IPhO

CLASS 12

QUESTION PAPER SET H

SCO INTERNATIONAL PHYSICS OLYMPIAD SAMPLE

DO NOT OPEN THIS BOOKLET UNTIL ASKED TO DO SO

Guidelines for the Candidate

1. Before the exam begins, you will have an additional 20 minutes to complete the OMR Sheet with personal information.
2. On the OMR Sheet, clearly write your name, **school code, class, roll number, and mobile number**..
3. Four sections make up the question paper:
4. Every inquiry must be answered. There are no failing grades. Calculator use is not allowed.
5. There is just ONE right response. Select ONE response choice only.
6. Use only an HB pencil or a blue or black ballpoint pen to indicate your choice of responses by darkening the corresponding circles on the OMR Sheet. E.g.

   Q.1: What is the capital of India?

   A. Kolkata B. Mumbai C. Delhi D. Chennai

   You must shade the circle next to option C on the OMR Sheet since that is the right response.

   

7. At the conclusion of the test, hand over the OMR Sheet to the Invigilator.
8. Before attempting the paper, kindly provide your personal information in the box provided on this page. .

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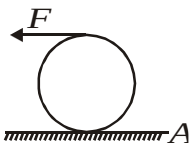
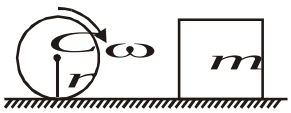
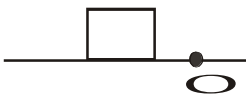
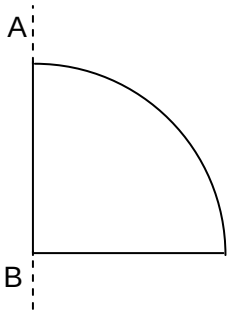
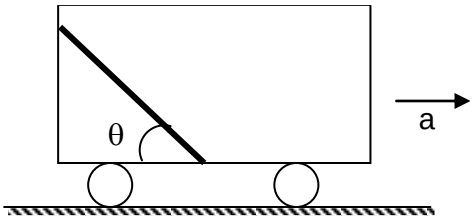
1.	**A massless string is wrapped around a hollow cylinder having mass m and radius r. The cylinder is kept on a rough horizontal surface (coefficient of friction is μ). A constant force F is applied as shown in the figure. In case of pure rolling, the friction force acting on the bottom most point of the cylinder is**  (A) 0 (B) μ mg (C) $\frac{\mu mg}{2}$ (D) $\frac{3\mu mg}{2}$
2.	**A sphere of radius r and mass m collides elastically with a cubical block of mass m and side 2r. The entire system is on a smooth horizontal ground. It is given that the sphere was rolling without slipping with an angular velocity ω at the time of collision. The velocities of the sphere and the block after the collision are**  **(A)** $\omega_{sphere} = 0,\ v_{sphere} = 0,\ v_{block} = v$ **(B)** $\omega_{sphere} = \omega, v_{sphere} = 0, v_{block} = v$ **(C)** $\omega_{sphere} = \omega, v_{sphere} = 0, v_{block} = 0$ **(D)** $\omega_{sphere} = \frac{\omega}{2}, v_{sphere} = \frac{v}{2}, v_{block} = \frac{v}{2}$
3.	**A cubical block of side a is moving with a velocity v on a smooth horizontal plane as shown in the figure. It hits a ridge at point O. The angular speed of the block after it hits O is:**  (A) $\frac{3v}{4a}$ (B) $\frac{3v}{2a}$ (C) $\frac{\sqrt{3}v}{\sqrt{2}a}$ (D) zero
4.	**In pure rolling, fraction of its total energy associated with rotation is α for a ring and b for a solid sphere. Then** (A) a = 1/3 (B) a = 1/4 (C) b = 2/5 (D) b = 2/7
5.	**A lamina of mass M is in shape of a quarter of circle of radius R as shown in figure. The moment of inertia of this lamina about axis AB is**



(A) $\frac{MR^2}{8}$ (B) $\frac{MR^2}{4}$

(C) $\frac{MR^2}{2}$ (D) MR^2

6. **A smooth rod of length *l* is kept inside a trolley at an angle θ as shown in the figure. What should be the acceleration a of the trolley so that the rod remains in equilibrium with respect to it ?**



(A) g tan θ (B) g cos θ

(C) g sin θ (D) g cot θ

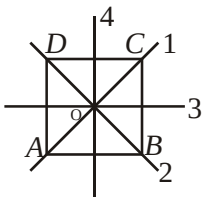
7. **A particle of mass m is projected with a velocity v_0 making an angle of 45° with horizontal. The magnitude of angular momentum of the projectile at its maximum height about the point of projection is**

(A) zero (B) $\frac{mv_0^3}{\sqrt{2}g}$ (C) $\frac{mv_0^3}{2\sqrt{2}g}$ (D) $\frac{mv_0^3}{4\sqrt{2}g}$

