Electrostatic Potential and Capacitance

Assertion & Reason Type Questions

Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.

Reason (R): Electrostatic force is a non-conservative force.

Answer : (c) Electrostatic force is conservative force.

Q2. Assertion (A): For a point charge, concentric spheres centered at a location of the charge are equipotential surfaces.

Reason (R): An equipotential surface is a surface over which potential has zero value.

Answer : (c) An equipotential surface is a surface over which potential is constant.

Q3. Assertion (A): An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.

Reason (R): Electrons move from a region of higher potential to a region of lower potential. **[CBSE SQP 2023-24]**

Answer : (c) Reason is false because electrons move from a region of lower potential to higher potential.

Q4. Assertion (A): If the distance between parallel plates of a capacitor is halved and dielectric constant is made three times, then the capacitance becomes six times.

Reason (R): Capacitance of the capacitor does not depend upon the nature of the material of the plates.

Answer : (c) The capacitance C with dielectric between the plates is given by

$$C = \frac{\varepsilon_0 KA}{d}$$

As, $d' = \frac{d}{2}$, $K' = 3K$, then new capacitance becomes

$$C' = \frac{\varepsilon_0 3KA}{\frac{d}{2}} \quad \Rightarrow \quad C' = \frac{6\varepsilon_0 KA}{d} = 6C$$

The capacitance C depends upon nature of the material (shape, size and separation) of the conductors.

Q5. Assertion (A): The dielectric constant for metals is infinity.

Reason (R): When a charged capacitor is filled completely with a metallic slab, its capacity becomes very large.

Answer : (c) The capacitance of a capacitor filled partially with a dielectric of thickness t is given by

$$C = \frac{\varepsilon_0 A}{d - t[1 - 1/K]}$$

For metals, $K = \infty$

$$\therefore \qquad C = \frac{\varepsilon_0 A}{d - t}$$

Now, if the capacitor is filled completely with a metallic slab, then t = d.
$\therefore$ C = ∞ i.e., when a charged capacitor filled fully with a metallic slab, then capacitor is short circuited i.e., it will no more work as a capacitor.

Q6. Assertion (A): When air between the plates of a parallel plate condenser is replaced by an insulating medium of dielectric constant, its capacity increases.

Reason (R): Electric field intensity between the plates with dielectric in between it is reduced.

Answer : (a) The capacity of a parallel plate condenser is given by,

$$C = \frac{Q}{V} \quad ...(1)$$

Electric field intensity becomes $\frac{1}{K}$ times [as, $K = E_0/E$], therefore potential V also becomes $1/K$ times.

Hence, from eq. (1), capacity becomes K times.

Thus, electric field decreases and capacitance increases when condenser is filled with insulated medium of some dielectric constant.

Q7. Assertion (A): In a parallel combination of capacitors, the total capacitance of the combination is the sum of capacitance of the individual capacitors.

Reason (R): In such a combination, voltage across each capacitor is same.

Answer : (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Q8. Assertion (A): If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel, then their equivalent capacitance (C_p) > equivalent capacitance in series (C_s).

Reason (R): $\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

Answer : (c) Equivalent capacitance of parallel combination is $C_p = G_1 + C_2 + C_3$ and in series, it will be

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

Q9. Assertion (A): The capacity of a given conductor remains same even if charge is varied on it.

Reason (R): Capacitance depends upon nearly medium as well as size and shape of conductor.

Answer : (a) Capacitance is basically a geometrical quantity.

Q10. Assertion: If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times.

Reason: Capacity of the capacitor does not depend upon the nature of the material.

Q11. Assertion: 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: The surface density of charge on the plate remains constant or unchanged.

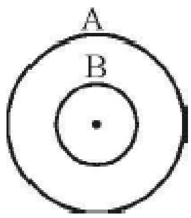
Q12. Assertion: The total charge stored in a capacitor is zero.

Reason: The field just outside the capacitor is σ/ε_0.
(σ is the charge density).

Q13. Assertion: The electrostatic force between the plates of a charged isolated capacitor decreases when dielectric fills whole space between plates.

Reason: The electric field between the plates of a charged isolated capacitance increases when dielectric fills whole space between plates.

Q14. Assertion: Two concentric charged shells are given. The potential difference between the shells depends on charge of inner shell.
Reason: Potential due to charge of outer shell remains same at every point inside the sphere.



Q15. Assertion: Two equipotential surfaces cannot cut each other.

