DPP - Daily Practice Problems

Chapter-wise Sheets

Date : | **Start Time :** | **End Time :**

PHYSICS

CP15

SYLLABUS : Electrostatic Potential and Capacitance

Max. Marks : 74 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 20 Questions divided into 5 sections.
  Section I has **6** MCQs with ONLY 1 Correct Option, **3** marks for each correct answer and **–1** for each incorrect answer.
  Section II has **4** MCQs with ONE or MORE THAN ONE Correct options.
  For each question, marks will be awarded in one of the following categories:
  Full marks: **+4** If only the bubble(s) corresponding to all the correct option(s) is (are) darkened.
  Partial marks: **+1** For darkening a bubble corresponding to each correct option provided NO INCORRECT option is darkened.
  Zero marks: If none of the bubbles is darkened.
  Negative marks: **–2** In all other cases.
  Section III has **4** Single Digit Integer Answer Type Questions, **3** marks for each Correct Answer and 0 marks in all other cases.
  Section IV has Comprehension Type Questions having **4** MCQs with ONLY ONE corect option, 3 marks for each Correct Answer and 0 marks in all other cases.
  Section V has **2** Matching Type Questions, **2** mark for the correct matching of each row and 0 marks in all other cases.
- You have to evaluate your Response Grids yourself with the help of Solutions.

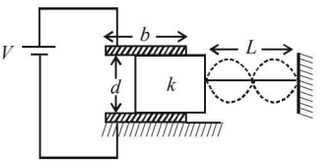
Section I - Straight Objective Type

This section contains 6 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

1. If the electrostatic potential were given by $\phi = \phi_0 (x^2 + y^2 + z^2)$, where ϕ_0 is constant, then the charge density giving rise to the above potential would be

(a) 0 (b) $-6\,\phi_0\varepsilon_0$ (c) $-2\,\phi_0\varepsilon_0$ (d) $-\dfrac{6\phi_0}{\varepsilon_0}$

2. A dielectric slab is attached to a string of mass per unit length μ, whose other end is fixed to a wall. Capacitor has square plates of side b and separation between the plates is d. Find the fundamental frequency of vibration of the string. (Dielectric slab remains in equilibrium)



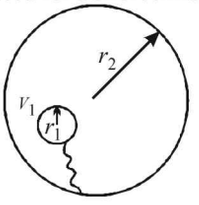
(a) $\dfrac{1}{2L}\sqrt{\dfrac{\in_0 bV^2(k-1)\mu}{2d}}$ (b) $\dfrac{1}{2L}\sqrt{\dfrac{\in_0 bV^2(k+1)\mu}{2d}}$

(c) $\dfrac{1}{2L}\sqrt{\dfrac{\in_0 bV(k-1)}{2d\mu}}$ (d) $\dfrac{1}{2L}\sqrt{\dfrac{\in_0 bV^2(k-1)}{2d\mu}}$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ

Space for Rough Work

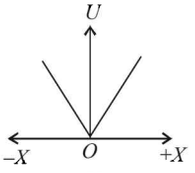
3. A metal sphere having a radius r_1 charged to a potential V_1 is enveloped by a thin-walled conducting spherical shell of radius r_2 (figure). Determine the potential V_2 acquired by the sphere after it has been connected for a short time to the shell by a conductor.

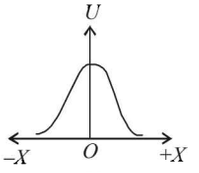


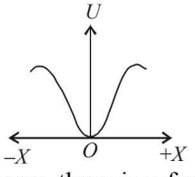
(a) $V_1 \frac{2r_1}{r_2}$ (b) $V_1 \frac{r_1}{2r_2}$

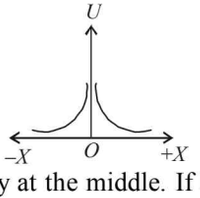
(c) $V_1 \frac{r_1}{r_2}$ (d) $V_1 \frac{r_2}{r_1}$

4. Four identical charges are placed at the four vertices of a square lying in YZ plane. A fifth charge is moved along X axis. The variation of potential energy (U) along X axis is correctly represented by

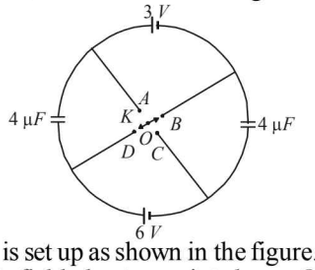
(a) 

(b) 

(c) 

(d) 

5. In figure, there is a four way key at the middle. If key is shown from situation BD to AD, then how much charge will flow through point O ?



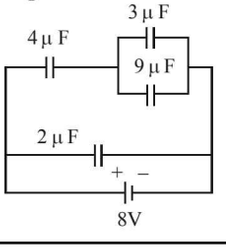
(a) 24 μC

(b) 36 μ**C**

(c) 72 μC

(d) 12 μC

6. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the 4 μ F and 9 μ F capacitors), at a point distance 30 m from it, would equal :



(a) 420 N/C

(b) 480 N/C

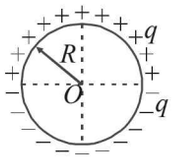
(c) 240 N/C

(d) 360 N/C

Section II - Multiple Correct Answer Type

This section contains 4 multiple correct answer(s) type questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONE OR MORE** is/are correct.