8. **The axis of rotation of a purely rotating body**

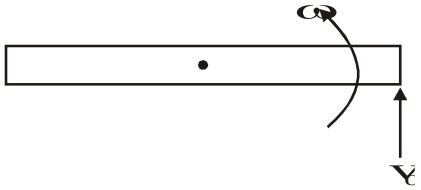
(A) must pass through the centre of mass
(B) may pass through the centre of mass
(C) must pass through a particle of the body
(D) may pass through a particle of the body

9. **The moment of inertia of a thin square plate ABCD of uniform thickness about the centre O and perpendicular to the plane is I. I_1, I_2, I_3 and I_4 are respectively the moment of inertia about axes 1, 2, 3 and 4 which are in the plane of the plate. Then**



(A) $I_2 = I_3$ (B) $I_3 + I_4 = I_1$ (C) $I_4 + I_3 = I_2$ (D) $I_1 + I_2 + I_3 + I_4 = I$

10. **A stick of length l and mass m lies on a frictionless horizontal surface on which it is free to move in any direction. A ball of same mass m moving with speed v_0 perpendicular to this length collides at the end of stick. The angular velocity of the rod when the collision is perfectly inelastic is**



(A) $\frac{12v_0}{7\ell}$ (B) $\frac{3v_0}{2\ell}$ (C) $\frac{24v_0}{5\ell}$ (D) $\frac{3v_0}{7\ell}$

11. **A block of mass m moving at a velocity v collides with another block of mass 2 m at rest. The lighter blocks comes to rest after collision. The coefficient of restitution is**

(A) 1/2 (B) 1 (C) 1/3 (D) 2/3

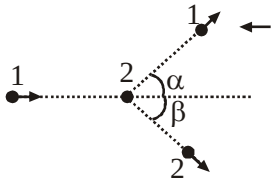
12. **A balls falls vertically on a smooth horizontal floor. If e is the coefficient of restitution for each impact. The percentage change in magnitude of momentum after n impacts will be**

(A) $\left(1-e^n\right)\times 100$ (B) $\left(1+e^n\right)\times 100$ (C) $\left(1-e^{2n}\right)\times 100$ (D) $\left(1+e^{2n}\right)\times 100$

13. **The magnitude of impulse developed by a mass 0.2 kg which changes velocity from $5\hat{i}-3\hat{j}+7\hat{k}$ m/sec to $2\hat{i}+3\hat{j}+\hat{k}$ m/sec is**

(A) 2.7 Ns (B) 1.8 Ns (C) 0.9 Ns (D) 3.0 Ns

14. **A man of mass M stands at one end of a plank of length ℓ which lies at rest on a frictionless surface. The man walks to other end of plank. If the mass of the plank is M/4. The distance that man moves relative to ground is**

	(A) $\frac{3\ell}{4}$ (B) $\frac{4\ell}{5}$ (C) $\frac{\ell}{5}$ (D) $\frac{\ell}{3}$
15.	**A ball of mass is thrown vertically upward with a velocity v_0. Power developed by gravity at time 't' is** (A) $mg(gt - v_0)$ (B) $mg(gt + v_0)$ (C) $-mg(v_0 + gt)$ (D) Zero
16.	**A moving ball collides with another identical ball at rest. If it is a perfectly elastic collision, then value of $\alpha + \beta$ is**  (A) $\pi/3$ (B) $\pi/4$ (C) $\pi/2$ (D) π
17.	**A body of mass m is falling freely through a height h from the top of a tower. Air drag is acting on body; the velocity just before striking the ground is $\sqrt{\frac{3}{2}gh}$. The work done by air drag is** (A) $-\frac{mgh}{4}$ (B) $-\frac{mgh}{2}$ (C) Zero (D) $-\frac{3mgh}{2}$
18.	**A body of mass m is dropped from a certain height. When it loses P.E. = u then the momentum of the body is** (A) $\sqrt{2mu}$ (B) $\sqrt{4mu}$ (C) $\frac{1}{2}\sqrt{mu}$ (D) $\frac{mu}{\sqrt{2}}$
19.	**The potential energy between the atoms in a molecule is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are positive constants and x is the distance between the atoms. The atom is in stable equilibrium when** (A) x = 0 (B) $x = \left(\frac{a}{2b}\right)^{1/6}$ (C) $x = \left(\frac{2a}{b}\right)^{1/6}$ (D) $x = \left(\frac{11a}{5b}\right)^{1/6}$

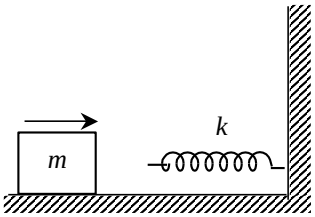
20. **A nail is located at a certain distance vertically below the point of suspension of a simple pendulum. The pendulum bob is released from a position when the string makes 60° with vertical, then the distance of nail from point of suspension such that the bob will just perform revolutions with nail as centre is (The length of pendulum is given as one metre)**

