GURUKUL QUIZ on Electrostatics

TIME: 3 Hrs Marks: 154

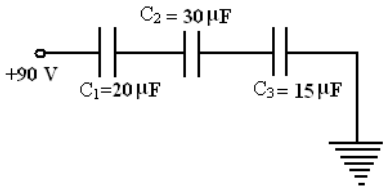
A. Q1 to Q30 are multiple choice questions.
B. Q31 to Q36 are subjective problems.
C. Q1 to Q10 carry each of 4 marks. 0 marks will be deducted for wrong answer.
D. Q11 to Q30 carry each of 3 marks. 1mark will be deducted for each wrong answer.
E. Q31 to Q36 carry each of 9 marks.

M.C.Q's(More than one may be correct option)

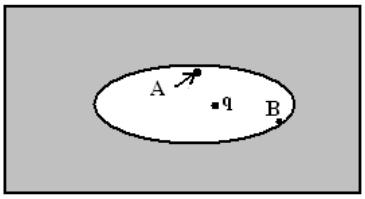
1. A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at x = 0 and positive plate is at x = 3d. The slab is equidistant from the plates. The capacitor is given some charge. As x goes from 0 to 3d,
   a. The magnitude of the electric field remains the same
   b. The direction of the electric field remains the same
   c. The electric potential increases continuously
   d. The electric potential increases at first, then decreases and again increases.
2. Two point charges + q and –q are held fixed at (-d, 0) and (d, 0) respectively of a x- y coordinate system. Then
   a. The electric field E at al points on the x – axis has the same direction
   b. Work has to be done in bringing a test charge from ∞ to the origin.
   c. Electric field at all points on y – axis is along x – axis.
   d. The dipole moment is 2qd along the x – axis.
3. A non-conducting sphere of radius R is uniformly charged. The magnitude of electric field due to the sphere at a distance r from its centre
   a. Increases as r increases for r <R
   b. Decreases as r increases for 0 < r < ∞
   c. Decreases as r increases for R < r <∞
   d. is discontinuous at r =R
4. A ring of radius R carries uniformly distributed charge + Q. a point charge (-q) is placed on the axis of the ring at a distance 2R from the centre of the ring and released from rest.
   a. The motion is harmonic in nature
   b. The motion is periodic
   c. The electric field strength at an arbitrary position of (- q) along the axis of the ring is $\frac{kqx}{(R^2+x^2)^{3/2}}$ inwardly directed [k = $(4\pi \in_0)^{-1}$]
   d. The electric force strength is $\frac{kQqx}{(R^2+x^2)^{3/2}}$ inwardly directed at an arbitrary position of (-q) along the axis of the ring
5. The electric potential V at any point (x, y, z) in space is given by $V = 4x^2$
   a. The y – and z – components of the electrostatic field at any point are zero
   b. The x- component at a point is given (- $8x\hat{\imath}$)
   c. The x – component at a point (1, 0.2) is (- 8 $\hat{\imath}$).
   d. The y – and z- components of the field are constant in magnitude.
6. A parallel plate air capacitor to a battery. The quantities charge, voltage, electric field and energy associated with this capacitor are given by Q_0, V_0, E_0 and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with the battery still in connection. The corresponding quantities now given by Q, V, E and E are related to the previous one as

a. $Q > Q_0$ b. $V > V_0$ c. $E > E_0$ d. $U > U_0$

7. Capacitor C_1 of capacitance μF and Capacitor 2μF are separately charged fully by a common battery. The two capacitors are then separately allowed to discharge through equal resistors at time t = 0
   a. The current in each of the two discharging current is zero at t = 0.
   b. The current in the two discharging circuits at t= 0 are equal but not zero.
   c. The currents in the two discharging circuits at t = 0 are unequal.
   d. Capacitor C_1 losses 50% of its initial charge sooner than C_2 losses 50% of its initial charge.
8. A variable parallel plate capacitor and an electroscope are connected in parallel to a battery. The reading of the electroscope would not decreased by
   a. Increasing the area of overlap of plates
   b. Placing a block of paraffin wax between the plates
   c. Decreasing the distance between the plates
   d. Decreasing the battery potential.
9. In the given circuit, choose the correct option (S)



   a. Total charge in this series combination is 600 μC
   b. The potential difference between the plates of C_1 is 30 V
   c. The potential difference between the plates of C_2 is 30V
   d. The potential difference between the plates of C_3 is 40 V
10. An ellipsoidal cavity is made within a perfect conductor. A positive charge q is placed at the centre of the cavity. The points A and B are on the cavity surface as shown in the figure. Then

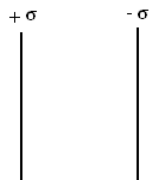


   a. Electric field near A in the cavity = electric field near B in the cavity.
   b. Charge density at A = charge density at B
   c. Potential at A = potential at B
   d. Total electric field flux through the surface of the cavity is q/ε_0.

