SNS ACADEMY

SYSTEM OF PARTICLES WORKSHEET

Date : 15-Nov-22

11th Standard CBSE

Physics

Reg.No. : | | | | | | |

10 x 3 = 30

1) 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 axis of symmetry?

2) If ice on poles melts, then what is the change in duration of day?

3) A solid cylinder of mass 20 kg rotates about its axis with angular speed of 100 rad/s. The radius of cylinder is 0.25m. What is KE of rotation of cylinder?

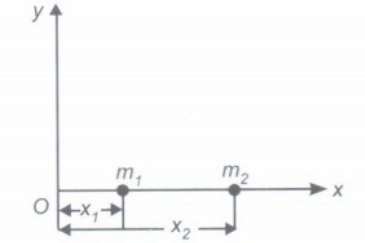
4) What is the moment of inertia of a solid cylinder of mass M and radius R about axis tangential to cylinder surface and parallel to the axis of cylinder?

5) If two point masses are placed at (+2 m), and (- 2 m), is it necessary that the centre of mass of system must lie at origin?

6) A fan of moment of inertia is 0.6 kg-m^2 is to be run upto a working speed of 0.5 rps. What is the angular momentum of the fan?

7) Find the scalar and vector products of two vectors $\mathbf{a} = (3\hat{\mathbf{i}} - 4\hat{\mathbf{j}} + 5\hat{\mathbf{k}})$ and $\mathbf{b} = (-2\hat{\mathbf{i}} + \hat{\mathbf{j}} - 3\hat{\mathbf{k}})$

8) What will be the centre of mass of the pair of particles described below in figure on the x-axis?



9) Find the torque of a force $(7\hat{i} + 3\hat{j} - 5\hat{k})\mathbf{N}$ the origin, the force acts on a particle whose position vector is $(\hat{i} - \hat{j} + \hat{k})m$.

10) . Derive the relations

(i) $L = I\omega$ (ii) $\tau = I\alpha$

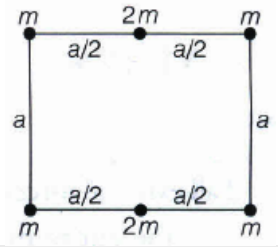
22 x 4 = 88

11) Two bodies of masses 1 kg and 2 kg are located at (1, 2) and (-1, 3), respectively. Calculate the coordinates of the centre of mass.

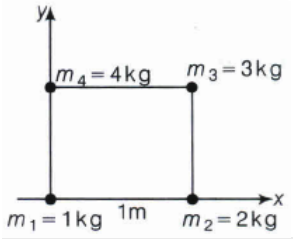
12) A hoop of radius 2m weighs 100 kg. It rolls along a horizontal floor so that its centre of mass has a speed of 20 cm/s. How much work has to be done to stop it?

13) Three masses 3 kg, 4 kg and 5 kg are located at the corners of an equilateral triangle of side lm, then what are the coordinates of centre of mass of this system.

14) Six particles are placed at different points of a square as shown in the figure. Find the centre of mass for the system of six particles.



15) If four particles of mass 1kg, 2kg, 3kg and 4kg are placed at the four vertices A, B, Cand D of square of side lm. Find the position of the centre of mass of the particle.



16) Establish the relation $\theta = \omega_0 t = \frac{1}{2}\alpha t^2$where the letters have their usual meanings

17) The moment of inertia of a body about a given axis is 1.2 kg m^2.Initially the body is at rest. In order to produce a rotational K.E. of 1500 J,for how much duration, an acceleration of 25 rad/s^2 must be applied about that axis?

18) If the Earth were to suddenly contract to $\frac{1}{n}$ th of its present radius, without any change in its mass,then what will be the effect on the duration of the day?

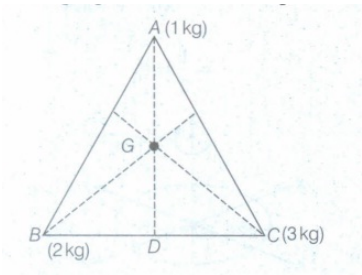
19) The moments of inertia of two rotating bodies A and Bare I_A and l_B· ($I_A > I_B$) and their angular momenta are equal. Which one has greater K.E.?

20) At a certain time, a 0.25 kg object has a position vector $\mathbf{r} = 2\hat{\mathbf{i}} - 2\hat{\mathbf{k}}$ m. At that, .instant, its velocity is $\mathbf{v} = -5\hat{\mathbf{i}} + 5\hat{\mathbf{k}}$m/s and the-force acting on it is $\mathbf{F} = 4\hat{\mathbf{j}}$N .

(i) What is the angular momentum of the object about the origin?

(ii) What is torque on it?

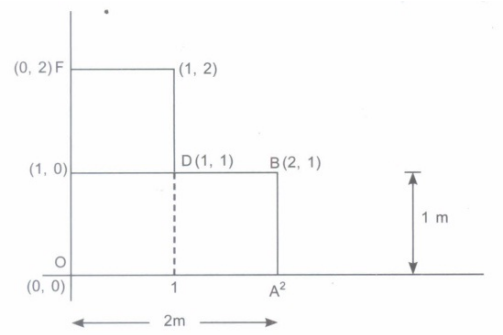
21) Three balls of masses 1kg, 2kg and 3kg are arranged at the corners of an equilateral triangle of side 1m. What will be the moment of inertia of the system about an axis through the centroid and perpendicular to the plane of triangle.



