PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 33

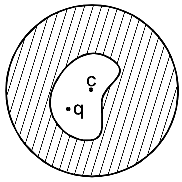
Total Marks : 33

Max. Time : 36 min.

Topics : Electrostatics, Gravitation, Work, Power and Energy, Projectile Motion, Elasticity & Viscosity, Geometrical Optics, Sound Wave, Friction

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.7	(3 marks, 3 min.)	[21, 21]
Subjective Questions ('–1' negative marking) Q.8	(4 marks, 5 min.)	[4, 5]
Match the Following (no negative marking) (2 × 4) Q.9	(8 marks, 10 min.)	[8, 10]

1. The figure shows a charge q placed inside a cavity in an uncharged conductor. Now if an external electric field is switched on :

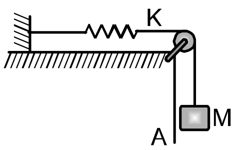


(A) only induced charge on outer surface will redistribute.
(B) only induced charge on inner surface will redistribute.
(C) both induced charge on outer and inner surface will redistribute.
(D) force on charge q placed inside the cavity will change.

2. A certain quarternary star system consists of three stars, each of mass m, moving in same circular orbit about a stationary central star of mass M. The three identical stars orbit in same sense and are symmetrically located with respect to each other. Considering gravitational force of all remaining bodies on every star, the time period of each of three stars is :

(A) $2\pi\sqrt{\dfrac{r^3}{G\left(M+\dfrac{m}{3}\right)}}$ (B) $2\pi\sqrt{\dfrac{r^3}{G\left(M+\dfrac{m}{\sqrt{3}}\right)}}$ (C) $2\pi\sqrt{\dfrac{r^3}{G(M+3m)}}$ (D) $2\pi\sqrt{\dfrac{r^3}{G(M+\sqrt{3}m)}}$

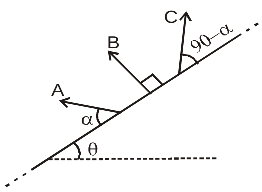
3. Block A in the figure is released from rest when the extension in the spring is x_0 ($x_0 < Mg/k$). The maximum downwards displacement of the block is (ther is no friction) :



(A) $\dfrac{2Mg}{K} - 2x_0$ (B) $\dfrac{Mg}{2K} + x_0$

(C) $\dfrac{2Mg}{K} - x_0$ (D) $\dfrac{2Mg}{K} + x_0$

4. Three stones A, B, C are projected from surface of very long inclined plane with equal speeds and different angles of projection as shown in figure. The incline makes an angle θ with horizontal. If H_A, H_B and H_C are maximum height attained by A, B and C respectively above inclined plane then : (Neglect air friction)

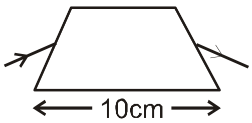


(A) $H_A + H_C = H_B$ (B) $H_A^2 + H_C^2 = H_B^2$ (C) $H_A + H_C = 2H_B$ (D) $H_A^2 + H_C^2 = 2H_B^2$

5. When a ball is released from rest in a very long column of viscous liquid, its downward acceleration is 'a'(just after release). Then its acceleration when it has acquired two third of the maximum velocity :

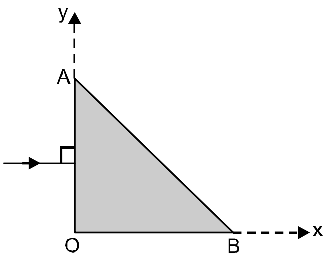
(A) $\frac{a}{3}$ (B) $\frac{2a}{3}$ (C) $\frac{a}{6}$ (D) none of these

6. An isosceles trapezium of reflecting material of refractive index $\sqrt{2}$ and dimension of sides being 5cm, 5cm, 10cm and 5cm. The angle of minimum deviation by this when light is incident from air and emerges in air is:



(A) $22\frac{1}{2}°$ (B) 45° (C) 30° (D) 60°

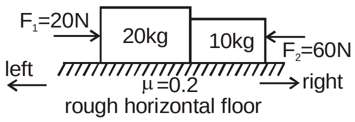
7. A triangular medium has varying refracting index $n = n_0 + ax$, where x is the distance (in cm) along x–axis from origin and $n_0 = \frac{4}{3}$. A ray is incident normally on face OA at the mid–point of OA. The range of a so that light does not escape through face AB when it falls first time on the face AB (OA = 4 cm, OB = 3 cm and AB = 5 cm) : (Surrounding medium is air)



