PHYSICS

BOOKS - KUMAR PRAKASHAN KENDRA PHYSICS (GUJRATI ENGLISH)

SYSTEMS OF PARTICLES AND ROTATIONAL MOTION

Section A Questions Answers

1. What is a rigid body ? Explain the differences between rigid body and solid body.

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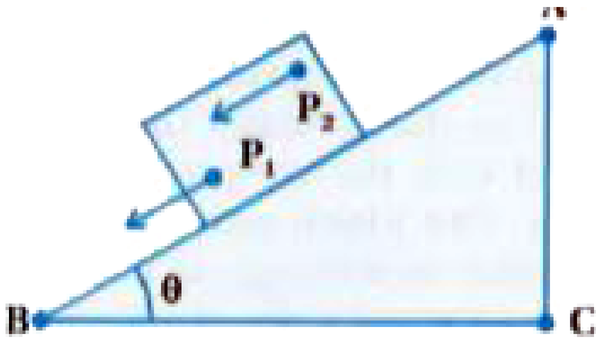
2. Explain translational motion by given illustration.



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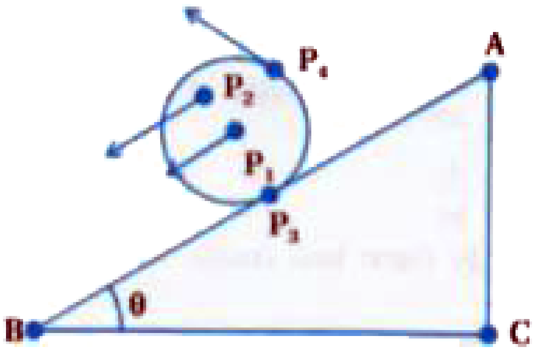
3. What is rotational motion? Explain it with example.



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4. Characteristic of rotational motion.

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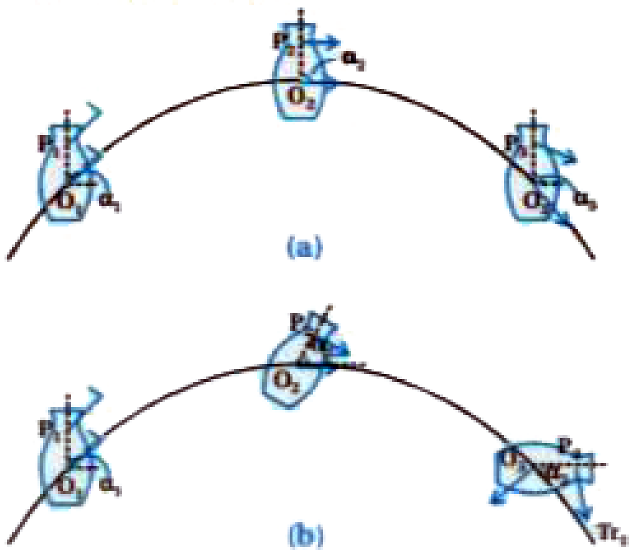
5. Explain with illustration the pure translation and combination of translation and rotation motion of rigid body.



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6. What is system of particle?

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7. Define centre of mass.

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8. Obtain an expression for the position vector of centre of mass of a system of n particles in one dimension.

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9. Obtain an expression for the position vector of centre of mass of a system n particles in two dimension.

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10. Obtain the general expression of centre of mass for distributed n particles of system in three dimension.

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11. For determining centre of mass of a body why a body is considered as composited of multiple of small mass elements?

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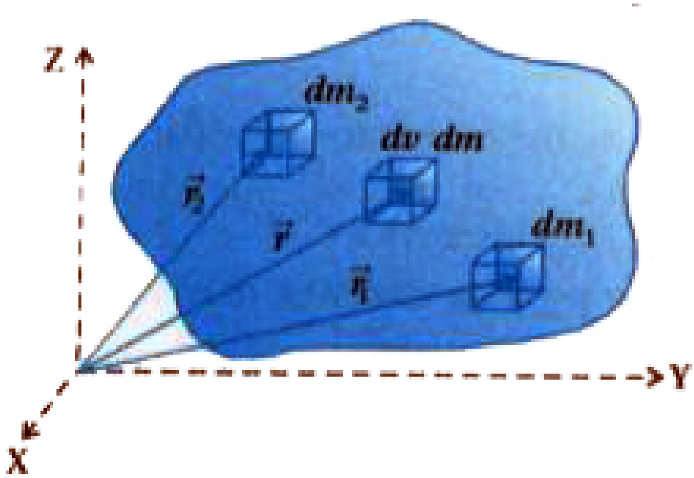
12. Explain the theoretical method for estimation of the centre of mass of a solid body.



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13. Obtain the position of centre of mass of a thin rod of uniform density.

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14. Write the expression of centre of mass of a system of .n. particles and derive the formula of force acting on its centre of mass.

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15. Discuss the forces acting on the n particles in a system.

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16. Some of notable matters in derivation of $M\vec{A} = \vec{F}_{ext}$.

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17. How can general body be obtained?

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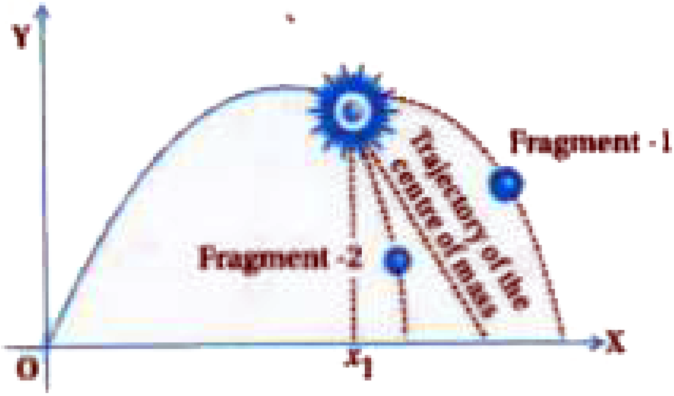
18. Discuss the explosion of projectile.



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19. Obtain an expression for the velocity of centre of mass for n particles of system.

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20. Show that the total momentum of system of particles is equal to the product of total mass of system and velocity of centre of mass.

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21. Obtain Newton.s second law for system of particle and write it.

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22. State the explain the law of conservation of momentum of the system of particle.

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23. Explain the conservation of linear momentum for the radioactive decay of radium nucleus.

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24. Discuss the occurrence of binary (double) stars in a astronomy.

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25. Explain cross product of two vectors.

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26. State and explain right hand screw rule.

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27. State and explain the charateristics of vector product of two vectors.

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28. Explain with defination of angular position, angular displacement and angular speed for the motion of rigid body.

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29. Explain that angular velocity is a vector and its direction is given by right hand screw rule.

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30. Relation between linear and angular velocity for object in rotational motion is $\overrightarrow{v} = \overrightarrow{r} \times \overrightarrow{\omega}$

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31. Define angular acceleration.

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32. What is torque? Explain the torque acting on a particle.

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33. Explain linear and angular momentum.

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34. Explain Cartesian components of angular momentum of a particle.

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35. Obtain the relation between angular momentum of a particle and torque acting on it.

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36. Obtain the relation between angular momentum of a particle and torque acting on it.

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37. Write the law of conservation of angular momentum.

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38. Write condition of translational equilibrium of particle.

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39. Can a body will remain in partial equilibrium? Explain with illustration.

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40. What is couple? Give its illustration.

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41. Explain the construction and working of an ideal lever and also explain the principle of moment of force.

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42. Write short note on centre of Gravity.

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43. Write the difference between centre of gravity and centre of mass of a body?

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44. Obtain the expression of moment of inertia and define it. What are the factors on which moment of inertia depends? Write its unit and dimensional formula.

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45. Find the moment of inertia of ring about an axis passing through the centre and perpendicular to its plane.

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46. Find the moment of inertia of thin and massless rod about an axis passing through its centre of mass of rod and pair of mass is suspended on both end of this rod.

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47. Write the short note on radius of gyration.

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48. Write the short note on radius of gyration.

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49. Write the practical uses of moment of inertia.

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50. State and prove theorem of perpendicular axes.

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51. State and prove theorem of parallel axis.

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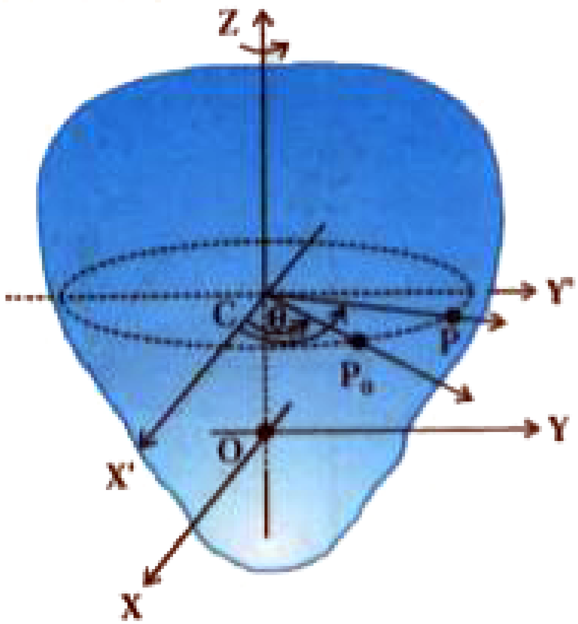
52. Explain angular velocity and angular acceleration about fixed axis and derive the equation of rotational motion and write the analogy between the equations of linear motion and rotational motion.



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53. Which matters should take in mind for calculation of torque and which are not?

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54. Explain work done by torque.

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55. Explain work done by torque.

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56. Obtain the relation between angular momentum of a particle and torque acting on it.

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57. Derive the equation of angular momentum in the case of rotational motion about a fixed axis.

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58. Obtain $\tau = I\alpha$ from angular momentum of rigid body.

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59. Write the law of conservation of angular momentum.

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60. Obtain the necessary condition $v_{cm} = R\omega$ for rolling body without stepping.

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61. Derive an expressions for the kinetic energy and velocity on an inclined plane of inclination θ for the body rolling without sliding.

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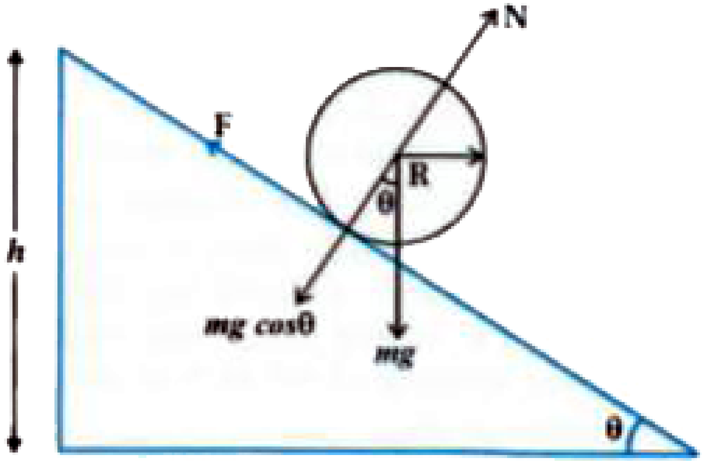
62. Little more for rolling body :



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63. By accepting a equation of friction force $F = mg\sin\theta\left\{\frac{k^2}{k^2+R^2}\right\}$ derive an expression for the static friction of rolling body from the slope.

