PHYSICS

BOOKS - MODERN PUBLICATION PHYSICS (KANNADA ENGLISH)

ROTATIONAL MOTION

Level I Mcq

1. A uniform rectangular block has length twice as large as the breath. It is lying on the

horizontal plane, which is gradually being raised so as to be inclined to the horizontal at an angle θ. For what value θ, the block be at the point of toppling?

A. 70.6°

B. 65.8°

C. 45.5°

D. 26.6°

Answer: D

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2. A thin circular ring of mass M and radius R is rotating about its central axis with angular velocity ω. Four point objects each of mass m are attached gently to the opposite ends of two perpendicular diameters, the angular velocity of the ring is given by :

A. $\frac{M}{M+m}.\omega$

B. $\frac{M}{M+4m}.\omega$

C. $\frac{M+4m}{M}.\omega$

D. $\frac{M-4m}{M+4m}.\omega$

Answer: B

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3. What is the moment of inertia of a thin rod of length L and mass M about an axis passing through one end and perpendicular to its length?

A. $\frac{1}{3}ML^2$

B. $\frac{1}{12}ML^2$

C. ML^2

D. $\frac{1}{2}ML^2$

Answer: A

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4. The centre of mass of a system of two particles of masses m_1 and m_2 is at a distance a_1, from mass m_1 and at a distance a_2 from mass m_2 such that :

A. $\frac{a_1}{a_2} = \frac{m_2}{m_1}$

B. $\frac{a_1}{a_2} = \frac{m_1}{m_2}$

C. $\frac{a_1}{a_2} = \frac{m_1}{(m_1 + m_2)}$

D. $\frac{a_1}{a_2} = \frac{m_2}{(m_1 + m_2)}$

Answer: A

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5. Three particles of the same mass lie in the x-y plane. The (x, y) coordinates of their positions are (1, 1), (2, 2) and (3, 3) respectively.

The (x, y) co-ordinates of the centre of mass are:

A. (1, 2)

B. (2, 2)

C. (4, 2)

D. (6, 6)

Answer: B

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6. A child is standing at one end of a long trolley moving with a speed v on a smooth horizontal track. If the child starts running towards the other end of the trolley with a speed u, the centre of mass of the system (trolley + child) will move with a speed :

A. v

B. $(v - u)$

C. $(v + u)$

D. zero

Answer: A

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7. When a sphere of moment of inertia I moves down an inclined plane, the percentage of energy which is rotational, is approximately :

A. $100\ \%$

B. $72\ \%$

C. $28\ \%$

D. None of these

Answer: C

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8. A solid disc first rolls without slipping and then slides without rolling down the same inclined plane. The velocities in two cases at the bottom are in the ratio of

A. $1:2$

B. $2:\sqrt{6}$

C. $\sqrt{6}:3$

D. $\sqrt{3}:1$

Answer: B

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9. Moment of inertia of a solid sphere of density ρ and radius R is given by :

A. $\frac{105}{176}\rho R^2$

B. $\frac{176}{105}\rho R^2$

C. $\frac{176}{105}\rho R^2$

D. None of these

Answer: B

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10. A thin uniform rod of length 2l is acted upon a constant torque. The angular velocity changes from zero to ω in time t. The value of torque is :

A. $\frac{ml^2\omega}{t}$

B. $\frac{ml^2\omega}{12t}$

C. $\frac{ml^2\omega}{3t}$

D. $\frac{2ml^2\omega}{t}$

Answer: C

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11. Speed of a solid sphere after rolling down an inclined plane is :

A. $\left(\frac{10}{7}gh\right)^{1/2}$

B. $\sqrt{\frac{6}{5}gh}$

C. $\sqrt{\frac{4}{5}gh}$

D. $(gh)^{1/2}$

Answer: A

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12. Four spheres of radius r each of mass m placed with their centres on the four corners of the square of side 'a'. The M.I. of the system

about an axis along one of the sides of square is :

A. $\frac{4}{5}mr^2 + 2ma^2$

B. $\frac{4}{5}mr^2 + 4ma^2$

C. $\frac{8}{5}mr^2$

D. $\frac{8}{5}mr^2 + 2ma^2$

Answer: D

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13. A homogenous disc of mass 2 kg and radius 10 cm is rotating about its axis with an angular velocity of 4 rad s^{-1}. The angular momentum of the disc is :

A. 1 kg ms^{-1}

B. 0.6 kg ms^{-1}

C. 1.2 kg ms^{-1}

D. None of these

Answer: D

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14. If the earth were to suddenly shrink to I/n of its present radius without any change in its mass the duration of the new day will be

A. $\frac{24}{n}h$

B. $24nh$

C. $\frac{24}{n^2}h$

D. $24n^2h$

Answer: C

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15. A ring rolls down an inclined plane. At the bottom its kinetic energy is E. Theratio of its rotational K.E. to the translational K.E. is :

A. $1:4$

B. $1:2$

C. $1:1$

D. $2:1$

Answer: C

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16. A mass sliding down an inclined plane and reaches the bottom with velocity v. If the same mass is in the form of a disc and rolls down the same inclined plane, what is its velocity at the bottom ?

A. v

B. $\sqrt{\frac{2}{3}v}$

C. $\sqrt{2}v$

D. $\frac{v}{\sqrt{2}}$

Answer: B

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17. If earth suddenly stops revolving and whole of its K.E. is used up for raising its temperature and if S = specific heat, R = radius, ω = angular velocity of earth, the rise of temperature of earth is : (J = joules constant)

A. $\frac{R^2\omega^2}{5S}$

B. $\frac{R^2\omega^2}{5J}$

C. $\frac{R^2\omega^2}{5JS}$

D. $\frac{R^2\omega}{5JS}$

Answer: C

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18. A solid sphere rolls down on an inclined plane of 30° inclination. Ratio of acceleration when it rolls and slides is :

A. $5:7$

B. $7:5$

C. $2:5$

D. $3:5$

Answer: A

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19. Angular momentum of the earth revolving around the sun is proportional to r^n, where r

is the distance between the earth and the sun.

Value of n is :

A. 2

B. 1

C. $1/2$

D. $3/2$

Answer: C

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20. The moment of inertia of two spheres of equal masses about their diameters are equal. If one of them is solid and other is hollow, the ratio of their radii is :

A. $\sqrt{3}:\sqrt{5}$

B. $3:5$

C. $\sqrt{5}:\sqrt{3}$

D. $5:3$

Answer: C

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21. If the earth were to tripple its present distance from the sun then number of days in one year will be :

A. 365×3

B. 365×27

C. $365 \times 3\sqrt{3}$

D. $365 / 3\sqrt{3}$

Answer: C

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22. Moment of inertia of a solid sphere about a diameter is 8 g cm^2 (mass = 5 g, radius = 2 cm). Moment of inertia of the solid sphere about a tangent shall be :

A. $28gcm^2$

B. $40gcm^2$

C. $18gcm^2$

D. $12gcm^2$

Answer: A

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23. A stone of mass 4 kg whirled in a horizontal circle of radius 1 m and makes 2 revolutions/s. Moment of inertia of the stone about the axis of rotation is :

A. $65kgm^2$

B. $4kgm^2$

C. $16kgm^2$

D. $1kgm^2$

Answer: B

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24. In the above question, the angular momentum of the stone is :

A. $64\pi kg \times m^2/s$

B. $16\pi kg \times m^2/s$

C. $4\pi kg \times m^2/s$

D. $\pi kg \times m^2 / s$

Answer: B

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25. A thin circular ring of mass m and r is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m are attached gently to the opposite ends of a diameter of the ring wheel now rotates with an angular velocity :

A. $\omega M/(M+m)$

B. $\omega(M-2m)/(M+2m)$

C. $\omega M/(M+2m)$

D. $\omega(M+2m)/M$

Answer: C

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26. Two identical balls one solid and other hollow are allowed to roll down an inclined

plane, which one of them reached the base first?