(A) $a > \frac{1}{9}$ (B) $a > \frac{2}{9}$ (C) $a > \frac{1}{3}$ (D) None of these

8. A string 25 cm long fixed at both ends and having a mass of 2.5 g is under tension. A pipe closed from one end is 40 cm long. When the string is set vibrating in its first overtone and the air in the pipe in its fundamental frequency, 8 beats per second are heard. It is observed that decreasing the tension in the string decreases the beat frequency. If the speed of sound in air is 320 m/s. Find tension in the string.

9. Two blocks of masses 20 kg and 10 kg are kept or a rough horizontal floor. The coefficient of friction between both blocks and floor is $\mu = 0.2$. The surface of contact of both blocks are smooth. Horizontal forces of magnitude 20 N and 60 N are applied on both the blocks as shown in figure. Match the statement in column-I with the statements in column-II.



Column-I	Column-II
(A) Frictional force acting on block of mass 10 kg	(p) has magnitude 20 N
(B) Frictional force acting on block of mass 20 kg	(q) has magnitude 40 N
(C) Normal reaction exerted by 20 kg block on 10 kg block	(r) is zero
(D) Net force on system consisting of 10 kg block and 20 kg block	(s) is towards right (in horizontal direction).

Answers Key

1.	(A)	**2.**	(B)	**3.**	(A)	**4.**	(A)
5.	(A)	**6.**	(C)	**7.**	(B)		

8. 27.04 N **9.** (A) p,s (B) p,s (C) q,s (D) r

Hints & Solutions

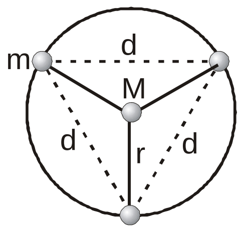
1. The distribution of charge on the outer surface, depends only on the charges outside, and it distributes itself such that the net, electric field inside the outer surface due to the charge on outer surface and all the outer charges is zero. Similarly the distribution of charge on the inner surface, depends only on the charges inside the inner surface, and it distributes itself such that the net, electric field outside the inner surface due to the charge on inner surface and all the inner charges is zero.
Also the force on charge inside the cavity is due to the charge on the inner surface. Hence answer is option **(A)**.

2. The distance between the orbiting stars is $d = 2r\cos 30° = \sqrt{3}\,r$. The net inward force on orbiting stars is

$$\frac{Gm^2}{d^2}\cos 30° + \frac{GMm}{r^2} + \frac{Gm^2}{d^2}\cos 30° = \frac{mv^2}{r}$$

$$\therefore \quad G\left[\frac{m}{\sqrt{3}} + M\right] = \frac{4\pi^2 r^3}{T^2}$$

$$\text{or} \quad T = 2\pi\sqrt{\frac{r^3}{G\left(M + \frac{m}{\sqrt{3}}\right)}}$$



3. $\frac{1}{2}kx_0^2 + Mgh = \frac{1}{2}k(x_0+h)^2 + 0$

$\Rightarrow h = \frac{2Mg}{k} - 2x_0$

Maximum downward displacement

$= [\frac{2Mg}{k} - 2x_0]$

4. $H = \dfrac{u_{\perp}^2}{2a_{\perp}}$

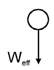
$a_{\perp}$ is same for all the three cases.

$H_A = \dfrac{(u\sin\alpha)^2}{2a_{\perp}}$, $H_B = \dfrac{u^2}{2a_{\perp}}$

and $H_C = \dfrac{(u\cos\alpha)^2}{2a_{\perp}}$

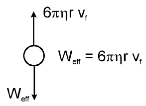
$\therefore H_B = H_A + H_C$

5. (A)



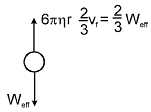
when the ball is released

Figure (1)



when the ball attains terminal velocity

Figure (2)



when the ball attains 2/3rd of terminal velocity

Figure (3)

When the ball is just released, the net force on ball is W_{eff} (= mg – buoyant force)
The terminal velocity 'v_f' of the ball is attained when net force on the ball is zero.

