Electric Charges and Fields

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): When we rub a glass rod with silk, the rod gets positively charged and the silk gets negatively charged.

Reason (R): On rubbing, electrons from silk cloth moves to the glass rod.

Answer : (c) When we rub a glass rod with silk cloth, electrons from the glass rod are transferred to the silk cloth. Thus, the rod gets positively charged and the silk gets negatively charged.

Q2. Assertion (A): A negative charge in an electric field moves along the direction of the electric field.

Reason (R): On a negative charge, a force acts in the direction of the electric field.

Answer : (d) Negative charge moves in the opposite direction to the electric field, as it experiences force in the direction opposite to electric field.

Q3. Assertion (A): If there exists coulomb attraction between two bodies, both of them may not be charged.

Reason (R): In Coulomb attraction two bodies are oppositely charged.

Answer : (b) Coulomb attraction exists even when one body is charged and the other is uncharged.

Q4. Assertion (A): The force with which two charges attract or repel each other are not affected by the presence of a third charge.

Reason (R): Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to other charges, taken one at a time.

Answer : (b) Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges, taken one at a time. The individual forces are unaffected due to the presence of other charges. This is the principle of superposition of charges.

Q5. Assertion (A): Work done in moving a charge around a closed path, in an electric field is always zero.

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

Answer :

(a) We know that the work done by the conservative force around any closed path is zero, *i.e.*, $\oint F \cdot dl = 0$.

Q6. Assertion (A): Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.

Reason (R): Negative gradient of electric potential is electric field.

Answer :

(a) Because $\vec{E} = -\nabla \vec{V}$, so the electric field is always perpendicular to equipotential surface and the direction of electric field must be in the direction of decreasing of electric potential.

Q7. Assertion (A): As force is a vector quantity, hence electric field intensity is also a vector quantity.

Reason (R): The unit of electric field intensity is Newton per coulomb.

Answer :

(b) The electric field intensity is equal to force experienced by unit positive test charge q0 placed at that point i.e,

$\vec{E} = \frac{\vec{F}}{q_0}$, thus $\vec{E}$ is also a vector quantity

And $E = \frac{F}{q} = \frac{\text{Newton}}{\text{Coulomb}}$

Q8. Assertion (A): No two electric lines of force can intersect each other.

Reason (R): Tangent at any point of electric line of force gives the direction of electric field.

Answer : (a) If the two electric lines of force can intersect each other, then at the point of intersection, we can draw two tangents to the two lines of force. This would mean two directions of electric field intensity at the point of intersection, which is not possible.

Q9. Assertion (A): The surface charge densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

Reason (R): Surface charge density is equal to charge per unit area.

Answer :

(b) As, $\sigma_1 = \sigma_2$ (Given)

$$\frac{q_1}{4\pi r_1^2} = \frac{q_2}{4\pi r_2^2} \text{ or } \frac{q_1}{q_2} = \frac{r_1^2}{r_2^2}$$

Then ratio of electric field intensities,

$$\frac{E_1}{E_2} = \frac{q_1}{4\pi\varepsilon_0 r_1^2} \times \frac{4\pi\varepsilon_0 r_2^2}{q_2}$$

$$= \frac{q_1}{q_2} \times \frac{r_2^2}{r_1^2} = \frac{q_1}{q_2} \times \frac{q_2}{q_1} = 1$$

i.e., $E_1 = E_2$

Q10. Assertion (A): The electric flux emanating out and entering a closed surface are 8 x 10^3 and 2 × 10^3 Vm respectively. The charge enclosed by the surface is 0.053 μC.

Reason (R): Gauss's theorem in electrostatics may be applied to verify.

Answer : (a) According to Gauss's theorem in electrostatics,

$$\phi = \frac{q}{\varepsilon_0}$$

$$q = \varepsilon_0 \phi = 8.85 \times 10^{-12} \left(8 \times 10^3 - 2 \times 10^3\right)$$

$$= 53.10 \times 10^{-9}\ \text{C} = 0.053\ \mu\text{C}$$

Q11. Assertion: Electron move away from a region of lower potential to a region of higher potential.

Reason: An electron has a negative charge.

Q12. Assertion: A metallic shield in form of a hollow shell may be built to block an electric field.

Reason: In a hollow spherical shield, the electric field inside it is zero at every point.

Q13. Assertion: Electric lines of force never cross each other.

Reason: Electric field at a point superimpose to give one resultant electric field.

Q14. Assertion: The Coulomb force is the dominating force in the universe.

