

Electrostatic Potential and Capacitance — Assignment 1

Class 12 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Electric Potential and Potential Difference

MCQ Questions (choose the correct option)

- The SI unit of electric potential is the
 - volt
 - joule
 - coulomb
 - farad
- Electric potential is a
 - scalar quantity
 - vector quantity
 - tensor quantity
 - dimensionless quantity
- The work done in moving a charge q through a potential difference V is
 - qV
 - q/V
 - V/q
 - qV^2
- The electric potential at a distance r from a point charge Q is
 - $(1/4\pi\epsilon_0)(Q/r)$
 - $(1/4\pi\epsilon_0)(Q/r^2)$
 - $(1/4\pi\epsilon_0)(Qr)$
 - $(1/4\pi\epsilon_0)(Q^2/r)$

1 Mark Questions

- Define electric potential.
- Write the expression for the electric potential due to a point charge.
- Is electric potential a scalar or a vector quantity?

2 Mark Questions

- Define electric potential and derive the expression for the potential due to a point charge.
- Calculate the work done in moving a charge of 2 C through a potential difference of 12 V. (Ans: 24 J)

3 Mark Questions

- Derive the relation between electric field and electric potential ($E = -dV/dr$).
- Two point charges $+4 \mu\text{C}$ and $-4 \mu\text{C}$ are separated by 0.2 m. Find the electric potential at the midpoint of the line joining them. (Ans: 0)

Capacitance and Capacitors

MCQ Questions (choose the correct option)

1. The SI unit of capacitance is the
 - (A) farad
 - (B) volt
 - (C) coulomb
 - (D) ohm
2. The capacitance of a parallel-plate capacitor is
 - (A) $\epsilon_0 A/d$
 - (B) $\epsilon_0 d/A$
 - (C) $\epsilon_0 A d$
 - (D) $A/\epsilon_0 d$
3. When a dielectric of dielectric constant K completely fills a capacitor, its capacitance becomes
 - (A) K times the original
 - (B) $1/K$ times the original
 - (C) unchanged
 - (D) K^2 times the original
4. The capacitance of an isolated conducting sphere of radius R is
 - (A) $4\pi\epsilon_0 R$
 - (B) $4\pi\epsilon_0 R^2$
 - (C) $4\pi\epsilon_0/R$
 - (D) $\pi\epsilon_0 R$

1 Mark Questions

1. Define capacitance.
2. Write the expression for the capacitance of a parallel-plate capacitor.
3. On what factors does the capacitance of a parallel-plate capacitor depend?

2 Mark Questions

1. Define capacitance and derive $C = \epsilon_0 A/d$ for a parallel-plate capacitor in air.
2. A capacitor of capacitance $5 \mu\text{F}$ is charged to 100 V . Find the charge stored on each plate. (Ans: $5 \times 10^{-4} \text{ C}$)

3 Mark Questions

1. Derive the expression for the capacitance of a parallel-plate capacitor, and explain how inserting a dielectric increases it.
2. A parallel-plate capacitor has plates of area 0.02 m^2 separated by 1 mm . Find its capacitance in air ($\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$). (Ans: $\approx 1.77 \times 10^{-10} \text{ F}$)

Dielectrics and Polarisation**MCQ Questions (choose the correct option)**

1. A dielectric is a material that
 - (A) is an insulator and gets polarised in an electric field
 - (B) conducts electricity
 - (C) is always polar

- (D) has no effect in an electric field
- 2. The polarisation of a dielectric is measured by its
 - (A) dipole moment per unit volume
 - (B) total charge
 - (C) resistance
 - (D) permittivity only
- 3. When a dielectric is inserted between the plates of a capacitor, its capacitance
 - (A) increases
 - (B) decreases
 - (C) is unchanged
 - (D) becomes zero
- 4. The dielectric constant of a medium is also called its
 - (A) relative permittivity
 - (B) conductivity
 - (C) susceptibility
 - (D) resistivity

1 Mark Questions

1. What is a dielectric?
2. Define dielectric constant.
3. What is meant by the polarisation of a dielectric?

2 Mark Questions

1. Explain why the capacitance of a capacitor increases when a dielectric fills the space between its plates.
2. Define dielectric constant and give the relation between the permittivity ϵ and the dielectric constant K . (Ans: $\epsilon = K \epsilon_0$)

3 Mark Questions

1. Explain the polarisation of a dielectric. Distinguish between polar and non-polar molecules and describe the effect on the net field inside.
2. Derive the expression for the capacitance of a parallel-plate capacitor partly filled with a dielectric slab of thickness t and dielectric constant K .

