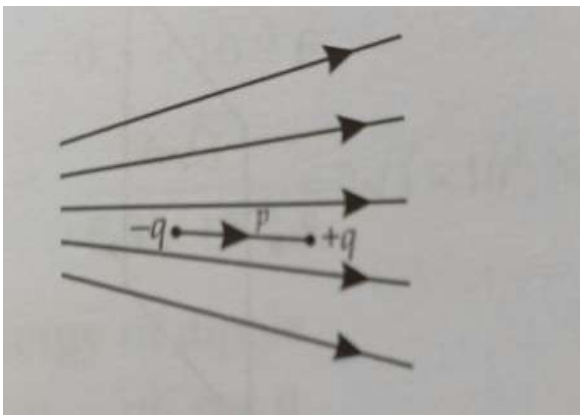
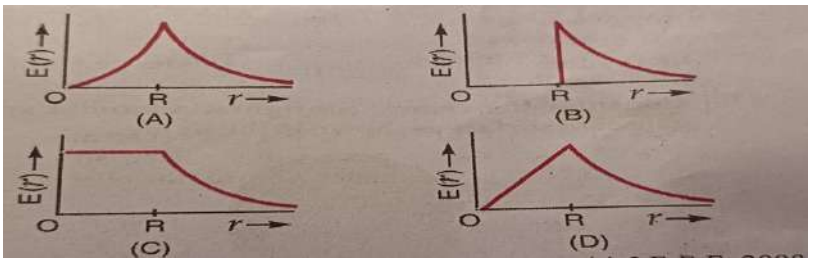
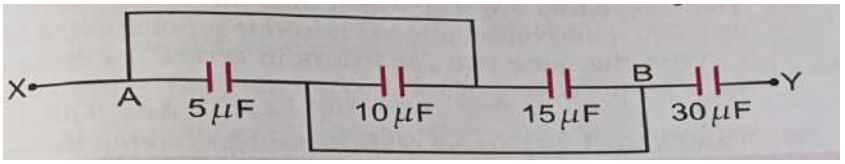
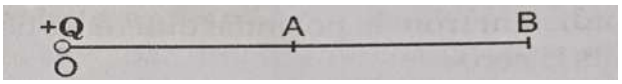
July Unit Test ,2024
SET - A
Class : XII
Subject : PHYSICS

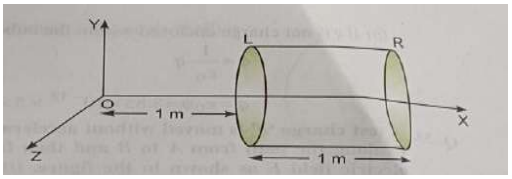
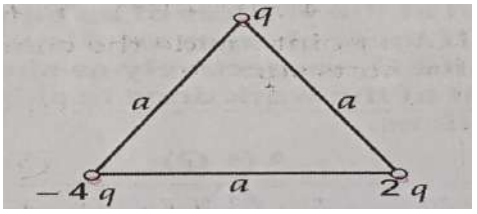
Time: 1 hr 30 min. **M.M.:35**

General Instructions:-

I. There are 17 questions in all. All questions are compulsory.
II. This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
III. Section A contains seven MCQ of one mark each, Section B contains five questions of two marks each, Section C contains three questions of three marks each, section D contains case study based questions of 4 marks and section E contains one long questions of five marks .

