PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 47

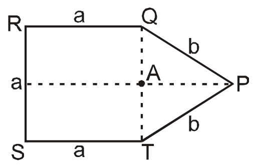
Total Marks : 31

Max. Time : 35 min.

Topics : Center of Mass, Circular Motion, Work, Power and Energy

Type of Questions			M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4		(3 marks 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.6		(4 marks 5 min.)	[8, 10]
Match the Following	(no negative marking) (2 × 4)Q.7	(8 marks 10 min.)	[8, 10]
Assertion and Reason	(no negative marking) Q. 8	(3 marks 3 min.)	[3, 3]

1. A homogeneous plate PQRST is as shown in figure. The centre of mass of plate lies at midpoint A of segment QT. Then the ratio of $\frac{b}{a}$ is (PQ = PT = b; QR = RS = ST = a)



(A) $\frac{13}{4}$ (B) $\frac{13}{2}$

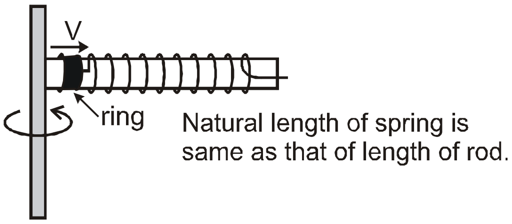
(C) $\sqrt{\frac{13}{2}}$ (D) $\sqrt{\frac{13}{4}}$

2. A particle is rotated in a vertical circle connected by a light string of length ℓ and keeping the other end of the string fixed. The minimum speed of the particle when the string is horizontal for which the particle will complete the circle is

(A) $\sqrt{g\ell}$ (B) $\sqrt{2g\ell}$

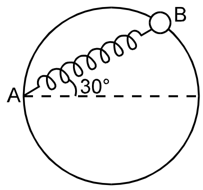
(C) $\sqrt{3g\ell}$ (D) $\sqrt{5g\ell}$

3. A ring attached with a spring is fitted in a smooth rod. The spring is fixed at the outer end of the rod. The mass of the ring is 3kg & spring constant of spring is 300 N/m. The ring is given a velocity 'V' towards the outer end of the rod. And the rod is set to be rotating with an angular velocity ω. Then ring will move with constant speed with respect to the rod if :



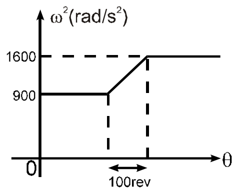
(A) angular velocity of rod is increased continuously
(B) ω = 10 rad/s
(C) angular velocity of rod is decreased continuously.
(D) constant velocity of ring is not possible.

4. A bead of mass m is attached to one end of a spring of natural length R and spring constant $K = \frac{(\sqrt{3}+1)mg}{R}$. The other end of the spring is fixed at point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released is :



(A) $\frac{mg}{2}$ (B) $\sqrt{3}$ mg (C) $3\sqrt{3}$ mg (D) $\frac{3\sqrt{3}mg}{2}$

5. The square of the angular velocity ω of a certain wheel increases linearly with the angular displacement during 100 rev of the wheel's motion as shown.Compute the time t required for the increase.



6. A particle of mass 2kg starts to move at position x = 0 and time t = 0 under the action of force F = (10 + 4x) N along the x-axis on a frictionless horizontal track. Find the power delivered by the force in watts at the instant the particle has moved by the distance 5m.

7. In column-I condition on velocity, force and acceleration of a particle is given. Resultant motion is described in column-II. $\vec{u}$ = initial velocity, $\vec{F}$ = resultant force and $\vec{v}$ = instantaneous velocity.

Column-I	**Column-II**
(A) $\vec{u}\times\vec{F}=0$ and $\vec{F}$ = constant	(p) path will be circular path
(B) $\vec{u}\cdot\vec{F}=0$ and $\vec{F}$ = constant	(q) speed will increase
(C) $\vec{v}\cdot\vec{F}=0$ all the time and $\lvert\vec{F}\rvert$ = constant and the particle always remains in one plane.	(r) path will be straight line
(D) $\vec{u}=2\hat{i}-3\hat{j}$ and acceleration at all time $\vec{a}=6\hat{i}-9\hat{j}$	(s) path will be parabolic

8. **STATEMENT–1 :** The work done by all forces on a system equals to the change in kinetic energy of that system. This statement is true even if nonconservative forces act on the system.