7. A non conducting ring of radius R is charged as shown in figure :



(a) The electric field is zero at the centre of the ring

(b) the electric potential is zero at centre of the ring

(c) the electric potential at the centre is, $V = \frac{2q}{4\pi \epsilon_0 R}$

(d) the electric field at the centre is , $E = \frac{q}{\pi^2 \epsilon_0 R^2}$

8. Which of the following quantities do not depend on the choice of zero potential or zero potential energy ?

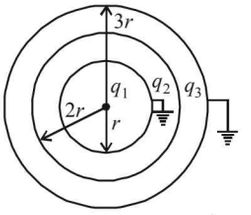
(a) Potential at a point

(b) Potential difference between two points

(c) Potential energy of two-charge system

(d) Change in potential energy of a two-charge system

9. Three concentric conducting spherical shells have radii r, $2r$ and $3r$ and charge q_1, q_2 and q_3 respectively as shown in the figure. Select the correct alternatives



(a) $q_1 + q_3 = -q_2$

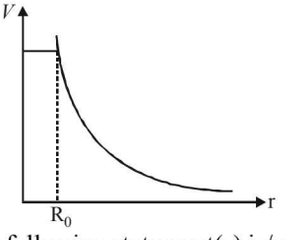
(b) $q_1 = -\frac{q_2}{4}$

(c) $\frac{q_3}{q_1} = 3$

(d) $\frac{q_3}{q_2} = -\frac{1}{3}$

10. A spherical symmetric charge system is centered at origin. Given, Electric potential

$$V = \frac{Q}{4\pi\varepsilon_0 R_0} \ (r \le R_0), \quad V = \frac{Q}{4\pi\varepsilon_0 r} \ (r > R_0)$$



Which of the following statement(s) is/are correct ?

(a) Within $r = 2R_0$ total enclosed net charge is Q

(b) Electric field is discontinued at $r = R_0$

(c) Charge is only present at $r = R_0$

(d) Electrostatic energy is zero for $r < R_0$

RESPONSE GRID										
	3. (a)(b)(c)(d)	4. (a)(b)(c)(d)	5. (a)(b)(c)(d)	6. (a)(b)(c)(d)	7. (a)(b)(c)(d)
	8. (a)(b)(c)(d)	9. (a)(b)(c)(d)	10. (a)(b)(c)(d)		

Space for Rough Work

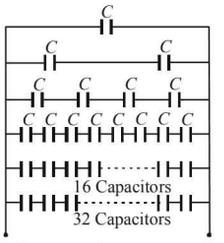
Section III - Integer Type

This section contains 4 questions. The answer to each of the questions is a single digit integer ranging from 0 to 9.

11. Two square metal plates of side 1 m are kept 0.01 m apart like a parallel plate capacitor in air in such a way that one of their edges is perpendicular to an oil surface in a tank filled with an insulating oil. The plates are connected to a battery of emf 564 *V*. The plates are then lowered vertically into the oil at a speed of $0.001\ ms^{-1}$. Calculate the current (in nano ampere) drawn from the battery during the process. (Dielectric constant of oil = 11, $\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-1}$)

12. Two insulated metal spheres of radii 10 cm and 15 cm charged to a potential of 150 V and 100 V respectively, are connected by means of a metallic wire. What is the charge on the first sphere (in e.s.u.) ?

13. Infinite number of identical capacitors (each of capacity 1 μF) are connected as shown in figure. Find the equivalent capacitance (in μF)of system between the terminals shown in figure.



14. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system decreased by a factor of x. Find the value of x.

Section IV - Comprehension Type

Directions (Qs. 15-18) : Based upon the given paragraphs, 4 multiple choice questions have to be answered. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

PARAGRAPH-1

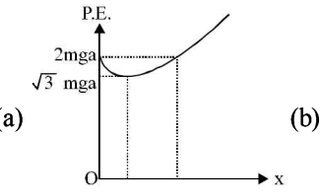
A non-conducting disc of radius 'a' and uniform surface charge density σ is placed on the ground, with its axis vertical. A particle of mass m and positive charge q is dropped, along the axis of the disc, from a height H with zero initial velocity. The particle has $q/m = 4\pi\varepsilon_0 g/\sigma$.