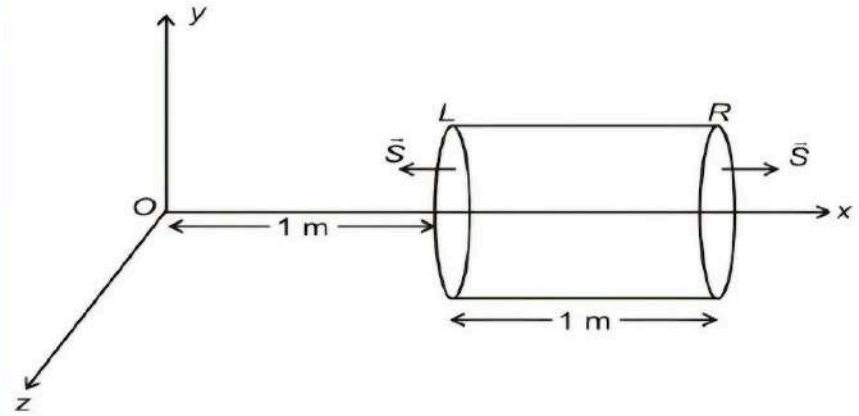
Q. No.	Questions	Marks
	SECTION – A	
1	A negatively charged object X is repelled by another charged object Y. However an object Z is attracted to object Y. Which of the following is the most possibility for the object Z? a) Positively charged only b) negatively charged only c) neutral or positively charged d) neutral or negatively charged	1
2	Figure given shows electric field lines in which an electric dipole $\vec{p}$ is placed as shown.Which of the following statement is correct?  a) The dipole will not experience any force b) The dipole will experience a force towards right c) The dipole will experience a force towards left d) The dipole will experience a force upwards	1
3	A charge q is placed at the point of intersection of body diagonals of a cube. The electric flux passing through any one of its face is a) $q/6\varepsilon_0$ b) $3q/\varepsilon_0$ c) $6q/\varepsilon_0$ d) none of these	1
4	A charge Q is placed at the centre of the line joining two charges q and q. The system of three charges will be in equilibrium if Q is a) +q/3 b) -q/3 c) +q/4 d) -q/4	1

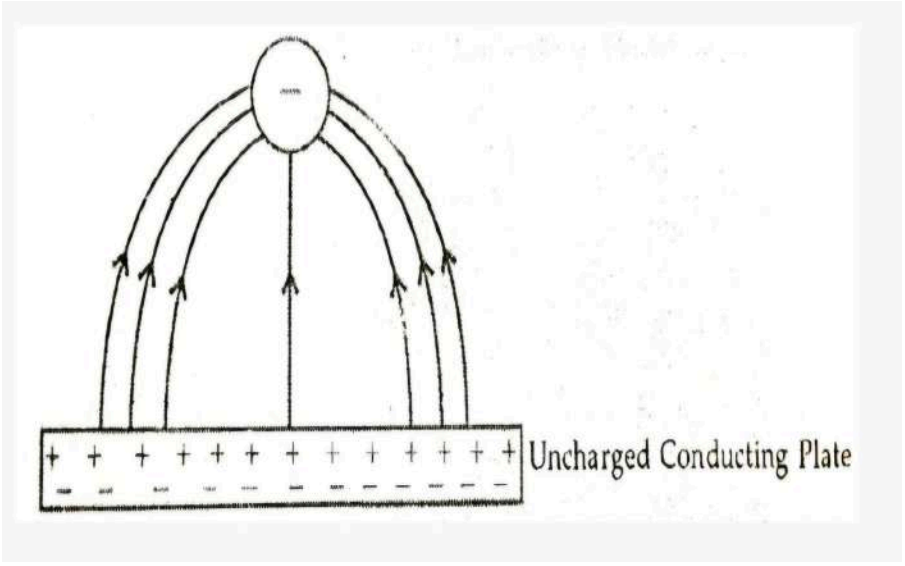
5	**A thin spherical shell of radius R has charge Q spread uniformly over its surface .Which of the following graphs most closely represents the Electric field E(r) produced by shell in range 0 to infinity, where r is the distance from the centre of the shell?**  	**1**
6	**Assertion (A): A system of three positive charges, each having a charge q and placed equally distant from each other along a straight line can not be in equilibrium.** **Reason (R) : The charge in the middle experience zero net force, but the force on other charges is not zero.** **(a) Both A and R are true and R is the correct explanation of A** **(b) Both A and R are true but R is not the correct explanation of A** **(c) A is true but R is false** **(d) A is false and R is also false**	**1**
7	**Assertion (A) : A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times.** **Reason (R) : The surface density of charge on the plate remains constant or unchanged.** **(a) Both A and R are true and R is the correct explanation of A** **(b) Both A and R are true but R is not the correct explanation of A** **(c) A is true but R is false** **(d) A is false and R is also false**	**1**
	SECTION - B	
8	**Why should electrostatic field be zero inside the conductor? Also explain why presence of dielectric increases capacitance of capacitor.**	**2**
9	**Four capacitors are connected as shown in figure:**  **Calculate the equivalent capacitance between the points X and Y.**	**2**
10	**Using Gauss theorem, find electric field intensity at any point due to a line Charge.**	**2**
11	**a) Show that there is no work done in moving a charge from one point to another on an equipotential surface.** **b) A point charge + Q is placed at a point O as shown in figure**  **Is the potential difference V(A) - V(B) positive, negative or zero?**	**2**
12	**Derive the relation between electrical susceptibility and dielectric constant.**	**2**
	SECTION - C	

