



NEET — JEE MAINS - ADVANCED

Chapter 2 : Electrostatic Potential and Capacitance (50 Important MCQs)

by - Tomar Sir

Notes

50 important MCQs from GSEB, CBSE, NEET and JEE exams · Answer key at the end

Section A — Multiple Choice Questions

Each question carries 4 marks. Choose the correct option.

Q.1 If an aluminium sheet of negligible thickness is placed between the two plates of a capacitor, then its capacitance will

- (A) increase (B) decrease (C) become infinite (D) remain the same

Q.2 The capacitance of a capacitor is 100 μF . The work done for depositing a charge of $8 \times 10^{-18} \text{ C}$ on it will be

- (A) $16 \times 10^{-32} \text{ J}$ (B) $3.1 \times 10^{-26} \text{ J}$ (C) $4 \times 10^{-10} \text{ J}$ (D) $32 \times 10^{-32} \text{ J}$

Q.3 An electric charge $10^{-3} \mu\text{C}$ is placed at the origin (0, 0) of an X-Y coordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2, 0) respectively. The potential difference between the points A and B will be

- (A) 9 V (B) 0 V (C) 2 V (D) 4.5 V

Q.4 An ideal battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the emf of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be

- (A) 1 (B) 2 (C) $\frac{1}{4}$ (D) $\frac{1}{2}$

Q.5 The potentials of points P and Q are 10 V and -4 V respectively. The work done in taking 100 electrons from P to Q is

- (A) $22.4 \times 10^{-16} \text{ J}$ (B) $2.24 \times 10^{-16} \text{ J}$ (C) $-9.6 \times 10^{-17} \text{ J}$ (D) $9.6 \times 10^{-17} \text{ J}$

Q.6 Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together, the potential on each one can be made zero. Then

- (A) $5C_1 = 3C_2$ (B) $3C_1 = 5C_2$ (C) $3C_1 + 5C_2 = 0$ (D) $9C_1 = 4C_2$

Q.7 A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm, with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is $3 \times 10^4 \text{ V/m}$, the charge density of the positive plate will be close to

- (A) $3 \times 10^4 \text{ C/m}^2$ (B) $6 \times 10^4 \text{ C/m}^2$ (C) $6 \times 10^{-7} \text{ C/m}^2$ (D) $3 \times 10^{-7} \text{ C/m}^2$

Q.8 Assume that an electric field $\vec{E} = 30x^2 \hat{i}$ exists in space. Then the potential difference $V_A - V_0$, where V_0 is the potential at the origin and V_A the potential at $x = 2$ m, is

- (A) -80 J/C (B) 80 J/C (C) 120 J/C (D) -120 J/C

Q.9 A $4 \mu\text{F}$ capacitor is connected in series with a parallel combination of $3 \mu\text{F}$ and $9 \mu\text{F}$, and this branch is connected across an 8 V battery. A $2 \mu\text{F}$ capacitor is also connected directly across the battery. The magnitude of the electric field due to a point charge Q (equal to the sum of the charges on the $4 \mu\text{F}$ and $9 \mu\text{F}$ capacitors), at a point 30 m from it, would equal

- (A) 240 N/C (B) 360 N/C (C) 420 N/C (D) 480 N/C

Q.10 A capacitance of $2 \mu\text{F}$ is required in an electrical circuit across a potential difference of 1.0 kV. A large number of $1 \mu\text{F}$ capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is

- (A) 24 (B) 32 (C) 2 (D) 16

Q.11 A, B and C are concentric metal shells of radii a , b and c respectively ($a < b < c$). Their surface charge densities are σ , $-\sigma$ and σ respectively. The electric potential on the surface of shell B is

- (A) $\frac{\sigma}{\epsilon_0} \left[\frac{a^2 - b^2}{a} + c \right]$ (B) $\frac{\sigma}{\epsilon_0} \left[\frac{a^2 - b^2}{b} + c \right]$
 (C) $\frac{\sigma}{\epsilon_0} \left[\frac{b^2 - c^2}{b} + a \right]$ (D) $\frac{\sigma}{\epsilon_0} \left[\frac{b^2 - c^2}{c} + a \right]$

