PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 66

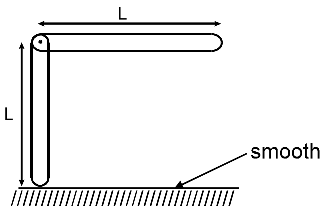
Total Marks : 26

Max. Time : 27 min.

Topics : Center of Mass, Magnetic Effect of Current and Magnetic Force on Charge/current, Gravitation, Heat, Rotation

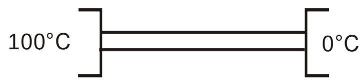
Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 3 min.)**	**[9, 9]**
Multiple choice objective ('–1' negative marking) Q.4	**(4 marks, 4 min.)**	**[4, 4]**
Subjective Questions ('–1' negative marking) Q.5	**(4 marks, 5 min.)**	**[4, 5]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks, 3 min.)**	**[9, 9]**

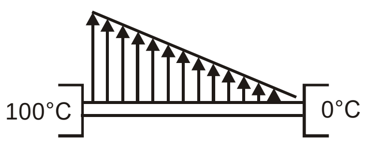
1. Two identical rods are joined at one of their ends by a pin. Joint is smooth and rods are free to rotate about the joint. Rods are released in vertical plane on a smooth surface as shown in the figure. The displacement of the joint from its initial position to the final position is (i.e. when the rods lie straight on the ground) :



(A) $\frac{L}{4}$ (B) $\frac{\sqrt{17}}{4}L$ (C) $\frac{\sqrt{5}L}{2}$ (D) none of these

2. A conducting cylindrical rod of uniform cross-sectional area is kept between two large chambers which are at temperatures 100°C and 0°C respectively. The conductivity of the rod increases with x, where x is distance from 100°C end. The temperature profile of the rod in steady-state will be as :



(A)


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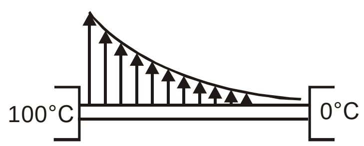
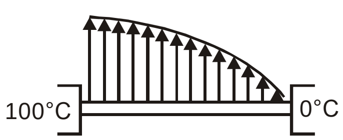


(C)


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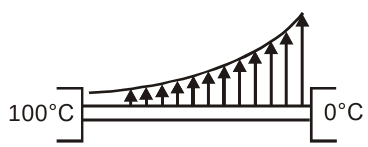


3. Two observers moving with different velocities see that a point charge produces same magnetic field at the same point A . Their relative velocity must be parallel to $\vec{r}$, where $\vec{r}$ is the position vector of point A with respect to point charge. This statement is :

(A) true

(B) false

(C) nothing can be said

(D) true only if the charge is moving perpendicular to the $\bar{r}$

4. Suppose the earth suddenly shrinks in size, still remaining spherical and mass unchanged (All gravitational forces pass through the centre of the earth).

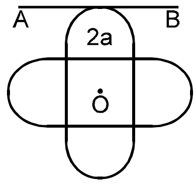
(A) The days will become shorter.

(B) The kinetic energy of rotation about its own axis will increase

(C) The duration of the year will increase.

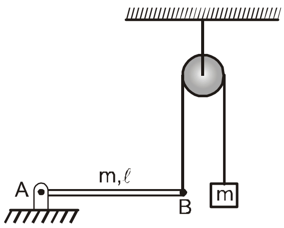
(D) The magnitude of angular momentum about its axis will increase.

5. A symmetric lamina of mass M consists of a square shape with a semicircular section over each of the edge of the square as in figure. The side of the square is 2a. The moment of inertia of the lamina about an axis through its centre of mass and perpendicular to the plane is 1.6 Ma^2. The moment of inertia of the lamina about the tangent AB in the plane of lamina is _______________.



COMPREHENSION

Uniform rod AB is hinged at the end A in a horizontal position as shown in the figure (the hinge is frictionless, that is, it does not exert any friction force on the rod). The other end of the rod is connected to a block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'.