13	**A hollow cylindrical box of length 1 m and area of cross section 25 cm^2 is placed in a 3 D coordinate system as shown in figure. The electric field in the region is given by $\vec{E}$ = 50x $\hat{i}$, where E in NC^{-1} and x in metres. Find** **I. Net flux through the cylinder.** **II. Charge enclosed by the cylinder** 	**3**
14	**Obtain an expression for the work done to dissociate the system of three charges placed at the vertices of an equilateral triangle of side a as shown in figure** 	**3**
15	**a) Draw a pattern of electric field lines, when a point charge -Q is kept near an uncharged conducting plate.** **b) If potential (in volt) in a region is expressed as** **V(x,y,z) = 6xy - y + 2yz** **Find the electric field (in N/C) at point (1,1,0)**	**1** **2**
	SECTION - D	
16	**An electric dipole of length 0.1 m consists of two charges of + 500 uC (micro coulomb) and - 500 uC (micro coulomb). It is placed in an electric field of strength 10^4 N/C along the direction of the electric field.** **i) The electric dipole moment of the dipole is** **a) 50 × 10^{-6} uCm b) 50 × 10^{-6} Cm c) 500 × 10^{-6} uCm d) 500 × 10^{-6} Cm** **ii) The torque acting on the electric dipole is** **a) Zero ii) 5 Nm iii) 50 Nm iv) 500 Nm** **iii) The work done in rotating the electric dipole through an angle of 90° is** **a) 0.05 J b) 0.5 J c) 5 J d) 50 J** **iv) In case, the electric dipole was placed at an angle of 180° to an uniform electric field, the dipole will be** **a)not in equilibrium b) in stable equilibrium c) in unstable equilibrium d) none of these**	**4**
	SECTION - E	
17	**a) Derive an expression for capacitance of a parallel plate capacitor when a dielectric slab partially fills the space between the plates.** **b) An electrical technician requires a capacitance of 2uF in a circuit across a potential difference of 1 kV. A large no. of 1uF capacitors are available to him, each of which can withstand a potential difference of not more than 400V. Suggest a possible arrangement that requires a minimum no. of capacitors**	**3** **2**

Answer Key
Physics XII (Set - A)
July Test(2024-2025)

1	C	1
2	C	1
3	A	1
4	D	1
5	B	1
6	A	1
7	C	1
8	As charges resides on the surface of conductor, so electric field should be zero inside the conductor. The presence of di electric decreases the electric field which further decreases the potential, so according to formula C=q/V As the potential decreases, capacitance increases..	1 1
9	C_s = 5 + 10 + 15 = 30 uF C_p = (30 × 30) / 30 + 30 = 15 uF	1 1
10	Derivation Only	2
11	$W/q_o = V_b - V_A$ As $V_b = V_A$ So , $W/q_o = 0$ Hence W = 0 V(A) - V(B) is positive as Direction Of electric field is in direction of decreasing potential by formula E = - dV/dR	 0.5 0.5 0.5 0.5
12	Derivation only	2

13	 (i) Electric flux through a surface $\varphi = \vec{E}\cdot\vec{S}$ Flux through the left surface, $\varphi_L = -\lvert E\rvert\lvert S\rvert$ $= -50x,\lvert S\rvert$ Since $x = 1m$ $\varphi_L = -50\times1\times25\times10^{-4}$ $= -1250\times10^{-4}$ $= -0.125\ Nm^2C^{-1}$ Flux through the right surface, $\varphi_R = \lvert E\rvert\lvert S\rvert$ Since $x = 2m$, $\varphi_R = 50\times2\times\lvert s\rvert$ $= 50\times2\times25\times10^{-4}$ $= 2500\times10^{-4}$ $= 0.250\ Nm^2C^{-1}$ Now, flux through the cylinder $\varphi_{Ace} = \varphi_R + \varphi_L$ $= 0.250 - 0.125$ $= 0.125\ Nm^2C^{-1}$ ii) Using Gauss Theorem, we can calculate the charge inside the cylinder. $\Phi_{net} = \frac{q}{\epsilon_o}$ $\Rightarrow q = \epsilon_o\varphi_{net}$ $= 8.854\times10^{-12}\times0.125$ $= 8.854\times10^{-12}\times\frac{1}{8}$ $= 8.854\times10^{-12}\times\frac{1}{8}$	0.5 0.5 0.5 0.5 0.5 0.5

