Electrostatic Potential and Capacitance

1. Two point P and Q are maintained at the potentials of 10 V and –4 V respectively. The work done in moving 100 electrons from P to Q is **[AIEEE-2009]**

   (1) 9.60×10^{-17} J (2) -2.24×10^{-16} J

   (3) 2.24×10^{-16} J (4) -9.60×10^{-17} J

2. *This question contains Statement-1 and statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.*

   Statement 1 : 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.

   Statement 2 : The net work done by a conservative force on an object moving along a closed loop is zero. **[AIEEE-2009]**

   (1) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statment-1.

   (2) Statment-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1.

   (3) Statement-1 is false, Statement-2 is true.

   (4) Statement-1 is true, Statement-2 is false.

3. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio $\frac{t_1}{t_2}$ will be **[AIEEE-2010]**

   (1) 2 (2) 1

   (3) $\frac{1}{2}$ (4) $\frac{1}{4}$

4. *This question has Statement 1 and Statement 2. Of the four choices given after the statements, choose the one that best describes the two Statements.*

   An insulating solid sphere of radius R has a uniformly positive charge density ρ. As a result of this uniform charge distribution there is a finite value of electric potential at the centre of the sphere, at the surface of the sphere and also at a point out side the sphere. The electric potential at infinity is zero.

   Statement 1 : When a charge 'q' is taken from the centre of the surface of the sphere, its potential energy changes by $\frac{q\rho}{3\varepsilon_0}$.

   Statement 2 : The electric field at a distance $r (r < R)$ from the centre of the sphere is $\frac{\rho r}{3\varepsilon_0}$.

   [AIEEE-2012]

   (1) Statement 1 is true Statement 2 is false

   (2) Statement 1 is false Statement 2 is true

   (3) Statement 1 is true Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

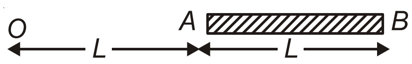
   (4) Statement 1 is true, Statement 2, is true; Statement 2 is not the correct explanation of Statement 1.

5. Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero. Then **[JEE (Main)-2013]**

   (1) $5C_1 = 3C_2$ (2) $3C_1 = 5C_2$

   (3) $3C_1 + 5C_2 = 0$ (4) $9C_1 = 4C_2$

6. A charge Q is uniformly distributed over a long rod AB of length L as shown in the figure. The electric potential at the point O lying at a distance L from the end A is **[JEE (Main)-2013]**



   (1) $\frac{Q}{8\pi\varepsilon_0 L}$ (2) $\frac{3Q}{4\pi\varepsilon_0 L}$

   (3) $\frac{Q}{4\pi\varepsilon_0 L \ln 2}$ (4) $\frac{Q \ln 2}{4\pi\varepsilon_0 L}$

7. Assume that an electric field $\vec{E} = 30x^2\hat{i}$ exists in space. Then the potential difference $V_A - V_O$, where V_O is the potential at the origin and V_A the potential at $x = 2$ m is **[JEE (Main)-2014]**

(1) 120 J (2) –120 J

(3) –80 J (4) 80 J

8. A parallel plate capacitor is made of two circular plates separated by a distance 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is 3×10^4 V/m, the charge density of the positive plate will be close to

(1) 6×10^{-7} C/m^2 (2) 3×10^{-7} C/m^2

(3) 3×10^4 C/m^2 (4) 6×10^4 C/m^2

9. A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}, \frac{5V_0}{4}, \frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then **[JEE (Main)-2015]**

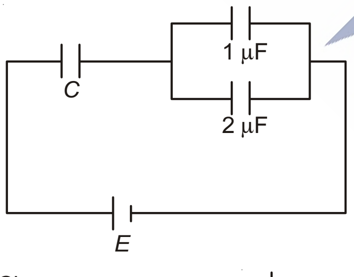
(1) $R_1 = 0$ and $R_2 > (R_4 - R_3)$

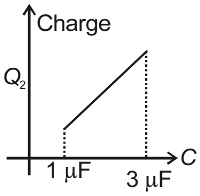
(2) $R_1 \neq 0$ and $(R_2 - R_1) > (R_4 - R_3)$

