PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

ELECTROSTATIC POTENTIAL AND CAPACITANCE

Jee Main 5 Years At A Glance

1. The equivalent capacitance between A and B in the circuit given below is

A. $4.9\mu F$

B. $3.6\mu F$

C. $5.4\mu F$

D. $2.4\mu F$

Answer: D

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2. A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20V. If a dielectric material of dielectric constant $k = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be

A. $1.2nC$

B. $0.3nC$

C. $2.4nC$

D. $0.9nC$

Answer: A

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3. There is a uniform electrostatic field in a region. The potential at various points on a small sphere centred at P, in the region, is found to vary between in limits 589.0V to 589.8 V. What is the potential at a point on the sphere whose radius vector makes an angle of 60° with the direction of the field ?

A. 589.5V

B. 589.2V

C. 589.4V

D. 589.6V

Answer: C

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4. A capacitance of $2.0\mu F$ is required in an electrical circuit across a potential differences of 1.0 kV. A large number of $1\mu F$ capacitors are available which can withstand a potential differences of not more than 300V. The minimum number of capacitors required to achieve this is

A. 24

B. 32

C. 2

D. 16

Answer: B

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5. Within a spherical charge distribution of charge density $\rho(r)$, N equipotential surface of potential

$V_0, V_0 + \Delta V, V_0 + 2\Delta V, \ldots V_0 + N\Delta V (\Delta V > 0)$, are drawn and have increasing radii $r_0, r_1, r_2, \ldots . R_N$, respectively. If the difference in the radii of the surface is constant for all values of V_0 and ΔV then :-

A. $\rho(r) =$ constant

B. $\rho(r) \propto \frac{1}{r^2}$

C. $\rho(r) \propto \frac{1}{r}$

D. $\rho(r) \propto r$

Answer: C

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6. 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 $9\mu F$ capacitors), at a point distance 30 mn from it, would equal:

A. 420 N/C

B. 480N/C

C. 240N/C

D. 360N/C

Answer: A

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7. An electric field $\overrightarrow{E} = \left(25\hat{i} + 30\hat{j}\right)NC^{-1}$ exists in a region of space.If the potential at the origin is taken to be zero then the potential at x=2 m y=2 m is :?

A. $-110V$

B. $-140V$

C. $-120V$

D. $-130V$

Answer: A

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8. A uniformly charged solid shpere fo radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotentail 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 respecatively. Then

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

B. $2R = R_4$

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

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

Answer: A

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9. Three capacitors each of $3\mu F$, are provided. These cannot be combined to provide the resultant capacitance of

A. $1\mu F$

B. $2\mu F$

C. $4.5\mu F$

D. $6\mu F$

Answer: D

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10. Assume that an electric field $\overrightarrow{E} = 30x^2\hat{i}$ exists in space. Then the potential differences $V_A - V_0$ where V_0 is the potential at the origin and V_A, the potential at $x = 2m$ is

A. 120J/C

B. $-120J/C$

C. $-80J/C$

D. $80\frac{J}{C}$

Answer: C

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Exercise 1 Concept Builder

1. An uncharged insulated conductor A is brought near a charged insulated condutor B. what happens to charge and potential of B ?

A. the charge and potential of B, both remain constant

B. both charge and potential change

C. the charge remains constant, but potential decreases

D. the charge remains constant, but potential increases

Answer: C

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2. The electric field and the electric potential at a point are E and V respectively.

A. If E=0,V must be zero

B. If V=0, E must be zero

C. If $E \neq 0$, V cannot be zero

D. None of these

Answer: D

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3. Prove that, if an insulated, uncharged conductor is placed near a charged conductor and no other conductors are present, the uncharged body must be intermediate in potential between that of the charged body and that of infinity.