Reason: The Coulomb force is weaker than the gravitational force.

Q15. Assertion: In a cavity within a conductor, the electric field is zero.

Reason: Charges in a conductor reside only at its surface.

Q16. Assertion: When bodies are charged through friction, there is a transfer of electric charge from one body to another, but no creation or destruction of charge.

Reason: This follows from conservation of electric charges.

Q17. Assertion: The tyres of aircraft are slightly conducting.

Reason: If a conductor is connected to ground, the extra charge induced on conductor will flow to ground.

Q18. Assertion: Some charge is put at the centre of a conducting sphere. It will move to the surface of the sphere.

Reason: Conducting sphere has no free electrons at the centre.

Q19. Assertion: Coulomb force and gravitational force follow the same inverse-square law.

Reason: Both laws are same in all aspects.

Q20. Assertion: The coulomb force is the dominating force in the universe.

Reason: The coulomb force is weaker than the gravitational force.

Q21. Assertion: If there exists coulomb attraction between two bodies, both of them may not be charged.

Reason: In coulomb attraction two bodies are oppositely charged.

Q22. Assertion: A deuteron and an □-particle are placed in an electric field. If F1 and F2 be the forces acting on them and a1 and a2 be their accelerations respectively then, a1 = a2.

Reason: Forces will be same in electric field.

Q23. Assertion: The property that the force with which two charges attract or repel each other are not affected by the presence of a third charge.

Reason: Force on any charge due to a number of other charge is the vector sum of all the forces on that charge due to other charges, taken one at a time.

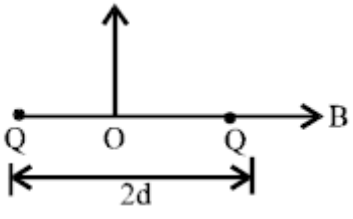
Q24. Assertion: A metallic shield in form of a hollow shell may be built to block an electric field.

Reason: In a hollow spherical shield, the electric field inside it is zero at every point.

Q25. Assertion: A point charge is brought in an electric field, the field at a nearby point will increase or decrease, depending on the nature of charge.

Reason: The electric field is independent of the nature of charge.

Q26. Assertion: Consider two identical charges placed distance 2d apart, along x-axis.



The equilibrium of a positive test charge placed at the point O midway between them is stable for displacements along the x-axis.

Reason: Force on test charge is zero.

Q27. Assertion: When a conductor is placed in an external electrostatic field, the net electric field inside the conductor becomes zero after a small instant of time.

Reason: It is not possible to set up an electric field inside a conductor.

Q28. Assertion: A uniformly charged disc has a pin hole at its centre. The electric field at the centre of the disc is zero.

Reason: Disc can be supposed to be made up of many rings. Also electric field at the centre of uniformly charged ring is zero.

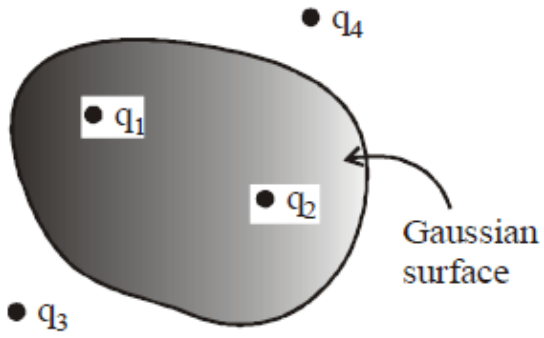
Q29. Assertion: Electric lines of field cross each other.

Reason: Electric field at a point superimpose to give one resultant electric field.

Q30. Assertion: On bringing a positively charged rod near the uncharged conductor, the conductor gets attracted towards the rod.

Reason: The electric field lines of the charged rod are perpendicular to the surface of conductor.

Q31. Assertion: Four point charges q1, q2, q3 and q4 are as shown in figure. The flux over the shown Gaussian surface depends only on charges q1 and q2.



Reason: Electric field at all points on Gaussian surface depends only on charges q1 and q2.

Q32. Assertion: On disturbing an electric dipole in stable equilibrium in an electric field, it returns back to its stable equilibrium orientation.

Reason: A restoring torque acts on the dipole on being disturbed from its stable equilibrium.

Q33. Assertion: On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.

Reason: Electric field is inversely proportional to square of distance from the charge or an electric dipole.

Q34. Assertion: The electric flux of the electric field $\oint E.dA$ is zero. The electric field is zero everywhere on the surface.

Reason : The charge inside the surface is zero.