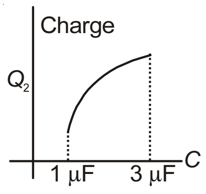
(3) $R_1 = 0$ and $R_2 < (R_4 - R_3)$

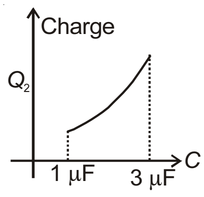
(4) $2R < R_4$

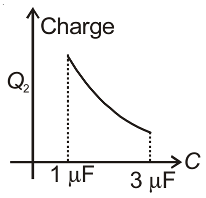
10. In the given circuit, charge Q_2 on the 2 μF capacitor changes as C is varied from 1 μF to 3 μF. Q_2 as a function of C is given properly by (Figures are drawn schematically and are not to scale) **[JEE (Main)-2015]**



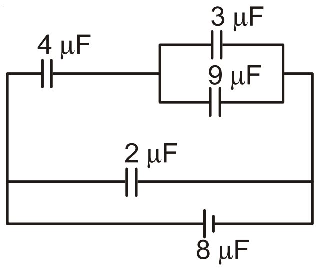
(1) 

(2) 

(3) 

(4) 

11. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the 4 μF and 9 μF capacitors), at a point distant 30 m from it, would equal : **[JEE (Main)-2016]**



(1) 360 N/C (2) 420 N/C

(3) 480 N/C (4) 240 N/C

12. A capacitance of 2 μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1 μF capacitors are available which can withstand a potential difference of not more than 300 V.The minimum number of capacitors required to achieve this is

[JEE (Main)-2017]

(1) 2 (2) 16

(3) 24 (4) 32

13. Three concentric metal shells A, B and C of respective radii a, b and c ($a < b < c$) have surface charge densities $+\sigma$, $-\sigma$ and $+\sigma$ respectively. The potential of shell B is **[JEE (Main)-2018]**

(1) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2 - b^2}{a} + c\right]$ (2) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2 - b^2}{b} + c\right]$

(3) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2 - c^2}{b} + a\right]$ (4) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2 - c^2}{c} + a\right]$

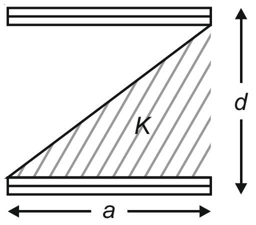
14. A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20 V. If a dielectric material of dielectric constant $K = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be **[JEE (Main)-2018]**

(1) 1.2 nC (2) 0.3 nC

(3) 2.4 nC (4) 0.9 nC

15. A parallel plate capacitor is made of two square plates of side a, separated by a distance d(d << a). The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure. Capacitance of this capacitor is

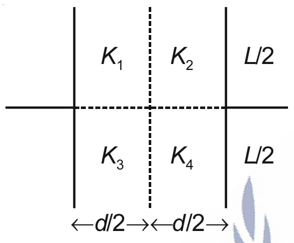
[JEE (Main)-2019]



(1) $\dfrac{K\varepsilon_0 a^2}{d(K-1)}\ln K$ (2) $\dfrac{K\varepsilon_0 a^2}{d}\ln K$

(3) $\dfrac{K\varepsilon_0 a^2}{2d(K+1)}$ (4) $\dfrac{1}{2}\dfrac{K\varepsilon_0 a^2}{d}$

16. A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants K_1, K_2, K_3, K_4 arranged as shown in the figure. The effective dielectric constant K will be **[JEE (Main)-2019]**



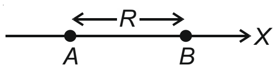
(1) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{2(K_1+K_2+K_3+K_4)}$

(2) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{K_1+K_2+K_3+K_4}$

(3) $K = \dfrac{(K_1+K_3)(K_2+K_4)}{K_1+K_2+K_3+K_4}$

(4) $K = \dfrac{K_1K_2}{K_1+K_2} + \dfrac{K_3K_4}{K_3+K_4}$

17. Two electric dipoles, A, B with respective dipole moments $\vec{d}_A = -4qa\hat{i}$ and $\vec{d}_B = -2qa\hat{i}$ are placed on the x-axis with a separation R, as shown in the figure **[JEE (Main)-2019]**