A. less than the charged conductor and more than at infinity.

B. more than the charged conductor and less than at infinity.

C. more tha the charged conductor and move than at infinity.

D. less than the charged conductor and less than at infinity.

Answer: A

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4. Two connectric spheres of radii R and r have similar charges with equal surface charge densities $(sigam)$. The electric potential at their common centre is

A. σ / ε_0

B. $\frac{\sigma}{\varepsilon_0}(R-r)$

C. $\frac{\sigma}{\varepsilon_0}(R+r)$

D. None of these

Answer: C

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5. From a point charge, there is a fixed point A. At a, there is an electric field of 500 V/m and potential difference of 3000 V. Distance between point charge and A will be

A. 6m

B. 12m

C. 16 m

D. 24m

Answer: A

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6. In a hollow spherical shell, potential (V) changes with respect to distance (s) from centre as

A.

B.

C.

D.

Answer: B

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7. Two metal pieces having a potential difference of $800V$ are $0.02m$ apart horizontally. A particle of mass $1.96 \times 10^{-15} kg$ is suspended in equilibrium between the plates. If the e is the elementary charge, then charge on the particle is

A. 8

B. 6

C. 0.1

D. 3

Answer: D

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8. The electric potential V (in volt) varies with x (in metre) according to the relation $V = 5 + 4x^2$ The force experienced by a negative charge of 2×10^{-6} C located at $x = 0.5$ m is $z \times 10^{-6}$N then the value of z is ?

A. $2 \times 10^{-6} N$

B. $4 \times 10^{-6} N$

C. $6 \times 10^{-6} N$

D. $8 \times 10^{-6} N$

Answer: D

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9. The 1000 small droplets of water each of radius r and charge Q, make a big drop of spherical shape. The potential of big drop is how many times the potential of one small droplet

A. 1

B. 10

C. 100

D. 1000

Answer: C

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10. The electric potential at a point (x, y) in the x-y plane is given by $V = -kxy$. The field intentisy at a distance r in this plane, from the origin is proportional to

A. r^2

B. r

C. $\frac{1}{r}$

D. $\frac{1}{r^2}$

Answer: B

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11. Four charge $q_1 = 2 \times 10^{-8} C, q_2 = -2 \times 10^{-8} C, q_3 = -3 \times 10^{-8} C,$ and $q_4 = 6 \times 10^{-8} C$ are palced at four corners of a square of side $\sqrt{2}$m. What is the potential at the centre of the square?

A. 270V

B. 300V

C. Zero

D. 100V

Answer: A

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12. The electric potential at point A is 1V and at another point B is 5V. A charge $3\mu C$ is released from B. What will be the kinetic energy of the charge as it passes through A?

A. $8 \times 10^{-6} J$

B. $12 \times 10^{-6} J$

C. $12 \times 10^{-9} J$

D. $4 \times 10^{-6} J$

Answer: B

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13. In moving from A to B along an electric field line, the work done by the electric field on an electric is $6.4 \times 10^{-19} J$. If ϕ_1 and ϕ_2 are equipotential surfaces, then the potential difference $V_C - V_A$ is

A. $-4V$

B. $4V$

C. zero

D. 6.4V

Answer: B

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14. A large insulated sphere of radius r charged with Q units of electricity is placed in contact with a small insulated uncharged sphere of radius r' and is then separated. The charge on the smaller sphere will now be.

A. $\frac{Q(r' + r)}{r'}$

B. $\frac{Q(r' + r)}{r}$

C. $\frac{Qr}{r' + r}$

D. $\frac{Qr'}{r' + r}$

Answer: D

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15. Electrical field intensity is given as $\overline{E} = (2x+1)y\hat{i} + x(x+1)\hat{j}$. The potential of a point (1,2) if potential at origin is 2 volt ils

A. 2V

B. 4V

C. $-2V$

D. 0V

Answer: C

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16. Two small identical metal balls of radius rare at a distance a $(a < \ < r)$ from each other and are charged, one with a potential V_1 and the other with a potential V_2 . The charges on the balls are:

