PHYSICS

BOOKS - MAXIMUM PUBLICATION

SYSTEM OF PARTICLE AND ROTATIONAL MOTION

Exercise

1. If $\overrightarrow{a} = \left(a_x\left(\hat{i}\right)\right) + \left(a_y\left(\hat{j}\right)\right) + \left(a_z\left(\hat{k}\right)\right)$

and $\overrightarrow{b} = \left(b_x\left(\hat{i}\right)\right) + \left(b_y\left(\hat{j}\right)\right) + \left(b_z\left(\hat{k}\right)\right)$

,obtain $\vec{a} X \vec{b}$ in terms of rectangular components.

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2. What is the analogue of force in the case of rotational motion.

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3. The door is a rigid body which can rotate about a fixed axis passing through the hinges.

What makes the door rotate?

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4. When you fix a handle in a door where do you fix it?

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5. What is the significance of the concept of radius of gyration?

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6. In a fly wheel,most of the mass is concentrated at the rim?Explain why?

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7. A thin circular ring is rotating about an axis passing through its center and perpendicular to its plane. Find the moment of inertia of the ring about its diameter.

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8. If the polar ice cap melts what will happen to the length of the day?

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9. If the earth losses the atmosphere what will happen to the length of the day?

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10. A girl is standing on a turn table. What happens to the rotation speed if she stretches her hand?

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11. How does a diver take advantage of conservation of angular momentum?

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12. The dimension of angular momentum is

A. $M^0L^1T^{-1}$

B. $M^1L^2T^{-2}$

C. $M^1L^2T^{-1}$

D. $M^2L^1T^{-2}$

Answer: C

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13. Why spokes are provided in a bicycle wheel?

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14. A ballet dancer , an acrobat and an ice skater make use of an important principle in physics. Which is that principle?

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15. A cat is able to land on her feet after a fall. Which principle of physics is being used by her?

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16. A body is rotating in steady rate. What is torque acting on the body?

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17. A flyweel is revolving with constant angular velocity. A chip of its rim breaks and flies away. What will be the effect on the angular velocuty?

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18. Is radius of gyration of a body constant quantity?

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19. What is another name for angular momentum?

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20. Match the following:

A	B
Quick lime	$Ca(OCl)_2$
Plaster of Paris	CaO
Bleaching powder	$Ca(OH)_2$
Slaked lime	$CaSO_4 . \frac{1}{2}H_2O$
	$CaCl_2$
	$CaCO_3$

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21. Give the law of conservation of a angular momentum.

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22. A cat is able to find on its feet after a fall, taking the advantage of principle of conservation of angular momentum. Explain how cat is able to do so

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23. If the polar ice cap melts what will happen to the length of the day?

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24. A girl has to lean towards right when carrying a bag in her left hand.why?

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25. If the earth losses the atmosphere what will happen to the length of the day?

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26. A girl is standing on a turn table. What happens to the rotation speed if she stretches her hand?

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27. How does a diver take advantage of conservation of angular momentum?

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28. A rigid body consists of n particles of mass $m1$,$m2$,$m3$,........... The body rotates about an axis with an angular velocity ω

Starting from kinetic the energy of a single particle,arrive at an equation of kinetic energy of rotation.

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29. Moment of inertia is also called rotational inertia.Why?

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30. The handle of a door is always found at one edge of the door which is located at a maximum possible distance away from hinges. Give reason for it.

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31. The handle of a door is always found at one edge of the door which is located at a maximum possible distance away from hinges. In which direction will the torque act while the door opens inside the room?

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32. The handle of a door is always found at one edge of the door which is located at a maximum possible distance away from hinges.

If the door handle is fixed at the middle of the door,what difference do you feel in the applied force to open the door.

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33. What are moment of inertia and radius of gyration?

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34. How will you distinguish a hard boiled egg and a raw egg by spinning each on a table top?

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35. Show that the total angular momentum of a rotating system remains constant if no torque acts on the system.

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36. A rigid body can rotate an axis with a constant angular velocity and angular momentum L.

What is its moment of inertia about the axis?

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37. A rigid body can rotate an axis with a constant angular velocity and angular momentum L.

Obtain a mathematical expression for rotational kinetic energy.

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38. A platform diver holds his hands and legs straight and makes loops in air before entering into water.

State the principle behind this.

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39. A platform diver holds his hands and legs straight and makes loops in air before entering into water.

What happens when he tries to land in the pool by stretching his arms and legs?

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40. A platform diver holds his hands and legs straight and makes loops in air before entering into water.

In the above situation,rotational kinetic energy is not conserved.Explain.

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41. Moment of inertia of a thin ring of Radius R about an axis passing through any diameter is $\left(\frac{1}{2}MR^2\right)$.

What is the radius of gyration of the ring about an axis passing through any diameter?

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42. A thin metal ring of radius $0.25m$ and mass $2kg$ starts from rest and roll down an inclined plane.If the linear velocity on reaching the foot of the plane is $2\frac{m}{s}$,Calculate its rotational kinetic energy at that instant.

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43. State the principle used by a ballet dancer to increase his/her angular speed.