STATEMENT–2 : The total work done by internal forces may be positive.
(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

Answers Key

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1.	(D)	**2.**	(C)	**3.**	(B)
4.	(D)	**5.**	$\frac{40\pi}{7}$ sec.	**6.**	300
7.	(A) r (B) q,s (C) p (D) q,r	**8.**	(B)		

Hint & Solutions

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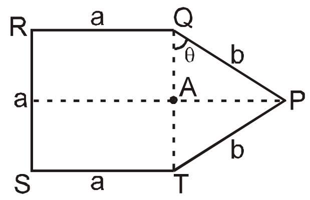
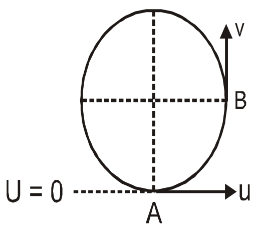
1. If centre of mass is at A

$$a^2 \sigma \frac{a}{2} = \sigma \frac{1}{2} ab \sin\theta \frac{1}{3} b \sin\theta$$

or $\frac{b}{a} = \sqrt{\frac{13}{4}}$



2.



Minimum velocity at lowest point to complete the circle is u = $\sqrt{5g\ell}$

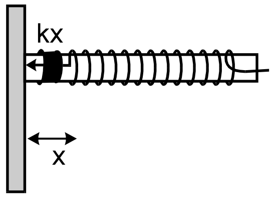
so by energy conservation between point A and B

$k_i + u_i = k_f + v_f$

$$\frac{1}{2} m \times 5 g\ell + 0 = \frac{1}{2} mv^2 + mg\ell$$

$$\Rightarrow \quad V = \sqrt{3g\ell}$$

3. For the ring to move in a circle at constant speed the net force on it should be zero. Here spring force will provide the necessary centripetal force.

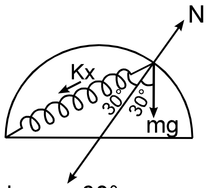


$\therefore \quad kx = mx\omega^2$

$\Rightarrow \quad \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{300}{3}} = 10$ rad/sec. **Ans.**

4. The extension is spring is $x = 2R\cos 30° - R$

$= \left(\sqrt{3} - 1\right)R$



k x cos30° + mg cos 30°

Applying Newton's second law to the bead normal to circular ring at point B

$N = K\left(\sqrt{3} - 1\right)R \;\cos 30° + mg\cos 30°$

$= \frac{\left(\sqrt{3}+1\right)}{R}\, mg\left(\sqrt{3} - 1\right) R\cos 30° + mg\cos 30°$

$N = \frac{3\sqrt{3}\,mg}{2}$.

5. We have $\Delta\theta = 2\pi \times (100 \text{ rev}) = 200\,\pi$ rad

So $\omega^2 = \omega_0^{\,2} + 2\alpha\Delta\theta$

$\Rightarrow \quad 1600 = 900 + 2\alpha \times 200\pi$

$\Rightarrow \quad \alpha = \frac{700}{400\pi} = \frac{7}{4\pi}$

Also $\quad \omega = \omega_0 + \alpha t$

$\Rightarrow \quad 40 = 30 + \frac{7}{4\pi} t$

$\Rightarrow \quad t = \frac{40\pi}{7}$

6. According to W.E. theorem

$$\frac{1}{2}mV^2 - 0 = \int_0^5 (10 + 4x)\,dx$$

V = 10m/s

Force at that moment = (10 + 20) = 30 N

Instantaneous power = $\vec{F}.\vec{V}$

= 30 × 10 = 300W

7. (A) $\vec{F}$ = constant and $\vec{u} \times \vec{F} = 0$

Therefore initial velocity is either in direction of constant force or opposite to it. Hence the particle will move in straight line and speed may increase or decrease.

(B) $\vec{u} \cdot \vec{F} = 0$ and $\vec{F}$ = constant

initial velocity is perpendicular to constant force, hence the path will be parabolic with speed of particle increasing.

(C) $\vec{v} \cdot \vec{F} = 0$ means instantaneous velocity is alway perpendicular to force. Hence the speed will remain constant. And also $|\vec{F}|$ = constant. Since the particle moves in one plane, the resulting motion has to be circular.

(D) $\vec{u} = 2\hat{i} - 3\hat{j}$ and $\vec{a} = 6\hat{i} - 9\hat{j}$. Hence initial velocity is in same direction of constant acceleration, therefore particle moves in straight line with increasing speed.

8. Both the statements are true. The work done by all forces on a system is equal to change in its kinetic energy, irrespective of fact whether work done by internal forces is positive, is zero or is negative.