The distance from A at which both of them produce the same potential is

(1) $\dfrac{\sqrt{2}R}{\sqrt{2}-1}$ (2) $\dfrac{\sqrt{2}R}{\sqrt{2}+1}$

(3) $\dfrac{R}{\sqrt{2}-1}$ (4) $\dfrac{R}{\sqrt{2}+1}$

18. A charge Q is distributed over three concentric spherical shells of radii a, b, c ($a < b < c$) such that their surface charge densities are equal to one another. The total potential at a point at distance r from their common centre, where $r < a$, would be **[JEE (Main)-2019]**

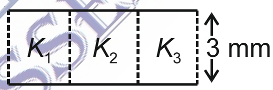
(1) $\dfrac{Q(a+b+c)}{4\pi\varepsilon_0(a^2+b^2+c^2)}$

(2) $\dfrac{Q}{4\pi\varepsilon_0(a+b+c)}$

(3) $\dfrac{Q(a^2+b^2+c^2)}{4\pi\varepsilon_0(a^3+b^3+c^3)}$

(4) $\dfrac{Q}{12\pi\varepsilon_0}\dfrac{ab+bc+ca}{abc}$

19. A parallel plate capacitor is of area 6 cm^2 and a separation 3 mm. The gap is filled with three dielectric materials of equal thickness (see figure) with dielectric constants K_1 = 10, K_2 = 12 and K_3 = 14. The dielectric constant of a material which when fully inserted in above capacitor, gives same capacitance would be **[JEE (Main)-2019]**



(1) 36 (2) 14

(3) 12 (4) 4

20. Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, –2) and (0, –2). The work required to put a fifth charge Q at the origin of the coordinate system will be **[JEE (Main)-2019]**

(1) $\dfrac{Q^2}{2\sqrt{2}\pi\varepsilon_0}$ (2) $\dfrac{Q^2}{4\pi\varepsilon_0}\left(1+\dfrac{1}{\sqrt{3}}\right)$

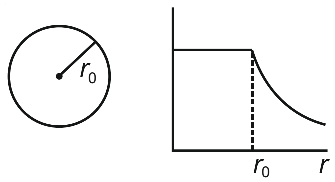
(3) $\dfrac{Q^2}{4\pi\varepsilon_0}$ (4) $\dfrac{Q^2}{4\pi\varepsilon_0}\left(1+\dfrac{1}{\sqrt{5}}\right)$

21. A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates. The work done by the capacitor on the slab is **[JEE (Main)-2019]**

(1) 560 pJ (2) 692 pJ

(3) 508 pJ (4) 600 pJ

22. The given graph shows variation (with distance r from centre) of **[JEE (Main)-2019]**



(1) Potential of a uniformly charged spherical shell

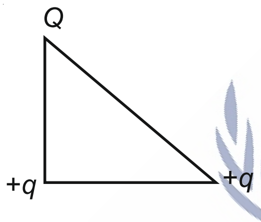
(2) Electric field of a uniformly charged sphere

(3) Electric field of uniformly charged spherical shell

(4) Potential of a uniformly charged sphere

23. Three charges Q, $+q$ and $+q$ are placed at the vertices of a right-angle isosceles triangles as shown below. The net electrostatic energy of the configuration is zero, if the value of Q is

[JEE (Main)-2019]

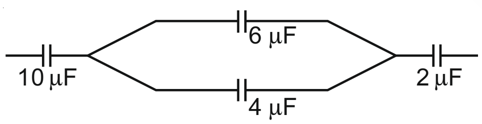


(1) $\dfrac{-\sqrt{2}q}{\sqrt{2}+1}$ (2) $+q$

(3) $-2q$ (4) $\dfrac{-q}{1+\sqrt{2}}$

24. In the figure shown below, the charge on the left plate of the 10 μF capacitor is –30 μC. The charge on the right plate of the 6 μF capacitor is