(A) 80 cm above the point of suspension
(B) 80 cm below the point of suspension
(C) 60 cm below the point of suspension
(D) 60 cm above the point of suspension

21. **A particle is acted upon by a conservative force** $F = \left(7\hat{i} - 6\hat{j}\right)$ **N. The work done by the force when the particle moves from origin (0, 0) to the position (– 3m, 4m) is given by**

(A) 3 J (B) 10 J (C) – 45 J (D) –10 J

22. **A block of mass m moves towards a light spring of stiffness k on a smooth horizontal plane. If it compresses the spring through a distance x_0, then the magnitude of total change in momentum of the block.**

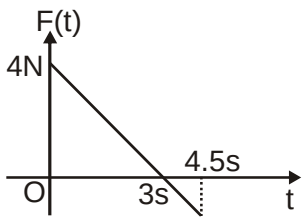


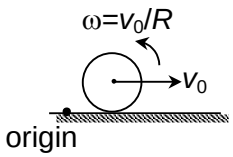
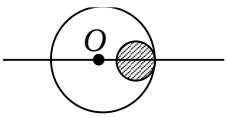
(A) $\sqrt{\frac{m}{k}}x_0$ (B) $\sqrt{2mk}x_0$ (C) $\frac{\sqrt{mk}x_0}{2}$ (D) $\sqrt{mk}x_0$

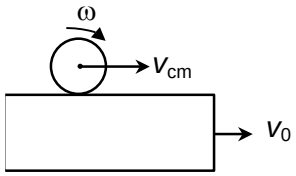
23. **A ball approaches a moving wall of infinite mass with speed v along normal to the wall. The speed of the wall is u away from the ball and u < v. The speed of ball after an elastic collision is**

(A) u + v away from the wall (B) 2u + v away from the wall
(C) v – u towards from the wall (D) v – 2u away from the wall

24. **A block of mass 2 kg is free to move along the x-axis. It is at rest and from t = 0 onwards it is subjected to a time-dependent force F(t) in the x-direction. The force F(t) varies with t as shown in the figure.**



	The kinetic energy of the block after 4.5 s is (A) 4.50 J (B) 7.50 J (C) 5.06 J (D) 14.6 J
25.	**Two particles of equal mass have velocities $\vec{v}_1 = 2\hat{i}$ m/s and $\vec{v}_2 = 2\hat{j}$ m/s. First particle has an acceleration $\vec{a}_1 = (3\hat{i} + 3\hat{j})$ m/s² while the acceleration of the other particle is zero. The center of mass of the two particles moves on a** (A) circle (B) parabola (C) straight line (D) ellipse
26	**A uniform disc of mass m and radius R is moving with speed v_0 and rotating with angular velocity $\omega = \frac{v_0}{R}$ on a smooth horizontal surface as shown then find the total angular momentum of a body about origin**  (A) $\frac{3}{2}mv_0R$ (B) $\frac{1}{2}mv_0R$ (C) mv_0R (D) $3\,mv_0R$
27	**From a uniform circular plate of radius R, a small circular plate of radius R/4 is cut off as shown. If O is the center of the complete plate, then the distance of the new center of mass of the remaining plate from O will be**  (A) R/20 (B) R/16 (C) R/15 (D) $\frac{3}{4}R$
28	**In the given figure, the sphere rolls without slipping on the plank which is moving with constant velocity v_0. The radius and angular velocity of the sphere is r and ω respectively. The velocity of centre of mass of the sphere is**

	 (A) $v_0 + r\omega$ (B) $v_0 - r\omega$ (C) $r\omega$ (D) v_0
29	**A uniform rod AB of mass m and length l is at rest on a smooth horizontal surface. An impulse p is applied to the end B. The time taken by the rod to turn through a right angle is** (A) $2\pi\frac{ml}{p}$ (B) $2\pi\frac{p}{ml}$ (C) $\frac{\pi ml}{12p}$ (D) $\frac{\pi p}{ml}$
30	**A bullet of mass m is fired from below into a bob of mass M of a long simple pendulum. The bullet stays inside the bob and the bob rises to a height h. The initial speed of the bullet will be** (A) $hg\left[\frac{(M+m)}{m}\right]$ (B) $\sqrt{\left(\frac{2h}{g}\right)}\left[\frac{M+m}{m}\right]$ (C) $\sqrt{\left(\frac{2h}{g}\right)}\left[\frac{m}{M+m}\right]$ (D) $\sqrt{(2gh)}\left[\frac{M+m}{m}\right]$

ANSWER KEY

1	A	11	A	21	C
2	B	12	B	22	D
3	A	13	B	23	D
4	D	14	C	24	C
5	B	15	C	25	C
6	D	16	C	26	B
7	D	17	A	27	A
8	B	18	A	28	A
9	A	19	C	29	C
10	B	20	B	30	D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