A. Hollow ball

B. Solid ball

C. Both reach together

D. None reaches

Answer: B

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27. What is the moment of inertia and K.E. of a thin uniform ring of mass 2 kg and diameter 1 m rotating about the axis passing through its centre and perpendicular to the plane of the ring?

A. $0.5kgm^2$

B. $1.0kgm^2$

C. $2.0kgm^2$

D. $4.0kgm^2$

Answer: A

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28. A solid sphere and a disc. Of same diameter and mass roll down from rest on a frictionless inclined plane. The ratio of their acceleration is :

A. $15:14$

B. $7:8$

C. $1:1$

D. $2:1$

Answer: A

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29. A thin uniform ring of mass 5 kg and radius 0.2 metre is making 2100 r.p.m. about its central axis. Its moment of inertia and kinetic energy of rotation is :

A. $0.2kgm^2, 4836J$

B. $0.4kgm^2, 3648J$

C. $0.02kgm^2, 3936J$

D. $0.04kgm^2, 8436J$

Answer: A

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30. In a rectangle ABCD, BC = 2AB. The moment of inertia along which of the axis is minimum?

A. BC

B. BD

C. HF

D. EG

Answer: D

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31. The M.I. of a cyclinder about the axis of symmetry is equal to the M.I. about the axis passing through its centre and perpendicular to its length. The ratio of its length to the radius is :

A. $\sqrt{3}:1$

B. $1:\sqrt{3}$

C. $\sqrt{2}:1$

D. $1:\sqrt{2}$

Answer: A

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32. The ratio of angular momentum of the electron in the first allowed orbit to that in the second allowed orbit of hydrogen atom is :

A. $\sqrt{2}$

B. $\sqrt{1/2}$

C. $\frac{1}{2}$

D. 2

Answer: C

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33. A metre stick held vertically with one end on the floor is allowed to fall. Speed of the other end when it hits the floor is :

A. Nearly 3 m/s

B. 5.5 m/s

C. 7 m/s

D. 9 m/s

Answer: B

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34. A solid sphere rolls without sliding with constant velocity. What fraction of total K.E of sphere is rotational K.E. ?

A. $1/5$

B. $2/5$

C. $2/3$

D. $2/7$

Answer: D

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35. A particle of mass m travels with speed v along + ve direction of x-axis parallel to line $y = 6$. At $t = 0$, the particle is at (0, 6). The

angular momentum of particle about origin is

:

A. 0

B. 6 mv directed along + ve y axis

C. 6 mv directed along - ve z axis

D. 6 mv directed along +ve z axis

Answer: C

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36. A constant couple of 500 Nm turns a wheel of moment of inertia 100 kg m^2 about an axis through its centre, the angular velocity gained in two second is :

A. 5 rad s^{-1}

B. $100ms^{-1}$

C. $200ms^{-1}$

D. 10 rad s^{-1}

Answer: D

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37. A ring rolls on a plane surface. The fraction of total energy associated with its rotation is :

A. $\frac{1}{2}$

B. 1

C. $\frac{1}{4}$

D. $\frac{2}{1}$

Answer: A

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38. The moment of inertia of a straight thin rod of mass M and length L about an axis perpendicular to its length and passing through its C.G. is :

A. $\frac{1}{12}ML^2$

B. $\frac{1}{3}ML^2$

C. $\frac{1}{2}ML^2$

D. ML^2

Answer: A

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39. A wheel of moment of inertia $5 \times 10^{-3} kgm^2$ is making 20 rps. It is stopped in 20 s. The angular retardation is :

A. π rad s^{-2}

B. 2π rad s^{-2}

C. 4π rad s^{-2}

D. 8π rad s^{-2}

Answer: B

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40. The moment of inertia of circular disc about its diameter is 200 g cm^2. Then its moment of inertia about an axis passing through its centre and normal to its face is :

A. $100gcm^2$

B. $200gcm^2$

C. $400gcm^2$

D. $1000gcm^2$

Answer: C

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41. The angular velocity of body changes from 1 revolution per 16 seconds to 1 revolution per second without applying an external torque. The ratio of radii of gyration in two cases is :

A. $1:4$

B. $4:1$

C. $16:1$

D. $1:16$

Answer: B

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42. A flywheel rotating about a fixed axis has a K.E. of 360 J, when its angular speed is 30 rad s^{-1}. The M.I. of the flywheel about the axis of rotation is :

A. $0.15 kgm^2$

B. $0.8kgm^2$

C. $0.6kgm^2$

D. $0.75kgm^2$

Answer: B

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43. Two discs one of density 7.2 g cm^{-3} and other of density 8.9 gcm^{-3} are of same mass and thickness. Their M.I. are in the ratio of :

A. $\frac{7.2}{8.9}$

B. $\frac{1}{8.9 \times 7.2}$

C. $\frac{8.9}{7.2}$

D. $\frac{(8.9 \times 7.2)}{1}$

Answer: C

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44. A particle of mass m slides down an inclined plane and reaches the bottom with linear velocity v. If the same mass is in the

form of ring and rolls without slipping down the same inclined plane, its velocity will be:

A. v

B. $\sqrt{2}v$

C. $\frac{v}{\sqrt{2}}$

D. 2v

Answer: C

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45. From a given sample of uniform wire, two circular loops P and Q are made. P of radius 'r' and Q of radius nr. If the M.I. of Q about its axis is 4 times than that of P, then value of n is :

A. $(4)^{1/3}$

B. $(4)^{2/3}$

C. $(4)^{1/4}$

D. $(4)^{1/2}$

Answer: A

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46. A particle of mass m rotating in a plane circular path of radius r has angular momentum L. The centripetal force acting on its is :

A. $\frac{L^2}{mr}$

B. $\frac{L^2 m}{r^2}$

C. $\frac{L^2}{mr^3}$

D. $\left[\frac{L}{mr}\right]^{1/2}$

Answer: C

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47. A mass m is moving with a constant velocity along a line parallel to the X-axis away from the origin, its angular momentum w.r.t. origin :

A. is zero

B. is constant

C. goes on decreasing

D. goes on increasing

Answer: A

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48. A rod of length L rotates about an axis passing through its centre and normal to its length with an angular velocity ω. If A is the cross section and D is the density of material of rod, its rotational K.E. is :

A. $\frac{1}{2}AL^3D\omega^2$

B. $\frac{1}{6}AL^3D\omega^2$

C. $\frac{1}{24}AL^3\omega^2D$

D. $\frac{1}{12}AL^3D\omega^2$

Answer: C

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49. A ring is rotating without slipping. The ratio of its translational kinetic energy to the total K.E. is :

A. $1:2$

B. $2:3$

C. $3:2$

D. $2:1$

Answer: A

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50. A hollow sphere of mass m and radius 'r' is rotating with velocity ω. It suddenly stops and

75% of K.E. is converted into heat. If its specific heat is 's' J/kg/K, the rise of temperature is :

A. $\frac{R^2\omega^2}{4s}$

B. $\frac{3R^2\omega^2}{20s}$

C. $\frac{R^2\omega^2}{12s}$

D. $\frac{2R^2\omega^2}{3s}$

Answer: A

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51. A disc is rotating with angular velocity $\vec{\omega}$. A force $\vec{F}$ acts at a point whose position vector with respect to the axis of rotation is $\vec{r}$. The power associated with the torque due to the force is given by :

A. $\left(\vec{r} \times \vec{F}\right) \times \vec{\omega}$

B. $\left(\vec{r} \times \vec{F}\right) . \vec{\omega}$

C. $\vec{r} . \left(\vec{F} \times \vec{\omega}\right)$

D. $\vec{r} \times \left(\vec{F} . \vec{\omega}\right)$

Answer: B

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52. The ratio of the radii of gyration of a circular disc and a circular ring of the same radii about a tangential axis is :

A. $1:\sqrt{2}$

B. $\sqrt{2}:1$

C. $\sqrt{2}:\sqrt{3}$

D. $\sqrt{5}:\sqrt{6}$

Answer: D

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53. If a disc of mass m and radius r is reshaped into a ring of radius 2r, the mass remaining the same, the radius of gyration goes up by a factor of :

A. 4

B. 2

C. $2\sqrt{2}$

D. $\sqrt{2}$

Answer: C

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54. Four tiny masses are connected by a rod of negligble mass as shown in fig. The moment of inertia of the system about axis AB is :

A. $30ma^2$

B. $50ma^2$

C. $40ma^2$

D. $60ma^2$

Answer: B

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55. In above question, the radius of gyration of the system about axis AB is :

A. $\sqrt{5}a$

B. $\sqrt{2a}$

C. $\sqrt{3}a$

D. $2a$

Answer: A

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56. Three point-mases m_1, m_2 and m_3 are located at the vertices of an equilateral triangle of side a. What is the moment of inertia of the system about an axis along the altitude of the triangle passing through m_1?