Q35. Assertion: On moving a distance two times the initial distance away from an infinitely long straight uniformly charged wire the electric field reduces to one third of the initial value.

Reason: The electric field is inversely proportional to the distance from an infinitely long straight uniformly charged wire.

Q36. Assertion (A): No two electric lines of force can intersect each other.

Reason (R): Tangent at any point of electric line of force gives the direction of electric field.

Q37. Assertion (A): Electric force acting on a proton and an electron, moving in a uniform electric field is same, where as acceleration of electron is 1836 times that of a proton.

Reason (R): Electron is lighter than proton.

Q38. Assertion (A): As force is a vector quantity, hence electric field intensity is also a vector quantity

Reason (R): The unit of electric field intensity is newton per coulomb.

Q39**. Assertion (A):** Sharper is the curvature of spot on a charged body lesser will be the surface charge density at that point

Reason (R): Electric field is non-zero inside a charged conductor.

Q40**. Assertion (A):** The surface densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

Reason (R): Surface density is equal to charge per unit area

Q41**. Assertion (A):** Three equal charges are situated on a circle of radius r such that they form on equilateral triangle, then the electric field intensity at the centre is zero.

Reason (R): The force on unit positive charge at the centre, due to the three equal charges are represented by the three sides of a triangle taken in the same order. Therefore, electric field intensity at centre is zero.

Q42. Assertion (A): The electric lines of forces diverges from a positive charge and converge at a negative charge.

Reason (A): A charged particle free to move in an electric field always move along an electric line of force.

Q43. Assertion (A): Charging is due to transfer of electrons.

Reason (R): Mass of a body decreases slightly when it is negatively charged.

Q44. Assertion (A): Range of Coulomb force is infinite.

R**eason (R):** Coulomb force acts between two charged particles.

Q45. Assertion (A): A small metal ball is suspended in a uniform electric field with an insulated thread. If high energy X-ray beam falls on the ball, the ball will be deflected in the electric field.

Reason (R): X-rays emits photoelectron and metal becomes negatively charged.

Q46**. Assertion (A):** If a point charge be rotated in a circle around a charge, the work done will be zero.

Reason (R): Work done is equal to dot product of force and distance

ANSWER KEY 11 to 46

Q11 : (a)

Q12 : (a)

Q13 : (b)

Q14 : (d)

Q15 : (a)

Q16 : (a) Conservation of electric charge states that the total charge of an isolated system remains unchanged with time

Q17 : (b) Both the statements are independently correct.

Q18 : (a) Because of repulsion, the free electrons will mole to the outer surface.

Q19 : (c) Coulomb force and gravitational force follow the same inverse-square law. But gravitational force has only one sign which is always attractive, while coulomb force can be of both signs which are attractive and repulsive.

Q20 : (d) Gravitational force is the dominating force in nature and not coulomb's force. Gravitational force is the weakest force. Also, Coulomb's force > > gravitational force.

Q21 : (b) Coulomb attraction exists even when one body is charged, and the other is uncharged.

Q22 : (c)

Q23 : (b) Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges, taken one at a time. The individual force are unaffected due to the presence of other charges. This is the principle of superposition of charges.

Q24 : (a) The electrostatic shielding is possible by metallic conductor.

Q25 : (c) The electric field will increase if positive charge is brought in an electric field.

Q26 : (b) If +ve charge is displaced along x-axis, then net force will always act in a direction opposite to that of displacement and the test charge will always come back to its original position.

Q27 : (c) Statement-1 is correct. The induced field cancels the external field. Statement-2 is false. When a current is set up in a conductor, there exists an electric field inside it.

Q28 : (a) The electric field due to disc is superposition of electric field due to its constituent ring as given in Reason.

Q29 : (d) Assertion is Incorrect, Reason is correct. (d) Two field lines never intersect.

Q30 : (b) Though the net charge on the conductor is still zero but due to induction negatively charged region is nearer to the rod as compared to the positively charged region. That is why the conductor gets attracted towards the rod

Q31 : (d) Electric field at any point depends on presence of all charges.

Q32 : (a) The restoring torque brings it back to its stable equilibrium.

Q33 : (d)	**Q34** : (d)	**Q35** : (a)	**Q36** : (a)
Q37 : (a)	**Q38** : (b)	**Q39** : (d)	**Q40** : (b)
Q41 : (a)	**Q42** : (c)	**Q43** : (c)	**Q44** : (b)
Q45 : (c)	**Q46** : (a)		