14	Work done to keep the system bound is $W = \frac{K q_1 q_2}{a} + \frac{K q_2 q_3}{a} + \frac{K q_1 q_3}{a}$ $W = \frac{K q(-4q)}{a} + \frac{K(-4q)2q}{a} + \frac{K q(2q)}{a}$ $W = \frac{-K 4q^2}{a} - \frac{K 8q^2}{a} + \frac{K 2q^2}{a}$ $W = \frac{K q^2}{a}(-4-8+2) = \frac{-10 K q^2}{a}$ Therefore, the work done to dissociate the system is $W_d = -W = \frac{10 K q^2}{a}$	0.5 0.5 0.5 0.5 0.5 0.5
15	a)  	1

b)

$$V(x, y, z) = 6xy - y + 2yz$$

As we know that

$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

0.5

Now,

$$\frac{\partial V}{\partial x} = 6y; \qquad \frac{\partial V}{\partial y} = 6x - 1 + 2z$$

$$\frac{\partial V}{\partial z} = 2y$$

0.5

So the electric field become

$$\vec{E} = -6y\,\hat{i} - (6x - 1 + 2z)\,\hat{j} - 2y\,\hat{k}$$

At $(1, 1, 0) \Rightarrow x = 1,\ y = 1,\ z = 0$

0.5

$$\vec{E} = -6\hat{i} - 5\hat{j} - 2\hat{k}$$

0.5

16	i) b ii) a iii) b iv) c	1 1 1 1
17	a) Derivation only. Suppose a number of capacitors are connected in series and these series circuits are connected in parallel (row) to each other. the potential difference across each row must be 1000 V and potential difference across each capacitor must be 400 V. hence,number of capacitors in each row is given as $\frac{1000}{400} = 2.5$ Hence, there are three capacitors in each row. Capacitance of each row $= \frac{1}{1+1+1} = \frac{1}{3}\mu F$ Let there are n rows each hacing three capacitors, which are connected in parallel. Hence, equivalent capacitance of the circuit is given as $\frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \ldots. \; n \text{ terms}$ $= \frac{n}{3}$ However, capacitance of the circuit is given as $2\mu F$ $\therefore \frac{n}{3} = 2$ $n = 6$ Hence, 6 rows of three capacitors are present in the circuit. a minimum of 6 × 3 i.e., 18 capacitors are required for the given arragements. b)	3 0.5 0.5 0.5 0.5