A. $(m_1 + m_2)\frac{a^2}{4}$

B. $(m_1 + m_2 + m_3)\frac{a^2}{4}$

C. $(m_2 + m_3)\frac{a^2}{4}$

D. $(m_1 + m_3)\frac{a^2}{4}$

Answer: C

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57. The moment of inertia of a solid sphere of mass M and radius R, about an axis through its centre, is $\frac{2}{5}MR^2$. The moment of inertia

about an axis tangential to the surface of the sphere will be :

A. $\frac{4}{5}MR^2$

B. $\frac{6}{5}MR^2$

C. $\frac{7}{5}MR^2$

D. MR^2

Answer: C

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58. The moment of inertia of a uniform circular disc of mass M and radius R about any of its diameter is $\frac{1}{4}MR^2$. What is the moment of inertia of the disc about an axis passing through its centre and normal to the disc?

A. MR^2

B. $2MR^2$

C. $\frac{3}{2}MR^2$

D. $\frac{1}{2}MR^2$

Answer: D

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59. A solid cyclinder of mass 4 kg and radius 20 cm is rotating about its axis with a frequency of $10/\pi$ Hz. What is the rotational kinetic energy of the cylinder?

A. 4 J

B. 8 J

C. 16 J

D. 32 J

Answer: C

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60. A flywheel of moment of inertia $250kgm^2$ is rotating at an angular speed of 12 rad s^{-1}. What torque is needed to stop the wheel in 6 s ?

A. 500 Nm

B. 1000 Nm

C. 1500 Nm

D. 2000 Nm

Answer: A

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61. A circular disc is rolling down an inclined plane without slipping. If the angle of inclination is 30°, the acceleration of the disc down the inclined plane is :

A. g

B. $\frac{g}{2}$

C. $\frac{g}{3}$

D. $\frac{\sqrt{2}}{3}g$

Answer: C

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62. A uniform disc of mass m and radius r rotates about frictionless axle passing through its centre and perpendicular to its plane. A chord is wound over the rim of the

disc. A uniform force F is applied to the other end of chord. The tangential acceleration is proportional to :

A. R^1

B. R^{-1}

C. R^{-2}

D. R^0

Answer: D

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63. A light massless cord is wrapped around the circumference of a disc of radius 'r' and a steady downward pull F is applied tangentially on the free acceleration of the wheel is :

A. $\frac{F}{Mr}$

B. $\frac{2F}{M}$

C. $\frac{2F}{Mr}$

D. $\frac{M}{2F}$

Answer: C

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64. A solid sphere is rotating about its diameter. Due to increase in room temperature, its volume increases by 0.5 %. If no external torgue acts, the angular speed of the sphere will :

A. Increase by nearly $\frac{1}{2}\%$

B. Increase by nearly $\frac{1}{3}\%$

C. Decrease by nearly $\frac{2}{3}\%$

D. Decrease by nearly $\frac{1}{3}\%$

Answer: D

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65. A mass m is moving with a constant velocity along a line parallel to the X-axis away from the origin, its angular momentum w.r.t. origin :

A. Remains constant

B. Is zero

C. Goes on increasing

D. Goes on decreasing

Answer: A

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66. A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown in fig. The magnitude of angular momentum of the disc about the origin is :

A. $\frac{1}{2}MR^2\omega$

B. $MR^2\omega$

C. $2MR^2\omega$

D. $\frac{3}{2}MR^2\omega$

Answer: D

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67. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown in fig. The moment of

inertia of the loop about the axis XX' is :

A. $\frac{3\rho L^3}{8\pi^2}$

B. $\frac{\rho L^3}{8\pi^2}$

C. $\frac{\rho L^3}{16\pi^2}$

D. $\frac{5\rho L^3}{16\pi^2}$

Answer: A

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68. A rigid body rotates about a fixed axis with variable angular speed $\omega = A - Bt$ where A and B are constant. Find the angle through which it rotates before it comes to rest :

A. $\frac{A^2}{2B}$

B. $\frac{A^2 - B^2}{2A}$

C. $\frac{A^2 - B^2}{2B}$

D. $\frac{(A - B)A}{2}$

Answer: A

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69. A pendulum consisting of a small sphere of mass m suspended by aninextensible and massless string of length l is made to swing in a vertical plane. If the breaking strength of the string is 2 mg, then the maximum angular amplitude of the displacement from the vertical can be

A. 0°

B. 60°

C. 60°

D. 90°

Answer: C

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70. Two particles which are initially at rest move towards each other under the action of their mutual attraction. If their speeds are v and 2v at any instant, then the speed of center of mass of the system is,

A. 0

B. V

C. 3V

D. 1.5 V

Answer: A

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71. Two blocksof masses 10 kg and 4 kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An

impulse gives a velocity of 14m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :

A. 5 m/s

B. 10 m/s

C. 20 m/s

D. 30 m/s

Answer: B

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72. Two girls of weights 40 kg and 60 kg stand at A and B and are 10 m apart. They pull on a massless string stretched between them. Then they will meet at :

A. 4 m from A

B. 6 m from A

C. Mid point of AB

D. None of these

Answer: B

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73. A shell has mass 3 kg and radius 1m. Its moment of inertia about the tangent is :

A. $2kgm^2$

B. $5kgm^2$

C. $9kgm^2$

D. $3kgm^2$

Answer: B

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74. A sphere, disc and a ring each having same mass M and radius R roll down without slipping from an inclined plane. Which of three will reach foot of inclined plane first :

A. Ring

B. Disc

C. Sphere

D. All the three will reach at same time.

Answer: C

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75. A solid sphere, a hollow sphere and a ring are released from top of an inclined plane (frinctionless) so that they slide down the plane. Then maximum acceleration down the plane is for (no rolling) :

A. solid sphere

B. hollow sphere

C. ring

D. all same

Answer: D

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76. Moment of inertia of a circular wire of mass M and radius R about its diameter is :

A. $MR^2/2$

B. MR^2

C. $2MR^2$

D. $MR^2/4$

Answer: A

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77. The minimum velocity (in ms^{-1})` with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is :

A. 60

B. 30

C. 15

D. 25

Answer: B

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78. Consider a body, shown in fig, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse J = MV is imparted to the body at one its ends, what would be its angular velocity?

A. V / L

B. $2V / L$

C. $V / 3L$

D. V / AL

Answer: A

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79. A particle undergoes uniform circular motion. About which point on the plane of the

circle, will the angular momentum of the particle remain conserved?

