**PHYSICS**

**DPP**

DAILY PRACTICE PROBLEMS

# DPP No. 34

**Total Marks : 32**

**Max. Time : 36 min.**

**Topics : Gravitation ,Work, Power and Energy, Elasticity & Viscosity, Sound Wave, Relative Motion, Electrostatics.**

| Type of Questions | | M.M., Min. |
|---|---|---|
| Single choice Objective ('–1' negative marking) Q.1 | (3 marks, 3 min.) | [3, 3] |
| Multiple choice objective ('–1' negative marking) Q.2 | (4 marks, 4 min.) | [4, 4] |
| Subjective Questions ('–1' negative marking) Q.3 to Q.6 | (4 marks, 5 min.) | [16, 20] |
| Comprehension ('–1' negative marking) Q.7 to Q.9 | (3 marks, 3 min.) | [9, 9] |

**1.** The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is $V_0$. The value of orbital velocity for another satellite orbiting at an altitude of half of earth's radius is

(A) $\left(\frac{3}{2}\right)V_0$ (B) $\sqrt{\frac{3}{2}}V_0$ (C) $\sqrt{\frac{2}{3}}V_0$ (D) $\left(\frac{2}{3}\right)V_0$

**2.** The potential energy (in joules) of a particle of mass 1kg moving in a plane is given by V = 3x + 4y, the position coordinates of the point being x and y, measured in metres. If the particle is at rest at (6, 4) ; then

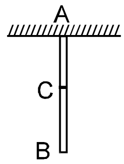
(A) its acceleration is of magnitude $5m/s^2$

(B) its speed when it crosses the y–axis is 10m/s

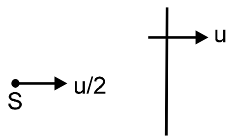
(C) it crosses the y-axis (x = 0) at y = –4

(D) it moves in a striaght line passing through the origin (0, 0)

**3.** A wire of uniform cross section is hanging vertically and due to its own weight its length changes. There is a point 'C' on the wire such that change in length AC is equal to the change in length BC. Points A, B & C are shown in figure. Find $\frac{AC}{BC}$.

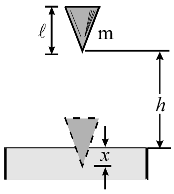



**4.** A wall is moving with velocity u and a source of sound moves with velocity $\frac{u}{2}$ in the same direction as shown in the figure. Assuming that the sound travels with velocity 10u. Find the ratio of incident sound wavelength on the wall to the reflected sound wavelength by the wall.



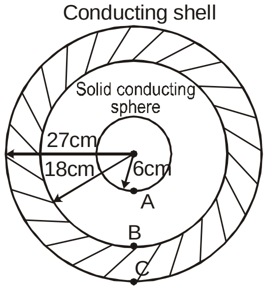

**5.** Two particles P and Q are moving with velocities of $(\hat{i}+\hat{j})$ and $(-\hat{i}+2\hat{j})$ respectively. At time t = 0, P is at origin and Q is at a point with position vector $(2\hat{i}+\hat{j})$. Find the equation of the path of Q with respect to P.

**6.** A cone of mass 'm' falls from a height 'h' and penetrates into sand. The resistance force R of the sand is given by $R = kx^2$. If the cone penetrates upto a distance x = d where d < $\ell$ , then find the value of 'k'.

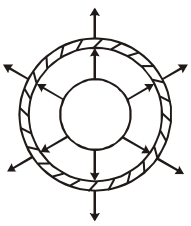
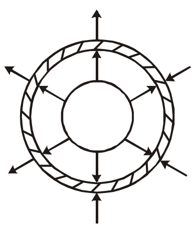
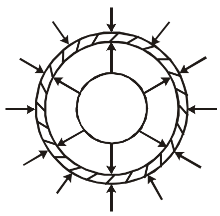
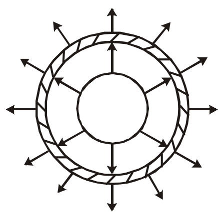



**COMPREHENSION**

A solid, conducting sphere of radius 6 cm carries a charge 3nC. This sphere is located centrally inside a thick, conducting sphere with an inner radius of 18 cm and an outer radius of 27 cm. The hollow sphere is also given a charge 3nC.Three points A, B and C are marked on the surfaces as shown.




**7.** Which one of the following figures shows a qualitatively accurate sketch of the electric field lines in and around this system ?

(A)  (B)  (C)  (D) 

**8.** Suppose $V_A$,$V_B$ and $V_C$ are potentials at points A,B and C respectively then values of potential differences $V_C - V_B$ and $V_B - V_A$ respectively are :

(A) 0 V and – 300 V
(B) 0 V and 300 V
(C) 450 V and 150 V
(D) 0 V and – 150 V

**9.** Suppose the shell is given additional charge 3nC. The potential difference $V_B - V_A$ will become :

(A) –100 V (B) –200 V (C) 300 V (D) –300 V

# Answers Key

**1.** (C) **2.** (A,B,C) **3.** $\frac{AC}{PC} = \frac{\ell - x}{x} = (\sqrt{2} - 1)$

**4.** $\mathbf{\frac{9}{11}}$ **5.** **x + 2y = 4** **6.** $\frac{3mg}{d^3}(h + d)$

**7.** (D) **8.** (A) **9.** (D)

# Hints & Solutions

**2.** U = 3x + 4y

$$a_y = \frac{F_y}{m} = \frac{-(\partial U/\partial x)}{m} = -3$$

$$a_x = \frac{F_y}{m} = \frac{-(\partial U/\partial y)}{m} = -4$$

$\Rightarrow$ $|\vec{a}|$ = **5 m/s²**

Let at time 't' particle crosses y-axis

then $-6 = \frac{1}{2}(-3)t^2$

$\Rightarrow$ t = 2 sec.