$\therefore$ Viscous force $6\pi\eta r\ v_f = W_{eff}$

When the ball acquires $\dfrac{2}{3}$rd of its maximum velocity v_f

the viscous force is $= \dfrac{2}{3} W_{eff}$.

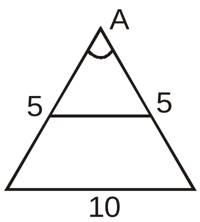
Hence net force is $W_{eff} - \dfrac{2}{3}W_{eff} = \dfrac{1}{3}W_{eff}$

$\therefore$ required acceleration is $= \dfrac{a}{3}$

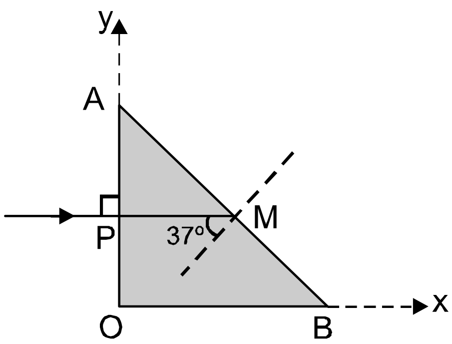
6. If we complete the trapezium as shown It becomes an equilateral triangle

$\Rightarrow$ A = 60°

$$\frac{\sin\left[\dfrac{A+\delta_{min}}{2}\right]}{\text{Smn}\dfrac{A}{2}} = \mu$$



$$\frac{\sin\left[\dfrac{60+\delta_{min}}{2}\right]}{\sin\dfrac{60}{2}} = \sqrt{2}, \quad \delta_{min} = 30°$$

7. 

Clearly, PM = $\frac{3}{2}$ cm

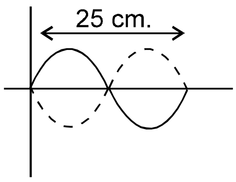
$$37^\circ > \sin^{-1}\frac{1}{n_0 + a(3/2)}$$

$$\frac{3}{5} > \frac{1}{n_0 + \frac{3a}{2}}$$

$$3n_0 + \frac{9a}{2} > 5$$

$$\frac{9a}{2} > 1$$

$$a > \frac{2}{9}$$

8. 

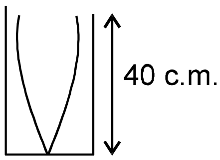
$\mu = \frac{2.5}{25}$ = 0.1 g / cm = 10^{-2} Kg/m

I[st] overtone

λ_s = 25 cm = 0.25 m

$$f_s = \frac{1}{\lambda_s}\sqrt{\frac{T}{\mu}}$$

pipe in fundamental freq



λ_p = 160 cm = 1.6 m

$$f_p = \frac{V}{\lambda_p}$$

$\because$ by decreasing the tension , beat freq is decreased

$\therefore\ f_s > f_p$

$\Rightarrow\ f_s - f_p = 8$

$$\Rightarrow\ \frac{1}{0.25}\sqrt{\frac{T}{10^{-2}}} - \frac{320}{1.6} = 8$$

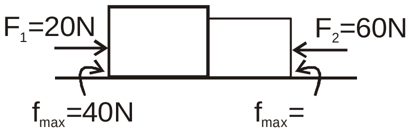
$$\Rightarrow\ T = 27.04\ N$$

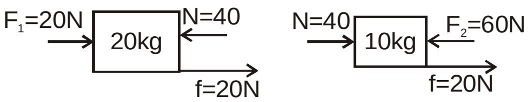
9. (A) p,s (B) p,s (C) q,s (D) r

The minimum horizontal force required to push the two block system towards left

= 0.2 × 20 × 10 + 0.2 × 10 × 10 = 60.

Hence the two block system is at rest. The FBD of both of blocks is as shown. The friction force f and normal reaction N for each block is as shown.





FBD of both blocks

Hence magnitude of friction force on both blocks is 20 N and is directed to right for both blocks. Normal reaction exerted by 20 kg block on 10 kg block has magnitude 40 N and is directed towards right. Net force on system of both blocks is zero.