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64. By accepting a equation for the static friction of rolling body from the slope, obtain the condition for rolling on the slope :

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Section A Hots

1. What is torque? Explain the torque acting on a particle.

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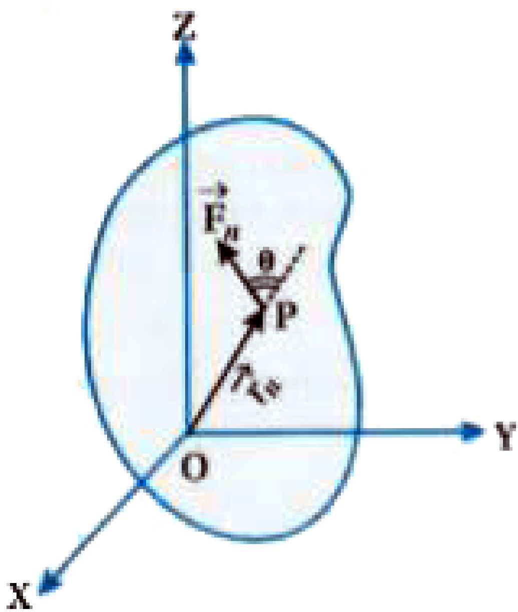
2. Explain the torque acting on a rigid body.



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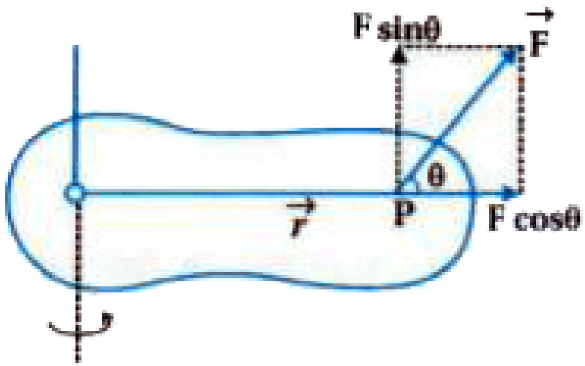
3. Physical interpretation of the definition of torque :



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Section A Try Yourself Vsqs

1. What is a rigid body ? Explain the differences between rigid body and solid body.

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2. Particle is point like object with dimension.

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3. What is a rigid body ? Explain the differences between rigid body and solid body.

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4. In pure translation motion velocity of every particle of body at any instant is what? Equal or unequal?

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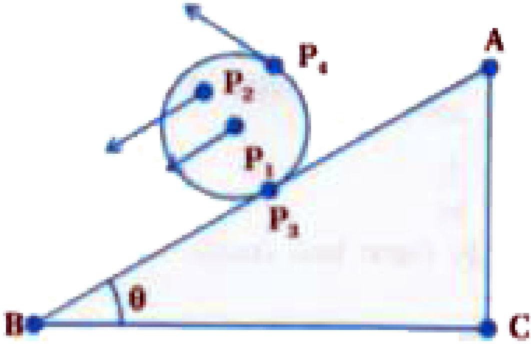
5. What is rotational motion? Explain it with example.



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6. What is axis?

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7. What is precession?

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8. In motion of spinning top at any one place, whether the point in spinning top remains stationary or line remains stationary?

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9. What is pure translational motion?

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10. What is combined translation and rotation motion?

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11. Define centre of mass.

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12. Mention the position of centre of mass of two particles of equal mass.

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13. Mention the centre of mass of three particles which are not in line but have equal masses.

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14. Obtain an expression for the position vector of centre of mass of a system of n particles in one dimension.

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15. To find the centre of mass of rigid body why it is not possible to know $\Sigma m_i \overrightarrow{r_i}$ for all the particles?

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16. Write the meaning of homogeneous bodies.

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17. Mention the position of centre of mass of ring. Disc and spheres.

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18. Integration is zero for a point of homogeneous body. which is that point?

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19. What are the position of centre of mass of symmetrical OR homogeneous bodies?

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20. In general form what are the coordinates of centre of mass of a rigid body.

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21. What do you mean by mass element dm?

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22. Which types of force acting on the system of particle?

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23. Why does the internal forces acting on the centre of mass of the system be neglected?

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24. The multiplication of total mass of system and the acceleration of its centre of mass denote what?

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25. Equation $M\overrightarrow{A} = \overrightarrow{F}_{ext}$ denote what?

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26. Under which force the centre of mass is moving?

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27. If the explosion in projectile takes place, which force acting its centre of mass?

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28. Which type of forces are responsible in explosion of chemical bomb internal or external forces?

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29. When explosion of bomb projected which forces do not contribute in the motion of centre of mass?

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30. Explain linear momentum. Represent it in formula form.

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31. Write the symbolic form of Newton.s second law.

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32. What is the total momentum of the system of particle?

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33. State the Newton.s second law for the system of particle?

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34. Write the law of conservation of total linear momentum for the system of particle.

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35. If the total external forces on the system of particle is zero, then find the velocity and acceleration of its centre of mass.

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36. If one observed from the reference frame from which the centre of mass seems rest, then what will its velocity of particle?

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37. Explain cross product of two vectors.

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38. State and explain right hand screw rule.

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39. What is the cross product of two vectors if they are parallel or antiparallel?

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40. Why the cross product of two vectors is not commutative?

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41. Write the distributive law for the product of two vectors.

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42. Explain with defination of angular position, angular displacement and angular speed for the motion of rigid body.

Watch Video Solution

43. Write the relation between linear speed and angular speed.

Watch Video Solution

44. Write the relation between linear speed and angular speed.

Watch Video Solution

45. Write definition of instantaneous velocity

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46. How to be verify fixed axis?

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47. The angular velocity of particle of rigid body is not constant.

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48. What is direction of angular velocity for a rigid body?

Watch Video Solution

49. Write the change in magnitude and direction of angular velocity with respect to time of a rotating body about a fixed axis.

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50. Define angular momentum.

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51. Write SI unit of angular momentum and dimensional formula.

Watch Video Solution

52. What is the physical quantity of the time rate of the angular momentum?

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53. Why $\overrightarrow{v} \times \overrightarrow{p} = 0$ for rotating particle?

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54. Write the Newton.s second law for the system of particle performing rotational motion.

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55. State the explain the law of conservation of momentum of the system of particle.

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56. If torque is takne relative with reference point and this point is displaced, the condition of rotation be valid?

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57. Discuss when can you say that the system is in thermal equilibrium and when can you say that system is in mechanical, chemical and thermodynamics equilibrium ?

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58. Write the condition for rotational equilibrium.

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59. Write condition of translational equilibrium of particle.

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60. For equilibrium of the particle what must be the forces acting on it?

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61. Which type of motion exist due to moment of force (couple)?

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62. What causes for the couple acting on the needle of compass?

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63. Write the principle of moment of force for lever.

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64. Define mechnical advantage in lever.

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65. When does a body (system) have different centre of gravity and centre of mass?

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66. Obtain the expression of moment of inertia and define it. What are the factors on which moment of inertia depends? Write its unit and dimensional formula.

Watch Video Solution

67. Obtain the expression of moment of inertia and define it. What are the factors on which moment of inertia depends? Write its unit and dimensional formula.

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68. How moment of inertia depend on the angular momentum?

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69. What is analogues to mass of linear velocity in rotational motion?

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70. What is radius of gyration? Write its unit and dimensional formula.

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71. State and prove theorem of perpendicular axes.

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72. State and prove theorem of parallel axis.

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73. Theorem of perpendicular axis be applicable to which type of body?

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74. Will the theorem of perpendicular axis be applicable to a solid sphere?

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75. How many degrees of freedom does a rotational motion about fixed axis?

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76. Write the formula for rotational kinetic energy.

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77. Write the formula for power in rotational motion.

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78. Derive the equation of angular momentum in the case of rotational motion about a fixed axis.

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79. Give the rotational analogue of force.

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80. Which forces needed for the rotational motion about a fixed axis?

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81. Why the components of position vectors along axis are not needed for determining the torque in the rigid body?

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82. Write the formula of work done by torque in rotational rigid body about a the fixed axis.

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83. Write the formula for power in rotational motion.

Watch Video Solution

84. Write the Newton.s second law for the system of particle performing rotational motion.

Watch Video Solution

85. Derive the equation of angular momentum in the case of rotational motion about a fixed axis.

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86. Why the angular momentum perpendicular to the axis $(L_{\perp})$ in a rotational motion about a fixed axis?

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87. Write the law of conservation of linear momentum.

Watch Video Solution

88. Why contact points of surface of circular body are stationary?

Watch Video Solution

89. How is the motion of rolling sphere from the slope?

Watch Video Solution

90. Write the general formula for the kinetic energy of rolling body from the slope.

Watch Video Solution

91. How much the acceleration parallel to the surface of slope for a rolling body?

Watch Video Solution

92. Write the equation of friction force parallel to the surface of slope for rolling body.

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93. The condition for rolling without slipping on a slope having friction is ....

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94. Why coefficient friction is considered as static friction?

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Section B Numericals

1. Find the centre of mass of three particles at the vertices of an equilateral triangle. The masses of the particles are 100g, 150g, and

200g respectively. Each side of the equilateral triangle is 0.5m long.

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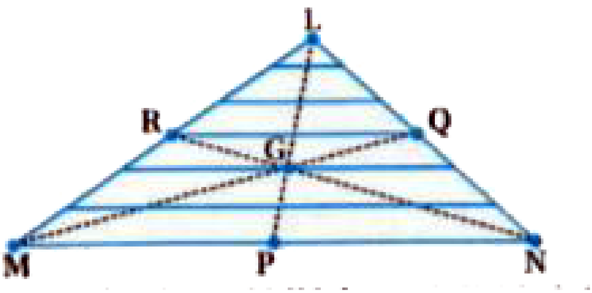
2. Find the centre of mass of a triangular lamina.



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3. Find the centre of mass of a uniform L-shaped lamina (a thin flat plate) with dimensions as shown. The mass of the lamina is 3 kg.

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4. Find the scalar and vector products of two vectors.

$$a = \left(3\hat{i} - 4\hat{j} + 5\hat{k}\right) \text{ and } b = \left(-2\hat{i} + \hat{j} - 3\hat{k}\right)$$

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5. Find the torque of a force $7\hat{i} + 3\hat{j} - 5\hat{k}$ about the origin. The force acts on a particle whose position vector is $\hat{i} - \hat{j} + \hat{k}$.

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6. Show that the angular momentum about any point of a single particle moving with constant velocity remains constant throughout the motion.

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7. Show that moment of a couple does not depend on the point about which you take the moments.

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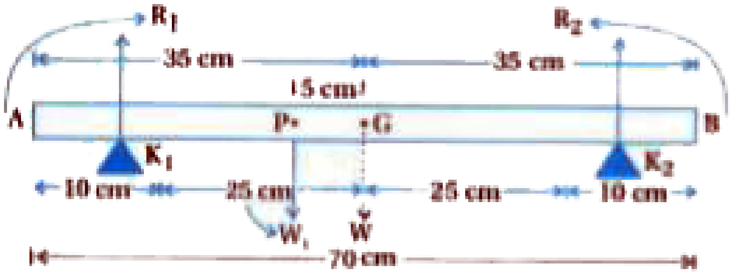
8. A metal bar 70 cm long and 4.00 kg in mass supported on two knife-edges placed 10 cm from each end. A 6.00 kg load is suspened at

30 cm from one end. Find the reactions at the knife-edges. (Assumes the bar to be of uniform cross section and homogeneous).