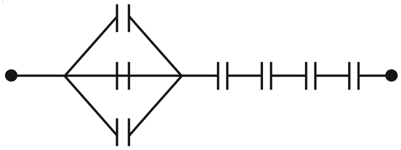
[JEE (Main)-2019]

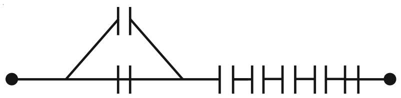


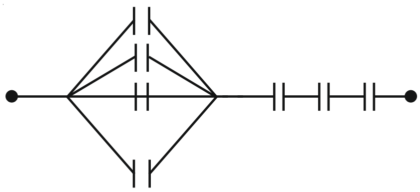
(1) +18 μC (2) –12 μC

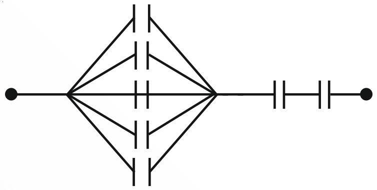
(3) +12 μC (4) –18 μC

25. Seven capacitors, each of capacitance 2 μF, are to be connected in a configuration to obtain an effective capacitance of $\left(\dfrac{6}{13}\right)$ μF. Which of the combinations, shown in figures below, will achieve the desired value? **[JEE (Main)-2019]**

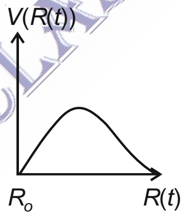
(1) 

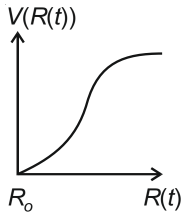
(2) 

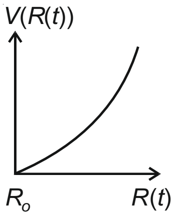
(3) 

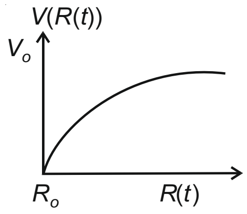
(4) 

26. There is a uniform spherically symmetric surface charge density at a distance R_0 from the origin. The charge distribution is initially at rest and starts expanding because of mutual repulsion. The figure that represents best the speed $V(R(t))$ of the distribution as a function of its instantaneous radius $R(t)$ is **[JEE (Main)-2019]**

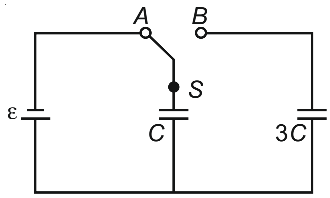
(1) 

(2) 

(3) 

(4) 

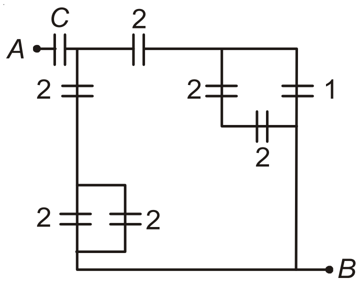
27. In the figure shown, after the switch 'S' is turned from position 'A' to position 'B', the energy dissipated in the circuit in terms of capacitance 'C' and total charge 'Q' is **[JEE (Main)-2019]**



(1) $\frac{3}{8}\frac{Q^2}{C}$ (2) $\frac{1}{8}\frac{Q^2}{C}$

(3) $\frac{5}{8}\frac{Q^2}{C}$ (4) $\frac{3}{4}\frac{Q^2}{C}$

28. In the circuit shown, find C if the effective capacitance of the whole circuit is to be 0.5 μF. All values in the circuit are in μF. **[JEE (Main)-2019]**



(1) $\frac{7}{11}\mu$F (2) 4 μF

(3) $\frac{6}{5}\mu$F (4) $\frac{7}{10}\mu$F

29. A parallel plate capacitor with plates of area 1 m^2 each, are at a separation of 0.1 m. If the electric field between the plates is 100 N/C, the magnitude of charge on each plate is: **[JEE (Main)-2019]**

$\left(\text{Take } \varepsilon_0 = 8.85\times10^{-12}\frac{C^2}{N\,m^2}\right)$

(1) 8.85×10^{-10} C (2) 9.85×10^{-10} C

(3) 6.85×10^{-10} C (4) 7.85×10^{-10} C

30. Voltage rating of a parallel plate capacitor is 500 V. Its dielectric can withstand a maximum electric field of 10^6 V/m. The plate area is 10^{-4} m^2. What is the dielectric constant if the capacitance is 15 pF?