July Unit Test 2024
Class : XI
Subject : PHYSICS

SET - B

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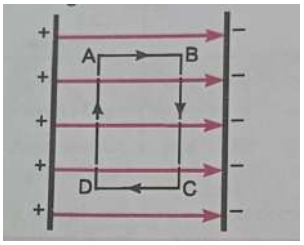
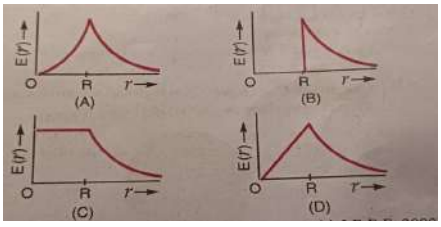
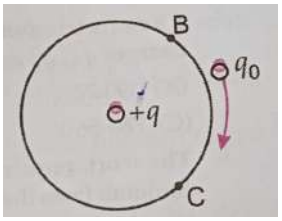
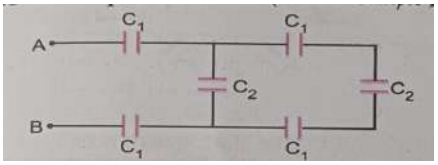
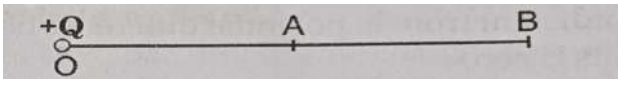
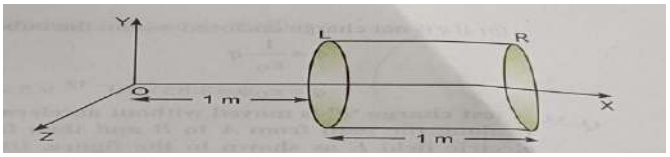
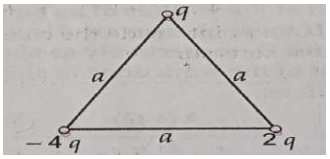
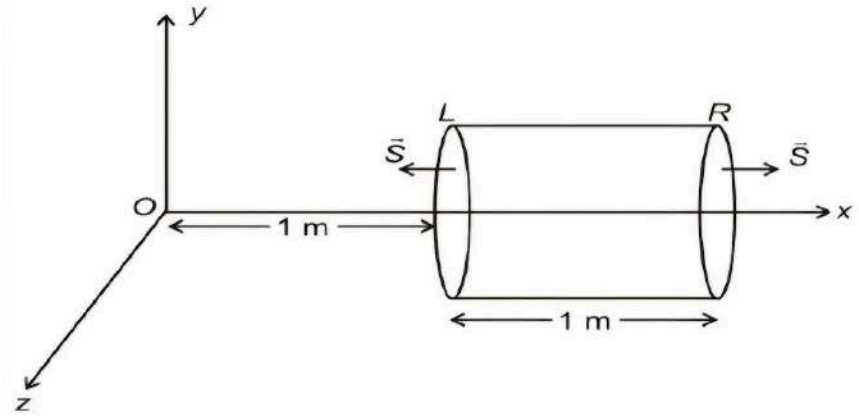
Q. No.	Questions	Marks
	SECTION – A	
1	The electric potential V at any point (x,y,z) is given by $V= 3x^2$ where x in metres and V in volts .The electric field at point (1m,0,2m) is a) 6 V/m along negative x-axis b) 6 V/m along positive x-axis c) 1.5 V/m along negative x-axis d) 1.5 V/m along positive x-axis	1
2	A uniform field E exist between two charged plates as shown in figure. Distance AB and CD are L , distance BC and AD are 2L.  What would be the work done in moving a charge q along the closed rectangular path ABCDA? a) EL b) 2EL c) zero d) none of these	1
3	A thin spherical shell of radius R has charge Q spread uniformly over its surface .Which of the following graphs most closely represents the Electric field E(r) produced by shell in range 0 to infinity, where r is the distance from the centre of the shell? 	1
4	A charge q is placed at the centre of one face of a cube. The total electric flux through faces of cube is a) $q/2\varepsilon_0$ b) $q/ 6\varepsilon_0$ c) $6q/\varepsilon_0$ d) none of these	1