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9. A 3m long ladder weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1 m from the wall as shown in Fig.7.27. Find the reaction forces of the wall and the floor.

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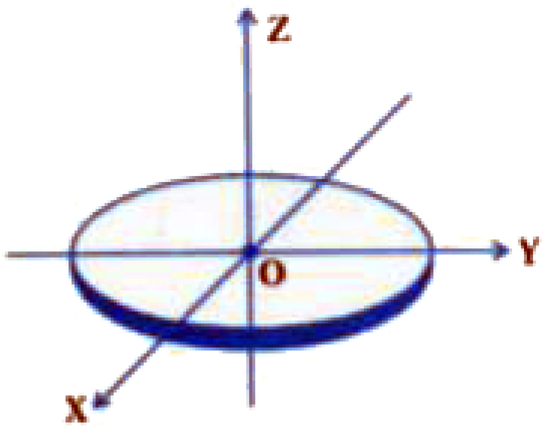
10. What is the moment of inertia of a disc about one of its diameter?



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11. What is the moment of inertia of a rod of mass M, length l about an axis perpendicular to it through one end?

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12. What is the moment of inertia of a ring about a tangent to the circle of the ring?

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13. Obtain equation $\omega = \omega_0 + \alpha t$ from first principle.

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14. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. (i) What is its angular acceleration, assuming the acceleration to be uniform? (ii) How many revolutions does the engine make during this time?

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15. A cord of negligible mass is wound round the rim of a fly wheel of mass 20 kg and radius 20 cm. A steady pull of 25 N is applied on the cord as shown in Fig. 7.35. The flywheel is mounted on a horizontal axle with frictionless bearings.

(a) Compute the angular acceleration of the wheel.

(b) Find the work done by the pull, when 2m of the cord is unwound.

(c) Find also the kinetic energy of the wheel at this point. Assume that the wheel starts from rest.

(d) Compare answers to parts (b) and (c).

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16. Three bodies, a ring, a solid cylinder and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity?

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17. In ΔABC, mass of 100g, located on point A, mass of 200 g located on point C and mass of 150 g is located at point B, they are kept in xy-plane, find the coordinate of centre of mass of ΔABC.

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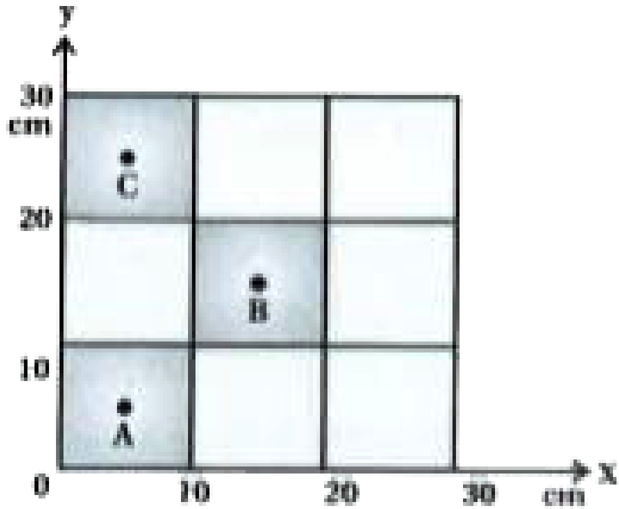
18. Find the centre of mass of uniform thin sheet as shown in figure.



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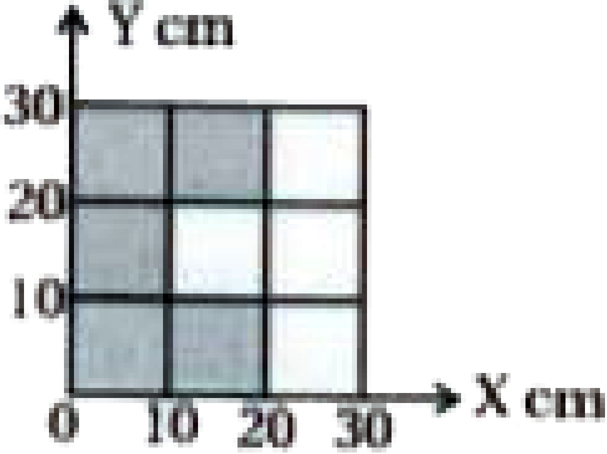
19. Find the centre of mass of uniform thin sheet as shown in figure.



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20. If

$\vec{a} = 2\hat{i} - \hat{j} - 5\hat{k}$ and $\vec{b} = \hat{i} + \hat{j} + 2\hat{k}$,

then find scalar and vector product.

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21. If a position vector of a point is $\vec{r} = 7\hat{i} + 3\hat{j} + \hat{k}$ and force acting on it is $\vec{F} = -3\hat{i} + \hat{j} + 5\hat{k}$ then find torque.

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22. Prove that moment of inertia of uniform ring of mass M and radius R about its geometric axis is MR^2

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23. Find the moment of inertia and radius of gyration of uniform cross-section rod of mass 4 kg and length 90 cm about an axis through one end and perpendicular to the length of rod.

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24. Find the moment of inertia and radius of gyration of uniform cross-section rod of mass M and length l about an axis through a point at distance $\frac{l}{3}$ from one end and perpendicular to the length of rod.

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25. Find moment of inertia of a ring of mass 4kg and radius 20cm about its tangent.

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26. Initial angular speed of wheel is 20 rad s^{-1}. Its angular displacement during 10 s is 100

rad then how many revolution it makes from initially to remain rest. What is its angular acceleration?

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27. The angular speed of a motor wheel is increased from 600 rpm to 1560 rpm in 8 seconds. (i) What is its angular acceleration, assuming the acceleration to be uniform? (ii) How many revolutions does the engine make during this time?

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28. A cord of negligible mass is wound round the rim of a fly wheel of mass 20 kg and radius 20 cm. A steady pull of 25 N is applied on the cord as shown in Fig. 7.35. The flywheel is mounted on a horizontal axle with frictionless bearings.

(a) Compute the angular acceleration of the wheel.

(b) Find the work done by the pull, when 2m of the cord is unwound.

(c) Find also the kinetic energy of the wheel at this point. Assume that the wheel starts from rest.

(d) Compare answers to parts (b) and (c).

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29. Three bodies, a ring, a solid cylinder and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of the bodies are identical. Which of the bodies reaches the ground with maximum velocity?

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Section B Numericals From Textual Exercise

1. Give the location of the centre of mass of a (i) sphere, (ii) cylinder, (iii) ring, and (iv) cube, each of uniform mass density. Does the centre of mass of a body necessarily lie inside the body ?

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2. In the HCl molecule, the separation between the nuclei of the two atoms is about $1.27\text{Å}(1\text{Å} = 10^{-10} m)$. Find the approximate location of the CM of the molecule, given that a 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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3. A child sits stationary at one end of a long trolley moving uniformly with a speed V on a smooth horizontal floor. If the child gets up and runs about on the trolley in any manner, what is the speed of the CM of the (trolley + child) system ?

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4. Show that the area of the triangle contained between the vectors $\vec{a}$ and $\vec{b}$ is one half of the magnitude of $\vec{a} \times \vec{b}$.

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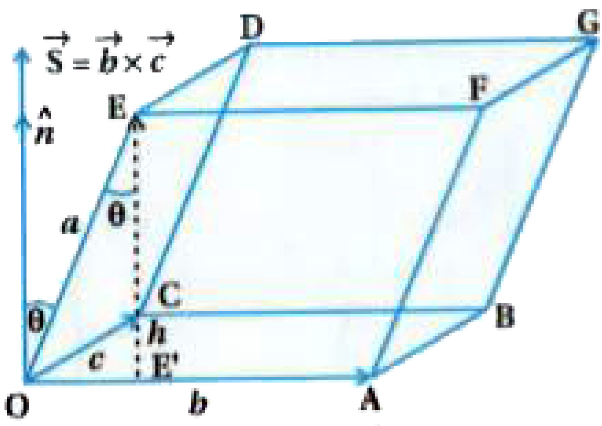
5. Show that $\vec{a} . \left(\vec{b} \times \vec{c}\right)$ is equal in magnitude to the volume of the parallelopiped formed on the three vectors, $\vec{a}, \vec{b}$ and $\vec{c}$



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6. Find the components along the x, y, z axes of the angular momentum l of a particle, whose position vector is r with components x, y, z and momentum is p with components p_x, p_y and p_z. Show that if the particle moves only in the x-y plane the angular momentum has only a z-component.

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7. Two particles, each of mass m and speed v, travel in opposite directions along parallel lines separated by a distance d. Show that the vector angular momentum of the two particle system is the same whatever be the point about which the angular momentum is taken.

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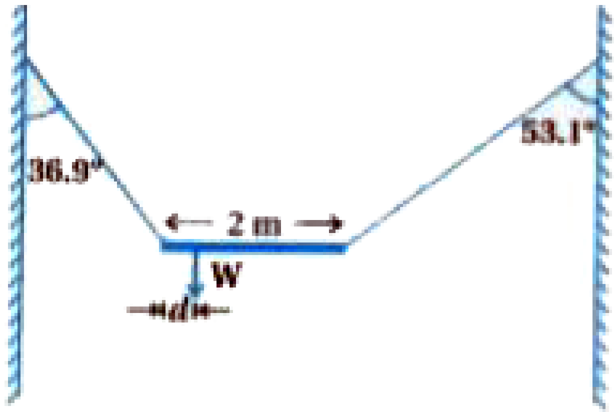
8. A non-uniform bar of weight W is suspended at rest by two strings of negligible weight as shown in figure. The angles made by the strings with the vertical are 36.9° and 53.1° respectively. The bar is 2 m long. Calculate the distance d of the centre of gravity of the bar from its left end.



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9. A car weights 1800 kg. The distance between its front and back axles is 1.8 m. Its centre of gravity is 1.05 m behind the front axle. Determine the force exerted by the level ground on each front wheel and each back wheel.

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10. (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 $2\frac{MR^2}{5}$, 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 $\frac{MR^2}{4}$, find its moment of inertia about an axis normal to the disc and passing through a point on its edge.

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11. Torques of equal magnitude are applied to a hollow cylinder and a solid sphere, both having the same mass and radius. The cylinder is free to rotate about its standard axis of symmetry, and the sphere is free to rotate about an axis passing through its centre. Which of the two will acquire a greater angular speed after a given time.

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

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13. (a) A child stands at the centre of a turntable with his two arms outstretched. The turntable is set rotating with an angular speed of 40 rev/min. How much is the angular speed of the child if he folds his hands back and thereby reduces his moment of inertia to $\frac{2}{5}$ times the initial value? Assume that the turntable rotates without friction.

(b) Show that the child.s new kinetic energy of rotation is more than the initial kinetic energy of rotation. How do you account for this increase in kinetic energy?

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

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15. To maintain a rotor at a uniform angular speed of 200 rad s-1, an engine needs to transmit a torque of 180 N m. What is the power required by the engine ? (Note: uniform angular velocity in the absence of friction implies zero torque. In practice, applied torque is needed to counter frictional torque). Assume that the engine is 100% efficient.

