PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 19

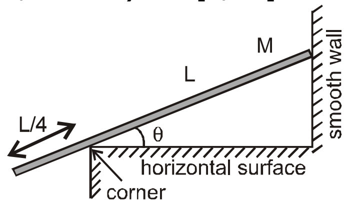
Total Marks : 37

Max. Time : 40 min.

Topics : Rigid Body Dynamics, Electrostatics, Kinematics, Sound Wave, Friction, Fluid

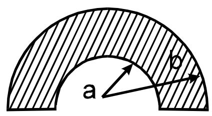
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Multiple choice objective ('–1' negative marking) Q.5	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.6	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4)Q.10	(8 marks, 10 min.)	[8, 10]

1. A uniform rod of mass M and length L leans against a frictionless wall, with quarter of its length hanging over a corner as shown. Friction at corner is sufficient to keep the rod at rest. Then the ratio of magnitude of normal reaction on rod by wall and the magnitude of normal reaction on rod by corner is



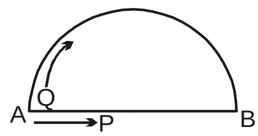
(A) $\frac{1}{2\sin\theta}$ (B) $\frac{2}{\sin\theta}$ (C) $\frac{1}{2\cos\theta}$ (D) $\frac{2}{\cos\theta}$

2. A non – conducting semicircular disc (as shown in figure) has a uniform surface charge density σ. The ratio of electric field to electric potential at the centre of the disc will be :



(A) $\frac{1}{\pi}\frac{\ell n b/a}{(b-a)}$ (B) $\frac{2}{\pi}$ (C) $\frac{1}{\pi}\frac{\ell n(b/a)^2}{(b-a)}$ (D) $\frac{\pi(b-a)}{2\ell n(b/a)}$

3. Two particles P and Q start their journey simultaneously from point A. P moves along a smooth horizontal wire AB. Q moves along a curved smooth track. Q has sufficient velocity at A to reach B always remaining in contact with the curved track. At A, the horizontal component of velocity of Q is same as the velocity of P along the wire. The plane of motion is vertical. If t_1, t_2, are times taken by P and Q respectively to reach B then (Assume velocity of P is constant)

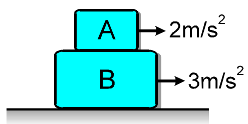


(A) $t_1 = t_2$ (B) $t_1 > t_2$ (C) $t_1 < t_2$ (D) none of these

4. A receiver and a source of sonic oscillations of frequency 200 Hz are located on the x – axis. The receiver is fixed and the source swings harmonically along that axis with a circular frequency ω and an amplitude 50 cm. At what value of ω (in rad/sec) will the frequency band width ($f_{max} - f_{min}$) registered by the stationary receiver be equal to 20 Hz. [The velocity of sound is equal to 340 m/s]

(A) 17 (B) 34 (C) 68 (D) 8.5

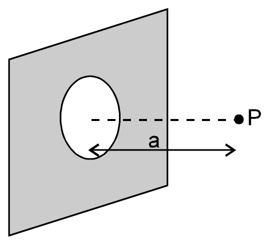
5. Block A is kept on block B as shown in figure. It is known that acceleration of block A is 2 m/s^2 towards right and acceleration of block B is 3 m/s^2 towards right under the effect of unknown forces. Direction of friction force acting on A by B ($\mu_{AB} = 0.3$)



(A) is necessarily towards right (B) may be towards right

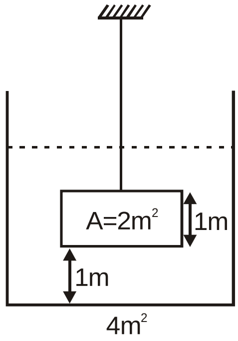
(C) may be towards left (D) may be zero

6. An infinitely large non- conducting plane of uniform surface charge density σ has circular aperture of certain radius carved out from it. The electric field at a point which is at a distance 'a' from the centre of the aperture (perpendicular to the plane) is $\frac{\sigma}{2\sqrt{2}\,\epsilon_0}$. Find the radius of aperture :



COMPREHENSION

A tank of base area 4 m^2 is initially filled with water up to height 2m. An object of uniform cross-section $2m^2$ and height 1m is now suspended by wire into the tank, keeping distance between base of tank and that of object 1m. Density of the object is $2000 kg/m^3$. Take atmospheric pressure $1 \times 10^5 N/m^2$; $g = 10 m/s^2$.



7. The downwards force exerted by the water on the top surface of the object is :

(A) 2.0×10^5 N (B) 2.1×10^5 N (C) 2.2×10^5 N (D) 2.3×10^5 N

8. The tension in the wire is :

(A) 0.1×10^5 N (B) 0.2×10^5 N (C) 0.3×10^5 N (D) 0.4×10^5 N

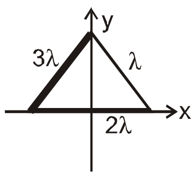
9. The buoyant force on the object is :

(A) 0.1×10^5 N (B) 0.2×10^5 N (C) 0.3×10^5 N (D) 0.4×10^5 N

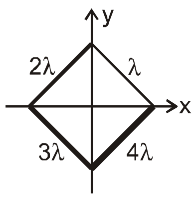
10. In each situation of column-I a mass distribution is given and information regarding x and y-coordinate of centre of mass is given in column-II. Match the figures in column-I with corresponding information of centre of mass in column-II.