Along y-direction :

$$\Delta y = \frac{1}{2}(-4)(2)^2 = -8$$

$\Rightarrow$ particle crosses y-axis at **y = – 4**

At (6, 4) : U = 34 & KE = 0

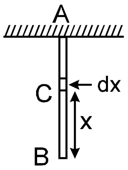
At (0, – 4) : U = – 16

$\Rightarrow$ KE = 50

or, $\frac{1}{2}mv^2 = 50$

$\Rightarrow$ **v = 10 m/s** while crossing y-axis

**3.**




Tension in elementary section of width dx is

T = λ xg (λ = mass / length)

∴ extension of length x (= BC) of wire is

$$\Delta x = \int_0^x \frac{(\lambda x g)}{YA} dx = \frac{\lambda x^2}{2YA} \qquad \text{... (1)}$$

$\Rightarrow$ extension in total length of wire $\ell$(=AB) is 2Δx

$$2\Delta x = \frac{\lambda \ell^2 g}{2YA} \qquad \text{... (2)}$$

$\therefore$ from equation (1) and (2)

$x = \frac{\ell}{\sqrt{2}}$

**Ans.** $\frac{AC}{PC} = \frac{\ell - x}{x} = (\sqrt{2} - 1)$

**4.** $\lambda_i$ = wavelength of the incident sound

$= \frac{10u - \frac{u}{2}}{f} = \frac{19u}{2f}$

$f_i$ = frequency of the incident sound

$= \frac{10u - u}{10u - \frac{u}{2}} f = \frac{18}{19} f = f_r$ = frequency of the reflected sound

$\lambda_r$ = wavelength of the reflected sound

$= \frac{10u + u}{f_r} = \frac{11u}{18f} \times 19$ **=** $\frac{11 \times 19}{18} \cdot \frac{u}{f}$

$\frac{\lambda_i}{\lambda_r} = \frac{19u}{2f} \times \frac{18f}{11 \times 19u} = \mathbf{\frac{9}{11}}$ **Ans.**

**5.** $\vec{r}_P = (\hat{i} + \hat{j})t$

$\vec{r}_Q = (2\hat{i} + \hat{j}) + (-\hat{i} + 2\hat{j})t$

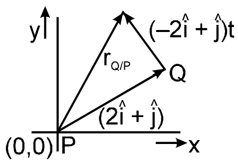
$\vec{r}_{QP} = \vec{r}_Q - \vec{r}_P = 2\hat{i} + \hat{j} + (-2\hat{i} + t\hat{j})$

$\vec{r}_{QP} = (2 - 2t)\hat{i} + (1 + t)\hat{j}$

$x = 2 - 2t \quad y = 1 + t$

$\Rightarrow \quad x = 2 - 2(y - 1)$

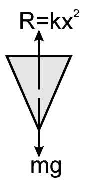
**x + 2y = 4 Ans.**




**6.** Force on cone while it is penetrating the sand is shown in F.B.D. below

Applying work energy theorem to the cone as x changes from 0 to d

$\Delta$KE = work done by mg + work done by resistive force R



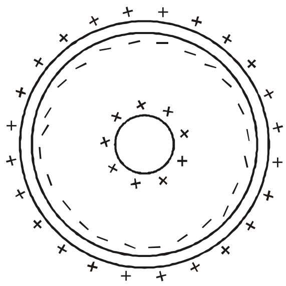

$$K_{Final} - K_{Initial} = mgd - \int_0^d kx^2\,dx$$

$$0 - mgh = mgd - \int_0^d kx^2\,dx$$

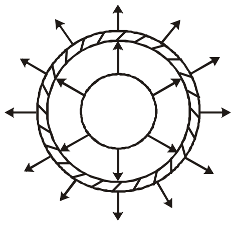
$$\therefore \quad \frac{kd^3}{3} = (mgd + gh)$$

$$\Rightarrow \quad k = \frac{3mg}{d^3}(h + d)$$

**7.** (A) Charge distribution on system is shown below



So electric lines of forces are as shown below



Since number of lines of force are proportional to charge so no. of lines of forces emerging from inner sphere should be equal to the no. of lines of forces emerging from outer shell.

**8.** $V_B = K\left[\frac{6\times10^{-9}}{27\times10^{-2}} - \frac{3\times10^{-9}}{18\times10^{-2}} + \frac{3\times10^{-9}}{18\times10^{-2}}\right] = 200\ V$

$V_A = K\left[\frac{6\times10^{-9}}{27\times10^{-2}} - \frac{3\times10^{-9}}{18\times10^{-2}} + \frac{3\times10^{-9}}{6\times10^{-2}}\right]$

$= \quad 200\ V - 150\ V + 450\ V$

$= \quad 500\ V$

$V_C = V_B$ (as shell is conducting)

Therefore, $V_C - V_B = 0$

$V_B - V_A = -300\ V$

**9.** Potential at point B and point C increases by same value, keeping their difference unchanged.