(Given, $\varepsilon_0 = 8.86 \times 10^{-12}$ C^2/Nm^2)

[JEE (Main)-2019]

(1) 3.8 (2) 4.5

(3) 8.5 (4) 6.2

31. A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of $-4\,Q$, the new potential difference between the same two surfaces is

[JEE (Main)-2019]

(1) $-2\,V$ (2) V

(3) $2\,V$ (4) $4\,V$

32. The electric field in a region is given by $\vec{E} = (Ax + B)\hat{i}$, where E is in NC^{-1} and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at x = 1 is V_1 and that at x = – 5 is V_2, then $V_1 - V_2$ is : **[JEE (Main)-2019]**

(1) 180 V (2) –520 V

(3) 320 V (4) –48 V

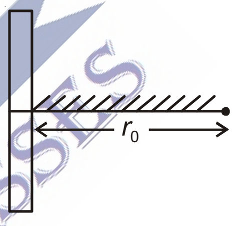
33. A parallel plate capacitor has 1 μF capacitance. One of its two plates is given +2 μC charge and the other plate, +4 μC charge. The potential difference developed across the capacitor is :

[JEE (Main)-2019]

(1) 5 V (2) 1 V

(3) 3 V (4) 2 V

34. A positive point charge is released from rest at a distance r_0 from a positive line charge with uniform density. The speed (v) of the point charge, as a function of instantaneous distance r from line charge, is proportional to : **[JEE (Main)-2019]**



(1) $v \propto \sqrt{\ln\left(\frac{r}{r_0}\right)}$ (2) $v \propto e^{+r/r_0}$

(3) $v \propto \ln\left(\frac{r}{r_0}\right)$ (4) $v \propto \left(\frac{r}{r_0}\right)$

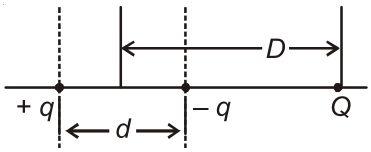
35. A capacitor with capacitance 5 μF is charged to 5 μC. If the plates are pulled apart to reduce the capacitance to 2 μF, how much work is done?

[JEE (Main)-2019]

(1) 2.55×10^{-6} J (2) 6.25×10^{-6} J

(3) 3.75×10^{-6} J (4) 2.16×10^{-6} J

36. A system of three charges are placed as shown in the figure



If $D >> d$, the potential energy of the system is best given by **[JEE (Main)-2019]**

(1) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{D^2}\right]$

(2) $\frac{1}{4\pi\varepsilon_0}\left[+\frac{q^2}{d}+\frac{qQd}{D^2}\right]$

(3) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}+\frac{2qQd}{D^2}\right]$

(4) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{2D^2}\right]$

37. The parallel combination of two air filled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage, V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constant K is placed between the two plates of the first capacitor. The new potential difference of the combined system is **[JEE (Main)-2019]**

(1) $\frac{(n+1)V}{(K+n)}$ (2) $\frac{V}{K+n}$

(3) V (4) $\frac{nV}{K+n}$

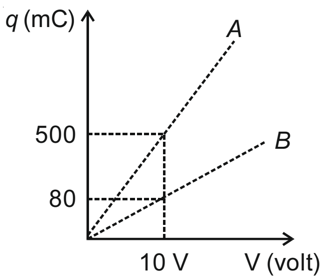
38. A uniformly charged ring of radius $3a$ and total charge q is placed in xy-plane centred at origin. A point charge q is moving towards the ring along the z-axis and has speed v at $z = 4a$. The minimum value of v such that it crosses the origin is : **[JEE (Main)-2019]**

(1) $\sqrt{\frac{2}{m}}\left(\frac{1}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$ (2) $\sqrt{\frac{2}{m}}\left(\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