A. $q_1 = V_1 a,\ q_2 = V_2 a$

B. $q_1 = V_1 r,\ q_2 = V_2 r$

C. $q_1 = \left(\frac{V_1 + V_2}{2}\right) a,\ q_2 = \left(\frac{V_1 + V_2}{2}\right) r$

D. $q_1 = -\frac{r}{a}(rV_2 - aV_1,\ q_2 =) - \frac{r}{a}(rV_1 - aV_2)$

Answer: D

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17. Two small equal point charges of magnitude q are suspended from a common point on the ceiling by insulating mass less strings of equal lengths. They come to equilibrium with each string making angle θ from the vertical. If the mass of each charge is m, then the electrostatic potential at the centre of line joining the will be $\left(\frac{1}{4\pi\varepsilon lion_0} = k\right)$

A. $2\sqrt{km > an\theta}$

B. $\sqrt{kmg\tan\theta}$

C. $4\sqrt{kmg/\tan\theta}$

D. $3\sqrt{kmg/\tan\theta}$

Answer: C

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18. Two points P and Q are maintained at the potentials of 10V and -4V, respectively. The work done in moving 100 electrons from P to Q is:

A. $9.60 \times 10^{-17} J$

B. $-2.24 \times 10^{-16} J$

C. $2.24 \times 10^{-16} J$

D. $-9.60 \times 10^{-17} J$

Answer: C

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19. A square of side a charge Q at its centre and charge q at one of the corners. The work required to be done in moving the charge q from the corner to the diagonally opposite corner is

A. zero

B. $\frac{Qq}{4\pi\varepsilon lo_0 a}$

C. $\frac{Qq\sqrt{2}}{4\pi\varepsilon_0 a}$

D. $\frac{Qq}{2\pi\varepsilon_0 a}$

Answer: A

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20. An alpha particle is acceleration through a potential difference of 10^6 volt. Its kinetic energy will be

A. 1MeV

B. 2MeV

C. 4MeV

D. 8MeV

Answer: B

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21. A and B are two points in an electric field . If the work done in carrying $4.0C$ of electric charge from A to

B is $16.0J$, the potential difference between A and B is

A. zero

B. 2.0V

C. 4.0V

D. 16.0V

Answer: C

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22. A conductor carries a certain charge. When it is connected to another uncharged conductor of finite capacity, then the energy of the combined system is

A. more than that of the first conductor

B. less than that of the first conductor

C. equal to that of the first conductor

D. uncertain

Answer: B

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23. If a unit positive charge is taken from one point to another over an equipotential surface ,then

A. work is done on the charge

B. work is dione by the charge

C. work done on the charge is constant

D. no work is done

Answer: D

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24. A ball of mass 1 kg carrying a charge $10^{-8}C$ moves from a point A at potential 600 V to a point B at zero potential. The change in its kinetic energy is

A. -6×10^{-6}erg

B. $-6 \times 10^{-6}J$

C. $6 \times 10^{-6}J$

D. 6×10^{-6} erg

Answer: C

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25. A positive point charge q is carried from a point B to a point A in the electric field of a point charge +Q at O. If the permittivity of free space is ε_0, the work done in the process is given by (where $a = OA$ and $b = OB$) -

A. $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a}+\frac{1}{b}\right)$

B. $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

C. $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a^2}-\frac{1}{b^2}\right)$

D. $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a^2}+\frac{1}{b^2}\right)$

Answer: B

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26. There exists a uniform electric field $E = 4 \times 10^5 Vm^{-1}$ directed along negative x-axis such that electric potential at origin is zero. A charge of $-200\mu C$ is palced at origin, and a charge of $+200\mu C$ is placed at (3m,0). The electrostatic potential energy of the system is

A. 120J

B. $-120J$

C. $-240J$

D. zero

Answer: A

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27. As shown in fig. a dust particle with mass $m = 5.0 \times 10^{-9}$ kg and charge $q_0 = 2.0nC$ starts from rest at point a and moves in a straight line to point b. What is its speed v at point b?