Reason: Two equipotential surfaces are parallel to each other.

Q16. Assertion: The potential difference between any two points in an electric field depends only on initial and final position.

Reason: Electric field is a conservative field so the work done per unit positive charge does not depend on path followed.

Q17. Assertion: Electric field inside a conductor is zero.

Reason: The potential at all the points inside a conductor is same.

Q18. Assertion: Electric field is discontinuous across the surface of a spherical charged shell.

Reason: Electric potential is continuous across the surface of a spherical charged shell.

Q19. Assertion: Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.

Reason: Electrostatic force is a non conservative force.

Q20. Assertion: Two adjacent conductors of unequal dimensions, carrying the same positive charge have a potential difference between them.

Reason: The potential of a conductor depends upon the charge given to it.

Q21. Assertion: Electric potential and electric potential energy are different quantities.

Reason: For a system of positive test charge and point charge electric potential energy = electric potential.

Q22. Assertion: For a non-uniformly charged thin circular ring with net charge is zero, the electric field at any point on axis of the ring is zero.

Reason: For a non-uniformly charged thin circular ring with net charge zero, the electric potential at each point on axis of the ring is zero.

Q23. Assertion: For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

Reason: The net work done by a conservative force on an object moving along a closed loop is zero.

Q24. Assertion: Polar molecules have permanent dipole moment.

Reason: In polar molecules, the centres of positive and negative charges coincide even when there is no external field.

Q25. Assertion: Dielectric polarisation means formation of positive and negative charges inside the dielectric.

Reason: Free electrons are formed in this process.

Q26. Assertion: In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.

Reason: The dipoles of a polar dielectric are randomly oriented.

Q27. Assertion: For a point charge, concentric spheres centered at a location of the charge are equipotential surfaces.

Reason: An equipotential surface is a surface over which potential has zero value.

Q28. Assertion: Electric energy resides out of the spherical isolated conductor.

Reason: The electric field at any point inside the conductor is zero.

Q29. Assertion: Two equipotential surfaces cannot cut each other.

Reason: Two equipotential surfaces are parallel to each other.

Q30. Assertion: Two equipotential surfaces can be orthogonal.

Reason: Electric field lines are normal to the equipotential surface.

Q31. Assertion: The equatorial plane of a dipole is an equipotential surface.

Reason: The electric potential at any point on equatorial plane is zero.

Q32. Assertion: The electric potential at any point on the equatorial plane of a dipole is zero.

Reason: The work done in bringing a unit positive charge from infinity to a point in equatorial plane is equal for the two charges of the dipole.

Q33. Assertion: 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 stored becomes k times.

Reason: The surface density of charge on the plate remains constant.

Q34. Assertion: Two metal plates having charges Q, –Q face each other at some separation and are dipped into an oil tank. If the oil is pumped out, the electric field between the plates increases.

Reason: Electric field between the plates, $E_{med} = E_{air}/K$

Q35. Assertion: When a dielectric slab is gradually inserted between the plates of an isolated parallel-plate capacitor, the energy of the system decreases.

Reason: The force between the plates decreases.

Q36. Assertion: A dielectric is inserted between the plates of a battery connected capacitor. The energy of the capacitor increases.

Reason: Energy of the capacitor, $U=CV^2/2$

ANSWER KEY 10 to 36

Q10 : (c) **Q11 :** (c) **Q12 :** (c) **Q13 :** (d)

Q14 : (a) **Q15 :** (c) **Q16 :** (a) **Q17 :** (b)

Q18 : (b) **Q19 :** (c) **Q20 :** (b)

Q21 : (c) Potential and potential energy are different quantities and cannot be equated.

Q22 : (d) For a non-uniformly charged thin circular ring with net zero charge, electric potential at each point on its axis is zero. Hence electric field at each point on its axis must be perpendicular to the axis. Therefore Assertion is false and Reason is true.

Q23 : (a) **Q24 :** (c) **Q25 :** (c) **Q26 :** (a)

Q27 : (c)

Q28 : (a) As these is no electric field inside the conductor, and so no energy inside it.

Q29 : (c) Reason is false because the work done in bringing a unit positive charge from infinity to a point in equatorial plane is equal and opposite for the two charges of the dipole.

Q30 : (d) Two equipotential surfaces never intersect each other so they cannot be orthogonal.

Q31 : (b) **Q32 :** (d) **Q33 :** (c) **Q34 :** (c)

Q35 : (c) **Q36 :** (a)