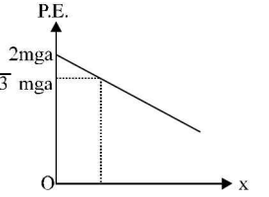
15. Electrostatic potential at H is

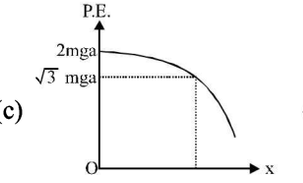
(a) $\frac{\sigma}{\varepsilon_0}\left[(a^2+H^2)^{1/2}-H\right]$ (b) $\frac{\sigma}{\varepsilon_0}\left[(a^2+H^2)^{1/2}+H\right]$

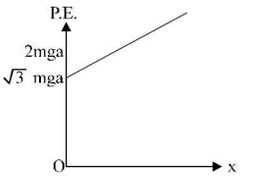
(c) $\frac{\sigma}{2\varepsilon_0}\left[(a^2+H^2)^{1/2}-H\right]$ (d) $\frac{\sigma}{2\varepsilon_0}\left[(a^2+H^2)^{1/2}+H\right]$

16. Which of the following is the correct graph of the potential energy of the particle as a function of its height?

(a)


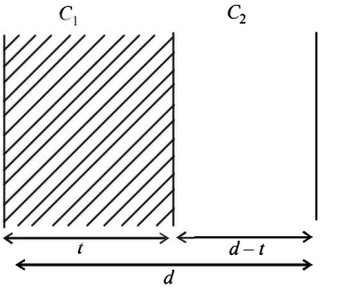
(b)


(c)


(d)


PARAGRAPH-2

A parallel plate condenser consists of two plates of area A and separation d. A slab of thickness t and dielectric constant k is inserted between the plates with its faces parallel to the plates and having the same surface area as shown in the figure. Given $k = 2$.



17. The capacitance of the system is

(a) $\frac{\varepsilon_0 A}{d-(t/2)}$ (b) $\frac{\varepsilon_0 A}{d+(t/2)}$ (c) $\frac{\varepsilon_0 A}{d-t}$ (d) $\frac{\varepsilon_0 A}{d+t}$

18. For what value of t/d will the capacitance of the system be (3/2) times that of the condenser with air filling the full space

(a) 2/3 (b) 3/2 (c) 1 (d) 1/3

RESPONSE GRID			
11. ⓪①②③④⑤⑥⑦⑧⑨	12. ⓪①②③④⑤⑥⑦⑧⑨		
13. ⓪①②③④⑤⑥⑦⑧⑨	14. ⓪①②③④⑤⑥⑦⑧⑨	15. ⓐⓑⓒⓓ	
16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	

Space for Rough Work

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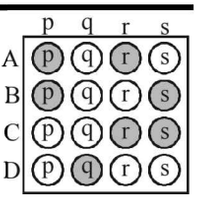
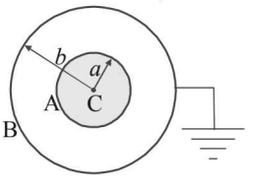
Section V - Matrix-Match Type

This section contains 2 questions. It contains statements given in two columns, which have to be matched. Statements in column I are labelled as A, B, C and D whereas statements in column II are labelled as p, q, r and s. The answers to these questions have to be appropriately bubbled as illustrated in the following example. If the correct matches are A-p, A-r, B-p, B-s, C-r, C-s and D-q, then the correctly bubbled matrix will look like the following:

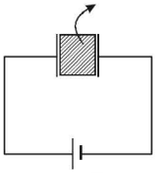
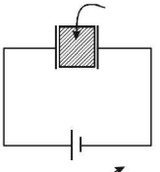
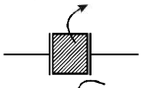
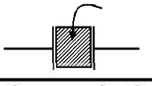


19. A conducting sphere A of radius a, with charge Q is placed concentrically inside a conducting shell B of radius b. B is earthed, C is the common centre of A and B. If P is point between shells A and B at distance r from centre C then for $a = 1\text{m}$, $b = 3\text{m}$ and $r = 2\text{m}$ $\left(K = \dfrac{1}{4\pi \in_0}\right)$



Column - I	Column - II
(A) Electric field at point P is	(p) KQ
(B) Electrical potential at point P is ($v_\infty = 0$)	(q) zero
(C) Electric potential difference between A and B is	(r) $\dfrac{KQ}{4}$
(D) Electric field outside the shell B at distance 5 m from centre C is	(s) $\dfrac{KQ}{6}$

20. Match the columns :

Column I	Column II
(A) Removal of dielectric when battery is present 	(p) Potential difference between plates increases.
(B) Insertion of dielectric when battery is present 	(q) Capacitance increases.
(C) Removal of dielectric when battery is not present 	(r) Stored energy increases.
(D) Insertion of dielectric when battery is not present 	(s) Charge present on plates decreases.

RESPONSE GRID	19. A - (p)(q)(r)(s); B - (p)(q)(r)(s); C - (p)(q)(r)(s); D - (p)(q)(r)(s) 20. A - (p)(q)(r)(s); B - (p)(q)(r)(s); C - (p)(q)(r)(s); D - (p)(q)(r)(s)

DAILY PRACTICE PROBLEM DPP CP15 - PHYSICS			
Total Questions	20	Total Marks	74
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	24	Qualifying Score	35

$$\text{Net Score} = \sum_{i=\text{I}}^{\text{V}} \left[\left(\text{correct}_i \times MM_i \right) - \left(In_i - NM_i \right) \right]$$

Space for Rough Work