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16. From a uniform disk of radius R, a circular hole of radius R/2 is cut out. The centre of the hole is at R/2 from the centre of the original disc. Locate the centre of gravity of the resulting flat body.

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17. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5 g are put one on top of the other at the 12.0 cm mark, the stick is found to be balanced at 45.0 cm. What is the mass of the metre stick?

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18. A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. (a) Will it reach the bottom with the same speed in each case? (b) Will it take longer to roll down one plane than the other? (c) If so, which one and why?

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19. A hoop of radius 2 m weights 100 kg. It rolls along a horizontal floor so that its centre of mass has a speed of 20 cm/s. How much work has to be done to stope it?

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20. The oxygen molecule has a mass of $5.30 \times 10^{-26} kg$ and a moment of inertia of $1.94 \times 10^{-46} kgm^2$ about an axis through its centre perpendicular to the lines joining the two atoms. Suppose the mean speed of such a molecule in a gas is 500 m/s and that its kinetic energy of rotation is $\frac{2}{3}$ of its kinetic energy of translation. Find the average angular velocity of the molecules.

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21. A cylinder and a cone are of same base radius and of same height. Find the ratio of

the volume of the cylinder to the volume of the cone.

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Section B Additional Exercise

1. The longest wavelength in Balmer series of hydrogen spectrum will be

A. 6557 Å

B. 1216 Å

C. 4800 Å

D. 4800 Å

Answer:

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2. A man stands on a rotating platform, with his arms stretched horizontally holding a 5 kg weight in each hand. The angular speed of the platform is 30 revolutions per minute. The man then brings his arms close to his body with the distance of each weight from the axis changing from 90cm to 20cm. The moment of inertia of the man together with the platform may be taken to be constant and equal to $7.6kgm^2$.

(a) What is his new angular speed? (Neglect friction.)

(b) Is kinetic energy conserved in the process? If not, from where does the change come about?

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3. A bullet of mass 10 g and speed 500 m/s is fired into a door and gets embedded exactly at the centre of the door. The door is 1.0 m wide and weighs 12 kg. It is hinged at one end and rotates about a vertical axis practically without friction. Find the angular speed of the door just after the bullet embeds into it.

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4. Two disc of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speeds ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident. (a) What is the angular speed of the two-disc system? (b) Show that the kinetic energy of the combined system is less than the sum of the initial kinetic energies of the two discs. How do you account for this loss in energy? Take $\omega_1 \neq \omega_2$.

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5. (a) Prove the theorem of perpendicular axes.

(Hint : Square of the distance of a point (x, y) in the x-y plane from an axis through the origin perpendicular to the plane is $x^2 + y^2$).

(b) Prove the theorem of parallel axes.

(Hint : If the centre of mass is chosen to be the origin $\Sigma m_1(r_i = 0)$.

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6. Prove that result that the velocity v of translation of a rolling body (like a ring, disc, cylinder or sphere) at the bottom of an inclined plane of a height h is given by $v^2 = \frac{2gh}{\left(1 + \frac{k^2}{R^2}\right)}$ using dynamical consideration (i.e. by consideration of forces and torques). Note k is the radius of gyration of the body about its symmetry axis, and R is the radius of the body. The body starts from rest at the top of the plane.

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7. In terms of Rydberg constant R, the wave number of the first Balmer line is

Watch Video Solution

8. The ionisation energy of hydrogen atom is 13.6 eV. Following Bohr's theory the energy corresponding to a transition between 3rd and 4th orbits is

A. 3.40 eV

B. 1.51 eV

C. 0.85 eV

D. 0.66 eV

Answer:

Watch Video Solution

9. A solid disc and a ring, both of radius 10 cm are placed on a horizontal table simultaneously, with initial angular speed equal to $10\pi \ \text{rad}\,\text{s}^{-1}$. Which of the two will start to roll earlier ? The co-efficient of kinetic friction is $\mu_k = 0.2$.

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10. A cylinder of mass 10 kg and radius 15 cm is rolling perfectly on a plane of inclination 30o. The co- efficient of static friction $\mu_s = 0.25$.

(a) How much is the force of friction acting on the cylinder ?

(b) What is the work done against friction during rolling ?

(c) If the inclination θ of the plane is increased, at what value of θ does the cylinder begin to skid, and not roll perfectly ?

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11. During rolling, the force of friction acts in the same direction as the direction of motion of the CM of the body.

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12. Separation of Motion of a system of particles into motion of the centre of mass and motion about the centre of mass :

(a) Show $p = p_{i}. + m_{i}V$ where p_{i} is the momentum of the ith particle (of mass m_{i}) and $p_{i}. = m_{i}v_{i}.$. Note $v_{i}.$ is the velocity of the i^{th} particle relative to the centre of mass Also, prove using the definition of the centre of mass $\Sigma p_{i}. = 0$

(b) Show $K = K. + \frac{1}{2}MV^{2}$ where K is the total kinetic energy of the system of particles, K. is the total kinetic energy of the system when the particle velocities are taken with respect to the centre of mass and $\frac{1}{2}MV^2$ is the kinetic energy of the translation of the system as a whole (i.e. of the centre of mass motion of the system). The result has been used in Sec. 7.14).

(c) Show $\overrightarrow{L} = \overrightarrow{L.} + \overrightarrow{R} \times \overrightarrow{MV}$ where $\overrightarrow{L.} = \Sigma \overrightarrow{r_i.} \times \overrightarrow{p_i.}$ is the angular momentum of the system about the centre of mass with velocities taken relative to the centre of mass. Remember $\overrightarrow{r._i} = \overrightarrow{r_i} - \overrightarrow{R}$, rest of the notation is the velcities taken relative to the centre of mass. Remember $\overrightarrow{r._i} = \overrightarrow{r_i} - \overrightarrow{R}$ rest of the notation is the standard notation used in the chapter. Note $\overrightarrow{L}$, and $\overrightarrow{MR} \times \overrightarrow{V}$ can be said to be angular momenta, respectively, about and of the centre of mass of the system of particles.

(d) Show $\dfrac{\overrightarrow{dL.}}{dt} = \sum \overrightarrow{r_i.} \times \dfrac{\overrightarrow{dp.}}{dt}$ Further, show that $\dfrac{\overrightarrow{dL.}}{dt} = \tau._{ext}$ where $\tau._{ext}$ is the sum of all external torques acting on the system about the centre of mass. (Hint : Use the definition of centre of mass and Newton.s Thrid Law. Assume the internal forces between any two particles act along the line joining the particles.)

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Section B Numerical From Darpan Based On Textbook

1. The particles of mass m_1, m_2 and m_3 are placed on the vertices of an equilateral triangle of sides .a.. Find the centre of mass of this system with respect to the position of particle of mass m_1.

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2. In a system of three particles, the linear momenta of the three particles are (1,2,3), (4,5,6) and (5,6,7). These components are in $kgms^{-1}$. If the velocity of centre of mass of the system is $(30, 39, 48)ms^{-1}$, then find the total mass of the system.

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3. A sphere of mass 4 kg collides with a wall, at an angle of 30° with the wall and rebounds in the direction making an angle of 60° with its original direction of motion. Find the force on the wall if the ball remains in contact with the wall for 0.1s. The initial and final velocities are the same, equal to $1ms^{-1}$

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4. The distance between two particles of masses m_1 and m_2 is r. If the distance of these particles from the centre of mass of the system are r_1 and r_2 respectively, then show that

$$r_1 = r\left(\frac{m_2}{m_1 + m_2}\right) \text{ and } r_2 = r\left(\frac{m_1}{m_1 + m_2}\right)$$

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5. In terms of Rydberg constant R, the shortest wavelength in Balmer series of hydrogen atom

spectrum will have wavelength

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6. Rutherford's experiments suggested that the size of the nucleus is about

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7. A truck is moving at a speed of 54 km/h. The radius of its wheels is 50 cm. On applying the brakes the wheels stop after 20 rotations.

What will be the linear distance travelled by the truck during this? Also find the angular acceleration of the wheels.

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8. The force acting on a particle $\overrightarrow{r} = (4, 6, 12)m$ of a rigid body is $\overrightarrow{F} = (6, 8, 10)N$. Find the magniude of the torque producing the rotational motion. Axis of rotation is along the unit vector $\frac{1}{\sqrt{3}}(1, 1, 1)$.

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9. Find the moment of inertia of a uniform circular disc about an axis passing through its geometrical centre and perpendicular to its plane and radius of gyration.

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10. A string is wound around a disc of radius r and mass M and at the free end of the string a body of mass m is suspended. The body is then allowed to descend. Show that the angular accelerationof the disc = $\dfrac{mg}{R\left(M+\frac{m}{2}\right)}$

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11. A string is hanged to strong support O as shown in figure. It is wrapped to a disc of mass m and radius R at its other end. This string is weightless and unstretchable then find the linear acceleration of centre of mass of disc.

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12. Energy of an electron in the second orbit of hydrogen atom is E and the energy of electron in 3rd orbit of He will be

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13. A hollow cylinder rolls (about its geometrical axis) without slipping on an inclined plane of angle θ. Find its linear acceleration in the direction parallel to the surface of the inclined plane.

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14. Nuclear sizes are expressed in a unit named

A. Fermi

B. angstrom

C. newton

D. tesla

Answer:

Watch Video Solution

15. Pick out the scalar quantity

A. force

B. pressure

C. velocity

D. acceleration

Answer:

Watch Video Solution

16. Sound waves in air are

A. transverse

B. longitudinal

C. electromagnetic

D. polarised

Answer:

Watch Video Solution

17. Prove that moment of inertia of uniform ring of mass M and radius R about its geometric axis is MR^2

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Section C Objective Questions Vsqs

1. Give two examples of a rigid body where the center of mass lies outside in material of rigid body.

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2. Two young men going in double ride over a bike along a straight road, one man sitting back fall down over the bike then velocity of bike increases or decreases ? Why ?

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3. Write the difference between centre of gravity and centre of mass of a body?

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4. .Does the velocity of all particles of a system is equal to the velocity of centre of mass?..

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5. Why law of conservation of linear momentum is universal and fundamental law ?

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6. Which two physical quantities remains constant in law of conservation of momentum? Which quantity remain zero?

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7. On which factors centre of mass of rigid body depends?

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8. Write the kinetic energy of a body of momentum p and velocity v.

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9. Why do internal forces in a system do not effect the velocity of a system?

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10. If a gas is filled in a rest sphere, its molecules moves randomly due to the heat energy. Will the centre of mass of molecules exist?

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11. Mention the position of centre of mass of two particles of equal mass.

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12. What is the SI unit of angular velocity and angular acceleration?

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13. What is the value of tangential component of a linear acceleration for a representation particle moving in uniform angular motion rotational motion?

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14. The linear variable of all particles are same in rotational motion of rigid body.

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15. Give the rotational analogue of force.

Watch Video Solution

16. How will you determine the direction of torque?

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17. Which component of torque is responsible for the rotation motion about Z-axis?

Watch Video Solution

18. Give the formula for the moment of couple.

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19. What is the physical quantity of the time rate of the angular momentum?

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20. What is a rigid body ? Explain the differences between rigid body and solid body.

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21. Angular position θ is scalar where angular displacement $\Delta\theta$ is vector.

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22. Which quantity have unit rpm. Show it in rad/s.