M.C.Q's (Only one correct option)

11. Torque acting on an electric dipole placed in a uniform electric dipole is maximum. Under this configuration, the system has
   a. Maximum potential energy
   b. Minimum potential energy and it is zero.
   c. Minimum potential energy and it is negative.
   d. Neither minimum nor maximum potential energy.

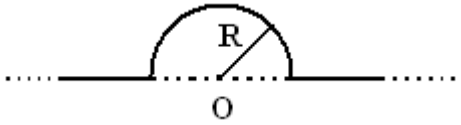
12. Five balls numbered A to E, are suspended using separate threads. Pairs (A, B), (B, D) and (D, A) show electrostatic attraction while pairs (B, C) and (D, E) sow repulsion. About A we can say it is
    a. Positive charged
    b. Negative charged
    c. Neutral
    d. Either positively or negatively charged.
13. Two large conducting plates are placed parallel to each other and they carry equal and opposite charges with surface density σ as shown. Electric field at the left of the first plate is



    a. $\frac{\sigma}{\varepsilon_0}$ b. $\frac{\sigma}{2\varepsilon_0}$ c. $\frac{2\sigma}{\varepsilon_0}$ d. zero

14. In bringing an electron towards an α- particle, electrostatic potential energy of the system
    a. Decreases b. Increases c. remains unchanged d. may increase or decrease

15. If linear charge density of a semicircular wire as shown in the figure is **λ** then



    a. Electric field at O is $\frac{\lambda}{2\varepsilon_0}$
    b. Electric field at the O is $\frac{\lambda}{2\pi\varepsilon_0 R}$
    c. Electric field at the O is $\frac{\lambda}{2\pi\varepsilon_0 R} + \frac{\lambda}{2\varepsilon_0 R}$.
    d. None of these.
16. Electric charges q, q , −2q are placed at the corners of an equilateral triangle side l. The magnitude of the electric dipole moment of the system is
    a. ql b. 2ql c. √3 ql d. 4ql
17. A charge +q is fixed at each of the points x = x_o, x = $3x_0$, x = $5x_o$,…..∞ on the x – axis and a charge –q is fixed at each of points x = $2x_0$, x = $4x_0$, x = $6x_0$,……..∞. Here x_o is a positive quantity. Take the electric potential at a point due to charge Q at a distance r from it to be $\frac{Q}{4\pi\varepsilon_0 r}$. Then the potential at origin due to above system o charges is
    a. 0 c. ∞
    b. $\frac{q}{8\pi\varepsilon_0 x_0 \ln 2}$ d. $\frac{q \ln 2}{4\pi\varepsilon_0 x_0}$
18. A point charge Q is located at the centre of a hollow spherical conductor having inner radius as R_1 and outer radius R_2. The conductor being uncharged initially. The potential at the inner surface will be
    a. $KQ\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$ c. $KQ\left[\frac{1}{R_2} - \frac{1}{R_1}\right]$

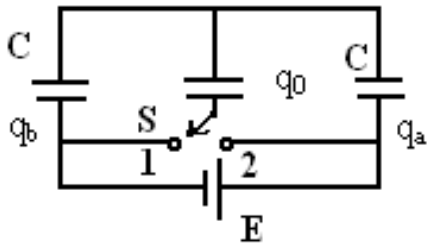
b. $KQ\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$ d. none of these