A. $26ms^{-1}$

B. $34ms^{-1}$

C. $46ms^{-1}$

D. $14ms^{-1}$

Answer: C

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28. Two identical thin ring, each of radius R meters, are coaxially placed a distance R metres apart. If Q_1 coulomb, and Q_2 coulomb, are repectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of the other is

A. zero

B. $\frac{q(Q_1 - Q_2)\left(\sqrt{2} - 1\right)}{\sqrt{2}.4\pi\varepsilon_0 R}$

C. $\frac{q\sqrt{2}(Q_1 + Q_2)}{4\pi\varepsilon_0 R}$

D. $\frac{q(Q_1 + Q_2)\left(\sqrt{2} + 1\right)}{\sqrt{2}.4\pi\varepsilon_0 R}$

Answer: B

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29. A parallel plate capacitor is charged to a certain voltage. Now if the dielectric material (with dielectric constant k) is removed then the

A. capacitance increases by a factor of k

B. electric field reduces by a factor k

C. voltage across the capacitor decreases by a factor k

D. None of these

Answer: D

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30. A parallel plate capacitor is charged and then isolated. The effect of increasing the plate separation on charge, potential and capacitance respectively are

A. Constant, decreases, decreases

B. Increases, decreases, decreases

C. Constant, decreases, increases

D. Constat, increases, decreases

Answer: D

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31. If in a parallel capacitor, which is connected to a battery we fill in whole space of its plates, then which of the following increases?

A. Q and V

B. V and E

C. E and C

D. Q and C

Answer: D

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32. A dielectric slab is inserted between the plates of an isolated charged capacitor. Which of the following quantities will remain the same?

A. The charge on the capacitor

B. The stored energy in the Capacitor

C. The potetial difference between the plates

D. The electric field in the capacitor

Answer: A

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33. A cylindrical capacitor has charge Q and length L. If both the charge and length of the capacitor are doubled by keeping other parameters fixed, the energy stored in the capacitor

A. remains same

B. increases two times

C. decreases two times

D. increases four times

Answer: B

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34. To establish an instantaneous displacement current of $2A$ in the space between two parallel plates of $1\mu F$ capacitor, the potential difference across the capacitor plates will have to be changed at the rate of

A. $2 \times 10^4 V / s$

B. $4 \times 10^6 V / s$

C. $2 \times 10^6 V / s$

D. $4 \times 10^4 V / s$

Answer: C

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35. Two identical metal plates are given poistive charges Q_1 and Q_2 $(< Q_1)$ respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C, the potencial difference between them is

A. $\dfrac{Q_1 + Q_2}{2C}$

B. $\dfrac{Q_1 + Q_2}{C}$

C. $\dfrac{Q_1 - Q_2}{C}$

D. $\dfrac{Q_1 - Q_2}{2C}$

Answer: C

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36. A parallel plate capacitor with air between the plates has a capacitance of 8 pF. Calculate the capacitace if the distance between the plates is reduced by half and the space between them is filled with a substance of dielectric constant $(\varepsilon_r = 6)$

A. 72pF

B. 81pF

C. 84pF

D. 96pF

Answer: D

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37. A parallel state air capacitor has capacitance of 100 μF. The plates are at a distance d apart. If a slab of thickness t $(t \leq d)$ and dielectric constant 5 is introduced between the parallel plates, then the capacitance can be

A. $50 \mu F$

B. $100 \mu F$

C. $200 \mu F$

D. $500 \mu F$

Answer: C

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38. A uniform electric field $\vec{E}$ exists between the plates of a charged condenser. A charged particle enters the space between the plates and perpendiculars to $\vec{E}$. The path of the particle between the plates is a

A. Straight line

B. hyperbola

C. parabola

D. circle

Answer: C

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39. A parallel plate condenser is filled with two dielectric as shown. Area of each plate is Am^2 and the separation is tm. The dielectric constnats are k_1 and k_2 respectively. Its capacitance in farad will be

A. $\frac{\varepsilon_0 A}{t}(k_1 + k_2)$

B. $\frac{\varepsilon_0 A}{t} \cdot \frac{k_1 + k_2}{2}$

C. $\frac{2\varepsilon_0 A}{t}(k_1 + k_2)$

D. $\frac{\varepsilon_0 A}{t} \cdot \frac{k_1 - k_2}{2}$

Answer: B

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40. An air capacitor of capacity $C = 10\mu F$ is connected to a constant voltage battery of $12V$. Now the space between the plates is filled with a liquid of dielectirc constant 5. The charge that flows now from battery to the capacitor is