A. at the centre of the circle

B. on the circumference of the circle

C. inside the circle

D. outside the circle

Answer: A

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80. A circular disc X of radius R is made from an iron plate of thickness t, and another disc Y of radius 4R is made from an iron plate of thickness $\frac{t}{4}$. Then the relation between the moment of inertia I_X and I_Y is :

A. $I_Y = 64I_X$

B. $I_Y = 32I_X$

C. $I_Y = 16I_X$

D. $I_Y = I_X$

Answer: A

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81. A particle performing uniform circular motion has angular momentum L. If its angular frequency is doubled and its kinetic halved, then the new angular momentum is :

A. $\frac{L}{2}$

B. $\frac{L}{4}$

C. $2L$

D. $4L$

Answer: B

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82. Let $\vec{F}$ be the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin. Then :

A. $\vec{r} . \vec{\tau} = 0$ and $\vec{F} . \vec{\tau} = 0$

B. $\vec{r} . \vec{\tau} = 0$ and $\vec{F} . \vec{\tau} = 0$

C. $\vec{r} . \vec{\tau} \neq 0$ and $\vec{F} . \vec{\tau} = 0$

D. $\vec{r} . \vec{\tau} \neq 0$ and $\vec{F} . \vec{\tau} \neq 0$

Answer: A

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83. A child is standing with folded hands at the center of a platform rotating about its central axis. The kinetic energy of the system is K. The child now stretches his arms so that the moment of inertia of the system doubles. The kinetic energy of the system now is :

A. 2K

B. $\frac{K}{2}$

C. $\frac{K}{4}$

D. 4K

Answer: B

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84. Which of the following statements is FALSE for a particle moving in a circle with a constant angular speed ?

A. The velocity vector is tangent to the circle

B. The acceleration vector is tangent to the circle

C. The acceleration vector points to the centre of the circle

D. The velocity and acceleration vectors are perpendicular to each other

Answer: B

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85. One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that :

A. $I_A = I_B$

B. $I_A > I_B$

C. $I_A < I_B$

D. $\frac{I_A}{I_B} = \frac{d_A}{d_B}$

Answer: C

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86. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that :

A. its velocity is constant

B. its acceleration is constant

C. its kinetic energy is constant

D. it moves in a straight line

Answer: C

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87. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same which one of the following will not be affected?

A. moment of inertia

B. angular momentum

C. angular velocity

D. rotational kinetic energy

Answer: B

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88. An angular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces

experienced by the two particles situated on the inner and outer parts of the ring $\frac{F_1}{F_2}$ is :

A. $\frac{R_2}{R_1}$

B. $\left(\frac{R_1}{R_2}\right)^2$

C. 1

D. $\frac{R_1}{R_2}$

Answer: D

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89. A body of mass M while falling vertically downwards under gravity breaks into two parts , a body B of mass $\frac{1}{3}M$ and body C of mass $\frac{2}{3}M$. The centre of mass of bodies B and C taken together shifts compared to that of body A towards :

A. depends on the height of breaking

B. does not shift

C. body C

D. body B

Answer: B

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90. The moment of Inertia of a uniform semicircular disc of mass M and radius 'r' about a line perpendicular to the plane of the disc through the centre is :

A. $\frac{1}{4}Mr^2$

B. $\frac{2}{5}Mr^2$

C. Mr^2

D. $\frac{1}{2}Mr^2$

Answer: D

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91. Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mas through a distance d, by what distance should the second particle be moved, so as to keep the centre of mass at the same position?

A. $\frac{m_2}{m_1}d$

B. $\frac{m_1}{m_1+m_2}d$

C. $\frac{m_1}{m_2}d$

D. d

Answer: C

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92. Four point masses, each of value m, are placed at the corners of a square ABCD of side l. The moment of inertia of this system about

an axis passing through A are parallel to BD is

:

A. $2m / l^2$

B. $\sqrt{3}ml^2$

C. $3ml^2$

D. ml^2

Answer: C

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93. A force of $-\overrightarrow{F}\hat{k}$ on O, the origin of the coordinate system. The torque about the point (1, -1) is :

A. $F\left(\hat{i}-\hat{j}\right)$

B. $-F\left(\hat{i}+\hat{j}\right)$

C. $F\left(\hat{i}+\hat{j}\right)$

D. $-F\left(\hat{i}-\hat{j}\right)$

Answer: C

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94. The potential energy of a 1kg particle free to move along x-axis is given by $V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right) J$. The total mechanical energy of the particle is 2J. Then, the maximum speed (in m/s) is :

A. $3/\sqrt{2}$

B. $\sqrt{2}$

C. $1/\sqrt{2}$

D. 2

Answer: D

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95. Angular momentum of the particle rotating with a central force is constant due to :

A. Constant linear momentum

B. Zero Torue

C. Constant Torque

D. Constant Force

Answer: B

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96. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the disc coincide. The centre of mass of the new disc is αR from the centre of the bigger disc. The value of α is :

A. $\frac{1}{2}$

B. $\frac{1}{6}$

C. $\frac{1}{4}$

D. $\frac{1}{3}$

Answer: D

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97. A round uniform body of radius R, mass M and moment of inertia 'I', rolls down (without slipping) an inclined plane making an angle θ with the horizontal. Then its acceleration is :

A. $\frac{g\sin\theta}{1+MR^2/I}$

B. $\frac{g\sin\theta}{1-I/MR^2}$

C. $\frac{g\sin\theta}{1+MR^2/I}$

D. $\frac{g\sin\theta}{1+I/MR^2}$

Answer: D

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98. For the given uniform lamina ABCD, whose centre is O.

A. $I_{AD} = 3I_{EF}$

B. $I_{AC} = I_{EF}$

C. $I_{AC} = \sqrt{2}I_{EF}$

D. $\sqrt{2}I_{AC} = I_{EF}$

Answer: B

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99. Consider a uniform square plate of side 'a' and mass 'm'. The moment of inertia of the

plate about an axis perpendicular to its plane and passing through one of its corners is :

A. $\frac{5}{6}ma^2$

B. $\frac{1}{12}ma^2$

C. $\frac{7}{12}ma^2$

D. $\frac{2}{3}ma^2$

Answer: D

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100. A thin uniform rod of length l and massm is swinging freely about a horizontal axis passing through its end. It maximum angular speed is ω. Its centre of mass rises to a maximum height of :

A. $\frac{1}{2}\frac{l^2\omega^2}{g}$

B. $\frac{1}{6}\frac{l^2\omega^2}{g}$

C. $\frac{1}{3}\frac{l^2\omega^2}{g}$

D. $\frac{1}{6}\frac{l\omega}{g}$

Answer: B

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Level Ii Mcq

1. A uniform disc of radius R has a hole cut out which has a radius r. The centre of hole is at a distance $\frac{R}{2}$ from the centre of disc. The position of centre of mass is :

A. $\frac{R-r}{R}$

B. $\frac{Rr^2}{2(R^2-r^2)}$

C. $\frac{Rr^2}{2(R^2+r^2)}$

D. None of these

Answer: B

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2. A rigid horizontal smooth rod AB of mass 0.75 kg and length 40 cm can rotate freely about a fixed vertical axis through its mid-point O. Two rings each of mass 1 kg initially at rest at a distance 10 cm from O on either side

of the rod. The rod is rotated with angular velocity of 30 rad s^{-1}. When the rings reach the ends of the rod, the angular velocity of the rod is :

A. 5

B. 10

C. 15

D. 20

Answer: B

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3. A square plate has a uniform shape and density. A small piece of irregular shape is removed from first quadrant of the plate and is then glued to the centre O of the plate leaving behind a hold at point P of plate. What happens to the M.I. of the plate about the Z-axis?

A. Increased

B. Decreased

C. Remains the same

D. Change cannot be predicted

Answer: B

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4. In the above question the centre of mass of plate is now shifted to which quadrant of plate for X - Y plane ?

A. First

B. second

C. third

D. fourth

Answer: C

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5. The density of a rod of 1 m and of non-uniform structure is given by $\rho(x) = a\left(1 + bx^2\right)$,

where a and b are constant such that

$a \leq x \leq 1$. The centre of mass of the rod will be at :

A. $\frac{3[2+b]}{4[3+b]}$

B. $\frac{4[2+b]}{3[3+b]}$

C. $\frac{3[3+b]}{4[2+b]}$

D. $\frac{4[3+b]}{3[2+b]}$

Answer: A

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6. The net value of an external torque acting on a system of particle is zero about a certain axis of rotation. Which of the following statements will hold good for the system?