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23. The angular velocity of a particle 5 cm away from the axis of rotation is 10 rad/s. What will its linear velocity at 10 cm away from axis?

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24. The linear velocity of a particle 2 cm away from the axis of rotation is $10cm^{-1}$. What will its angular velocity at 4 cm away from axis?

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25. Write the change in magnitude and direction of angular velocity with respect to time of a rotating body about a fixed axis.

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26. What is an angle between tangential and radiant components of linear acceleration in circular motion?

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27. What is the effet of radial and tangential components of linear acceleration in circular motion?

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28. Is the tangential acceleration of a particle moving along a fixed circle be always zero? When it will be zero?

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29. What is the ratio of angular speed of hour hand and minute hand of a clock?

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30. Which has less angular speed, hour hand of clock or the angular speed of earth on its own axis?

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31. The unit of torque and work are same but they are not a same physical quantity? Why?

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32. What does torque measured in rotational motion?

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33. To tighten the bolt, we prefer to use a wrench with a long arm why?

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34. Handle of the door is always kept on other side (far side) of the hinge. Why?

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35. We can not need to apply the force an all particles of door for opening or closing it. Why?

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36. What is the magnitude of torque for a body circulating with constant angular speed? Why?

Watch Video Solution

37. Can a body have the momentum if it moves along a straight path?

Watch Video Solution

38. If we change the axis of rotation does the magnitude of angular momentum change?

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39. Any rigid body can have more than one value of moment of inertia?

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40. What is physical quantity of the unit Joule $\times$ second^2?

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41. When does the magnitude of angular momentum will be zero?

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42. Write the dimensional formula of

$$\frac{\text{Angular momentum}}{\text{Linear momentum}}$$

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43. If the ice in the polar caps of earth melts, how will it affect angular velocity of earth?

Watch Video Solution

44. Write the necessary condition for solid cylinder rolling down without sliding.

Watch Video Solution

45. Can we use $v = r\omega$ for a body rolling without sliding?

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46. What is radius of gyration? Write its unit and dimensional formula.

Watch Video Solution

47. The angular velocity of a particle rotates with constant speed on only one circle about a fixed axis is constant but its linear velocity changes.. It is possible? Why?

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48. Is the linear velocity of a particle moving with constant angular speed about non fixed axis remains constant? Why?

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49. Write formula of vector form for the angular velocity and linear velocity

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50. Which component of linear acceleration of a particle moving in a constant circular motion on a fixed circle is constant and which component is not constant?

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51. Is the tangential acceleration of a particle moving along a fixed circle be always zero? When it will be zero?

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52. Write the difference between sound wave and light waves.

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Section D Ncert Exemplar Solutions

1. For which of the following does the centre of mass lie outside the body?

A. A pencil

B. A shotput

C. A dice

D. A bangle

Answer: D

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2. Find the maximum velocity for the overturn of a car moving on a circular track of radius 100 m. The co-efficient of friction between the road and tyre is 0.2

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3. A particle of mass m is moving in yz-plane with a uniform velocity v with its trajectory running parallel to $+ve$ y-axis and intersecting z-axis at $z = a$ in figure. The change in its angular momentum about the origin as it bounces elasticallyy from a wall at y = constant is ....

A. $mva\hat{e}_x$

B. $2mva\hat{e}_x$

C. $ymv\hat{e}_x$

D. $2ymv\hat{e}_x$

Answer: B

View Text Solution

4. When a disc rotates with uniform angular velocity, which of the following is not true?

A. The sence of rotation remains same

B. The orientation of the axis of rotation remains same

C. The speed of rotation is non-zero and remains same

D. The angular acceleration is non-zero and remains same

Answer: D

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5. Of the following properties of a wave, the one that is independent of the other is its

A. amplitude

B. velocity

C. wavelength

D. frequency

Answer: B

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6. In problem 5, the CM of the plate is now in the following quadrant of xy-plane.

A. I

B. II

C. III

D. IV

Answer: C

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7. The density of a non-uniform rod of length 1 m is given by $\rho(x) = a\left(1 + bx^2\right)$ where, a and b are constants and $0 \leq x \leq 1$. The centre of mass of the rod will be at ....

A. $\dfrac{3(2+b)}{4(3+b)}$

B. $\dfrac{4(2+b)}{3(3+b)}$

C. $\dfrac{3(3+b)}{4(2+b)}$

D. $\dfrac{4(3+b)}{3(2+b)}$

Answer: A

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8. A merry-go-round, made of ring-like platform of radius R and mass M is revolving with angular speed ω. A person of mass M is standing on it. At one instant, the person jumps off the round, radially away from the centre of the round (as seen from the round).

The speed of the round of afterward is ....

A. 2ω

B. ω

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

D. 0

Answer: A

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9. Choose the correct alternatives.

A. For a general rotational motion, angular momentum L and angular velocity ω need not be parallel

B. For a rotational motion about a fixed axis, angular momentum L and angular velocity ω are always parallel

C. For a general translational motion, momentum p and velocity v are always parallel

D. For a general translational motion, acceleration a and velocity v are always parallel.

Answer: A::C

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10. Figure shows two identical particles 1 and 2, each of mass m, moving in opposite directions with same speed v along parallel lines. At a particular instant r_1 and r_2 are their respective position vectors drawn from point A which is in the plane of the parallel lines. Choose the correct options.

A. Angular momentum I_1 of particle 1 about A is $I_1 = mv(r_1) \odot$

B. Angular momentum I_2 of particle 2 about A is $I_2 = mvr_2 \odot$

C. Total angular momentum of the system about A is $I = mv(r_1 + r_2) \odot$

D. Total angular momentum of the system about A is $I = mv(r_2 - r_1) \otimes$

Answer: A::B

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11. The net external torque on a system of particles about an axis is zero. Which of the following are compatible with it?

A. The forces may be acting radially from a point on the axis

B. The forces may be acting on the axis of rotation

C. The forces may be acting parallel to the axis of rotation

D. The torque caused by some forces may be equal and opposite to that caused by other forces

Answer: A::B::C::D

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12. Figure shows a lamina in xy-plane. Two axes z and z. pass perpendicular to its plane. A force F acts in the plane of lamina at point P as shown. Which of the following are true? (The point P is closer to z.-axis than the z-axis).

A. Torque τ caused by F about z-axis is along $-\hat{k}$

B. Torque τ. caused by F about z.-axis is along $-\hat{k}$

C. Torque τ caused by F about z-axis is greater in magnitude than the about z-axis

D. Total torque is given by $\tau = \tau + \tau$.

Answer: B::C

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13. RMS stands for......

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Section D Ncert Exemplar Solutions Very Short Answer Type Questions

1. The centre of gravity of a body on the earth coincides with its centre of mass for a small object whereas for an extended object it may not. What is the qualitative meaning of small and extended in this regard? For which of the following two coincides? A building, a pond, a lake, a mountain?

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2. Why does a solid sphere have smaller moment of inertia than a hollow cylinder of same mass and radius, about an axis passing through their axes of symmetry?

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3. Find the average value of current when the current that are equidistant are 4A, 5A and 6A.

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4. What is the current found by finding the current in an equidistant region and dividing by n?

A. RMS current

B. Average current

C. Instantaneous current

D. Total current

Answer:

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5. What is the type of current obtained by finding the square of the currents and then finding their average and then fining the square root?

A. RMS current

B. Average current

C. Instantaneous current

D. Total current

Answer:

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Section D Ncert Exemplar Solutions Short Answer Type Questions

1. The vector sum of a system of non-collinear forces acting on a rigid body is given to be non-zero. If the vector sum of all the torques due to the system of forces about a certain point is found to be zero, does this mean that it is necessarily zero about any arbitrary point?

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2. A wheel in uniform motion about an axis passing through its centre and perpendicular to its plane is considered to be in mechanical (translational plus rotational) equilibrium becaues no net external force or torque is required to sustain its motion. However, the particles that constitute the wheel do experience a centripetal the acceleration directed towards the centre. How do you reconcile this fact with the wheel being in equilibrium?

How would you set a half wheel into uniform motion about an axis passing through the centre of mass of the wheel and perpendicular to its plane? Will you require external forces to sustain the motion?

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3. What is the effective value of current?

A. RMS current

B. Average current

C. Instantaneous current

D. Total current

Answer:

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4. $(n-1)$ equal point masses each of mass m are placed at the vertices of a regular n-polygon. The vacant vertex has a position vector a with respect to the centre of the polygon. Find the position vector of centre of mass.

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Section D Ncert Exemplar Solutions Long Answer Type Questions

1. Find the centre of mass of a uniform :

(a) half-disc, (b) quarter-disc.

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2. Two disc of moments of inertia I_1 and I_2 about their respective axes (normal to the disc and passing through the centre), and rotating with angular speeds ω_1 and ω_2 are brought into contact face to face with their axes of rotation coincident. (a) What is the angular speed of the two-disc system? (b) Show that the kinetic energy of the combined system is less than the sum of the initial kinetic energies of the two discs. How do you account for this loss in energy? Take $\omega_1 \neq \omega_2$.

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3. A disc of radius R is rotating with an angular ω_0 about a horizontal axis. It is placed on a horizontal table. The coefficient of kinetic friction is μ_k.

(a) What was the velocity of its centre of mass before being brought in contact with the table?

(b) What happens to the linear velocity of a point on its rim when placed in contact with the table?

(c) What happens to the linear speed of the centre of mass when disc is placed in contact with the table?

(d) Which force is responsible for the effects in (b) and (c)?

(e) What condition should be satisfied for rolling to being?

(f) Calculate the time taken for the rolling to begin.

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4. Two cylindrical hollow drums of radii R and 2R and of a common height h are rotating with angular velocities ω (anti-clockwise) and ω (clockwise) respectively. Their axes, fixed are parallel and in a horizontal plane separated by $3R + \delta$. They are now brougth in contact $(\delta \to 0)$.

(a) Show the frictional forces just after contact.

(b) Identify forces and torques external to the system just after contact.

(c) What would be the ratio of final angular velocities when friction ceases?

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5. In a sinusoidal wave, average current is always _______ rms current.

A. Greater than

B. Less than

C. Equal to

D. Not related

Answer:

Watch Video Solution

6. For a rectangular wave, average current is ______ rms current.

A. Greater than

B. Less than

C. Equal to

D. Not related

Answer:

Watch Video Solution

Section E Multiple Choice Questions

1. Peak value divided by the rms value gives us

A. Peak factor

B. Crest factor

C. Both peak and crest factor

D. Neither peak nor crest factor

Answer: A

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2. Two identical eggs, one raw and other boiled, area rotated with the same angular speed. Which one will come to rest earlier?

A. can.t say anything

B. both eggs will come to rest simultaneously

C. boiled egg

D. raw egg

Answer: C

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3. An artificial satellite of mass 500 kg revolve around the earth, its angular momentum $4 \times 10^7 Js$. What will its Ariel velocity?

A. $2 \times 10^4 m^2 s^{-1}$

B. $2 \times 10^7 m^2 s^{-1}$

C. 0

D. $4 \times 10^4 m^2 s^{-1}$

Answer: D

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4. A car of mass 1200 kg travelling with speed of 60 km/h on a straight road is ahead of a scooter travelling with speed of 60 km/h, then what will the speed of centre of mass of these vehicles? Mass of scooter is 80kg

A. $60km/h$

B. $72km/h$

C. $75km/h$

D. $68km/h$

Answer: A

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5. If the resultant external force on a system is zero, then the total............of system remains constant.