A. $120\mu C$

B. $600\mu C$

C. $480\mu C$

D. $24\mu C$

Answer: C

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41. A parallel plate capacitor with air between the plates is charged to a potential difference of 500 V and then insulated. A plastic plate is inserted between the plates filling the whole gap. The potential difference between the plates now becomes 75V. The dielectric constant of plastic is

A. 44107

B. 5

C. 20/3

D. 10

Answer: C

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42. The capacitance of a parallel plate capacitor is C_a (fig a). A dielectric of dielectric constant K is inserted as shown in fig b and c. If C_b and C_c denote the capacitance in fig b and c then

A. both $C_b, C_c > C_a$

B. $C_c > C_a$ while $C_b > C_a$

C. both $C_b, C_c < C_a$

D. $C_a = C_b = C_c$

Answer: A

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43. A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an isulating handle. As a result the potential difference between the plates

A. does not change

B. becomes zero

C. increases

D. decreases

Answer: C

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44. If n drops, each of capacitance C and charged to a potential V, coalesce to form a big drop, the ratio of the energy stored in the big drop to that in each small drop will be

A. $n^{5/3}:1$

B. $n^{4/3}:1$

C. $n:1$

D. $n^3 : 1$

Answer: A

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45. During charging a capacitor variation of potential V of the capacitor with time t is shown as

A.

B.

C.

D.

Answer: A

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46. An unchanged parallel plate capacitor filled wit a dielectric constant K is connect to an air filled identical parallel capacitor charged to potential V_1. It the common potential is V_2, the value of K is

A. $\frac{V_1 - V_2}{V_1}$

B. $\frac{V_1}{V_1 - V_2}$

C. $\frac{V_2}{V_1 - V_2}$

D. $\frac{V_1 - V_2}{V_2}$

Answer: D

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47. A parallel plate capacitor is made by stacking n equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is 'C' then the resultant capacitance is

A. C

B. nC

C. (n-1)C

D. (n+1)C

Answer: C

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48. In a parallel plate capacitor, the distance between the plates is d and potential difference across the plate is V. Energy stored per unit volume between the plates of capacitor is

A. $\frac{Q^2}{2V^2}$

B. $\frac{1}{2}\varepsilon_0 V^2 / d^2$

C. $\frac{1}{2}\frac{V^2}{\varepsilon_0 d^2}$

D. $\frac{1}{2}\varepsilon_0 \frac{V^2}{d}$

Answer: B

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49. The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 micro-farad is

A. 16×10^{-32} joule

B. 3.1×10^{-26} joule

C. 4×10^{-10} joule

D. 32×10^{-32} joule

Answer: D

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50. Two capacitors of capacitances C_1 and C_2 are connected in parallel across a battery. IfQ_1 and Q_2

respectively be the charges on the capacitors, then $\frac{Q_1}{Q_2}$ will be equal to

A. $\frac{C_2}{C_1}$

B. $\frac{C_1}{C_2}$

C. $\frac{C_1^2}{C_2^2}$

D. $\frac{C_2^2}{C_1^2}$

Answer: B

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51. In the given figure the charge on $3\mu F$ capacitor is

A. $10\mu C$

B. $15\mu C$

C. $30\mu C$

D. $5\mu C$

Answer: A

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52. For the circuit shown in figure which of the following statements is true?

A. With S_1 closed

$V_1 = 15V, V_2 = 20V$

B. With S_3 closed

$V_1 = V_2 = 25V$

C. With S_1 and S_2 closed $V_1 = V_2 = 0$

D. With S_1 and S_3 closed $V_1 = 30V, V_2 = 20V$

Answer: D

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53. A capacitor has two circular plates whose radius are 8 cm and distance between them is 1mm.When mica (dielectric constant =6) is placed between the plates, the capacitance of this capacitor and the energy stored when it is given potetial of 150 volt respectively are

