PHYSICS

BOOKS - BINA LIBRARY PHYSICS (ASSAMESE ENGLISH)

SYSTEM OF PARTICLES AND ROTATIONAL MOTION

Example

1. The dot product of two vectors of magnitudes 4 units and 5 units is 10 units in magnitude . Find the angle between them.

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2. Show that vector $\overline{A} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\overline{B} = 6\hat{i} - 9\hat{j} + 12\hat{k}$ are parallel.

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3. A car is moving from rest, After 10 seconds its wheels rotate 360 times in 1 minute. If the radius of the wheel is 50cm, then find angular acceleration.

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4. A car is moving from rest, After 10 seconds its wheels rotate 360 times in 1 minute. If the radius of the wheel is 50cm, then find angular velocity after 30 seconds

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5. A car is moving from rest, After 10 seconds its wheels rotate 360 times in 1 minute. If the radius of the wheel is 50cm, then find the linear distance travelled in 6 minutes.

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6. The angular speed of a motor wheeen is increased from 1200 r.p.m to 3000 r.p.m. in 10

seconds. Calculate the number of revolutions made by the engine during the time.

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7. Find the torque of a force $\vec{F} = 7\hat{i} + 3\hat{j} - 5\hat{k}$ about the point whose position vector is $\vec{r} = \hat{i} - \hat{j} + \hat{k}$.

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8. A fly wheel has a moment of inertia ok 5 kgm^2. If 10^5 joule of work is done on it, what is its angular speed? Find torqure required to stop it in 10 seonds

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9. A wheel has a MI $100kgm^2$. It is to be accelerated from rest to angular velocity 200`rads^(-1) in 10 seconds. Find the torque

required and the final kinetic energy of the wheel.

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10. A flywheel of mass 25kg has a radius of 0.2 m. What force should be applied to the rim so that it acquires an angular acceleration of 5 $rads^{-2}$?

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11. A circular wheel of MI $0.08 kgm^2$ is rotating 30 rotations per second. When a retarding troque is applied the rate of rtation is reduced to 10 rotations per second in 2 minutes. Find the torque.

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12. A rope of negligible mass is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the

cylinder if the rops is pulled with a force of 30 N? What is the linear acceleration of the rope?

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13. Given the M.I. of a dise of mass M and radius R about any of its diameter to be MR^2 /4. Find its M.I about an axis (i) passing through its centre and normal to it, and (ii) passing through a point at its edge and normal to it.

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14. MI of a thin circular disc about an axis passing through its centre and perpendicular to its plane is 1/2 MR^2, where M is the mass of the disc and R is its radius. Find an expression for radius of gyratiuon of the disc about an axis tangential to the edge and peerpendicular to the plane of rotation.

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15. Calculate the rotation kinetic energy of the earth about its own axis.

(M= 6×10^{24}kg and R = 6400km)

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16. The electron in a hydrogen atom revolves with a velocity 4.13×10^{16} rad/sec in an orbit of radius 5.29×10^{11}m. Calculate its angular momentum (given.m =9.11×10^{-31} kg.)

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17. A body of mass 10 kg is rotating on a circular path of radius 1 m with time period 3.14S. Calculate its angular momentum and rotational kinetic energy.

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18. A solid cylinder of radius 5 cm and mass 0.5 kg rolls down an inclined plane (1 in 10). Calculate the acceleration and total energy of the cylinder after 10 S.

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Exercise

1. Define torque. State its dimensions.

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2. What is the role of MI in rotational motion?

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3. What is radius of gyration? It is a constant quantity?

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4. What do you mean by angular momentum.

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5. What is KE of rotation of rigid body ?

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6. Express torque in terms of moment of inertia.

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7. Express angular momentum of a system of particles in term of M.I.

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8. Name the physical quantity which has the same meaning as momentum.

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9. Name the physical quantity which has the same meaning as rate of change of angular momentum.

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10. Establish the principle of conservation of angular momentum.

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11. Show that the rate of change of angular momentum is proportional to the extrnal torque.

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12. Find an expression for the total kinetic energy of a rolling body.

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13. Find the ratio of total kinetic energy to the rotational kinetic energy of a rolling sphere moving along a horizontal plane.

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14. State and prove theorem of parallel axes.

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15. State and prove theorem of perpendicular axes.

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16. Find an expression for MI of a thin circular RING about an axis passing through its centre

and perpendicular to the plane of the ring.

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17. Obtain an expression for MI of a circular disc about a diameter of the disc.

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18. Derive an expression for MI of a solid cylinder about its axis.

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19. What do you mean by the moment of Inertia of a body?

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20. Establish a relation between the torque and moment of inertia of a rigid body.

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21. Drive an expression for the kinetic energy of a rigid body, rotating with a uniform angular velocity _____ and hence define moment of inertia

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22. Define moment of inertia of a body capable of rotation about an axis. Show that the moment of inertia of a body an axis is

numerically equal to twice its kinetic energy if it rotates with unit angular velocity.

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23. Define moment of inertia and radius of gyration. Deduce an expression for MI of a circular disc about an axis passing through its centre. Two circular discs have their masses in the ratio 1:2 and their diameters 2:1 . Calculate the ratio of their moments of inertia

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24. Establish a relation between angular momentum and moment of inertia.

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25. Establish a relation between moment of inertia and angular momentum.

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26. Show the rate of change of angular momentum of a particle is equal to the torque acting on it.

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27. what is law of conservation of angular momentum .

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28. what is law of conservation of angular momentum .

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29. Show that a cylinder will slip over an inclined plane of inclination θ, if the co-efficient of static friction between the plane and the cylinder is less than $\frac{1}{3}\tan\theta$.

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30. A solid sphere and a hollow sphere of the same mass and diameter, both initially at rest , roll down the same inclined plane. Which reaches the bottom first?