Q.12 A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20 V. If a dielectric material of dielectric constant $K = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be

- (A) 1.2 nC (B) 0.3 nC (C) 2.4 nC (D) 0.9 nC

Q.13 The voltage rating of a parallel plate capacitor is 500 V. Its dielectric can withstand a maximum electric field of 10^6 V/m. The plate area is 10^{-4} m². What is the dielectric constant if the capacitance is 15 pF? ($\epsilon_0 = 8.85 \times 10^{-12}$ C² N⁻¹ m⁻²)

- (A) 3.8 (B) 8.5 (C) 4.5 (D) 6.2

Q.14 A parallel plate capacitor has $1 \mu\text{F}$ capacitance. One of its two plates is given $+2 \mu\text{C}$ charge and the other plate is given $+4 \mu\text{C}$ charge. The potential difference developed across the capacitor is

- (A) 3 V (B) 1 V (C) 5 V (D) 2 V

Q.15 If two capacitors C_1 and C_2 are connected in parallel, the equivalent capacitance is $10 \mu\text{F}$. If both capacitors are connected across a 1 V battery, the energy stored in C_2 is 4 times that in C_1 . The equivalent capacitance if they are connected in series is

- (A) $16 \mu\text{F}$ (B) $1.6 \mu\text{F}$ (C) $4 \mu\text{F}$ (D) $\frac{1}{4} \mu\text{F}$

Q.16 A capacitor C is fully charged with voltage V_0 . After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitors is

- (A) $\frac{1}{6} CV_0^2$ (B) $\frac{1}{2} CV_0^2$ (C) $\frac{1}{4} CV_0^2$ (D) $\frac{1}{3} CV_0^2$

Q.17 A particle of charge q and mass m is subjected to an electric field $E = E_0(1 - ax^2)$ in the x -direction, where a and E_0 are constants. Initially the particle was at rest at $x = 0$. Other than the initial position, the kinetic energy of the particle becomes zero when its distance from the origin is

- (A) a (B) $\sqrt{\frac{1}{a}}$ (C) $\sqrt{\frac{3}{a}}$ (D) $\sqrt{\frac{2}{a}}$

Q.18 A dielectric slab (dielectric constant K) of thickness $\frac{3d}{4}$ is introduced in a capacitor of capacitance C and plate separation d . The final capacitance will be

- (A) $\frac{4}{3}(K+3)C$ (B) $\frac{4KC}{K+3}$ (C) $\frac{KC}{K+3}$ (D) $\frac{3KC}{K+C}$

Q.19 A parallel plate capacitor has plate area $A = 0.2 \text{ m}^2$ and separation $d = 1 \text{ m}$. One half of the gap (thickness $d/2$, full area) is air and the other half (thickness $d/2$, full area) is filled with a dielectric of $K = 3.2$. The equivalent capacitance is

- (A) $0.1 \epsilon_0$ (B) $0.2 \epsilon_0$ (C) $0.3 \epsilon_0$ (D) $0.4 \epsilon_0$

Q.20 A parallel plate capacitor is formed by two plates each of area $30\pi \text{ cm}^2$, separated by 1 mm . A material of dielectric strength $3.6 \times 10^7 \text{ V m}^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without dielectric breakdown is $7 \times 10^{-6} \text{ C}$, the dielectric constant of the material is (Use $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$)

- (A) 1.66 (B) 1.75 (C) 2.25 (D) 2.33

Q.21 If the charge on a capacitor is increased by 2 C , the energy stored in it increases by 44% . The original charge on the capacitor is (in C)

- (A) 10 (B) 20 (C) 30 (D) 40

Q.22 The capacitance of an isolated conducting sphere of radius R_1 becomes n times when it is enclosed by a concentric conducting sphere of radius R_2 connected to earth. The ratio of their radii $\left(\frac{R_2}{R_1}\right)$ is