A. $1.06 \times 10^5 F, 1.2 \times 10^{-9} J$

B. $1.068x10^{-9} F, 1.2 \times 10^{-5} J$

C. $1.2 \times 10^{-9} F, 1.068 \times 10^{-5} J$

D. $1.6 \times 10^{-9} F, 1.208 \times 10^{-5} J$

Answer: B

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54. In the given circuit if point C is connected to the earth and a potential of +2000V is given to the point A, the potential at B is

A. 1500V

B. 1000V

C. 500V

D. 400V

Answer: C

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55. Two circuits a and b have charged capacitors of capacitance C, 2C and 3C withh open switches. Charges on each of the capacitor are as shown in the figures. On closing the switches

A. No charge flows in a but charge flows from R to L in b

B. Charges flow from L to R in both a and b

C. Charges flow from R to L in a and from L to R in b

D. No charge flows in a but charge flows from L to R in b

Answer: C

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56. The capacitor whose capacitance is 6,6 and $3\mu F$ respectively are connected in series with 20 volt line. Find the charge on $3\mu F$.

A. $30\mu C$

B. $60\mu C$

C. $15\mu C$

D. $90\mu C$

Answer: A

57. A capacitor of capacitance $C_1 = 1\mu F$ can withstand maximum voltage $V_1 = 6kV$ and another capacitor of capacitance $C_2 = 3\mu F$ can withstand maximum voltage $V_2 = 4kV$. When the two capacitors are connected in series, the combined system can withstand a maximum voltage of

A. 4kV

B. 6kV

C. 8kV

D. 10kV

Answer: C

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58. Two capacitors $C_1 2\mu F$ and $C_2 = 6\mu F$ are connected in series, then connected in parallel to a third capacitor $C_3 = 3\mu F$. This arangement is then connected to a battery of emf 2V as shown in figure. How much energy is lost by the battery in charging the capacitor?

A. $\frac{16}{3} \times 10^{-6} J$

B. $\frac{32}{3} \times 10^{-6} J$

C. $11 \times 10^{-6} J$

D. $22 \times 10^{-6} J$

Answer: C

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Exercise 2 Concept Applicator

1. A non-conducting ring of radius $0.5m$ carries a total charge of 1.11×10^{-10}C distributed non-uniformly on its circumference producing an electric field E everywhere is space. The value of the integral $\int_{l=\infty}^{l=0} - E.\, dI(l = 0$ being centre of the ring) in volt is

A. $+2$

B. -1

C. -2

D. zero

Answer: A

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2. The potential (in volts) of a charge distribution is given by

$V(z) = 30 - 5z^2$ for $|z| \leq 1m$

$V(z) = 35 - 10|z|$ for $|z| \geq 1m$

V(z) does not depend on x and y. If this potential is generated by a constant charge per unit volume ρ_0 (in units of ε_0) which is spread over a certain regiion, then choose the correct statement.

A. $\rho_0 = 20\varepsilon_0$ is the entire region

B. $\rho_0 = 10\varepsilon_0$ for $|z| \leq 1$ m and $p_0 = 0$ elsewhere

C. $\rho_0 = 20\varepsilon_0$ for $|z| \leq 1$ m and $p_0 = 0$ else where

D. $\rho_0 = 4o\varepsilon_0$ in the entire region

Answer: B

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3. A system of two parallel plates, each of area A, are separated by distance d_1 and d_2. The space between them is filled with dielectrices of permitivities ε_1 and $\varepsilon)_2$. The permittivity of free space is ε_0. The equivalent capacitance of the system is

A. $\dfrac{\varepsilon_1\varepsilon_2 A}{\varepsilon_2 d_1 + \varepsilon_1 d_2}$

B. $\dfrac{\varepsilon_1\varepsilon_2\varepsilon_0 A}{\varepsilon_1 d_1 + \varepsilon_2 d_2}$

C. $\dfrac{\varepsilon_0 A}{\varepsilon_1 d_1 + \varepsilon_2 d_2}$

D. $\dfrac{\varepsilon_0 A}{\varepsilon_1 d_2 + \varepsilon_2 d_1}$

Answer: A

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4. A parallel plate capacitor is filled by a di-electric whose relative permittively varies with the applied voltage according to the law $= \alpha V$, where $\alpha = 1$ per volt. The same (but contiaining no di-electirc) capacitor charged to a voltage $V = 156$ volt is connected in parallel to the first "non-linear" uncharged capacitor. Determine the final voltage V_f across the capacitors.