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31. You are given circular discs of equal masses and thickness, but one is made of iron and the other of alminium. Which one will have large MI about the central axis?

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32. How can you distinguish a raw egg from a boiled egg by spinning it on a smooth table?

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33. If the ice on the polar cap of the earth melts how will it effect the duration of the day?

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34. If the earth suddenly shirnks, what will happen to the length of the day?

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35. The MI of the rotating bodies A and B are I_A and I_B. $I_A > I_B$, but the bodies have equal angular momenta then which one will have greater KE?

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36. If two circular discs of same weight and thickness are made from metals having different densities, which disc will have large MI about its central axis?

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37. Three bodies - a ring, a solid cylinder and a solid sphere of same mass and radii roll down an inclined plane from the same height. Which of the three will reach the ground first?

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38. A body of radius R and mass m is rolling horizontally without slipping with a unifrom speed v. It then rolls up in an inclined plane to a maximum height of h. If h $=\frac{3v^2}{4g}$, determine the MI of the body about its axis of rotation.

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39. A disc of mass 5 kg radius 0.5 m rolls on the ground at the rate of $10ms^{-1}$. Calculate

its KE.

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40. An engine needs to transmit a torque of 180 Nm to maintain a rotor ar a unifrom angular speed of $200 rads^{-1}$. What is the power the engine needed?

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41. A 40 kg flywheel in from of a circular disc of =1 m radius is making 120revolutions per minute. Calculate its angular momentum. [I = $\frac{1}{2}m \times r^2$]

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42. A rope of negligible mass is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the

cylinder if the rops is pulled with a force of 30 N? What is the linear acceleration of the rope?

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43. If the earth suddenly contracts to one third of its present radius, how much would the day be shortened ?

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44. Torque of a force F = $-3\hat{i}+\hat{j}+5\hat{k}$ acting at the point r = $7\hat{i}+3\hat{j}+\hat{k}$ is

A. $14\hat{i}-38\hat{j}+16\hat{k}$

B. $4\hat{i}+4\hat{j}+6\hat{k}$

C. $-14\hat{i}+38\hat{j}-16\hat{k}$

D. $-2\hat{i}+3\hat{j}+5\hat{k}$

Answer: A

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45. The radius is $2\hat{i} + \hat{j} + \hat{k}$, While linear momentum is $2\hat{i} + 3\hat{j} - \hat{k}$. The angular momentum is

A. $2\hat{i} - 4\hat{k}$

B. $4\hat{i} - 8\hat{k}$

C. $-4\hat{i} + 4\hat{j} + 4\hat{k}$

D. $4\hat{i} - 8\hat{j}$

Answer: B

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46. A man is moving with a constant velocity along a line parallel to X-axis away from the origin. Its angular momentum w.r.t origin is

[Hint : $L = mv \times r$ = constant, as m, v and r are constants]

A. Zero

B. constant

C. goes on increasing

D. goes on decreasing

Answer: B

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47. A solid sphere is moving on a horizontal plane. Ratio of its translational K.E. and rotational kinetic energy is

[Hint : $\frac{E_L}{E_r} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}I\omega^2} = \frac{mv^2}{\frac{2}{5}mr^2\omega^2} = \frac{mv^2}{\frac{2}{5}mv^2} = \frac{5}{2}$]

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

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

C. $\frac{3}{5}$

D. $\frac{5}{7}$

Answer: B

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48. If a sphere is rolling, the ratio of its rotational K.E to total energy is given by

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49. A body rolls down an inclined plane. If its K.E of rotational motion is 40% if its K.E. of translation, the body is

A. cylinder

B. ring

C. solid disc

D. solid sphere

Answer: D

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50. Two rings have their moments of inertia in ratio 2 : 1 and their diameters are in the ratio 2 : 1. The ratio of their masses is

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51. the motion of planet in solar system is an example of

A. conservation of energy

B. conservation of linear momenta

C. conservation of angular momentum

D. none of these

Answer: C

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52. A solid sphere and a hollow sphere of the same mass and diameter, both initially at rest , roll down the same inclined plane. Which reaches the bottom first?

A. solid cylinder

B. hollow cylinder

C. both together

D. one with higher density

Answer: A

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53. A 5 kg stationary bomb is exploded in three parts masses 1 : 1 : 3 respectively. Parts having same mass move in perpendicular direction with the velocity 30 m/s. Then the velocity of the bigger part is

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54. When a steady torque acts on a body it

A. gets linerar acceleration

B. gets angular acceleration

C. rotates at a constant speed

D. continues in its state of rest or unifrom motion

Answer: B

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55. A couple produces

A. purely linear motion

B. purely rotational motion

C. no motion

D. linear and rotational motion

Answer: B

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56. Moment of inertia of a body comes into play

A. in linear motion

B. in rotational motion

C. in motion along a curved path

D. None of the above

Answer: B

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57. The angular momentum of a body is defined as the product of

A. mass and angular velocity

B. linear velocity and angular velocity

C. MI and angular velocity

D. centripetal force and radius

Answer: C

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58. A mass M is moving with a constant velocity parallel to x axis. Its angular momentum w.r.t. origin

A. is zero

B. goes on increasing

C. goes on decreasing

D. remains constant

Answer: A

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59. When torque acting upon a system is zero, which of the following will remain constant?

A. force

B. linear impulse

C. angular momentum

D. linear momentum

Answer: C

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60. The MI of solid sphere and a spherical shell of equal mass about their diameters are equal. The ratio of their radii is

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61. A spherical ball rolls on a table without slipping .The fraction of its total energy associated with rotations

A. $\frac{2}{7}$

B. $\frac{3}{5}$

C. $\frac{3}{7}$

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

Answer: A

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