Combinations of Capacitors

MCQ Questions (choose the correct option)

1. When capacitors are connected in series, the equivalent capacitance is
 - (A) less than the smallest capacitance
 - (B) greater than the largest
 - (C) the sum of all capacitances
 - (D) always zero
2. When capacitors are connected in parallel, the equivalent capacitance is
 - (A) the sum of the individual capacitances
 - (B) less than the smallest
 - (C) the reciprocal of the sum
 - (D) unchanged

3. The reciprocal of the equivalent capacitance of capacitors in series equals
 - (A) the sum of the reciprocals of the individual capacitances
 - (B) the sum of the capacitances
 - (C) the product of the capacitances
 - (D) the average capacitance
4. Capacitors are connected in parallel in order to
 - (A) increase the total capacitance
 - (B) decrease the total capacitance
 - (C) increase the voltage rating only
 - (D) store no charge

1 Mark Questions

1. Write the formula for the equivalent capacitance of capacitors in series.
2. Write the formula for the equivalent capacitance of capacitors in parallel.
3. How should two capacitors be joined to obtain the maximum equivalent capacitance?

2 Mark Questions

1. Two capacitors of $2\ \mu\text{F}$ and $3\ \mu\text{F}$ are connected (i) in series and (ii) in parallel. Find the equivalent capacitance in each case. (Ans: (i) $1.2\ \mu\text{F}$ (ii) $5\ \mu\text{F}$)
2. Three capacitors of $2\ \mu\text{F}$ each are connected in series. Find the equivalent capacitance. (Ans: $2/3\ \mu\text{F}$)

3 Mark Questions

1. Derive the expression for the equivalent capacitance of three capacitors in series, and explain why it is smaller than the smallest capacitance.
2. In a circuit, a $1\ \mu\text{F}$ and a $2\ \mu\text{F}$ capacitor are in series, and this combination is in parallel with a $3\ \mu\text{F}$ capacitor. Find the total capacitance. (Ans: $\approx 3.67\ \mu\text{F}$)

Energy Stored in a Capacitor

MCQ Questions (choose the correct option)

1. The energy stored in a charged capacitor is
 - (A) $\frac{1}{2}CV^2$
 - (B) CV^2
 - (C) CV
 - (D) $\frac{1}{2}C^2V$
2. The energy stored in a charged capacitor resides in
 - (A) the electric field between the plates
 - (B) the plates' material
 - (C) the connecting wires
 - (D) the battery
3. If the plates of an isolated charged capacitor are pulled apart, the energy stored
 - (A) increases
 - (B) decreases
 - (C) remains the same
 - (D) becomes zero

4. The energy density of an electric field E in vacuum is

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

1 Mark Questions

- Write the expression for the energy stored in a capacitor.
- Where is the energy stored in a charged capacitor?
- Write the expression for the energy density of an electric field.

2 Mark Questions

- Derive the expression $U = \frac{1}{2}CV^2$ for the energy stored in a capacitor.
- A $10\ \mu\text{F}$ capacitor is charged to $50\ \text{V}$. Find the energy stored. (Ans: $1.25 \times 10^{-2}\ \text{J}$)

3 Mark Questions

- Derive the expression for the energy stored per unit volume in an electric field (energy density = $\frac{1}{2}\epsilon_0 E^2$), starting from $U = \frac{1}{2}CV^2$.
- A parallel-plate capacitor of capacitance $2\ \mu\text{F}$ is charged to $200\ \text{V}$. Find the energy stored, and state what happens to it when the plates are separated to double the distance with the battery still connected.