(a) The forces may be acting radially from a point on the axis

(b) The forces may be directed along the axis of rotation

(c) The forces may be acting parallel to the axis of rotation

(d) The torques caused by some forces are

equal and opposite to those caused by other forces.

A. (i) only

B. (i) and (ii)

C. (i), (ii), (iii)

D. All of these

Answer: D

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7. A regular polygon of n-sides with n vertices. On all but one vertex (n - 1) point masses each of mass m are placed. The vacant vertex has position vector '$\vec{a}$' w.r.t. the centre of polygen. What is the position vector of the centre of mass of polygon ?

A. $\frac{1}{n-1}a$

B. $\frac{1}{n}.a$

C. $\frac{1-a}{n}$

D. $\frac{n-1}{1-a} \times a$

Answer: A

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8. Two discs having moment of inertias I_1 and I_2 about their axes passing through their respective centres and normal to their surfaces are rotating with angular speeds ω_1 and ω_2 respectively. They are brought into contact face to face with their axes of rotation coinciding with each other, what is the angular speed of the two discs system?

A. $\frac{I_1\omega_1}{I_1 + I_2}$

B. $\frac{I_2\omega_2}{I_1 + I_2}$

C. $\frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

D. $\frac{\omega_1 + \omega_2}{I_1 + I_2}$

Answer: C

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9. In the above question what would be the loss in K.E. of system in the process?

A. $\frac{I_1 I_2 (\omega_1 - \omega_2)^2}{2(I_1 + I_2)}$

B. $\frac{(I_1 + I_2)(\omega_1^2 - \omega_2^2)}{2 I_1 I_2}$

C. $\frac{I_1 \omega_1^2 - I_2 \omega_2^2}{(I_1 + I_2)}$

D. $\frac{I_1 \omega_1^2 - I_2 \omega_2^2}{2(I_1 + I_2)}$

Answer: A

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10. A uniform solid disc of radius R and mass m is rotating about its horizontal axis AB with a

uniform angular speed of ω_0. It is placed on the horizontal table in contact with its surface. If the coefficient of kinetic frinction is μ_k, calculate the time taken for the rolling to begin.

A. $\dfrac{R\omega_0}{\mu_k g\left(1+\frac{mR^2}{I}\right)}$

B. $\dfrac{\omega_0\mu_k}{gR\left(1+\frac{mR^2}{I}\right)}$

C. $\dfrac{gR\omega_0}{\mu_k\left(1+\frac{mR^2}{I}\right)}$

D. $\dfrac{R\omega_0}{\mu_k g\left(\frac{mR^2}{I}\right)}$

Answer: A

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11. A uniform disc of radius R and mass M is rotating about its rim on a horizontal surface of a table. Now the disc is pulled, with a force F acting on the centre of disc. What is the maximum value of F for which the disc rolls without slipping ? (μ = coeff, of frictoin)

A. $F \leq 3\mu Mg$

B. $F = 2\mu Mg$

C. $F \leq 4\mu Mg$

D. None of these

Answer: A

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12. Two hollow cylinderical drums one of radius R and other 2R but of a common height 'h' are rotating with angular velocity ω in

anticlockwise direction and also ω in clockwise direction respectively, with their axes fixed and parallel to each other in a horizontal plane saparated by little greater than 3R distance so that they just do not touch each other. They are now brought in contact making the separation exactly 3R. What would be the ratio of final angular velocity of the two when friction ceases ?

A. $\frac{2}{1}$

B. $\frac{3}{1}$

C. $1/2$

D. $1/3$

Answer: A

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13. Four identical spheres each of radius 'a' are placed on a horizontal table touching one another so that their centres lie at the corners of a square of side 2a. Position of their centre of mass is :

A. 2a, a

B. 3a, a

C. a, a

D. $a / 2a / 2$

Answer: C

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14. Three particles of masses 2 kg, 4 kg and 6 kg are located at the vertices of an equilateral triangle of side 0.5 m. What is the position of

centre of mass if the origin is located at 2 kg mass and 4 kg mass located along x-axis ?

A. 0.29 m, 0.22 m

B. 2.9 m, 2.2 m

C. 1.9 m, 1.2 m

D. None of these

Answer: A

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15. Four particles of masses 1 kg, 2 kg, 3 kg and 4 kg are at the vertices of a rectangle of sides a and b with $a > b$. If a = 1 m, b = 2 m, what is the location of their centre of mass ?

A. 0.5 m, 1.4 m

B. 1.4 m, 0.5 m

C. 0.14 m, 0.05 m

D. 0.05 m, 0.14 m

Answer: A

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16. Four identical spheres each of radius 10 cm and equal mass 1 kg each are placed on horizontal surface touching each other so that their centres are located at the vertices of a square of side 20 cm. What is the distance of their centre of mass from the centre of either sphere?

A. 20 cm

B. 10 cm

C. $10\sqrt{2}$ cm

D. 5 cm

Answer: C

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17. When a sphere of moment of inertia I moves down an inclined plane, the percentage of energy which is rotational, is approximately :

A. $28\ \%$

B. $72\ \%$

C. $100\ \%$

D. None of these

Answer: A

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18. Two discs have same mass and thickness. Their materials are of densities ρ_1 and ρ_2. The

ratio of their moment of inertia about central axis will be :

A. $\rho_1 : \rho_2$

B. $\rho_1 \rho_1 : 1$

C. $1 : \rho_1 \rho_2$

D. $\rho_2 : \rho_1$

Answer: D

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19. A thin uniform rod of length 2l is acted upon a constant torque. The angular velocity changes from zero to ω in time t. The value of torque is :

A. $\frac{ml^2\omega}{3t}$

B. $\frac{2ml^2\omega}{t}$

C. $\frac{ml^2\omega}{t}$

D. $\frac{ml^2\omega}{12t}$

Answer: A

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20. What should be the ratio between the length and radius of the uniform solid cylinder so that its moment of inertia about central axis is the same as that about equatorial axis ?

A. $1:\sqrt{3}$

B. $\sqrt{3}:1$

C. $\frac{1}{\sqrt{3}}:\frac{1}{\sqrt{2}}$

D. $\sqrt{3}:\sqrt{2}$

Answer: B

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21. A rigid body rotates about a fixed axis with variable angular speed $\omega = A - Bt$ where A and B are constant. Find the angle through which it rotates before it comes to rest :

A. $\frac{a^2}{2b}$

B. $\frac{a^2 - b^2}{2ab}$

C. $\frac{a^2 - b^2}{2b}$

D. $\frac{a^2 - ab}{2a}$

Answer: A

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22. A uniform weter scale is made up of two parts. Half of it is of wood and half of it is of steel as shown.

First it is pivoted at the centre O of woodrn part and a force F is applied tangential to the

edge of steel part to give it a rotation similarly the process is repeated y the same force by pivoting it at the centre of steel part. In what way the angular acceleration are related in two cases ?

A. $\alpha_1 > \alpha_2$

B. $\alpha_1 < \alpha_2$

C. $\alpha_1 = \alpha_2$

D. None of these

Answer: B

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23. A metallic rod of uniform density and mass M has a length L, it is lying horizontally on the ground. How much work will be done in making it stand vertically?

A. MgL

B. $\frac{MgL}{3}$

C. $M\frac{g(L)}{2}$

D. $\frac{MgL}{4}$

Answer: C

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24. A disc of mass M and radius R is rotating freely about a horizontal axis passing through its centre. A body of mass M is fixed to its surface point at the highest point as shown. The disc is released. The angular speed picked up by the disc when the fixed boby comes to the lowest position A will be :

A. $\sqrt{\frac{2g}{3R}}$

B. $\sqrt{\frac{3g}{2R}}$

C. $\sqrt{\frac{3g}{8R}}$

D. $\sqrt{8g/3R}$

Answer: D

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25. A cylinder of height 20 cm is placed on a smooth inclined plane as shown. As the angle of inclination is increased to 45°, it starts

slipping on the plane. What is the radius of the cylinder?

