}\times 2 \times 6^2 = 36$ m. Displacement = 36 – 25 = 11 m (east). Distance = 36 + 25 = 61 m. Speed after 11 s is $v = u + at = 2\times 6 = 12$ ms^{-1}.	 1 1 1 0.5 0.5 1
8	When a body is moving in a circular path with constant speed, the centripetal acceleration acts on it. Or, If a particle moves in a straight line with constant speed then gravitational acceleration acts on it in vertically downward direction. When any part of the glass is tends to move, then the surrounding molecules are also in motion due to inter molecular attractive force. When the bullet hits the glass then large force is applied for fraction of time. Therefore the neighboring molecules remain at their initial position due to inertia of rest. As a result small hole generates. When the stone hits the glass then the glass molecules get maximum time to vibrate. So neighboring molecules are also in motion and the glass breaks. When a man jumps on the floor he gets more injury as the collision time is less, more reaction force experienced by the man. When he jumps on the heap of sand he moves downward into the sand which takes more time to become momentum zero. As the collision time is more, reaction force experienced by the man is less.	1 0.5 1 0.5 1 1
9	If a ball is thrown horizontally from a height, it moves initially along horizontal. The gravitational acceleration acts on it in vertically downward. So velocity of the ball is in vertically downward as well as horizontal. There is no change in position of pendulum as the car moves with constant speed. To rotate a body in circular path, centripetal force is required which is directed from body to centre. For this reason centripetal force is real force. Due to rotation centrifugal force acting on the body. For this reason it is pseudo force.	1 1 1 1 1
10	Friction between road and wheel of the car. Distance travelled by a ball for 1 second under free fall is $s_1 = \frac{1}{2}g \times 1^2 = \frac{g}{2}$. Distance travelled by a ball for 2nd second under free fall is $s_2 = \frac{1}{2}g(2\times 2 - 1) = \frac{3g}{2}$. Distance travelled by a ball for 3rd second under free fall is $s_2 = \frac{1}{2}g(2\times 3 - 1) = \frac{5g}{2}$. The ratio of distance travelled by it in 1st, 2nd and 3rd second of its motion is 1:3:5. When two person apply T amount of force to each other, then the tension acting on the rope is T.	1 0.5 1 1 0.5 1