A. 6V

B. 12V

C. 8V

D. 4V

Answer: B

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5. Consider two small balls carrying equal and opposite charges. If one is secured and other is related it can do work W_1 against the repulsive force (as it moves away). If before the second ball is released, they are connected by a conductor for some time, the second ball can do work

W_2 while moving away. The heat liberated in the conductor when the balls are connected, the energy at the expense of which heat is liberated and mechanical work changed is

A. $\frac{(q_1 + q_2)^2}{4}\left(\frac{1}{r} - \frac{1}{L}\right)$

B. $\frac{(q_1 + q_2)}{2}\left(\frac{1}{r} - \frac{1}{L}\right)$

C. $\frac{(q_1 + q_2)^2}{4}\left(\frac{1}{r^2} - \frac{1}{L^2}\right)$

D. $\frac{(q_1 + q_2)^2}{4}\left(\frac{1}{r} - \frac{1}{L}\right)$

Answer: A

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6. The electirc potential at a point (x, y, z) is given by

$V = -x^2y - xz^3 + 4$

The electric field $\overrightarrow{E}$ at that point is

A. $\overrightarrow{E} = \hat{i}2xy + \hat{j}(x^2 + y^2) + \hat{k}(3xz - y^2)$

B. $\overrightarrow{E} = \hat{i}z^3 + \hat{j}xyz + \hat{k}z^2$

C. $\overrightarrow{e} = \hat{i}(2xy - z^3) + \hat{j}xy^2 + \hat{k}3z^2x$

D. $\overrightarrow{E} = \hat{i}(2x + z^3) + \hat{j}x^2 + \hat{k}3xz^2$

Answer: D

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7. The electric field in a region surrounding the origin and along the x-axis is uniform. A small circle is drawn with the center at the origin cutting the axes pont A,B,C and D having coordinates (a,0),(0,a),(-a,0) and (0,-a) respectively as shown in fig. Then the potential is minimum at

A. A

B. B

C. C

D. D

Answer: A

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8. A charge $+q$ is fixed at each of the points $x = x_0$, $x = 3x_0$, $x = 5x_0$,............$x = \infty$ on the x axis, and a charge $-q$ is fixed at each of the points $x = 2x_0$, $x = 4x_0$, $x = 6x_0$, ...$x = \infty$. Here x_0 is a positive constant. Take the electric potential at a point due to a charge Q at a distance r from it to be $Q/(4\pi\varepsilon_0 r)$.Then, the potential at the origin due to the above system of

A. zero

B. $\dfrac{q}{8\pi\varepsilon_0 x_0 \log_e 2}$

C. infinity

D. $\dfrac{q \log_e 2}{4p\varepsilon_0 x_0}$

Answer: D

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9. Find equivalent capacitance between A and B. [Assume each conducting plate is having same dimensioins and neglect the thickness of the plate, $\frac{\varepsilon_0 A}{d} = 7\mu F$ Where A is area of plates $A >> d$]

A. $7\mu F$

B. $11\mu F$

C. $12\mu F$

D. $14\mu F$

Answer: B

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10. Three concentric spherical metallic spheres A, B and C of radii a, b and $c(a < b < c)$ have surface charge densities $\sigma, -\sigma$ and σ respectively.

