विध्न विचारत भीरु जन, नहीं आरम्भे काम,
विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक,
'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचितः मानव धर्म प्रणेता
सद्‌गुरु श्री रणछोड़दासजी महाराज

ELECTROSTATICS

Some questions (Assertion–Reason type) are given below. Each question contains STATEMENT – 1 (Assertion) and STATEMENT – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. So select the correct choice :

Choices are :

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.
(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.
(C) Statement – 1 is True, Statement – 2 is False.
(D) Statement – 1 is False, Statement – 2 is True.

401. **STATEMENT – 1**
Induced charge does not contribute to electric field or potential at a given point.
STATEMENT – 2
A point charge q_0 is kept outside a solid metallic sphere, the electric field inside the sphere is zero.

402. **STATEMENT – 1**
The surface of a charged conductor is always equipotential.
STATEMENT – 2
Electric field lines are always perpendicular to the equipotential surface.

403. **STATEMENT – 1**
Electric field at a point is always inversely proportional to (distance)^2.
STATEMENT – 2
Electric field due to a line charge at a point is inversely proportional to distance.

404. **STATEMENT – 1**
When the charges on a conductor are at rest, there is no electric field inside the conductor.
STATEMENT – 2
Magnetic field exists inside the magnet.

405. **STATEMENT – 1**
Electrostatic experiments do not work well on humid days.
STATEMENT – 2
Water is a good conductor of electricity.

406. **STATEMENT – 1**
The potential decreases in the direction of the electric field.

STATEMENT – 2
The external agent will do positive work in moving a positive charge from higher to lower potential.

407. **STATEMENT – 1**
Excess charge on a conductor resides entirely on the outer surface.

STATEMENT – 2
Like charges repel one another.

408. **STATEMENT – 1**
A conducting sphere charged upto 50V is placed at the centre of a conducting shell charged upto 100V and connected by a wire. All the charge of the shell flows to the sphere.

STATEMENT – 2
The positive charge always flows from higher to lower potential.

409. **STATEMENT – 1**
When a charged particle is placed in the cavity in a conducting sphere induced charge on the outer surface of the sphere is found to be uniformly distributed.

STATEMENT – 2
Conducting surface is equipotential surface.

410. **STATEMENT – 1**
When a charged body is brought near to an uncharged conducting body equal and opposite charge is induced on the nearer surface of the conducting body.

STATEMENT – 2
Net electric field inside the conductor is zero.

411. **STATEMENT – 1**
When a neutral body is charged negatively, its mass increases slightly.

STATEMENT – 2
When a body is charged negatively, it gains some electrons and electron has finite mass; though quite small.

412. **STATEMENT – 1**
A single isolated conductor is always equivalent to a capacitor.

STATEMENT – 2
The second plate of an isolated conductor can be assumed at infinity.

413. **STATEMENT – 1**
The two adjacent conductors carrying same charge can be at different potentials.

STATEMENT – 2
The potential of a conductor depends on the charge on it as well as shape and size of its and on the charge and shape and size of the surrounding charged bodies and their separation from the body.

414. **STATEMENT – 1**
Electric field intensity at surface of uniformly charge spherical shell is E. If shell is punchered at a point then intensity at punchered point become E/2.

STATEMENT – 2
Electric field intensity due to spherical charge distribution can be found out by using Gauss law.

415. **STATEMENT – 1**
A parallel plate capacitor is charged using a battery and then a dielectric slab is inserted completely filling space between plates without disconnecting battery. Electric field between plates of capacitor will decrease.

STATEMENT – 2
If battery remains connected then charge on plates of capacitor increases.

416. **STATEMENT – 1 :** Electric field intensity within an isolated conductor will be zero.

STATEMENT – 2 : No net charge can exist within an isolated conductor.

417. **STATEMENT – 1 :** If two concentric conducting sphere which are connected by a conducting wire. No charge can exist on inner sphere.

STATEMENT – 2 : When charge on outer sphere will exist then potential of inner shell and outer shell will be same.

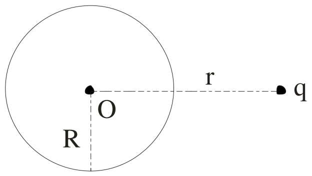
418. **STATEMENT – 1 :** Two concentric spherical shell of different radius are at potential V_A and V_B. If outer shell is earthed then potential difference will not be changed.

STATEMENT – 2 : Potential difference between the surfaces of two concentric spherical shells does not depends on the charge on the outer shell.

419. **STATEMENT – 1 :** The potential of an uncharged conducting sphere of radius R, for a point charge q located at distance r from its centre (r > R) is $\frac{Kq}{r}$.

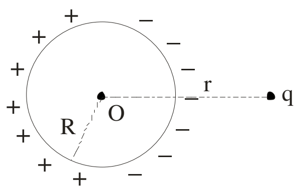
STATEMENT – 2 : Electric field intensity inside the conductor is zero therefore potential at each point on conductor is zero.