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44. State the principle used by a ballet dancer to increase his/her angular speed.

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45. What is the radius of gyration of the ring about an axis passing through its centre mass and perpendicular to its plane?

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46. The moment of inertia of a thin ring of Radius R about an axis passing through any diameter is $\left(\frac{1}{2}MR^2\right)$

A thin metal ring has a diameter $0.20cm$ and mass $1kg$.Calculate its moment of inertia about an axis passing through any tangent.

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47. The earth revolves around the sun in an elliptical orbit. The closest approach of the earth with the sun is called perihelion. When the earth approaches the perihelion, its speed increases. Explain this principle.

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48. As the earth approaches near the sun in its path,it moves faster. State whether this statement is correct or wrong. Why?

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49. A solid sphere of mass $3kg$ rolls on a horizontal surface with a linear speed of $30\frac{m}{s}$

.

Find the total kinetic energy of the sphere.

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50. A ring,disc and a sphere all of the same mass and radius roll down an inclined plane from the same height.Which of the three reaches the bottom at first and last.Explain.Why?

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51. A grindstone has moment of inertia $0.5 kgm^2$.What constant torque should be applied so that it attains an angular velocity of 120rpm in $8\,\text{sec}$.

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52. A grindstone has moment of inertia $0.5kgm^2$.What constant torque should be applied so that it attains an angular velocity of 120rpm in $8\,\text{sec}$.

In the above case what is the rate at which work is done at the end of $8\,\text{sec}$.

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53. In the HCl molecule, the Separation between the nuclei of the two atoms is about $1.27A(1A = 10^{-10}m)$ Find the approximate location of the centre of mass ofthe molecule Given : chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus

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54. A child sits stationary at one end of a long trolley moving uniformly with speed v on a smooth horizontal floor. If the child gets up and runs about on the trolley in any manner, what is the effect on the speed of the centre of mass of the (trolley + child) system?

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55. a) Find the moment of inertia of a sphere about a tangent to the sphere, given the moment of inertia of the sphere about any of its diameters to be $\frac{2MR^2}{5}$, where M is the mass of the sphere and R is the radius of the sphere.

b) Given the moment of inertia of a disc of mass M and radius R about any of its diameters to be $M\frac{R^2}{4}$, find its moment of inertia about an axis normal to the disc and passing through a point on its edge.

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56. A solid cylinder of mass $20kg$ rotates about its axis with angular speed $100rads^{-1}$. The radius of the cylinder is $0.25m$. What is the kinetic energy associated with the rotation of the cylinder? What is the magnitude of the angular momentum of the cylinder about its axis?

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57. A rope of negligible mass is wound round a hollow cylinder of mass $3kg$ and radius $40cm$. What is the angular acceleration of the cylinder if the rope is pulled with a force of $30N$? What is the linear acceleration of the rope ? Assume that there is no slipping.

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58. In a hammer throw event, a solid sphere of mass $16kg$ is tied to a light $50cm$long chain. A sportsman gives to ita constant moment of $30N - m$ for 10 seconds and then throws the sphere. Consider the sphere as a point mass. Find the moment of inertia about the axis of rotation.

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59. If L is the angular momentum and τ is the torque then prove that (τ = dL/dt)`

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60. Write an example for the motion in which angular momentum remains constant.

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61. Remya stands at the centre of a turn-table with her two arms outstretched. The table is set rotating with an angular speed of `40 revolutions per minute'. Write the expression for the rotational kinetic energy of the system and explain the terms

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62. Consider moment of inertia of a uniform thin circular disc about a diametrical axis of the disc. There is a theorem which helps to find the moment of inertia of the disc about another axis parallel to this axis. Give the statement of this theorem.

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63. A circular disc of mass $0.15kg$ and radius $0.1m$ makes 120 revolutions in one minute about its own axis. Calculate its angular momentum.

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64. The earth revolves around the sun in an elliptical orbit. The closest approach of the earth with the sun is called perihelion. When the earth approaches the perihelion, its speed increases. Explain this principle.

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65. A body rolls over a horizontal, smooth surface without slipping with a translational kinetic energy E. Show that the total kinetic energy of the body is $E\left(1+\left(\frac{k^2}{R^2}\right)\right)$ where k is the radius of gyration and R is the radius of the body. Using the above relation. Find the total kinetic energy of a circular disc.

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66. A wheel of mass $1000kg$and radius $1m$is rotating at the rate of $420r.p.m.$ What is the constant torque required to stop the wheel in $14rotations$, assuming the mass to be concentrated at the rim of the wheel ?

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67. State the parallel axes theorem on moment of inertia.

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68. Write the relation between moment of inertia and angular momentum.

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69. Moment of inertia plays the same roll in rotational motion as mass in linear motion. The moment of inertia of a body changes when the axis of rotation changes.If the moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is $\frac{MR^2}{2}$) ($M$is the mass of the disc and R its radius). Determine its moment of inertia about a diameter and about a tangent.

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70. State whether True or False: The location of centre of mass of a system is independent of the frame of reference used to locate it.