- (A) $\frac{n}{n-1}$ (B) $\frac{2n}{2n+1}$ (C) $\frac{n+1}{n}$ (D) $\frac{2n+1}{n}$

Q.23 The electric potential at a point P due to a point charge of $5 \times 10^{-9} \text{ C}$ is 50 V . The distance of P from the point charge is (Assume $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$)

- (A) 3 cm (B) 9 cm (C) 90 cm (D) 20.9 cm

Q.24 A capacitor of capacitance C is charged to a potential V . The flux of the electric field through a closed surface enclosing the positive plate of the capacitor is

- (A) $\frac{CV}{2\epsilon_0}$ (B) $\frac{2CV}{\epsilon_0}$ (C) $\frac{CV}{\epsilon_0}$ (D) zero

Q.25 A charge $Q = 10^{-6} \text{ C}$ is placed at the origin. Find the potential difference between two points A and B whose position vectors are $(\sqrt{3}\hat{i} + \sqrt{3}\hat{j}) \text{ m}$ and $(\sqrt{6}\hat{j}) \text{ m}$ respectively.

- (A) 0 (B) 1000 V (C) 2000 V (D) 500 V

Q.26 The electric potential V at any point (x, y, z) (all in metres) in space is given by $V = 4x^2 \text{ volt}$. The electric field at the point $(1, 0, 2)$ in volt/metre is

- (A) 8 along positive X-direction (B) 16 along negative X-direction
(C) 16 along positive X-direction (D) 8 along negative X-direction

Q.27 Four electric charges $+q, +q, -q$ and $-q$ are placed at the corners of a square of side $2L$, with the two $+q$ charges on the left side and the two $-q$ charges on the right side. The electric potential at point A , midway between the two $+q$ charges, is

- (A) $\frac{1}{4\pi\epsilon_0} \frac{2q}{L} (1 + \sqrt{5})$ (B) $\frac{1}{4\pi\epsilon_0} \frac{2q}{L} \left(1 + \frac{1}{\sqrt{5}}\right)$
(C) $\frac{1}{4\pi\epsilon_0} \frac{2q}{L} \left(1 - \frac{1}{\sqrt{5}}\right)$ (D) zero

Q.28 A conducting sphere of radius R is given a charge Q . The electric potential and the electric field at the centre of the sphere respectively are

- (A) zero and $\frac{Q}{4\pi\epsilon_0 R^2}$ (B) $\frac{Q}{4\pi\epsilon_0 R}$ and zero (C) $\frac{Q}{4\pi\epsilon_0 R}$ and $\frac{Q}{4\pi\epsilon_0 R^2}$ (D) both are zero

Q.29 A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K , which can just fill the air gap, is now inserted. Which of the following is incorrect?

- (A) The energy stored in the capacitor decreases K times.
- (B) The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K} - 1\right)$.
- (C) The charge on the capacitor is not conserved.
- (D) The potential difference between the plates decreases K times.

Q.30 A parallel plate air capacitor has capacitance C , plate separation d , and potential difference V applied between the plates. The force of attraction between the plates is

- (A) $\frac{C^2V^2}{2d^2}$
- (B) $\frac{C^2V^2}{2d}$
- (C) $\frac{CV^2}{2d}$
- (D) $\frac{CV^2}{d}$

Q.31 A parallel plate capacitor is to be designed using a dielectric of dielectric constant 5, so as to have a dielectric strength of 10^9 V m^{-1} . If the voltage rating of the capacitor is 12 kV, the minimum area of each plate required to have a capacitance of 80 pF is

- (A) $10.5 \times 10^{-6} \text{ m}^2$
- (B) $21.7 \times 10^{-6} \text{ m}^2$
- (C) $25.0 \times 10^{-5} \text{ m}^2$
- (D) $12.5 \times 10^{-5} \text{ m}^2$