A. Linear momentum

B. mass

C. linear velocity

D. mass work

Answer: A::B

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6. Suppose your mass is 50 kg, how fast should you run so that your linear momentum become equal to that of cycle rider of 100 kg moving along a straight road with a speed of 20 km/h?

A. $40m/s$

B. $20km/h$

C. $11.11 m/s$

D. $10.00 km/h$

Answer: C

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7. Particles of masses 10 g and 20 g have position vectors $(5, 3, 0)$ and $(2, 0, 3)$ respectively. The position vector of their centre of mass is .... cm.

A. $(1, 2, 3)$

B. $(3, 1, 2)$

C. $(2, 3, 1)$

D. $(3, 2, 1)$

Answer: B

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8. A monkey sitting on a tree at a height of 19.6 m, drop a 10 g seed of rose apple on a crocodile, at rest below the tree. If the seed falls in the mouth of the crocodile in 2 s time and becomes stationary, then the momentum gained by the crocodile (in addition to the seed) is.......... kg m/s. $(g = 9.8 ms^{-2})$

A. 0.196

B. 19.6

C. -0.196

D. -19.6

Answer: A

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9. Force (5, 6, 7) N acts on a particle with position vector (2, 2, 1) m. The magnitude of ϕ torque on the particle will be .... Nm.

A. $\sqrt{13}$

B. $\sqrt{149}$

C. $\sqrt{61}$

D. $\sqrt{23}$

Answer: B

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10. A wheel starts from rest and obtained angular velocity of 72 rad/s at the end of 3 s, then its constant acceleration will be.......... $\mathrm{rad/s^2}$.

A. 64

B. 16

C. 24

D. 4

Answer: C

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11. A circular ring of mass m and radius r is rotating in a horizontal plane about an axis vertical to its plane. What will its rotational kinetic energy? (Angular speed of ring is w)

A. $\frac{1}{2}mr^2w^2$

B. mr^2w^2

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

D. mrw^2

Answer: A

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12. If the ice on the polar caps of the earth melts and water collected about equator, how will that affect the duration of a day?

A. Day becomes short

B. Length of day cannot change

C. Day becomes long

D. Length of day and night becomes same

Answer: C

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13. What is physical quantity of the unit Joule $\times$ second^2?

A. Moment of inertia

B. Power

C. Work

D. Angular momentum

Answer: A

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14. A bomb of mass 50 kg at rest explodes into two pieces of masses 40 kg and 10 kg. The velocity of bigger pieces is zero then velocity of smaller piece is .... ms^{-1}.

A. 10

B. 50

C. 40

D. 0

Answer: B

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15. A bus of mass 2400 kg is moving on a straight road with a speed of 30 km/h. A car of mass 1600 kg is following the bus with speed of 40 km/h. How fast is the centre of mass of the system of two vehicles moving?

A. $70 km / h$

B. $75km/h$

C. $34km/h$

D. $68km/h$

Answer: C

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16. The location of centre of mass of a rigid body depends on...............

A. only mass distribution

B. only shape

C. both mass distribution and shape

D. shape and area

Answer: C

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17. A quillof 0.100 gm is falling with a velocity of $\left(-0.05\hat{j}\right)m/s$. When blown from lower side, its velocity changes to

$\left(0.2\hat{i} + 0.15\hat{j}\right) m/s$. The change in its momentum will be........kg m/s.

A. $2 \times 10^{-2}\hat{i} + 2 \times 10^{-2}\hat{j}$

B. $2 \times 10^{-2}\hat{i} - 2 \times 10^{-2}\hat{j}$

C. $2 \times 10^{-2}\hat{i} + 1 \times 10^{-2}\hat{j}$

D. $2 \times 10^{-5}\hat{i} + 2 \times 10^{-5}\hat{j}$

Answer: D

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18. The angular speed of hour hand of a watch is .... rad s^{-1}.

A. $\frac{\pi}{43200}$

B. $\frac{\pi}{1800}$

C. $\frac{\pi}{30}$

D. $\frac{\pi}{21600}$

Answer: D

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19. Suppose the earth suddenly expends and its radius become 2R (R = radius of earth) keeping its mass same, then that will be the length of the day which at present is of 24 hours?

A. 1.5 hr

B. 6 hr

C. 96 hr

D. 36 hr

Answer: C

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20. If axis of rotation of two identical cylinders, one solid and other hollow is taken as their geometrical axis. Then the ratio of radius of gyration of hollow one to that of solid is............

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

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

C. 2

D. $\sqrt{2}$

Answer: D

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21. A rigid body acquires angular speed of 100 rad s^{-1} after undergoing angular displacement of 600 rad in 12 s. Then the initial angular speed is .... rad/s

A. 8.33

B. 100

C. 0

D. 50

Answer: C

Watch Video Solution

22. A circular disc of radius r and mass m rotates about the axis passing through the centre and perpendicular to its plane. What will if rotational kinetic energy?

A. $\frac{1}{4}mr\omega^2$

B. $\frac{1}{2}mr\omega^2$

C. $\frac{1}{4}mr^2\omega^2$

D. $\frac{1}{2}mr^2\omega^2$

Answer: C

Watch Video Solution

23. A solid sphere rolls without slipping on an inclined plane of angle θ. Find its linear acceleration in the direction parallel to the surface of the inclined plane.

A. $\frac{5}{7}g\sin\theta$

B. $\frac{7}{5}g\sin\theta$

C. $\frac{3}{5}g\sin\theta$

D. $\frac{1}{2}g\sin\theta$

Answer: A

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24. What is moment of inertia in terms of angular momentum (L) and kinetic energy (K)?

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

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

C. $\frac{L}{2K^2}$

D. $\frac{L^2}{K}$

Answer: B

Watch Video Solution

25. The angular momentum of a wheel changes from 2L to 5L in 3 seconds. What will be the magnitude of torque acting on it?

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

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

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

D. L

Answer: D

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26. If the angular momentum of the body is increased by 50%, its rotational kinetic energy is increased by ....

A. $125\ \%$

B. $50\ \%$

C. $100\ \%$

D. $25\ \%$

Answer: A

Watch Video Solution

27. A rigid body is rotating about fix axis. P and Q are its particles. Which of the following physical quantity is same for P and Q?

A. angular momentum

B. angular speed

C. linear momentum

D. linear velocity

Answer: B

Watch Video Solution

28. A bird of 3 kg is flying with a constant velocity of $\left(2\hat{i}-4\hat{j}\right)m/s$ and another bird of 2 kg with $\left(2\hat{i}+6\hat{j}\right)m/s$. Then, the velocity of centre of mass of the system of two bird ....

Is m/s.

A. $10\hat{i} + 10\hat{j}$

B. $2\hat{i} + 2\hat{j}$

C. $2\hat{i} - 2\hat{j}$

D. $2\hat{i} + 0\hat{j}$

Answer: D

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29. The centre of mass of a ring of uniform mass distribution lies ....

A. at the centre of ring, but outside the material

B. outside the ring material

C. centre of ring, but inside the material

D. at the centre of ring

Answer: A

Watch Video Solution

30. A bomb of mass 60 kg moving uniformly with a velocity of 10m/s explodes spontaneously into two fragments of 40 kg and 20 kg. If the velocity of the larger fragments is zero, then calculate the velocity of the smaller fragement.

A. $40m / s$

B. $20m / s$

C. $50m / s$

D. $30m / s$

Answer: D

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31. The moment of inertia of a disc of uniform density about on axis coinciding with its diameter ....

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

B. MR^2

C. $\frac{1}{4}MR^2$

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

Answer: C

Watch Video Solution

32. A wheel initially at rest acquires an angular velocity of 128 rad s^{-1} in 4 s. Hence its constant angular acceleration is ....

A. 32 rad s^{-2}

B. 128 rad s^{-2}

C. 16 rad s^{-2}

D. 64 rad s^{-2}

Answer: A

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33. A shell following a parabolic path explodes some where in its flight. The centre of mass of fragment will continue to move in ....

A. any direction

B. horizontal direction

C. same parabolic path

D. vertical direction

Answer: C

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34. A bus of 2500 kg is moving on a straight road with a speed of 40 km/h. A car of 1500 kg is following the bus with a speed of 80 km/h. How fast is the centre of mass of the system of two vehicles moving?

A. 55 km/h

B. 72 km/h

C. 68 km/h

D. 70 km/h

Answer: A

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35. In cricket match, a bowler throws a ball of 0.5 kg with a speed of 20 m/s. When a batsman swings the bat the ball strikes with the bat normal to it, and returns in opposite direction with speed of 30 m/s. If the time of contact of the ball with the bat is 0.1s, then the force acting on the bat is......N.

A. 50

B. 125

C. 250

D. 25

Answer: C

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36. If the external force acting on a system of particle is zero then ....

A. $\overrightarrow{a}_{cm} = 0$

B. $\overrightarrow{v}_{cm} = 0$

C. $\overrightarrow{r}_{cm} = 0$

D. $\overrightarrow{p} = 0$

Answer: A

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37. The centre of mass of a rigid body .... the rigid body.

A. is inside

B. is outside

C. it can be either inside or outside

D. is at the centre of

Answer: C

Watch Video Solution

38. Angular momentum of the particle rotating with a centripetal force is constant due to ....

A. constant linear momentum

B. constant torque

C. zero torque

D. constant force

Answer: C

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39. The radius of gyration of a ring about the tangent perpendicular to its plane is...............

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

B. $\sqrt{2}R$

C. $2R$

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

Answer: B

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40. Kinetic energy and angular velocity of a rigid body are E and ω respectively. Now angular velocity of the body is increased by 2%. Find out kinetic energy.

A. $1.03E$

B. $1.08E$

C. $1.02E$

D. $1.04E$

Answer: D

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41. A fly wheel starts rotating from rest and acquires rotational speed of 360 revolution s^{-1} in 3 minutes. The average angular acceleration is..............

A. $3\frac{\text{revolution}}{(\text{second})^2}$

B. $4\frac{\text{revolution}}{(\text{second})^2}$

C. $1\frac{\text{revolution}}{(\text{second})^2}$

D. $2\frac{\text{revolution}}{(\text{second})^2}$

Answer: D

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42. Two identical spheres are rolling down the slope. One is solid and other is hollow, the ratio of moment of inertia of solid sphere (axis of rotation is diameter) to that of the hollow is ....

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

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

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

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

Answer: A

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43. A motor is rotating at a constant angular velocity of 600 rpm. The angular displacement in 2 second is ....

A. 40π rad

B. 20π rad

C. 10π rad

D. $\frac{100}{3}\pi$ rad

Answer: A

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44. A solid cylinder is rolling down the inclined plane without slipping. On which factor does the velocity of a cylinder at the bottom of an inclined plane depend?

A. Length of the cylinder

B. Height of inclined plane

C. Radius of the cylinder

D. Mass of the cylinder

Answer: B

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45. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotational energy will be ....

A. $\dfrac{R^2}{k^2 + R^2}$

B. $\dfrac{k^2 + R^2}{R^2}$

C. $\dfrac{k^2}{R^2}$

D. $\dfrac{k^2}{k^2 + R^2}$

Answer: D

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46. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its centre of mass when the cylinder reaches its bottom?