(3) $\sqrt{\frac{2}{m}}\left(\frac{4}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$ (4) $\sqrt{\frac{2}{m}}\left(\frac{2}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

39. Figure shows charge (q) versus voltage (V) graph for series and parallel combination of two given capacitors. The capacitances are :

[JEE (Main)-2019]



(1) 40 μF and 10 μF (2) 20 μF and 30 μF

(3) 60 μF and 40 μF (4) 50 μF and 30 μF

40. In free space, a particle A of charge 1 μC is held fixed at a point P. Another particle B of the same charge and mass 4 μg is kept at a distance of 1 mm from P. If B is released, then its velocity at a distance of 9 mm from P is : **[JEE (Main)-2019]**

$$\left[\text{Take } \frac{1}{4\pi\varepsilon_0}=9\times10^9\ \text{Nm}^2\text{C}^{-2}\right]$$

(1) 2.0×10^3 m/s (2) 6.32×10^4 m/s

(3) 1.5×10^2 m/s (4) 1.0 m/s

41. A point dipole $\vec{p}=-p_0\hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively :

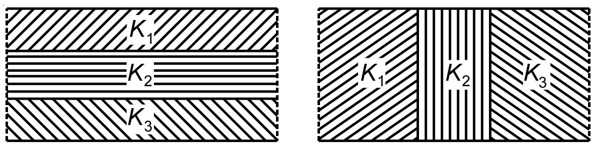
(Take $V = 0$ at infinity) **[JEE (Main)-2019]**

(1) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$ (2) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

(3) $0, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$ (4) $0, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

42. Two identical parallel plate capacitors, of capacitance C each, have plates of area A, separated by a distance d. The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1, K_2 and K_3. The first capacitor is filled as shown in fig. I, and the second one is filled as shown in fig II.

If these two modified capacitors are charged by the same potential V, the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II)): **[JEE (Main)-2019]**



(I) (II)

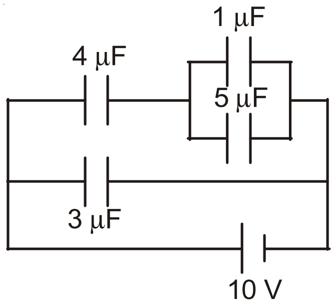
(1) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{K_1K_2K_3}$

(2) $\frac{E_1}{E_2}=\frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{9\,K_1K_2K_3}$

(3) $\frac{E_1}{E_2}=\frac{9\,K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

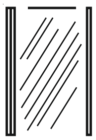
(4) $\frac{E_1}{E_2}=\frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

43. In the given circuit, the charge on 4 μF capacitor will be **[JEE (Main)-2019]**



(1) 5.4 μC (2) 9.6 μC

(3) 13.4 μC (4) 24 μC

44. 

A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant that varies as $k(x) = K(1 + \alpha x)$ where 'x' is the distance measured from one of the plates. If $(\alpha d) << 1$, the total capacitance of the system is best given by the expression **[JEE (Main)-2020]**

(1) $\dfrac{AK\varepsilon_0}{d}(1+\alpha d)$

(2) $\dfrac{A\varepsilon_0 K}{d}\left(1+\dfrac{\alpha^2 d^2}{2}\right)$

(3) $\dfrac{AK\varepsilon_0}{d}\left(1+\dfrac{\alpha d}{2}\right)$

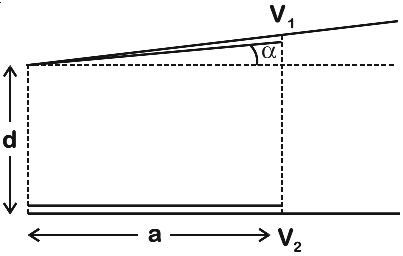
(4) $\dfrac{A\varepsilon_0 K}{d}\left(1+\left(\dfrac{\alpha d}{2}\right)^2\right)$

45. Effective capacitance of parallel combination of two capacitors C_1 and C_2 is 10 μF. When these capacitors are individually connected to a voltage source of 1 V, the energy stored in the capacitor C_2 is 4 times that of C_1. If these capacitors are connected in series, their effective capacitance will be **[JEE (Main)-2020]**