Q.32 The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A is

- (A) inversely proportional to the distance between the plates
- (B) independent of the distance between the plates
- (C) proportional to the square root of the distance
- (D) linearly proportional to the distance

Q.33 The capacitance of a parallel plate capacitor with air as medium is $6 \mu\text{F}$. With the introduction of a dielectric medium, the capacitance becomes $30 \mu\text{F}$. The permittivity of the medium is ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$)

- (A) $1.77 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
- (B) $0.44 \times 10^{-10} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
- (C) $5.00 \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
- (D) $0.44 \times 10^{-13} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$

Q.34 A short electric dipole has a dipole moment of $16 \times 10^{-9} \text{ C m}$. The electric potential due to the dipole at a point 0.6 m from its centre, on a line making an angle of 60° with the dipole axis, is $\left(\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2/\text{C}^2\right)$

- (A) 200 V
- (B) 400 V
- (C) zero
- (D) 50 V

Q.35 A parallel plate capacitor has a uniform electric field E in the space between the plates. If the distance between the plates is d and the area of each plate is A , the energy stored in the capacitor is ($\epsilon_0 =$ permittivity of free space)

- (A) $\frac{E^2Ad}{\epsilon_0}$
- (B) $\frac{1}{2}\epsilon_0E^2$
- (C) ϵ_0EAd
- (D) $\frac{1}{2}\epsilon_0E^2Ad$

Q.36 Two charged spherical conductors of radii R_1 and R_2 are connected by a wire. Then the ratio of their surface charge densities (σ_1/σ_2) is

- (A) $\frac{R_1^2}{R_2^2}$
- (B) $\frac{R_1}{R_2}$
- (C) $\frac{R_2}{R_1}$
- (D) $\sqrt{\frac{R_1}{R_2}}$

Q.37 Two hollow conducting spheres of radii R_1 and R_2 ($R_1 \gg R_2$) have equal charges. The potential would be

- (A) equal on both the spheres
- (B) dependent on the material property of the sphere
- (C) more on the bigger sphere
- (D) more on the smaller sphere

Q.38 Assertion A: The potential (V) at any axial point at 2 m distance (r) from the centre of a dipole of dipole moment of magnitude 4×10^{-6} C m is $\pm 9 \times 10^3$ V. (Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units.) Reason R: $V = \pm \frac{2p}{4\pi\epsilon_0 r^2}$, where r is the distance of any axial point situated 2 m from the centre of the dipole. Choose the correct answer.

- (A) A is true but R is false.
 (B) A is false but R is true.
 (C) Both A and R are true and R is the correct explanation of A.
 (D) Both A and R are true and R is not the correct explanation of A.

Q.39 A thin spherical shell of radius $R = 3$ cm carries a charge $q = 1$ μ C. C is its centre and P is a point on its surface. The potential difference between C and P (in V) is $\left[\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ SI units} \right]$

- (A) 0.5×10^5 (B) zero (C) 3×10^5 (D) 1×10^5

Q.40 If the plates of a parallel plate capacitor connected to a battery are moved closer to each other, then (A) the charge stored in it increases, (B) the energy stored in it decreases, (C) its capacitance increases, (D) the ratio of charge to its potential remains the same, (E) the product of charge and voltage increases. Choose the most appropriate answer.

- (A) (B), (D) and (E) only (B) (A), (B) and (C) only
 (C) (A), (B) and (E) only (D) (A), (C) and (E) only

Q.41 The electric field has a uniform value in the X-direction. The equipotential surfaces associated with this electric field are

- (A) parallel to the XY plane (B) parallel to the YZ plane
 (C) parallel to the XZ plane (D) concentric cylinders around the X-axis

Q.42 A charge Q is placed on a conducting sphere of radius R , which lies inside (and is concentric with) an uncharged spherical conducting shell of radius $2R$. The sphere is then connected to the shell by a metal wire. The heat energy produced will be