Column-I

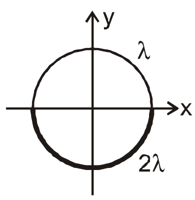
(A) An equilateral triangular wire frame is made using three thin uniform rods of mass per unit lengths λ, 2λ and 3λ as shown



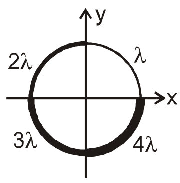
(B) A square frame is made using four thin uniform rods of mass per unit length lengths λ, 2λ, 3λ and 4λ as shown



(C) A circular wire frame is made of two uniform semicircular wires of same radius and of mass per unit length λ and 2λ as shown



(D) A circular wire frame is made of four uniform quarter circular wires of same radius and mass per unit length λ, 2λ, 3λ and 4λ as shown



Column-II

(p) $x_{cm} \geq 0$

(q) $y_{cm} \geq 0$

(r) $x_{cm} < 0$

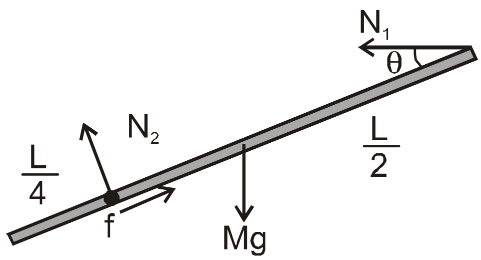
(s) $y_{cm} < 0$

Answers Key

1. (A) **2.** (C) **3.** (B) **4.** (B)
5. (B), (C), (D) **6.** a **7.** (B)
8. (B) **9.** (B)
10. (A) q,r (B) p,s (C) p,s (D) p,s

Hints & Solutions

1. The FBD of rod is
Taking moment of force about centre of mass



$$N_2 \times \frac{L}{4} - N_1 \sin\theta \times \frac{L}{2} = 0$$

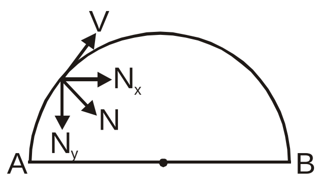
$$\therefore \quad \frac{N_1}{N_2} = \frac{1}{2\sin\theta}$$

2. $E = \int dE = \int_{x=a}^{b} \frac{2K\sigma\, dx}{x} = 2\,K\,\sigma\,\ell n\,\frac{b}{a}$

$$V = \int dV = \int_{x=a}^{b} \frac{K\,\pi\, x\,\sigma\, dx}{x} = K\,\sigma\,\pi\,(b-a).$$

$$\Rightarrow \quad \frac{E}{V} = \frac{2k\sigma\ell n(b/a)}{k\sigma\pi(b-a)} = \frac{\ln(b/a)^2}{\pi(b-a)}$$

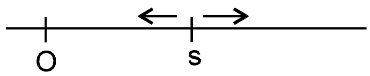
3.



The horizontal component of velocity of Q will increase and become maximum at the top ; and will again become same at B. Because of its greater horizontal velocity the particle Q will reach B earlier than P

$\therefore \quad t_1 > t_2$.

4. Given : f_0 = 200 Hz. , A = 50 cm = 0.5 m, V = 340 m/s.
According to question :



$$\frac{2f_0(V_s)_{max}}{V} = 20 \quad \Rightarrow 20$$

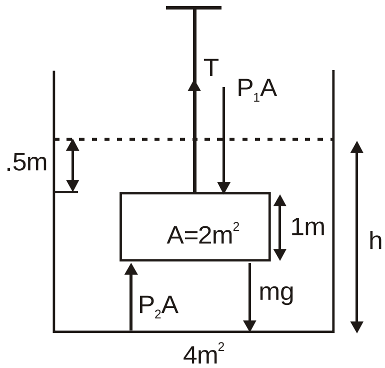
$$= \frac{2 \times 200 \times 0.5 \times \omega}{340} \quad \left(\text{since}; (V_S)_{max} = A\omega\right)$$

$\Rightarrow \omega$ = 34 rad/s.

5. B,C,D direction of friction do not dpend on direction of force but it depends on direction of relative motion (velocity)

6. **a**

9. (i) By conservation of volume
4 × h = 4 × 2 + 2 × 1 = 10
h = 2.5m
Pressure at top of the object
= P_0 + 0.5 × 1000 × 10
= 1.05 × 10^5 N/m^2
F = P_1A
= 1.05 × 10^5 × 2 = 2.1 × 10^5 N



By F.B.D.
$T + P_2A = mg = P_1A$
$T = mg + (P_1 - P_2) A$
$= mg - (P_2 - P_1) A$
= 2 × 2000 × 10 – (.2 × 10^5)
= .4 × 10^5 – 0.2 × 10^5 = 0.2 × 10^5 N
$F_b = V.\rho_w g$
= 2 × 1000 × 10 = 0.2 × 10^5 N

It is also equal to net contact force by the liquid = $P_2A - P_1A$ = 0.2 × 10^5N

Note : Net contact force and buoyant force are same.

10. (A) q,r (B) p,s (C) p,s (D) p,s
(A) Centre of mass lies in second quadrant.
(B), (C) and (D) Centre of mass lies on y-axis and below x-axis.