A. 10 cm

B. 20 cm

C. 15 cm

D. 25 cm

Answer: A

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26. A ring of radius 4a is rigidly fixed vertically on the horizontal surface of a table. A small disc of radius 'a' and mass 'm' is released from point P of the ring as shown. The disc rolls down without slipping to the lower most position A of the ring the speed of disc at this point is :

A. $(ga)^{1/2}$

B. $(2ga)^{1/2}$

C. $(3ga)^{1/2}$

D. $(4ga)^{1/2}$

Answer: D

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27. A solid cylinder of mass 2 kg and radius 0.2 m is rotating about its central axis passing through point O without any friction. Its speed is 3 rad s^{-1}. A point mass of 0.5 kg and moving with a velocity $5ms^{-1}$ strikes the cylinder and sticks to the point P as shown.

What is angular momentum of the cylinder before the collision?

A. 0.12 Js

B. 1.2 Js

C. 12 Js

D. 12.12 Js

Answer: A

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28. In the above question angular velocity of the system after the particle sticks to the cylinder

A. 0.3 rad s^{-1}

B. 5.3 rad s^{-1}

C. 10.3 rad s^{-1}

D. 8.3 rad s^{-1}

Answer: C

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29. In the above question the energy before and after the collision will be :

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30. A massless, inextensible string is wrapped round the circumference of a disc of mass M and radius R. The second end of the string is tied to a m which stands at vertical height 'h' from the ground initially. What will be the velocity of mass m when it is released and it

touches the ground?

A. $\sqrt{2gh}$

B. $\sqrt{2gh}.\ \frac{M}{m}$

C. $\sqrt{2gh \times \frac{m}{M}}$

D. $\left(4mgh \times \frac{1}{M+2m}\right)^{1/2}$

Answer: D

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31. A uniform disc of radius R has a hole cut out which has a radius r. The centre of hole is at a distance $\frac{R}{2}$ from the centre of disc. The position of centre of mass is shifted through a distance x from 'O' find x. If in this question the values of R = 6 m and that if r = 1 m, calculate the value of shift from 'O' and state whether it is towards left or right of O.

A. $\frac{R^2r}{2(R^2-r^2)}, \frac{3}{37}m$ towards left of 'O'

B. $\frac{Rr^2}{2(R^2+r^2)}, \frac{3}{37}m$ towards right of 'O'

C. $\frac{Rr^2}{2(R^2-r^2)}, \frac{3}{35}m$ towards left of 'O'

D. $\frac{Rr^2}{2(R^2+r^2)}, \frac{3}{35}m$ towards right of 'O'

Answer: C

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32. A block of mass 12 kg is attached to pulley of radius 10 cm fixed at the top of a smooth inclined plane by the help of a massless inextensible string. When released to move on the surface of inclined plane inclined to the horizontal at 37° its acceleration down the

plane is $2ms^{-2}$, what is the tension in the string?

A. 24.5 N

B. 23.4 N

C. 46.8 N

D. 69.2 N

Answer: C

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33. A uniform solid cylinder having mass M and radius R rotates about a horizontal frictionless axle AB. With the help of massless inextensible two ropes are suspended two masses with equal mass m by wrapping the ropes on the cylinder as shown. What will be the tension in each of the rope when masses are released from height 'h' above the ground?

A. $\frac{Mmg}{M+4m}$

B. $\frac{Mmg}{M+3m}$

C. $\frac{Mmg}{M+2m}$

D. None of these

Answer: A

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34. In the above question what is the angular velocity of cylinder after the masses fall down from height 'h'?

A. $\sqrt{\frac{8mgh/M+4m}{R}}$

B. $\sqrt{\frac{8mgh/M+m}{R}}$

C. $\sqrt{\frac{4mgh/M+m}{R}}$

D. $\sqrt{\frac{2mgh/M+2m}{R}}$

Answer: A

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35. In the above question what would be the acceleration of each of the following mass ?

A. $\frac{4mg}{M+m}$

B. $\frac{4mg}{M+2m}$

C. $\frac{4mg}{M+3m}$

D. $\frac{4mg}{M+4m}$

Answer: D

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36. A cylinder of mass M and radius R starts falling freely under gravity at $t = 0$ as shown in fig. The tension in each string at any given

times is T. What is value of 'T' ?

A. Mg

B. $\frac{Mg}{2}$

C. $\frac{Mg}{4}$

D. $\frac{Mg}{6}$

Answer: D

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37. In the above question what is the acceleration of the cylinder?

A. g

B. $g/3$

C. $2g/3$

D. $\frac{3g}{4}$

Answer: C

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38. In the above question the instantaneous power developed by the gravitational force at time t will be :

A. $\frac{1}{2}Mgt^2$

B. Mgt^2

C. $2/3Mg^2t$

D. Mg^2t

Answer: C

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39. A ball weighing 15 g is tied to a string 10 cm long. Initially the ball is held in position such that the string is horizontal. The ball is now released. A nail N is situated vertically below the support at a distance L. The minimum value of L such that the string will be wound round the nail is :

A. 2 cm

B. 6 cm

C. 4 cm

D. 8 cm

Answer: B

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40. A child stands at the centre of a turn table with his two arms out stretched. The turntable is set rotating with an angular speed of 40 rev/min. Now, the child folds his hands back and thereby reduces his moment of inertia to $\frac{2}{5}$ times the initial value. The new kinetic

energy of rotation is x times the initial kinetic energy of rotation. The value of x is :

A. 2.5

B. 5

C. 1

D. 6.756

Answer: A

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41. A nearly massless rod is pivoted at one end so that it can swing freely as a pendulum. Two masses 2m andm are attached to it at distance b and 3b respectively from the pivot. The rod is held horizontal and then released. The angular acceleration of the rod at the instant it is released is :

A. bg

B. $\frac{b}{g}$

C. $gb + 5$

D. $\frac{5g}{11b}$

Answer: D

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42. Two fly wheels A and B are mounted side by side with frictionless bearing on a common shaft. Their moments of inertia about the shaft are 5.0 kg m^2 and 20.0 kg m^2 respectively. Wheel A is made to rotate at 10 revolution per second. Wheel B, initially

stationary is now coupled to A with the help of a clutch. The rotation speed of the wheels will become

A. $2\sqrt{5}$ rps

B. 0.5 rps

C. 2 rps

D. None of these

Answer: C

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43. If I_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mass, and I_2 is the moment of inertia (about central axis) of the ring formed by bending the rod, then

A. $I_1 : I_2 = 1 : 1$

B. $I_1 : I_2 = \pi^2 : 3$

C. $I_1 : I_2 = \pi : 4$

D. $I_1 : I_2 = 3 : 5$

Answer: B

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44. If a disc slides from top to bottom of an inclined plane, it takes time t_1. If it rolls, it takes time t_2. Now, $\frac{t_2^2}{t_1^2}$ is

A. $\frac{1}{2}$

B. $\frac{2}{3}$

C. $\frac{3}{2}$

D. $\frac{2}{5}$

Answer: C

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45. From a given sample of uniform wire, two circular loops P and Q are made. P of radius 'r' and Q of radius nr. If the M.I. of Q about its axis is 4 times than that of P, then value of n is :

A. $4^{1/3}$

B. $4^{1/2}$

C. $4^{1/4}$

D. $4^{2/3}$

Answer: A

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46. A uniform rod of length l is free to rotate in a vertical plane about a fixed horizontal axis through O. The rod begins rotating from rest from its unstable equilibrium position. When it has turned through an angle θ, its angular

velocity ω is given as

A. $\sqrt{\frac{6g}{l}}\sin\theta$

B. $\sqrt{\frac{6g}{l}}\sin.\frac{\theta}{2}$

C. $\sqrt{\frac{6g}{l}}\cos.\frac{\theta}{2}$

D. $\sqrt{\frac{6g}{l}}\cos\theta$

Answer: B

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47. A wheel of radius R is rolling on the ground without slipping with a speed u. When it reaches point A on the road a small lump of mud gets detached from its highest point B and drops on the ground at point D. What is the horizontal range AD of the mud?