A. $\sqrt{4gh}$

B. $\sqrt{2gh}$

C. $\sqrt{\frac{3}{4}gh}$

D. $\sqrt{\frac{4}{3}gh}$

Answer: D

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47. A thin circular ring M and radius r is rotating about its axis with a constant angular velocity ω. Four objects each of mass m are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be...........

A. $\dfrac{(M-4m)\omega}{M+4m}$

B. $\dfrac{M\omega}{4m}$

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

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

Answer: C

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48. A wheel having moment of inertia $2kgm^2$ about its vertical axis, rotates at the rate of 60 rpm about the axis. The torque which can stop the wheel.s rotation in one minute would be..............

A. $\frac{\pi}{18}\frac{N}{m}$

B. $\frac{2\pi}{15}N.m$

C. $\frac{\pi}{12}N.m$

D. $\frac{\pi}{15}N.m$

Answer: D

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49. The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is ....

A. $1 : \sqrt{2}$

B. $1 : 3$

C. $2 : 1$

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

Answer: D

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50. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of disc is.............

A. $\dfrac{(I_1 + I_2)\omega}{I_1}$

B. $\dfrac{I_2\omega}{I_1 + I_2}$

C. ω

D. $\dfrac{I_1\omega}{I_1 + I_2}$

Answer: D

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51. Calculate the crest factor if the peak value of current is 10A and the rms value is 2A.

A. 5A

B. 10A

C. 5

D. 10

Answer: D

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52. Calculate the peak value of current if the crest factor is 10 and the rms value is 2A.

A. 20A

B. 10A

C. 20

D. 10

Answer: C

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53. Two bodies have their moment of inertia I and 2I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momentum will be in the ratio :

A. $2 : 1$

B. $1:2$

C. $\sqrt{2}:1$

D. $1:\sqrt{2}$

Answer: D

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54. A drum of radius R and mass M, rolls down without slipping along an inclined plane of angle θ, The frictional force ....

A. Dissipats energy as heat

B. Decreases the rotational motion of cylinder

C. Decreases the rotational and translation motion

D. Converts translational energy to rotational energy

Answer: D

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55. Which of the following is not an expression power?

A. $P = VI$

B. $P = I^2R$

C. $P = \frac{V^2}{R}$

D. $P = \frac{I}{R}$

Answer: D

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56. A wheel has angular acceleration of 3 rad/s^2 and initial angular speed of 2.00 rad/s. In a time 2 sec. it has rotated through an angle..........rad of :

A. 10

B. 12

C. 4

D. 6

Answer: A

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57. Which of the following statements are true?

A. Power is proportional to voltage only

B. Power is proportional to current only

C. Power is neither proportional to voltage nor to the current

D. Power is proportional to both the voltage and current

Answer: C

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58. A 250V bulb passes a current of 0.3A. Calculate the power in the lamp.

A. 75W

B. 50W

C. 25W

D. 100W

Answer: A

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59. The radius of gyration of a ring about the tangent perpendicular to its plane is...............

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

B. $1:\sqrt{2}$

C. $\sqrt{2}:1$

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

Answer: B

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60. There is a thin rod of uniform cross-section of mass M and length L. If this rodis is bent at 90° from the mid-point, then the moment of inertia about the axis passing through mid-point and perpendicular to the plane which includes both parts of rod is ....

A. $\dfrac{ML^2}{24}$

B. $\dfrac{ML^2}{12}$

C. $\dfrac{ML^2}{6}$

D. $\dfrac{\sqrt{2}ML^2}{24}$

Answer: B

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61. A thin circular ring of mass M and radius R is rotating in a horizontal plane about an axis vertical to its plane with a constant angular velocity ω. If two objects each mass m be attached gently to the opposite ends of a diameter of the ring, the ring will then rotate with an angular velocity ....

A. $\dfrac{\omega M}{M+2m}$

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

C. $\dfrac{\omega M}{M+m}$

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

Answer: A

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62. If $\overrightarrow{F}$ is the force acting on a particle having position vector $\overrightarrow{r}$ and $\overrightarrow{\tau}$ be the torque of this force about the region, 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. $\vec{r}\,.\,\vec{\tau} = 0$ and $\vec{F}\,.\,\vec{\tau} \neq 0$

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

Answer: B

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63. Four identical thin rods each of mass M and length l from a square frame. Moment of inerita of this frame about an axis through the centre of the square and perpendicular to its plane is ....

A. $\frac{2}{3}Ml^2$

B. $\frac{13}{3}Ml^2$

C. $\frac{1}{3}Ml^2$

D. $\frac{4}{3}Ml^2$

Answer: D

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64. Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i}+2\hat{j}+\hat{k}$ and $-3\hat{i}-2\hat{j}+\hat{k}$ respectively. The centre of mass of this system has a position vector.

A. $-2\hat{i}-\hat{j}+\hat{k}$

B. $2\hat{i}-\hat{j}-2\hat{k}$

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

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

Answer: A

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65. A circular disc of moment of inertia I_1 is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_1. Another disc of moment of inertia I_2 is placed coaxially on the rotating disc. Initially the second disc has zero angular speed. Eventually both the discs rotate with a constant angular speed ω_2. The energy lost by the initially rotating disc to friction is ....

A. $\frac{1}{2}\frac{I_2^2}{(I_1+I_2)}\omega_1^2$

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

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

D. $\frac{1}{2}\frac{I_2 I_1}{(I_1+I_2)}\omega_1^2$

Answer: D

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66. Two particle which are initially at rest, move towards each other under the action of their internal alteration. If there speeds are v and 2v at any instant, then the speed of centre of mass of the system will be..........

A. $2v$

B. zero

C. $1.5v$

D. v

Answer: B

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67. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta_{(t)} = 2t^3 - 6t^2$. The torque on the wheel becomes zero at .... s

A. 1

B. 0.5

C. 0.25

D. 2

Answer: A

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68. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is ....

A. $I_0 + \frac{ML^2}{2}$

B. $I_0 + \frac{ML^2}{4}$

C. $I_0 + 2ML^2$

D. $I_0 + ML^2$

Answer: B

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69. Kilowatt-hour(kWh) is a unit of

A. Current

B. Power

C. Energy

D. Resistance

Answer: C

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70. Two spherical bodies of mass M and 5 M and radii R and 2R repectively are released in free space with initial seperation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by smaller body just before collision is ....

A. $2.5R$

B. $4.5R$

C. $7.5R$

D. $1.5R$

Answer: C

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71. A force $\overrightarrow{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\overrightarrow{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of . α. for which angular momentum about origin is conserved is ....

A. 1

B. -1

C. 2

D. zero

Answer: B

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72. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about at perpendicular axis passing through the centre?

A. $\frac{13MR^2}{32}$

B. $\frac{11MR^2}{32}$

C. $\frac{9MR^2}{32}$

D. $\frac{15MR^2}{32}$

Answer: A

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73. A disc and a sphere of same radius but different masses roll off on two inclined planes of the same attitude and length. Which one of the two objects gets of the bottom of the plane first?

A. Sphere

B. Both reach at the same time

C. Depends on their masses

D. Disc

Answer: A

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74. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre it is subjected to a torque which produces a constant angular acceleration of 2.0 rad s^{-2}. Its net acceleration in ms^{-2} at the end of 2.0 s is approximately ....

A. 7.0

B. 6.0

C. 3.0

D. 8.0

Answer: D

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75. A particle of mass 10 g moves along a circle of radius 6.4 cm with constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal $8 \times 10^{-4} J$ by the end of the second revolution after the beginning of the motion?

A. $0.15 m / s^2$

B. $0.18 m / s^2$

C. $0.2 m / s^2$

D. $0.1 m / s^2$

Answer: D

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76. Two rotating bodies A and B masses m and 2m with moment of inertia I_A and $I_B (I_B > I_A)$ have equal kinetic energy of rotation. If L_A and L_B be their angular moment respectively, then ....

A. $L_B > L_A$

B. $L_A > L_B$

C. $L_A = \frac{L_B}{2}$

D. $L_A = 2L_B$

Answer: A

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77. A solid sphere of mass m and radius R rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation $\left(\frac{E_{\text{sphere}}}{E_{\text{cylinder}}}\right)$ will be = ...

A. $1:4$

B. $3:1$

C. $2:3$

D. $1:5$

Answer: D

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78. A light rod of length l has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about and axis perpendicular to the rod and passing through the centre of mass is ....

A. $(m_1 + m_2)l^2$

B. $\sqrt{m_1 m_2} l^2$

C. $\frac{m_1 m_2}{m_1 + m_2} l^2$

D. $\frac{m_1 + m_2}{m_1 m_2} l^2$

Answer: C

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79. A thin uniform rod of mass .M. and length .L. rotates with constant angular velocity . ω. about perpendicular axis passing through its centre. Two bodies each of mass $\frac{M}{3}$ are attached to its two ends. What is its angular velocity?

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

B. $\frac{1}{7}\omega$

C. $\frac{1}{6}\omega$

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

Answer: A

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80. A sphere of mass 3 kg and radius 0.2 m rolls down from the slope of height 7 m, its rotational kinetic energy will be ....

A. $42J$

B. $60J$

C. $36J$

D. $70J$

Answer: B

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81. In an orbital motion, the angular momentum vector is ....

A. along the radius vector

B. parallel to the linear momentum

C. in the orbital plane

D. perpendicular to the orbital plane

Answer: D

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82. A current of 5A flows in a resistor of 2 ohms. Calculate the energy dissipated in 300 seconds in the resistor.

A. $15KJ$

B. $15000kJ$

C. $1500J$

D. $150J$

Answer: A

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83. Calculate the work done in a resistor of 20 ohm carrying 5A of current in 3 hours.

A. 1.5J

B. 15J

C. 1.5kWh

D. 15kWh

Answer: A

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84. A horizontal platform is rotating with uniform angular velocity around the vertical axis passing through its centre. At some instant of time a viscous fluid of mass m is dropped a the centre and is allowed to spread out and finally fall. The angular velocity during this period ....

A. decreases continuously

B. decreases initially and increases again

C. remains unaltered

D. increases continuously

Answer: B

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85. Which among the following is a unit for electrical energy?

A. V(volt)

B. kWh(kilowatt-hour)

C. Ohm

D. C(coloumb)

Answer: C

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86. The moment of inertia of a rod about an axis through its centre and perpendicular to it is $\frac{1}{12}ML^2$ (where M is the mass and L, the length of the rod). The rod is bent in the middle so that the two halves make an angle 60°. The moment of inertia of the bent rod about the same axis would be..........

A. $\frac{1}{48}ML^2$

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

C. $\frac{1}{24}ML^2$

D. $\frac{ML^2}{8\sqrt{3}}$

Answer: B

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87. A bulb has a power of 200W. What is the energy dissipated by it in 5 minutes?

A. 60J

B. 600J

C. 60kJ

D. 6J

Answer: A

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88. If a solid sphere of mass 1 kg and radius 0.1 m rolls without slipping at a uniform velocity of 1 m/s along a straight line on a horizontal floor, the kinetic energy is ....

A. $\frac{7}{5}J$

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

C. $\frac{7}{10}J$

D. $1J$

Answer: C

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89. Out of the following, which one is not a source of electrical energy?