420. **STATEMENT – 1 :** A point charge q is placed in front of a solid conducting sphere. Electric field due to induced charges at the centre of sphere is zero.



STATEMENT – 2 : Electric field at a point inside the solid body of conductor is zero.

421. **STATEMENT – 1 :** Consider a conducting sphere of radius R. Now a charge q is placed in front of sphere. Electric potential at point O is $\frac{Kq}{r}$.



STATEMENT – 2 : Electric potential at the centre of sphere due to induced charges is zero.

422. **STATEMENT – 1 :** If three capacitors of capacitance $C_1 < C_2 < C_3$ are connected in parallel then their equivalent capacitance $C_{parallel} > C_{series}$

STATEMENT – 2 : $\frac{1}{C_{parallel}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

423. **STATEMENT – 1 :** A charged capacitor is disconnected from a battery. Now if its plates are separated further, the potential energy will fall.

STATEMENT – 2 : Energy stored in a capacitor is equal to the work done in charging it.

424. **STATEMENT – 1 :** There cannot be a potential difference between two adjacent conductors that carry the same amount of positive charge.

STATEMENT – 2 : Potential of a conductor can be found by (Q/c) ratio and capacity c depends on the geometrical parameters like size etc.

425. **STATEMENT – 1 :** When a capacitor is charged by a battery, both the plates receive charge equal in magnitude, no matter sizes of plates are identical or not.

STATEMENT – 2 : The charge distribution on the plates of capacitor is in accordance with charge conservation principle.

426. **STATEMENT – 1 :** Any charge will move from electric potential [V_1 to V_2] by its own; when $V_1 > V_2$.

STATEMENT – 2 : Electron moves from $V_1 = 2V$ towards $V_2 = 4$ V.

427. **STATEMENT – 1 :** The capacitance of any capacitor is always constant for any charge.

STATEMENT – 2 : If the charge on a capacitor increases; its capacitance increases as $C = \frac{Q}{V}$.

428. **STATEMENT – 1 :** A parallel plate capacitor is connected across battery through a key. A dielectric slab of constant K is introduced between the plates. The energy which is stored becomes K times

STATEMENT – 2 : The surface density of charge on the plate remains constant.

429. **STATEMENT – 1 :** A metallic shield in form of a hollow shell may be built to block an electric field.

STATEMENT – 2 : In a hollow spherical shield, the electric field inside it is zero at every point.

430. **STATEMENT – 1 :** Two charges q_1 and q_2 are placed at separation r. Then magnitude of force on each charge is F.

STATEMENT – 2 : Now a third charge q_3 is placed near q_1 and q_2. Then force on q_1 due to q_2 remains F.

431. A charge is given velocity perpendicular to uniform electric field then
STATEMENT – 1 : Initial power delivered by electric field is zero.

STATEMENT – 2 : Path of charged particle is circular.

432. **STATEMENT – 1 :** A charged conductor may have charged partcle inside it.

STATEMENT – 2 : There can't exist electric field lines inside the conductor.

433. **STATEMENT – 1 :** When one plate of a charge parallel plate capacitor is connected to the earth, its capacity increases.

STATEMENT – 2 : Electric potential difference between the plates decreases.

434. **STATEMENT – 1 :** If the distance between parallel plates of a capacitors is halved and dielectric constant is made three times, then the capacitor becomes 6 times.

STATEMENT – 2 : Capacity of a capacitor does not depend upon the nature of material of the capacitor plates.

435. **STATEMENT – 1 :** If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force.

STATEMENT – 2 : This force is due to the induced charge on the conducting surface, which is at zero potential.

436. **STATEMENT – 1 :** If there exists coulombic attraction between two bodies both of them may not be charged.

STATEMENT – 2 : In coulombic attraction two bodies are oppositely charged.

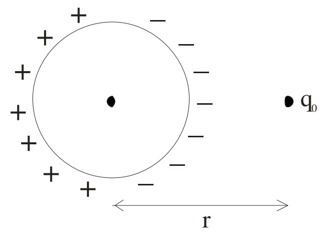
437. **STATEMENT – 1 :** On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.

STATEMENT – 2 : Electric field is inversely proportional to square of distance from the point charge.

Hint & Solution

401.	(D)	402.	(A)	403.	(D)	404.	(B)
405.	(C)	406.	(C)	407.	(B)	408.	(D)
409.	(B)	410.	(D)	411.	(A)	412.	(A)
413.	(A)	414.	(B)	415.	(D)	416.	(A)
417.	(A)	418.	(A)	419.	(C)	420.	(D)
421.	(A)	422.	(C)	423.	(D)	424.	(D)
425.	(A)	426.	(D)	427.	(C)	428.	(C)
429.	(A)	430.	(B)	431.	(C)	432.	(B)
433.	(C)	434.	(B)	435.	(A)	436.	(C)
437.	(D)						

401. Electric field due to q_0 is towards left and is $\frac{kq_0}{r^2}$ but electric field due to induced charge is towards right and will have same magnitude $\frac{kq_0}{r^2}$ so that electric field inside the sphere is zero.