A. $u\sqrt{R/g}$

B. $4u\sqrt{R/g}$

C. $3u\sqrt{R/g}$

D. $\sqrt{\frac{3R}{g}}$

Answer: B

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48. K.E. of body is increased by 300 percent, then percentage increase in linear momentum will be:

A. $300\ \%$

B. $200\ \%$

C. $100\ \%$

D. $150\ \%$

Answer: C

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49. A block of mass 2 kg hangs tangentially from the rim of a wheel of radius 0.5 m when released from rest the block falls vertically through 5 m height in 2 seconds the M.I. of

the wheel is :

A. $1kg.\ m^2$

B. $3.2kg.\ m^2$

C. $2.5kg.\ m^2$

D. $1.5kg.\ m^2$

Answer: D

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50. A solid sphere is resting on a smooth horizontal surface. A horizontal impulse I is applied at a height 'h' from the centre so that the sphere begins to rotate just after the application of the impulse. What is ratio h/R?

A. $\frac{1}{2}$

B. $2/5$

C. $\frac{1}{4}$

D. $\frac{1}{5}$

Answer: B

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51. An equilateral triangle ABC formed from a uniform wire has two small identical beds initially located at A. The triangle is set rotating about the vertical axis A O. Then the beads are released from rest simultaneously and allowed to slide down one along AB and other along AC as shown. Neglecting frictional effects, the quantities that are conserved as

the beads slide down, are :

A. angular velocity and total energy (kinetic and potential)

B. total angular momentum and total energy

C. angular velocity and moment of inertia about the axis of rotation

D. total angular momentum and the moment of inertia about the axis of

rotation

Answer: B

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52. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is :

A. $\frac{\rho L^3}{8\pi^2}$

B. $\frac{\rho L^3}{16\pi^2}$

C. $\frac{5\rho L^3}{16\pi^2}$

D. $\frac{3\rho L^3}{8\pi^2}$

Answer: D

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53. A smooth sphere A is moving on a frinctionless horizontal plane with angular speed ω and centre of mass velocity v. It collides elastically and head on with an

identical sphere B at rest. Neglect friction every where. After collision, their angular speeds are ω_A and ω_B respectively. Then :

A. $\omega_A > \omega_B$

B. $\omega_A = \omega_B$

C. $\omega_A = \omega$

D. $\omega_B = \omega$

Answer: C

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54. A particles of mass m moves along line PC with velocity v as shown. What is the angular momentum of the particle about P ?

A. mvL

B. mvl

C. mvr

D. zero

Answer: D

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55. A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in :

A. 

B. 

C. 

D. 

Answer: A

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56. An insect crawls up a hemispherical surface very slowly The coefficient of friction between the surface and the insect $1/3$. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by :

A. $\cot\alpha = 3$

B. $\tan\alpha = 3$

C. $\sec\alpha = 3$

D. $\cos ec\alpha = 3$

Answer: A

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57. Two blocks of masses 10 kg and 4 kg are connected by a negligible mass and placed on a frictionless horizontal surface. An impulse

gives a velocity of 14 m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :

A. 30 m/s

B. 20 m/s

C. 10 m/s

D. 5 m/s

Answer: C

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58. A cylinder rolls up an inclined plane, reaches some height, and then rolls down (without slipping throughout these motions). The directions of the frictional force acting on the cylinder are :

A. up the incline while ascending and down the incline while descending

B. up the incline while ascending and up the incline while descending

C. down the incline while ascending and upt the incline whole descending

D. down the incline while ascending as well as descending

Answer: B

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59. A circular platform is free to rotate in a horizontal plane about a vertical axis passing through its centre. A tortoise is sitting at the

edge of the platform. Now the platform is given an angular velocity ω_0. When the tortoise moves along a chord of the platform with a constant velocity (with respect to the platform), the angular velocity of the platform $\omega(t)$ will vary with time t as :

A. 

B. 

C. 

D. 

Answer: C

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60. Initial angular velocity of a circular disc of mass M is ω_1. Then two small spheres of mass m are attached gently to two diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc?

A. $\left(\frac{M+m}{M}\right)\omega_1$

B. $\left(\frac{M+4m}{M}\right)\omega_1$

C. $\left(\frac{M}{M+4m}\right)\omega_1$

D. $\left(\frac{M}{M+2m}\right)\omega_1$

Answer: D

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61. A disc is rolling (without slipping) on a horizontal surface C is its centre and Q and P are two points equidistant from C, Let V_P, V_Q and V_C be the magnitude of velocities of point P, Q and C respectively, then :

A. $V_Q > V_C > V_P$

B. $V_Q < V_C < V_P$

C. $V_Q = V_P, V_C = \frac{1}{2}V_P$

D. $V_Q < V_C > V_P$

Answer: A

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62. A circular disc of mass 9m, has a hole of radius R/3, cut from it as shown in given figure. The moment of inertia of the remaining

part of the disc about the axis passing through the centre of the disc and perpendicular to its plane will be :

A. $\frac{37}{9}mR^2$

B. $\frac{40}{9}mR^2$

C. $4mR^2$

D. $8mR^2$

Answer: C

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63. A particle moving in a circular path with decreasing speed. Which of the following is correct?

A. It will move in a spiral and finally reach the centre

B. Acceleration $\overrightarrow{a}$ is towards the centre

C. Only direction of $\overrightarrow{L}$ is constant

D. $\overrightarrow{L}$ constant

Answer: C

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64. A solid sphere of mass M and radius R having moment of inertia I about its diameter is recast into a solid disc of radius r and thickness t. The moment of inertia of the disc about an axis about the edge and perpendicular to the plane is I. Then the radius r of the disc is given by :

A. $r = \sqrt{\frac{2}{15}}R$

B. $r = \frac{2}{\sqrt{15}}R$

C. $r = \frac{2}{15}R$

D. $r = \frac{\sqrt{2}}{15}R$

Answer: B

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65. A solid cylinder is rolling down the inclined plane without slipping. Which of the following is/are correct ?

A. The friction force is dissipative

B. The friction force is necessarily changing

C. The friction force will aid rotation but hinder translation

D. The friction force is reduced, if θ is reduced

Answer: C::D

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66. A thin circular ring of mass m and r is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m are attached gently to the opposite ends of a diameter of the ring wheel now rotates with an angular velocity :

A. $\frac{\omega(m+2M)}{m}$

B. $\frac{\omega(m-2M)}{(m+2M)}$

C. $\frac{\omega m}{(m+M)}$

D. $\frac{\omega m}{(m+2M)}$

Answer: D

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67. A 'T' shaped object with dimensions shown in the fig., is lying on a smooth floor. A force $'\vec{F}'$ is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect to C.

A. $\frac{2}{3}l$

B. $\frac{3}{2}l$

C. $\frac{4}{3}l$

D. l

Answer: C

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68. A small object of uniform density rolls up a curved surface with an initial velocity 'u'. It

reaches upto maximum height of $\frac{3v^2}{4g}$ with respect to initial position. The object is :

A. Ring

B. solid sphere

C. hollowsphere

D. disc

Answer: D

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69. Two discs A and B are mounted coaxially on a vertical axle. The discs have moments of inertia I and 2I respectively about the common axis. Disc A is imparted an initial angular velocity 2ω using the entire potential energy of a spring compressed by a distance x_1. Disc B is imparted an angular velocity ω by a spring having the same spring constant and compressed by a distance x_2. Both teh discs rotate in the clockwise direction. The ratio $\frac{x_1}{x_2}$ is :

A. 2

B. $\frac{1}{2}$

C. $\sqrt{2}$

D. $\frac{1}{\sqrt{2}}$

Answer: C

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70. In the above question disc B is brought in contact with disc A, they acquire a common angular velocity in time t. The average

frictional torque on one disc by the other during this period is :

A. $\frac{2I\omega}{3t}$

B. $\frac{9I\omega}{2t}$

C. $\frac{9I\omega}{4t}$

D. $\frac{3I\omega}{2t}$

Answer: A

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71. In the above the question the loss of the kinetic energy during the above process is :

A. $\frac{I\omega^2}{2}$

B. $\frac{I\omega^2}{3}$

C. $\frac{I\omega^2}{4}$

D. $\frac{I\omega^2}{6}$

Answer: B

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72. A thin rod length 'L' is lying along the x-axis with its ends at $x = 0$ and $x = L$. Its linear density (mass/length) varies with x as k $\frac{x^n}{L}$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best approximates the dependence of x_{CM} on n?