19. Two fixed point charges + 4e and + e are separated by a distance 'a'. Where should a third point charge q be placed for it to be in equilibrium?
    a. 2a/3 from + 4e c. a/4 from + e
    b. a/3 from +4e d. 3a/4 from +e
20. a uniform electric field pointing in positive x – direction exists in a region. Let A be the origin, B be the point on the x – axis at x = +1 cm, C be the point on the y – axis at y = +1 cm. Then the potentials at the points A, B and C satisfy
    a. $V_A < V_B$ c.$V_A < V_C$
    b. $V_A > V_B$ d.$V_A > V_B$
21. A positive point charge is placed at the centre of a negatively charged conducting shell. If the charge is capable to move freely then it will
    a. Remain stationary
    b. Move towards the nearer wall of the conductor.
    c. Oscillate between the two walls.
    d. Oscillate between the centre and the wall.
22. P is a point on an equipotential surface S. The field at P is E. Then
    a. E is perpendicular to S is all cases.
    b. E will be perpendicular to S only if S is a plane surface.
    c. E may have a non- zero component along the tangent to S, if s is a curved surface.
    d. None of these.
23. A point charge Q_1 is placed at the centre of an uncharged conducting shell and an another point charge Q_2 is placed outside the shell at a distance from its centre
    a. The force on Q_1 is $\frac{kQ_1Q_2}{r^2}$ c. The force on Q_1 is 0
    b. The force on Q_2 is $\frac{kQ_1Q_2}{r^2}$ d. The force on Q_2 is zero.
24. A ring with a uniform charge Q and radius R, is placed in the y – z plan with its centre at the origin.
    a. The field at the origin is zero
    b. The field at the point (x, 0,0) is kQ/x^2
    c. The field at the point (x, 0,0) is $\frac{kQ}{R^2+x^2}$
    d. None of these.
25. A capacitor is 2μF is charged by connecting across a battery of 100V. Another capacitor of 4 μF is charged by connecting across the same battery. If both are then connected to each other in parallel, the potential drop across the combination may be
    a. 50V b. 100V c.200V d.400V
26. n drops each of capacitance C, coalesce to form a single drop. The capacitance of the single drop is
    a. C/n b. nC c.$n^{1/3}C$ d. $n^{2/3}C$
27. The difference in the effective capacitance of the two similar conductors when joined in series and parallel is 6μF. What is the capacitance of each capacitor?
    a. 6μF b. 4μF c. 8μF d.12μF
28. The potential difference reduces to 1/ 8 of original value for a 5μF isolated parallel plate charged capacitor when a glass plate is placed between plates. The value of relative dielectric constant of glass is
    a. 1.6 b. 5 c. 8 d. 40

29. The dielectric strength of a medium is $2kVmm^{-1}$. What is the maximum potential difference that can be set up across a 50μm specimen without puncturing it
    a. 10 V b. 100V c. 1000V d. 10,000V
30. A 2 microfarad capacitor of a T.V is subjected to 4000V potential difference. The energy stored in the capacitor
    a. 8J b. 16J c. 4J d. 2×10^{-3}J

SUBJECTIVE PROBLEMS

31. Four point charges + 8μC, - 1μC, -1μC and + 8μC are fixed at the points $-\sqrt{27.2}\,m$, $-\sqrt{3/2}$ m and $+\sqrt{3/2}$ m, $+\sqrt{27.2}\,m$ respectively on the y – axis. A particle of mass 6 x 10^{-4} kg and of charge + 0.1 μC moves along the – x axis direction. Its speed at $x = +\infty$ is $\boldsymbol{\nu}_0$. Find the least value of $\boldsymbol{\nu}_0$ for which the particle will cross the origin. Find also the kinetic energy a\of the particle at the origin. Assume that space is gravity free. Give $1/(4\pi\varepsilon_0) = 9 \times 10^9$ Nm^2/C^2.
32. A uniform electric field E, exists between the plates of a capacitor. The plate length is l and the separation of the plates is d.
    a) An electron and a proton start from the negative and positive plate respectively and go to the opposite plates. Which of them wins his race?
    b) An electron and a proton start from the midpoint of the separation of plates at one end of the plates. Which of the two will have greater deviation when they start with the
        i. Same initial velocity
        ii. Same initial kinetic energy, and
        iii. Same initial momentum?
33. Find the electric field caused by a disc of radius R , with a uniform positive surface charge density along the axis of the disc a distance x from its centre.
34. Three charges q_1, q_2 and q_3 are located at the vertices of an equilateral triangle of side a. Find the electric potential energy of the system.
35. When switch is swapped from 1 to 2, find the heat produced in the circuit?



36. What is $V_A - V_B$ in the arrangement shown? What is the condition such that $V_A - V_B = 0$?