6. Then just after release of block from this position, the tension in the thread is

(A) $\frac{mg}{8}$ (B) $\frac{5mg}{8}$ (C) $\frac{11mg}{8}$ (D) $\frac{3mg}{8}$

7. Then just after release of block from this position, the angular acceleration of the rod is

(A) $\frac{g}{8\ell}$ (B) $\frac{5g}{8\ell}$ (C) $\frac{11g}{8\ell}$ (D) $\frac{3g}{8\ell}$

8. Then just after release of block from this position, the magnitude of reaction exerted by hinge on the rod is

(A) $\frac{3mg}{16}$ (B) $\frac{5mg}{16}$ (C) $\frac{9mg}{16}$ (D) $\frac{7mg}{16}$

Answers Key

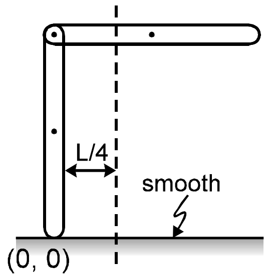
1.	(B)	**2.**	(B)	**3.**	(A)	**4.**	(A) (B)
5.	4.8 Ma^2			**6.**	(B)	**7.**	(D)
8.	(C)						

Hints & Solutions

1. Initially the centre of mass is at

$\frac{L}{4}$ distance from the vertical rod.

$$\left(\text{As, } x_{cm} = \frac{m(\frac{1}{2}) + m(0)}{m+m} = \frac{L}{4}\right)$$



centre of mass does not move in x-direction as $\Sigma F_x = 0$.
After they lie on the floor, the pin joint should be at L/4 distance from the origin shown inorder to keep the centre of mass at rest.

$\therefore$ Finally x-displacement of the pin is $\frac{L}{4}$ and y-displacement of the pin is obviously L.

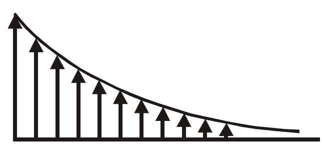
Hence net displacement = $\sqrt{L^2 + \frac{L^2}{16}} = \frac{\sqrt{17}L}{4}$

2. $H = -kA\frac{dT}{dx}$ $\Rightarrow \frac{dT}{dx} = \frac{-H}{kA}$

Now as k increases, $\frac{dT}{dx}$ becomes less (–)ve

So slope becomes less (–)ve

So curve will be



3. Since

$\vec{B} = \frac{\mu_0}{4\pi}q\frac{\vec{v}\times\vec{r}}{r^3}$, $\vec{v}\times\vec{r}$ must be same

where $\vec{v}$ = velocity of charge with respect to observer
Let A and B are the observers

then $(\vec{v}_C - \vec{v}_A) \times \vec{r} = (\vec{v}_C - \vec{v}_B) \times \vec{r}$

or $(\vec{v}_A - \vec{v}_B) \times \vec{r} = 0$

or $(\vec{v}_A - \vec{v}_B) \parallel \vec{r}$

4. $I_1\omega_1 = I_1\omega_1$ (Angular momentum is conserved)
As I_2 decreases. ω_2 increases.

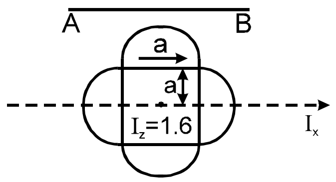
Thus $T = \frac{2\pi}{\omega}$ i.e. T decreases.

Therefore the earth is completing each circle around its own axis in lesser time.

$K.E. = \frac{1}{2} I \omega^2$

Therefore K.E. of rotation increases.
Duration of the year is dependent upon time taken to complete one revolution around the sun.

5. Using $\perp$ axis theorem



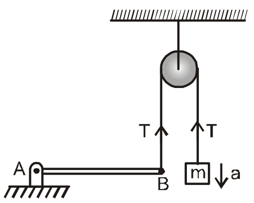
$\ell_x = \ell_y$
$2I_x = 1.6$
$I_x = .8\ Ma^2$
$I_{AB} = I_x + M(2a)^2$
$= 4.8\ Ma^2$
Ans.: 4.8 Ma²

6, 7 & 8.
Let α be the angular acceleration of rod and a be acceleration of block just after its release.

$\therefore$ mg – T = ma ..... (1)

$T\ell - mg\frac{\ell}{2} = \frac{m\ell^2}{3}\alpha$ .... (2)

and $a = \ell\alpha$ .... (3)



Solving we get

$$T = \frac{5mg}{8} \quad \text{and} \quad \alpha = \frac{3g}{8\ell}$$

Now from free body diagram of rod, let R be the reaction by hinge on rod

$$R + T - mg = m\,a_{cm} = m\,\frac{1}{2}\alpha$$

Solving we get

$$R = \frac{9mg}{16}$$