A. 

B. 

C. 

D. 

Answer: A

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73. A small particle of mass m is projected at an angle θ with the x-axis with an initial velocity v_0 in the x-y plane as shown in the fig. At a time $t < \frac{v_0 \sin\theta}{g}$, the angular momentum of the particle is :

A. $\frac{1}{2}mgv_0t^2\cos\theta\hat{i}$

B. $-mgv_0t^2\cos\theta\hat{j}$

C. $mgv_0t\cos\theta\hat{k}$

D. $-\frac{1}{2}mgv_0t^2\cos\theta\hat{k}$

Answer: D

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74. A binary star consists of two stars A (mass 2.2 M_s) and B (mass 11 M_s), where M_s is the mass of the sun. They are separated by a

distance d and are rotating about their centre of mass, which is stationary. The ratio of the total angular momentum of the binary star to the angular momentum of star B about the centre of mass is..... .

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Level Iii Mcq

1. Two particles of equal mass 'm' go around a circle of radius 'R' under the action of their

mutual gravitational attraction. The speed of each particle with respect to their centre of mass is :

A. $\sqrt{\frac{Gm}{4R}}$

B. $\sqrt{\frac{Gm}{3R}}$

C. $\sqrt{\frac{Gm}{2R}}$

D. $\sqrt{\frac{Gm}{R}}$

Answer: A

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2. A mass m hangs with the help of a string wrapped around a pulley on a frictionless bearing. The pulley has mass m and radius R. Assuming pulley to be a perfect uniform circular disc, the acceleration of the mass m if the string does not slip on the pulley, is

A. g

B. $\frac{2}{3}g$

C. $\frac{g}{3}$

D. $\frac{3}{2}g$

Answer: B

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3. A thin horizontal circular disc is rotating about a vertical axis passing through its centre. An insect is at rest at a point near the rim of the disc. The insect now moves along a diameter of the disc to reach its other end. During the journey of the insect, the angular speed of the disc :

A. continuously decreases

B. continuously increases

C. first increases and then decreases

D. remains unchanged

Answer: C

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4. A pulley of radius 2 m is rotated about its axis by a force $F = \left(20t - 5t^2\right)$ Newton (where t is measured in seconds) applied

tangentially. If the moment of inertia of the pulley about its axis of rotation is $10kgm^2$, the number of rotations made by the pulley before its direction of motion is reversed, is :

A. more than 3 but less than 6

B. more than 6 but less than 9

C. more than 9

D. less then 3

Answer: A

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5. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r. If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization, its energy will be given by :

A. $\frac{(m_1+m_2)n^2h^2}{2m_1m_2r^2}$

B. $\frac{(m_1+m_2)^2n^2h^2}{2m_1^2m_2^2r^2}$

C. $\frac{n^2h^2}{2(m_1+m_2)r^2}$

D. $\frac{2n^2h^2}{(m_1+m_2)r^2}$

Answer: A

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6. A hoop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will be the velocity of the centre of the loop when it ceases to slip?

A. $\frac{r\omega_0}{3}$

B. $\frac{r\omega_0}{2}$

C. $r\omega_0$

D. $\frac{r\omega_0}{4}$

Answer: B

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7. A bob of massm attached to an inextensible string of length l is suspended from a vertical support. The bob length l is suspended from a vertical support. The bob rotates in a

horizontal circle with an angular speed ω rad/s about the vertical. About the point of suspension :

A. angular momentum changes in direction but not in magnitude

B. angular momentum changes both in direction and magnitude

C. angular momentum is conserved

D. angular momentum changes in magnitude but not in direction

Answer: C

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8. A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slipon the cylinder, with what acceleration will the mass fall on release ?

A. g

B. $\frac{2g}{3}$

C. $\frac{g}{2}$

D. $\frac{5g}{6}$

Answer: C

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9. Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is Rand its height is h, the z_0 is equal to :

A. $\frac{3h}{4}$

B. $\frac{5h}{8}$

C. $\frac{3h^2}{8R}$

D. $\frac{h^2}{4R}$

Answer: A

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10. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis

passing through its centre and perpendicular to one of its faces is :

A. $\frac{MR^2}{16\sqrt{2\pi}}$

B. $\frac{4MR^2}{9\sqrt{3\pi}}$

C. $\frac{4MR^2}{3\sqrt{3\pi}}$

D. $\frac{MR^2}{32\sqrt{2\pi}}$

Answer: B

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Rcq

1. The moment of inertia of a circular disc of radius 2 m and mass 1 kg about an axis passing through the centre of mass but perpendicular to the plane of the disc is 2 kg m^2. Its moment of inertia about an axis parallel to this axis but passing through the edge of the disc is :

A. $10kgm^2$

B. $6kgm^2$

C. $8kgm^2$

D. $1kgm^2$

Answer: B

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2. A solid sphere of mass m rolls down an inclined plane without slipping from rest at the top of an inclined plane.The linear speed of the sphere at the bottom of the inclined

plane is v .The kinetic energy of the sphere at the bottom is

A. $\frac{1}{2}mv^2$

B. $\frac{5}{3}mv^2$

C. $\frac{2}{5}mv^2$

D. $\frac{7}{10}mv^2$

Answer: D

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3. A force $\vec{F} = 5\hat{i} + 2\hat{j} - 5\hat{k}$ acts on a particle whose position vector is $\vec{r} = \hat{i} - 2\hat{j} + \hat{k}$. What is the torque about the origin ?

A. $8\hat{i} + 10\hat{j} + 12\hat{k}$

B. $8\hat{i} + 10\hat{j} - 12\hat{k}$

C. $8\hat{i} - 10\hat{j} - 8\hat{k}$

D. $10\hat{i} - 10\hat{j} - \hat{k}$

Answer: A

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4. A rotating wheel changes angular speed from 1800 rpm to 3000 rpm in 20 s. What is the angular acceleration assuming to be uniform ?

A. 60π rad s^{-2}

B. 90π rad s^{-2}

C. 2π rad s^{-2}

D. 40π rad s^{-2}

Answer: C

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5. A body having a moment of inertia about its axis of rotation equal to 3 kg m^{-2} is rotating with angular velocity of 3 rad s^{-1}. Kinetic energy of this rotating body is same as that of a body of mass 27 kg moving with velocity v. The value of v is

A. $1ms^{-1}$

B. $0.5ms^{-1}$

C. $2ms^{-1}$

D. $1.5ms^{-1}$

Answer: A

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6. Moment of interia of a thin uniform rod rotating about the perpendicular axis passing through its center is I. If the same rod is bent

into a ring and its moment of inertia about its diameter is

A. $8\pi^2/3$

B. $5\pi^2/3$

C. $3\pi^2/2$

D. $2\pi^2/3$

Answer: D

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7. A person sitting firmly over a rotating stool has his arms stretched. If he folds his arms, his angular momentum about the axis of the rotation :

A. Increases

B. Decreases

C. Remains unchanged

D. Doubles.

Answer: C

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8. A uniform circular disc of mass 400 g and radius 4.0 cm is rotated about one of its diameter at an anglar speed of 10 rot/s. The kinetic energy of the disc is :

A. $3.2 \times 10^{-5} J$

B. $1.6 \times 10^{-3} J$

C. $3.2 \times 10^{-2} J$

D. $6.4 \times 10^{-4} J$

Answer:

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