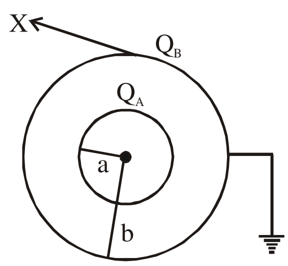


402. Conceptual.

403. Electric field due to line charge $E = \frac{\lambda}{4\pi\varepsilon_0 r}(\sin\alpha + \sin\beta)$.

404. Conceptual.

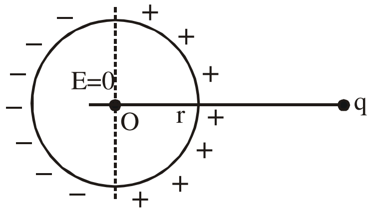
418.



$$V_A = \frac{KQ_A}{a} + \frac{KQ_B}{b}$$
$$V_B = \frac{KQ_A}{b} + \frac{KQ_B}{b}$$

$$V_A - V_B = \frac{KQ_A}{a} - \frac{KQ_A}{b} = KQ_A\left(\frac{1}{a} - \frac{1}{b}\right).$$

419.



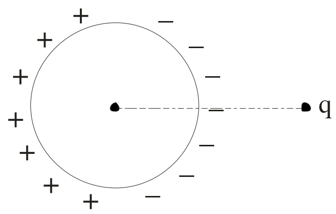
$$V_0 = \frac{Kq}{r} + \frac{K\sum \text{Induced charge}}{r}$$

$$V_0 = \frac{Kq}{r} + 0$$

Potential is constant.

420. At point O

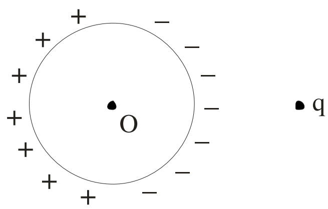
$$\vec{E}_{net} = \vec{E}_{in} + \vec{E}_q$$



$$\vec{E}_{net} = 0 \quad \Rightarrow \quad E_{in} + E_q \Rightarrow E_q = \frac{Kq}{r^2} \neq 0.$$

421. $$V_0 = \frac{Kq}{r} + \frac{K\int dq_{induce}}{R}$$

$$V_0 = \frac{Kq}{r} \quad (\because \int dq_{incide} = 0).$$



422. Equivalent capacitance of parallel combination is $C_{parallel} = C_1 + C_2 + C_3$.

423. Battery is disconnected from the capacitor so Q = constant

$$\text{Energy} = \frac{Q^2}{2C} = \frac{Q^2 d}{2\varepsilon_0 d}$$

$$\Rightarrow \text{Energy} \propto d$$

424. Since V = Q/c
If sizes of two capacitors are different then potentials will also be different. Thus potential difference may exist between them although they carry same amount of positive charge.

425. The sum of charges on both the plates should be zero.

426. Electron being a (–ve) charge; will move from lower to higher potential.

427. The capacitance depends upon the geometrical parameters only. And if Q is increased then V – increase.

428. In the given case V = V_0 (constant)

Energy stored in the capacitor $= \frac{1}{2}CV^2$.

$C' = CK$, so energy stored will become A times.
Q = CV, so Q will become K times

$\therefore$ surface charge density $\sigma' = \frac{Kq}{A} = K\sigma_0$.

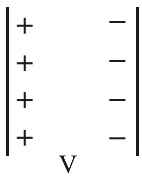
429. In a hollow spherical shield, the charge is present only on its surface but charge is zero at every point inside the hollow sphere. Hence, the metallic shield in form of hollow shell may be built to block an electric field.

430. Force of interaction between two charge is independent of presence of other charge.

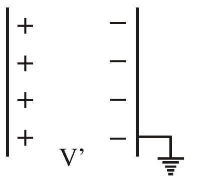
431. Path of charged particle is parabolic.

432. Inside the conductor, charged atoms are present.

433.



V ' = V



434. $$C_1 = \varepsilon_0 \times \frac{KA}{d}$$

$$\frac{C_1}{C_2} = \frac{K_1}{d_1} \times \frac{d_2}{K_2} = \frac{K_1}{K_2} \times \frac{d/2}{3} = \frac{1}{6}$$

$C_2 = 6C_1$.

435. Apply the concept of electric image.

436. Coulombic attraction exists even when one body is charged and the other is uncharged.

437. The rate of decrease of electric field is different in the two cases. In case of a point charge, it decreases as $1/r^2$ but in the case of electric dipole it decreases more rapidly, as $E = 1/r^2$.