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71. Moment of inertia is also called rotational inertia.Why?

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72. How will you distinguish a hard boiled egg and a raw egg by spinning each on a table top?

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73. A solid cylinder of mass $20kg$ rotates about its axis with angular speed $100rads^{-1}$. The radius of the cylinder is $0.25m$. What is the kinetic energy associated with the rotation of the cylinder? What is the magnitude of the angular momentum of the cylinder about its axis?

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74. A thin circular ring is rotating about an axis perpendicular to its plane. State the theorem which will help you to find the moment of inertia about its diameter.

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75. A thin circular ring is rotating about an axis passing through its center and perpendicular to its plane. Find the moment of inertia of the ring about its diameter.

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76. A ring rolls down the inclined plane without slipping. Find the velocity of the ring when it reaches the ground.

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77. Moment of inertia is the analogue of mass in rotational motion. But unlike mass, it is not a fixed quantity.Moment of inertia can be regarded as a measure of rotational inertia. Why?

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78. State any two factors on which the moment of inertia of a rigid body depends.

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79. Moment of inertia is the analogue of mass in rotational motion. But unlike mass, it is not a fixed quantity. The moments of inertia of two rotating bodies A and B are I_A and I_B If $(I_A > I_B)$ and their angular momentum are equal. Which one has a greater kinetic energy? Explain.

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80. State the perpendicular axis theorem.

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81. Moment of inertia of a ring about an axis passing through the center is MR^2. The moment of inertia about a diameter can be found using the perpendicular axis theorem.Obtain the expression for the moment of inertia of a ring about its diameter.

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82. What is the equation of the moment of inertia of a disc about an axis passing through its center and measured perpendicular to its plane?

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83. State the parallel axes theorem on moment of inertia.

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84. A coin is rolling on a plane surface. What fraction of its total kinetic energy is rotational?

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85. What do you mean by the center of mass of a rigid body?

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86. State the perpendicular axis theorem.

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87. Two identical concentric rings each of mass $M$and radius R are placed perpendicular to each other. What is the moment of inertia about an axis passing through the center of this system and perpendicular to the plane of one of the rings?

A. $\left(\left(\frac{3}{2}\right)MR^2\right)$

B. $(2MR^2)$

C. $(3MR^2)$

D. $\left(\left(\frac{1}{4}\right)MR^2\right)$

Answer: A

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88. Derive the mathematical relation between angular momentum and torque.

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89. A solid sphere is rotating about a diameter at an angular velocity ω If it cools so that its radius reduces to of $\frac{1}{n}$ th of its original value, its angular velocity becomes..

A. $\frac{\omega}{n}$

B. $\frac{\omega}{n^2}$

C. $n\omega$

D. $(n^2)\omega$

Answer: D

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90. The rotational analogue of force is moment of force, also called torque. The turning effect of force is maximum when the angle between r and F is.

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91. The rotational analogue of force is moment of force, also called torque.A wheel starting form rest acquires an angular velocity of $10ra\frac{d}{s}$ in two seconds. The moment of inertia of the wheel is $0.4kgm^2$. Calculate the torque acting on it.

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92. The rotational analogue of force is moment of force, also called torque.The possibility of falling backward with the ladder is more when you are high upon the ladder than when you just begin a climb. Explain why.

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93. Classical dancers bring their hands closer to their body to rotate faster. Name the principle employed by them.

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94. A wheel rolls along a straight line. Derive an expression for its total kinetic energy.

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95. The rotational analogue of force is

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96. Moment of inertia about a diameter of a ring is $\left(I_O = \frac{MR^2}{2}\right)$ Draw a diagram and find the moment of inertia about a tangent, parallel to the diameter of the ring.

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97. Moment of inertia about a diameter of a ring is $\left(I_O = \frac{MR^2}{2}\right)$ Draw a diagram and find the moment of inertia about a tangent, parallel to the diameter of the ring.

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98. The rotational analogue of mass is..........

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99. The angular momentum of a particle is the rotational analogue of its linear momentum.The equation connecting angular momentum and inear momentum is..

A. $\left(\left(\overrightarrow{l}\right) = \left(\overrightarrow{p}\right)X\left(\overrightarrow{r}\right)\right)$

B. $\left(\left(\overrightarrow{l}\right) = \left(\overrightarrow{r}\right)X\left(\overrightarrow{p}\right)\right)$

C. $\left(\left(\overrightarrow{l}\right) = \left(\overrightarrow{p}\right).\left(\overrightarrow{r}\right)\right)$

D. $\left(\left(\overrightarrow{l}\right) = \left(\frac{1}{2}\right)\left(\overrightarrow{r}\right)X\left(\overrightarrow{p}\right)\right)$

Answer: B

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100. Starting from the equation connecting angular momentum and linear momentum, deduce the relation between torque and angular momentum

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101. Moment of inertia in rotational motion is analogus to mass in linear motion.The moment of inertia of a circular disc about an axis perpendicular to the plane, at the centre is given by.

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

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

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

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

Answer: D

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102. What is the moment of inertia of a disc about one of its diameter?

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