22) (a) State the theorem of parallel axis. Using it derive an expression to find the moment of inertia of a rod of mass M, length I about an axis perpendicular to it passing through one of its ends.

(b) Find the centre of mass of a uniform L shaped lamina (a thin flat plate) with dimension as shown in fig. The mass of

lamina is 3 kg.



23) Two particles of mass 2 kgand 1 kg are moving along the same line with speeds 2 ms $^{-1}$ and 5 ms^{-1} respectively. What is the speed of the centre of mass of the system if both the particles are moving

(a) in same direction

(b) in opposite direction?

24) The centre of mass of a body is a point at which the entire mass of the body is supposed to be concentrated. The $\vec{r}$ of c.m of the system of two particles of masses m_1 and m_2 with position vector $\vec{r}_1$ and $\vec{r}_2$ is given by

$$\vec{r} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$$

for an isolated system, where no external force is acting $\vec{v}_{cm}$ = constant

Under no circumstance, the velocity of centre of mass of an isolated system can undergo a change.

(i) What should be the position of the centre of mass of a system of two particles of unequal masses?

(ii) An electron and a proton move towards each other with velocities v_1 and v_2 respectively. What is the velocity of their centre of mass?

(iii) Two bodies of masses 1kg and 2 kg are located at (1, 2) and (-1, 3) respesctively, determine the coordinates of the centre of mass.

(iv) A bomb dropped from an aeroplane in level flight explodes in the middle. How would be the motion of centre of mass of the fragments?

(v) Two blocks of masses 5 kg and 2 kg are placed on a frictionless surface and connected by a spring. An external kick gives a velocity of 14 ms^{-1} to the heavier block in the direction of the lighter one. Determine the velocity gained by the centre of mass.

(vi) Can centre of mass of a body lie where there is absolutely no mass? Give example.

(vii) Can centre of mass of a body coincide with the geometrical centre of the body?

25) Moment of inertia of a body about a given axis is the rotational inertia of the body about that axis. It is represented by 1= MK^2, where M is mass of body and K is radius of gy ration of the body about that axis. it is a scalar quantity, which is measured in kg m^2.

When a body rotates about a given axis and the axis of rotation also moves, then total K.E of body = K.E of translation + kinetic energy of rotation.

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

(i) Is the M.I of a body about a given axis is vector or scalar quantity?

(ii) On what factors does M.I of a body depend?

(iii) Determine the moment of inertia of circular disc and circular ring of same mass and radius about an axis perpendicular to plane.

(iv) A 40 kg flywheel in the form of a uniform circular disc of diameter 1 m is making 120 rpm. What is the M.I about a transverse axis through its centre?

(v) Determine kinetic of rotation of the flywheel in the above case.

(vi) Calculate radius of gyration of a cylindrical rod of mass m and length L about an axis of rotation perpendicular to its length and passing through its centre,

(vii) Determine 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.

26) The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16s.

(i) What is its angular acceleration, assuming the acceleration to be uniform?

(ii) How many revolutions does the engine make during this time?

27) A wheel has a constant angular acceleration of 4.2 rad/s^2 . During a certain 8.05 s interval, it turns through angle of 140 rad. Assuming that wheel started from rest, how it had been in motion before the start of the 8.0 s?

28) 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 in 30 rpm. The man then brings his arms close to his body with the distance of each weight from the axis changing from 90 cm to 20 cm. The moment of inertia of the man together with the platform may be taken to be constant and equal to 7.6 kg-m^2.

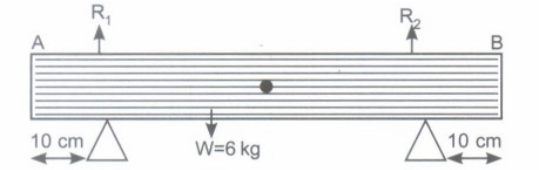
(a) What is his new angular speed? (Neglect friction)

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

29) Prove the 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, $v^2 = \frac{2gh}{1+k^2/R^2}$ 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.

30) If two particles of masses m_1 = 2 kg and m_2= 3 kg have position vectors $\mathbf{r}_1 = t\hat{\mathbf{i}} + 2t^2\hat{\mathbf{j}} + 2t\hat{\mathbf{k}}$ and $\mathbf{r}_2 = \hat{\mathbf{i}} + 2t^3\hat{\mathbf{j}} + 5\hat{\mathbf{k}}$ espectively, then the position vector of r_1 and r_2 is in metres and time is in seconds. Calculate the velocity and acceleration of centre of mass of two particles system.

31) What is Mechanical Advantage (M.A.) in the principle of moments for a lever? Find the reactions forces at knife edge as shown in the figure:



Where AB is a metal bar of 70 cm length having mass 4 kg and a 6 kg load is suspended from 30 em from the end A.

32) A mass m is allowed to roll down an inclined plane (θ). If the vertical height is h, find

(i) acceleration along the inclined plane.

(ii) velocity down the plane.

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