(1) 1.6 μF (2) 3.2 μF

(3) 4.2 μF (4) 8.4 μF

46. A capacitor is made of two square plates each of side 'a' making a very small angle α between them, as shown in figure. The capacitance will be close to **[JEE (Main)-2020]**



(1) $\dfrac{\varepsilon_0 a^2}{d}\left(1-\dfrac{3\alpha a}{2d}\right)$ (2) $\dfrac{\varepsilon_0 a^2}{d}\left(1-\dfrac{\alpha a}{2d}\right)$

(3) $\dfrac{\varepsilon_0 a^2}{d}\left(1+\dfrac{\alpha a}{d}\right)$ (4) $\dfrac{\varepsilon_0 a^2}{d}\left(1-\dfrac{\alpha a}{4d}\right)$

47. Consider two charged metallic spheres S_1 and S_2 of radii R_1 and R_2, respectively. The electric fields E_1 (on S_1) and E_2 (on S_2) on their surfaces are such that $E_1/E_2 = R_1/R_2$. Then the ratio V_1 (on S_1)/V_2(on S_2) of the electrostatic potentials on each sphere is **[JEE (Main)-2020]**

(1) $(R_1/R_2)^2$ (2) (R_2/R_1)

(3) $\left(\dfrac{R_1}{R_2}\right)^3$ (4) R_1/R_2

48. A 10 μF capacitor is fully charged to a potential difference of 50 V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20 V. The capacitance of the second capacitor is **[JEE (Main)-2020]**

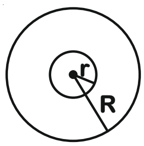
(1) 20 μF

(2) 10 μF

(3) 15 μF

(4) 30 μF

49. A charge Q is distributed over two concentric conducting thin spherical shells radii r and R ($R > r$). If the surface charge densities on the two shells are equal, the electric potential at the common centre is **[JEE (Main)-2020]**



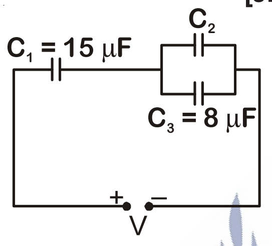
(1) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{(R+r)}{(R^2+r^2)}Q$ (2) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{(R+2r)Q}{2(R^2+r^2)}$

(3) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{(R+r)}{2(R^2+r^2)}Q$ (4) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{(2R+r)}{(R^2+r^2)}Q$

50. Two isolated conducting spheres S_1 and S_2 of radius $\frac{2}{3}R$ and $\frac{1}{3}R$ have 12 μC and –3 μC charges, respectively, and are at a large distance from each other. They are now connected by a conducting wire. A long time after this is done the charges on S_1 and S_2 are respectively **[JEE (Main)-2020]**

(1) 4.5 μC on both
(2) +4.5 μC and –4.5 μC
(3) 6 μC and 3 μC
(4) 3 μC and 6 μC

51. In the circuit shown in the figure, the total charge is 750 μC and the voltage across capacitor C_2 is 20 V. Then the charge on capacitor C_2 is **[JEE (Main)-2020]**



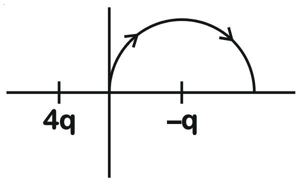
(1) 650 μC (2) 590 μC
(3) 160 μC (4) 450 μC

52. Concentric metallic hollow spheres of radii R and $4R$ hold charges Q_1 and Q_2 respectively. Given that surface charge densities of the concentric spheres are equal, the potential difference $V(R) - V(4R)$ is **[JEE (Main)-2020]**

(1) $\frac{3Q_2}{4\pi\varepsilon_0 R}$ (2) $\frac{3Q_1}{16\pi\varepsilon_0 R}$

(3) $\frac{Q_2}{4\pi\varepsilon_0 R}$ (4) $\frac{3Q_1}{4\pi\varepsilon_0 R}$

53. A two point charges $4q$ and $-q$ are fixed on the x-axis at $x = -\frac{d}{2}$ and $x = \frac{d}{2}$, respectively. If a third point charge 'q' is taken from the origin to $x = d$ along the semicircle as shown in the figure, the energy of the charge will **[JEE (Main)-2020]**