- (A) $\frac{1}{4\pi\epsilon_0} \frac{Q^2}{4R}$ (B) $\frac{1}{4\pi\epsilon_0} \frac{Q^2}{2R}$ (C) $\frac{1}{4\pi\epsilon_0} \frac{Q^2}{R}$ (D) $\frac{2}{4\pi\epsilon_0} \frac{Q^2}{3R}$

Q.43 Charges 3×10^{-9} C and -3×10^{-9} C are 3 cm apart. Points a and b divide the line between them into three 1 cm parts (a is 1 cm from the positive charge, b is 1 cm from the negative charge). A particle of mass $m = 5$ g and charge $q' = 2 \times 10^{-9}$ C starts from rest at a and moves along the straight line to b . What is its speed at b ?

- (A) 2.65 cm s^{-1} (B) 3.65 cm s^{-1} (C) 4.65 cm s^{-1} (D) 5.65 cm s^{-1}

Q.44 Charges of 1 μ C are placed at each of the four corners of a square of side $2\sqrt{2}$ m. The potential at the point of intersection of the diagonals is ($k = 9 \times 10^9$ SI unit)

- (A) 18×10^3 V (B) 1800 V (C) $18\sqrt{2} \times 10^3$ V (D) none of these

Q.45 The energy of a charged capacitor is U . It is removed from the battery and then connected in parallel to another uncharged capacitor having twice its capacitance. The energies of the first and second capacitors respectively are

- (A) $\frac{1}{9}U, \frac{1}{9}U$ (B) $\frac{2}{9}U, \frac{1}{9}U$ (C) $\frac{1}{9}U, \frac{2}{9}U$ (D) $\frac{2}{9}U, \frac{2}{9}U$

Q.46 A uniform electric field is prevailing in the X-direction in a certain region. The coordinates of points P, Q and R are (0, 0), (2, 0) and (0, 2) respectively. Which of the following is true for the potentials at these points?

- (A) $V_P > V_Q, V_P = V_R$ (B) $V_P = V_Q, V_P > V_R$
 (C) $V_P < V_R, V_Q = V_R$ (D) $V_P = V_Q, V_P < V_R$

Q.47 An electric dipole of dipole moment $\vec{p}$ is placed parallel to a uniform electric field $\vec{E}$. On rotating it through 180° , the amount of work done is

- (A) zero (B) $-2pE$ (C) pE (D) $2pE$

Q.48 A $2\ \mu\text{F}$ capacitor is charged by a $50\ \text{V}$ supply and a $3\ \mu\text{F}$ capacitor by a $100\ \text{V}$ supply. After removing the batteries, the plates with the same type of charge are joined together. The potential difference across them is V.

- (A) 80 (B) 333 (C) 200 (D) 75

Q.49 Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of the same sign and magnitude $17.7 \times 10^{-22}\ \text{C/m}^2$. What is E in the outer region of the second plate?

- (A) $4 \times 10^{-10}\ \text{N C}^{-1}$ (B) $1 \times 10^{-10}\ \text{N C}^{-1}$ (C) $2 \times 10^{-10}\ \text{N C}^{-1}$ (D) zero

Q.50 A slab of material of dielectric constant 3 has the same area as the plates of a parallel plate capacitor but has a thickness $\left(\frac{3}{4}\right)d$, where d is the separation of the plates. What is the potential difference between the plates when the slab is inserted? (Initial potential difference V_0 , charge kept constant.)

- (A) $\frac{V_0}{2}$ (B) $\frac{V_0}{4}$ (C) $\frac{V_0}{6}$ (D) $\frac{V_0}{3}$

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	11	B	21	A	31	B	41	B
2	D	12	A	22	A	32	B	42	A
3	B	13	B	23	C	33	B	43	C
4	D	14	B	24	C	34	A	44	A
5	B	15	B	25	A	35	D	45	C
6	B	16	A	26	D	36	C	46	A
7	C	17	C	27	C	37	D	47	D
8	A	18	B	28	B	38	A	48	A
9	C	19	C	29	C	39	B	49	C
10	B	20	D	30	C	40	D	50	A