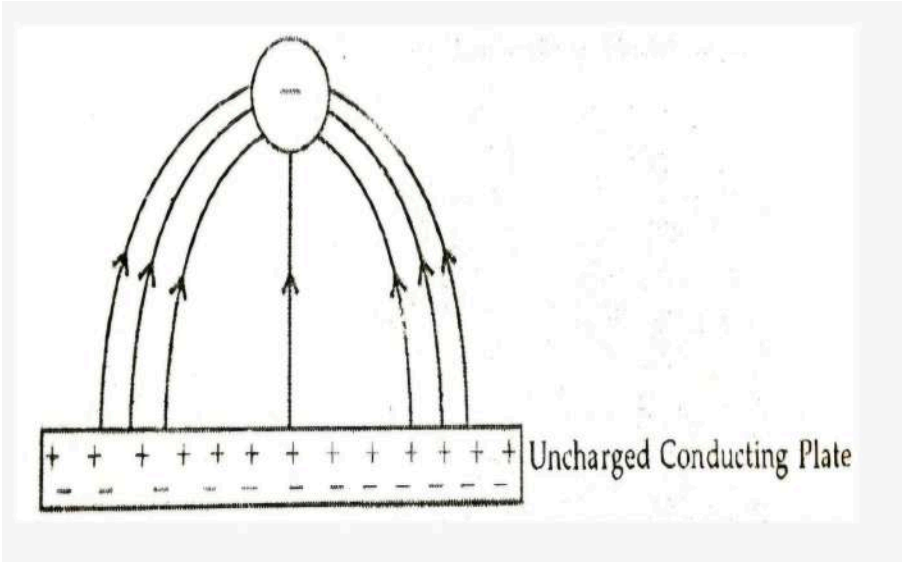
5	**A circle of radius r is drawn with charge +q at the centre. Another charge is brought from point B to C . Then work done is**  **a) Zero b) infinite c) positive d) negative**	**1**
6	**Assertion (A) : A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times.** **Reason (R) : The surface density of charge on the plate remains constant or unchanged.** **(a) Both A and R are true and R is the correct explanation of A** **(b) Both A and R are true but R is not the correct explanation of A** **(c) A is true but R is false** **(d) A is false and R is also false**	**1**
7	**Assertion (A): A system of three positive charges, each having a charge q and placed equally distant from each other along a straight line can not be in equilibrium.** **Reason (R) : The charge in the middle experience zero net force, but the force on the charges** **(a) Both A and R are true and R is the correct explanation of A** **(b) Both A and R are true but R is not the correct explanation of A** **(c) A is true but R is false** **(d) A is false and R is also false**	**1**
	SECTION - B	
8	**Why should electrostatic field be zero inside the conductor? Also explain why presence of dielectric increases capacitance of capacitor**	**2**
9	**Four capacitors are connected as shown in figure:**  **Calculate the equivalent capacitance between the points X and Y when C1 = 3pF and C2 = 2 pF.**	**2**
10	**Using Gauss theorem, find electric field intensity at any point due to a line Charge.**	**2**
11	**a) Show that there is no work done in moving a charge from one point to another on an equipotential surface.** **b) A point charge + Q is placed at a point O as shown in figure**  **Is the potential difference V(A) - V(B) positive, negative or zero?**	**2**
12	**Derive the relation between electrical susceptibility and dielectric constant.**	**2**

	SECTION - C	
13	**A hollow cylindrical box of length 1 m and area of cross section 25 cm^2 is placed in a 3 D coordinate system as shown in figure. The electric field in the region is given by $\vec{E}$ = 50x $\hat{i}$, where E in NC^{-1} and x in metres. Find** **I. Net flux through the cylinder.** **II. Charge enclosed by the cylinder** 	**3**
14	**Obtain an expression for the work done to dissociate the system of three charges placed at the vertices of an equilateral triangle of side a as shown in figure** 	**3**
15	**a) Draw a pattern of electric field lines, when a point charge -Q is kept near an uncharged conducting plate.** **b) Calculate the voltage needed to balance an oil drop carrying 10 electrons, when located between plates of capacitor, which are 5 mm apart. Given mass of drop = 3 × 10^{-16} kg.**	**1** **2**
	SECTION - D	
16	**An electric dipole of length 0.1 m consists of two charges of + 500 uC (micro coulomb) and - 500 uC (micro coulomb). It is placed in an electric field of strength 10^4 N/C along the direction of the electric field.** **i) The electric dipole moment of the dipole is** **a) 50 × 10^{-6} uCm b) 50 × 10^{-6} Cm c) 500 × 10^{-6} uCm d) 500 × 10^{-6} Cm** **ii) The torque acting on the electric dipole is** **a) Zero ii) 5 Nm iii) 50 Nm iv) 500 Nm** **iii) The work done in rotating the electric dipole through an angle of 90 is** **a) 0.05 J b) 0.5 J c) 5 J d) 50 J** **iv) In case, the electric dipole was placed at an angle of 180 to an uniform electric field, the dipole will be** **a)not in equilibrium b) in stable equilibrium c) in unstable equilibrium d) none of these**	**4**
	SECTION - E	
17	**a) Derive an expression for capacitance of a parallel plate capacitor when a dielectric slab partially fills the space between the plates.** **b) An electrical technician requires a capacitance of 2uF in a circuit across a potential difference of 1 kV. A large no. of 1uF capacitors are available to him, each of which can withstand a potential difference of not more than 400V. Suggest a possible arrangement that requires a minimum no. of capacitors**	**3** **2**

Answer Key
Physics XII (Set - B)
July Test(2024-2025)