(1) Decrease by $\frac{q^2}{4\pi\varepsilon_0 d}$

(2) Decrease by $\frac{4q^2}{3\pi\varepsilon_0 d}$

(3) Increase by $\frac{2q^2}{3\pi\varepsilon_0 d}$

(4) Increase by $\frac{3q^2}{4\pi\varepsilon_0 d}$

54. A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $\frac{C}{2}$. The energy loss in the process after the charge is distributed between the two capacitors is **[JEE (Main)-2020]**

(1) $\frac{1}{4}CV_0^2$ (2) $\frac{1}{3}CV_0^2$

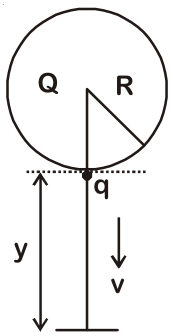
(3) $\frac{1}{6}CV_0^2$ (4) $\frac{1}{2}CV_0^2$

55. Two capacitors of capacitances C and $2C$ are charged to potential differences V and $2V$, respectively. These are then connected in parallel in such a manner that the positive terminal of one is connected to the negative terminal of the other. The final energy of this configuration is **[JEE (Main)-2020]**

(1) $\frac{3}{2}CV^2$ (2) $\frac{9}{2}CV^2$

(3) Zero (4) $\frac{25}{6}CV^2$

56. A solid sphere of radius R carries a charge $Q + q$ distributed uniformly over its volume. A very small point like piece of it of mass m gets detached from the bottom of the sphere and falls down vertically under gravity. This piece carries charge q. If it acquires a speed v when it has fallen through a vertical height y (see figure), then (assume the remaining portion to be spherical). **[JEE (Main)-2020]**



(1) $v^2 = y\left[\dfrac{qQ}{4\pi\varepsilon_0 R(R+y)m} + g\right]$

(2) $v^2 = 2y\left[\dfrac{qQ\,R}{4\pi\varepsilon_0 (R+y)^3 m} + g\right]$

(3) $v^2 = y\left[\dfrac{qQ}{4\pi\varepsilon_0 R^2 ym} + g\right]$

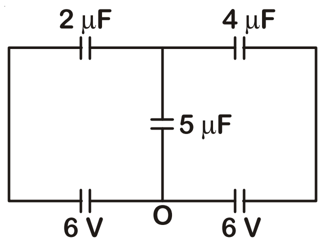
(4) $v^2 = 2y\left[\dfrac{qQ}{4\pi\varepsilon_0 R(R+y)m} + g\right]$

57. A parallel plate capacitor has plate of length 'ℓ', width 'w' and separation of plates is 'd'. It is connected to a battery of emf V. A dielectric slab of the same thickness 'd' and of dielectric constant k = 4 is being inserted between the plates of the capacitor. At what length of the slab inside plates, will the energy stored in the capacitor be two times the initial energy stored? **[JEE (Main)-2020]**

(1) $\dfrac{\ell}{4}$ (2) $\dfrac{\ell}{2}$

(3) $\dfrac{2\ell}{3}$ (4) $\dfrac{\ell}{3}$

58. In the circuit shown, charge on the 5 μF capacitor is **[JEE (Main)-2020]**



(1) 16.36 μC (2) 18.00 μC

(3) 5.45 μC (4) 10.90 μC

59. A 60 pF capacitor is fully charged by a 20 V supply. It is then disconnected from the supply and is connected to another uncharged 60 pF capacitor in parallel. The electrostatic energy that is lost in this process by the time the charge is redistributed between them is (in nJ) _________.

[JEE (Main)-2020]

60. A 5 μF capacitor is charged fully by a 220 V supply. It is then disconnected from the supply and is connected in series to another uncharged 2.5 μF capacitor. If the energy change during the charge redistribution is $\dfrac{X}{100}$ J then value of X to the nearest integer is _____. **[JEE (Main)-2020]**

❑ ❑ ❑