A. Solar cell

B. Battery

C. Potentiometer

D. Generator

Answer: A

Watch Video Solution

90. What is the moment of inertia of a cylinder of radius r, long its height?

A. mr^2

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

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

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

Answer: B

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91. Which among the following is an expression for energy?

A. V^2It

B. $V^2 Rt$

C. $V^2 \frac{t}{R}$

D. $V^2 \frac{t^2}{R}$

Answer: D

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92. Given, $\overrightarrow{\omega} = 2\hat{k}$ and $\overrightarrow{r} = 2\hat{i} + 2\hat{j}$. Find the linear velocity.

A. $4\hat{i} + 4\hat{j}$

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

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

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

Answer: C

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93. A metal solid sphere is rotating about an axis passing through its diameter, if its volume increased by 6% suddenly then its change in angular speed will be.........

A. decreased by 2%

B. increased by 2%

C. decreased by 4%

D. increased by 4%

Answer: C

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94. Two identical particles moves towards each other with velocity $2v$ and v respectively. Two velocity of centre of mass is ....

A. v

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

C. zero

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

Answer: D

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95. A girl is swinging a swing in the sitting position. What will be the effect on the time period of the swing if she stand up?

A. increase

B. decrease

C. remain same

D. increase if the child is tall and decrease if the child is short

Answer: B

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96. A battery converts__________

A. Electrical energy to chemical energy

B. Chemical energy to electrical energy

C. Mechanical energy to electrical energy

D. Chemical energy to mechanical energy

Answer: C

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97. A body A of mass M while falling vertically downwards under gravity breaks into two parts, a body B of mass $\frac{1}{3}M$ and a 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. body C

B. body B

C. depends on height of breaking

D. does not shift

Answer: D

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98. An annular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of force experienced by the two particles situated on the inner and outer parts of the ring. $\frac{F_1}{F_2}$ = ...

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

B. 1

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

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

Answer: A

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

B. Mr^2

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

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

Answer: A

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

A. $\dfrac{g\sin\theta}{1-\frac{MR^2}{I}}$

B. $\dfrac{g\sin\theta}{1+\frac{I}{MR^2}}$

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

D. $\dfrac{g\sin\theta}{1-\frac{I}{MR^2}}$

Answer: B

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101. The moment of inertia of a solid sphere with a density ρ and radius R about its diameter is

A. $\frac{105}{176}R^5\rho$

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

C. $\frac{176}{105}R^5\rho$

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

Answer: C

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102. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio $K_t : (K_t + K_r)$ for the sphere is

A. $2 : 5$

B. $7 : 10$

C. $10 : 7$

D. $5 : 7$

Answer: D

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103. A solid sphere is rotating freely about its symmetry axis in free space. Ther adius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere?

A. Angular momentum

B. Angular velocity

C. Rotational kinetic energy

D. Moment of inertia

Answer: A

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104. Three objects, A : (a solid sphere), B : (a thin circular disk) and C : (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation.

A. $W_A > W_C > W_B$

B. $W_C > W_B > W_A$

C. $W_B > W_A > W_C$

D. $W_A > W_B > W_C$

Answer: B

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105. The moment of the froce, $\overrightarrow{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at $(2, 0, -3)$, about the point $(2, -2, -2)$ is given by

A. $-7\hat{i} - 4\hat{j} - 8\hat{k}$

B. $-8\hat{i}-4\hat{j}-7\hat{k}$

C. $-7\hat{i}-8\hat{j}-4\hat{k}$

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

Answer: A

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Section F Questions From Module

1. If I_1 is the moment of inertia of a uniform rod about an axis perpendicular to its length and passing through its one end. Now ring formed by bending the rod, if the moment of inertia about the diameter of ring I_1 then $\frac{I_1}{I_2}$ = ...

A. $\frac{\pi^2}{3}$

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

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

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

Answer: D

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2. Two sphere of mass 2M and M are initially at rest at a distance R apart. Due to mutual force of attraction they approach each other. When they are at separation $\frac{R}{2}$, the acceleration of their centre of mass is ....

A. $0\frac{m}{s^2}$

B. $g\frac{m}{s^2}$

C. $3g\frac{m}{s^2}$

D. $12g\frac{m}{s^2}$

Answer: A

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3. A wheel has angular acceleration of 3 rad/s^2 and initial angular speed of 2.00 rad/s. In a time 2 sec. it has rotated through an angle..........rad of :

A. 10

B. 12

C. 4

D. 6

Answer: A

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4. The total kinetic energy of a body of mass 10 kg and radius 0.5 m moving with velocity of 2 m/s without slipping is 32.8 J. The radius of gyration of a body is ....

A. $0.25m$

B. $0.2m$

C. $0.5m$

D. $0.4m$

Answer: D

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5. Three identical metal balls, each of the radius r are placed touching each other on a horizontal surface such that an equilateral triangle is formed when centre of three balls are joined. Then where does their centre of mass?

A. On the horizontal surface

B. On the centre of any one of ball

C. On the line joining between ball

D.

Answer: A

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6. Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mass 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. d

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

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

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

Answer: D

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7. If the linear density of rod of length 3 m varies as $\lambda = 2 + x$ then the distance of centre of gravity of the rod is............

A. $\frac{7}{3}m$

B. $\frac{12}{7}m$

C. $\frac{10}{7}m$

D. $\frac{9}{7}m$

Answer: B

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8. One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about 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. $\dfrac{I_A}{I_B} = \dfrac{d_A}{d_B}$

Answer: C

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9. Moment of inertia of a uniform circular disc about its diameter is I. Its moment of inertia about a tangential axis parallel is its plane and passing through a point on its rim will be ....

A. $\dfrac{5}{2}I$

B. $3I$

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

D. $2I$

Answer: A

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10. Two identical concentric rings each of mass (m) and radius (r) placed perpendicularly. So the moment of inertia about axis of one of the ring is ....

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

B. mr^2

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

D. $2mr^2$

Answer: C

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11. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to the plane with n angular velocity ω another disc of one forth mass and same dimension is gently placed over it coaxially, the angular speed of the composite disc will be ....

A. $\frac{5}{4}\omega$

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

C. $\frac{4}{5}\omega$

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

Answer: C

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12. A child stands, hands at the side, on a turntable. The kinetic energy of system is K. The child now raises his arms, and the moment of inertia of system becomes twice. Then the kinetic energy of system will be ....

A. $2K$

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

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

D. $4K$

Answer: B

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13. Three sphere of masses m, m and m are located at the vertices of an equilateral triangle having side of same length. Find the moment of inertia of the system about one of side of triangle.

A. $\frac{3}{4}ml^2$

B. $\frac{4}{3}ml^2$

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

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

Answer: A

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14. The moment of inertia of a rod about an axis through its centre and perpendicular to it is $\frac{1}{12}ML^2$ (where M is the mass and L, the length of the rod). The rod is bent in the middle so that the two halves make an angle

60°. The moment of inertia of the bent rod about the same axis would be..........

A. $\frac{1}{48}ML^2$

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

C. $\frac{1}{24}ML^2$

D. $\frac{ML^2}{8\sqrt{3}}$

Answer: B

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15. Four identical thin rods each of mass M and length l from a square frame. Moment of inerita of this frame about an axis through the centre of the square and perpendicular to its plane is ....

A. $\frac{2}{3}Ml^2$

B. $\frac{13}{3}Ml^2$

C. $\frac{1}{3}Ml^2$

D. $\frac{4}{3}Ml^2$

Answer: D

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16. A solid sphere of mass M and radius R has a moment of inertia about an axis tangent to its surface is given by formula ....

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

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

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

D. $\frac{5}{3}MR^2$

Answer: B

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17. The centre of mass of three particles of masses 10 kg, 20 kg and 30 kg is on origin (0, 0, 0). Now where should one place a mass of 40 kg, so that centre of mass of system is equal to (3, 3, 3)?

A. $(0, 0, 0)$

B. $(7.5, 7.5, 7.5)$

C. $(1, 2, 3)$

D. $(4, 4, 4)$

Answer: B

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18. Acceleration of a solid cylinder rolls on inclined plane with a 30° angle is ....

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

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

C. g

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

Answer: A

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19. In carbon monoxide molecule distance between carbon and oxygen atom is 1.1Å. If mass of carbon atom is 12 amu and oxgyen atom is 16 amu where does the centre of mass of molecule lie?

A. at a distance of 6.3Å from a carbon atom

B. at a distance of 1Å from a oxygen atom

C. at a distance of 0.63Å from a carbon atom

D. at a distance of 0.12Å from a oxygen atom

Answer: C

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20. The ratio of moment of inertia about axis of a ring to a axis of disc of same mass and radius is ....

A. $1:1$

B. $2:1$

C. $4:1$

D. $1:2$

Answer: B

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21. The angular momentum of a wheel changes from 2L to 5L in 3 seconds. What will be the magnitude of torque acting on it?

A. L

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

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

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

Answer: A

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22. The radius of rear wheel of bicycle is two times then the radius of front wheel. If V_F and V_r are the speed of top most points of front and rear wheels respectively, then which one of the following is true?

A. $v_r = 2v_F$

B. $v_F = 2v_r$

C. $v_F = v_r$

D. $v_F > v_r$

Answer: C

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Section F Section A Questions Paper

1. What do you mean by mass element dm?

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2. What can be said for the centre of mass of system $M\frac{\overrightarrow{d}\ v_{cm}}{dt} = \overrightarrow{M}\,a_{cm} = \overrightarrow{F}$?

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3. What is linear momentum ? Write its SI unit

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4. Write the condition for rolling without slipping for a body on a slope.

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5. Can we write $\overrightarrow{a} = \overrightarrow{a_r} + \overrightarrow{a_r}$ instead of $\overrightarrow{a} = \overrightarrow{a_r} + \overrightarrow{a_r}$?

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6. Why it is necessary for reference point in definition of angular momentum?

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Section F Section B Questions Paper

1. A solar cell converts__________

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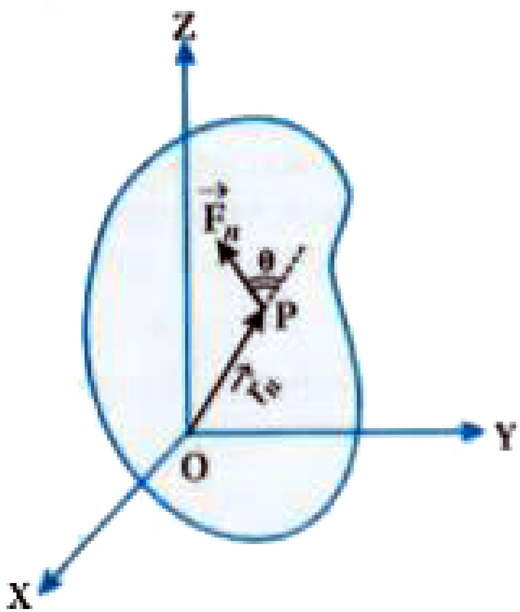
2. Explain the torque acting on a rigid body.



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Section F Section C Questions Paper

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

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2. Find the components along the x, y, z axes of the angular momentum l of a particle, whose position vector is r with components x, y, z and momentum is p with components p_x, p_y and p_z. Show that if the particle moves only in the x-y plane the angular momentum has only a z-component.

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Section F Section D Questions Paper

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

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