1	A	1
2	C	1
3	B	1
4	A	1
5	A	1
6	C	1
7	A	1
8	As charges resides on the surface of conductor, so electric field should be zero inside the conductor. The presence of di electric decreases the electric field which further decreases the potential, so according to formula $C=q/V$ As the potential decreases, capacitance increases..	1 1
9	$1/C_s = ⅓ + ½ + ⅓ = 7/6$ pF $C_p = 7/6 + 2 = 19/6$ $C = 60/61$	1 1
10	Derivation Only	2
11	a)$W/q_o = V_b - V_A$ As $V_b = V_A$ So , $W/q_o = 0$ Hence $W = 0$ b)V(A) - V(B) is positive as Direction Of electric field is in direction of decreasing potential by formula $E = - dV/dR$	 0.5 0.5 0.5 0.5
12	Derivation only	2

13	 (i) Electric flux through a surface $\varphi = \vec{E}\cdot\vec{S}$ Flux through the left surface, $\varphi_L = -\lvert E\rvert\lvert S\rvert$ $= -50x,\lvert S\rvert$ Since $x = 1m$ $\varphi_L = -50\times1\times25\times10^{-4}$ $= -1250\times10^{-4}$ $= -0.125\ Nm^2C^{-1}$ Flux through the right surface, $\varphi_R = \lvert E\rvert\lvert S\rvert$ Since $x = 2m$, $\varphi_R = 50\times2\times\lvert s\rvert$ $= 50\times2\times25\times10^{-4}$ $= 2500\times10^{-4}$ $= 0.250\ Nm^2C^{-1}$ Now, flux through the cylinder $\varphi_{Ace} = \varphi_R + \varphi_L$ $= 0.250 - 0.125$ $= 0.125\ Nm^2C^{-1}$ ii) Using Gauss Theorem, we can calculate the charge inside the cylinder. $\Phi_{net} = \frac{q}{\epsilon_o}$ $\Rightarrow q = \epsilon_o\varphi_{net}$ $= 8.854\times10^{-12}\times0.125$ $= 8.854\times10^{-12}\times\frac{1}{8}$ $= 8.854\times10^{-12}\times\frac{1}{8}$	0.5 0.5 0.5 0.5 0.5 0.5

14	Work done to keep the system bound is $W = \frac{K q_1 q_2}{a} + \frac{K q_2 q_3}{a} + \frac{K q_1 q_3}{a}$ $W = \frac{K q(-4q)}{a} + \frac{K(-4q)2q}{a} + \frac{K q(2q)}{a}$ $W = \frac{-K 4q^2}{a} - \frac{K 8q^2}{a} + \frac{K 2q^2}{a}$ $W = \frac{K q^2}{a}(-4-8+2) = \frac{-10 K q^2}{a}$ Therefore, the work done to dissociate the system is $W_d = -W = \frac{10 K q^2}{a}$	0.5 0.5 0.5 0.5 0.5 0.5
15	a)  	1

	b) $F_G = 3 \times 10^{-6} \times 10 = 3 \times 10^{-15}\ N$ $E = \left(\frac{mg}{10e}\right) = \left(\frac{3 \times 10^{-15}}{10 \times 1.6 \times 10^{-19}}\right) = 0.1875 \times 10^{4}\ V/m$ $V = Ed$ $= 0.1875 \times 10^{4} \times 5 \times 10^{-3}$ $= 9.375$ volt	0.5 0.5 0.5 0.5
16	i) b ii) a iii) b iv) c	1 1 1 1
17	a) Derivation only. b) Suppose a number of capacitors are connected in series and these series circuits are connected in parallel (row) to each other. the potential difference across each row must be 1000 V and potential difference across each capacitor must be 400 V. hence,number of capacitors in each row is given as $\frac{1000}{400} = 2.5$ Hence, there are three capacitors in each row. Capacitance of each row $= \frac{1}{1+1+1} = \frac{1}{3}\mu F$ Let there are n rows each hacing three capacitors, which are connected in parallel. Hence, equivalent capacitance of the circuit is given as $\frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \ldots n$ terms $= \frac{n}{3}$ However, capacitance of the circuit is given as $2\mu F$ $\therefore \frac{n}{3} = 2$ $n = 6$ Hence, 6 rows of three capacitors are present in the circuit. a minimum of 6 × 3 i.e., 18 capacitors are required for the given arragements.	3 0.5 0.5 0.5 0.5