A. $V_A = (a + b + c)\dfrac{\sigma}{\varepsilon_0}$

B. $V_B = \left(\dfrac{a^2}{b} - b + c\right)\dfrac{\sigma}{\varepsilon_0}$

C. $V_C = \left(\dfrac{a^2 + b^2}{b} + c\right)\dfrac{\sigma}{\varepsilon_0}$

D. $V_A = V_B = V_C = (a + b + c)\dfrac{\sigma}{\varepsilon_0}$

Answer: B

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11. An electron is taken from point A to point B along the path AB in a uniform electric field of intensity $E = 10 V m^{-1}$. Side AB=5m, and side BC=3m. Then the amount of work done on the elecltron is

A. $50 eV$

B. $40 eV$

C. $-50 eV$

D. $-40 eV$

Answer: B

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12. A capacitor is charged to a potential difference of 100 V and is then connected across a resistor. The potential difference across the capacitor decays exponentially with respect to time. After 1 sec, the P.D. between the plates of the capacitor is 80 V. what will be the potential difference between the plates after 2 sec ?

A. 40V

B. 56V

C. 60V

D. 64V

Answer: D

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13. Three identical metallic uncharged sphere A, B and C each of radius, a are kept at the corners of an equilateral triangle of side $d(d >> a)$ as shown in fig. The fourth sphere (of radius a), which has a charge q, touches A and is then removed to a position far away. B is earthed and then the earth connection is removed. C is then earthed. The charge on C

A. $\frac{qa}{2d}\left(\frac{2d-a}{2d}\right)$

B. $\frac{qa}{2d}\left(\frac{2d-a}{d}\right)$

C. $-\frac{qa}{2d}\left(\frac{d-a}{d}\right)$

D. $\frac{2qa}{d}\left(\frac{d-a}{2d}\right)$

Answer: C

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14. Six capacitors each of capacitance $1\mu F$ are connected as shown in fig. Find the charge flowing in direction 1 as shown in the figure will be

A. $12\mu C$

B. $6\mu C$

C. $3\mu C$

D. None of these

Answer: B

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15. An electron having charge e and mass m starts from the lower plate of two metallic paltes separated by a distance d. If the potential difference between the plates is V, the time taken by the electron to reach the upper plate is given by

A. $\sqrt{\frac{2md^2}{eV}}$

B. $\sqrt{\frac{md^2}{eV}}$

C. $\sqrt{\dfrac{md^2}{2eV}}$

D. $\dfrac{2md^2}{ev}$

Answer: A

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16. In an isolated parallel plate capacitor of capacitance C, the four surface have charges Q_1, Q_2, Q_3 and Q_4 as shown. The potential difference between the plates is

A. $\dfrac{Q_1 + Q_2 + Q_3 + Q_4}{2C}$

B. $\dfrac{Q_2 + Q_3}{2C}$

C. $\frac{Q_2 - Q_3}{2C}$d

D. $\frac{Q_1 + Q_4}{2C}$

Answer: C

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17. A capacitor of capacitance C_o is charged to a potential V and then isolated. A small capacitor C is then charged from C_o, discharged and charged again, the process being repeated n times. Due to this, potential of the large capacitor is decreased to V. Find the capacitance of the small capacitor :

A. $C_0\left(\frac{V_0}{V}\right)^{1/n}$

B. $C_0\left[\left(\frac{V_0}{V}\right)^{1/n}-1\right]$

C. $C_0\left[\left(\frac{V}{V_0}\right)-1)\right]^{n}$

D. $C_0\left[\left(\frac{V}{V_0}\right)^{n}+1\right]$

Answer: B

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18. The point charge q is within the cavity of an electrically neutral conducting shell whose outer surface has spherical shape.

Find the potential V at a point P lying outside the shell at a distance r from the cenre O of the Outer sphere.

A. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

B. $V = \frac{1}{2\pi\varepsilon_0}\frac{q}{r}$

C. $V = \frac{1}{\pi\varepsilon_0}\frac{q}{r}$

D. $V = \frac{3}{4p\varepsilon_0}\frac{q}{r}$

Answer: A

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19. A parallel plate capacitor of area A plate separation d is filled wit two dielectrics as shown.What is the capacitance of the arrangement?

A. $\dfrac{3K\varepsilon_0 A}{4d}$

B. $\dfrac{4K\varepsilon_0 A}{3d}$

C. $\dfrac{(K+1)\varepsilon_0 A}{2d}$

D. $\dfrac{K(K+3)\varepsilon_0 A}{2(K+1d)}$

Answer: D

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20. Three infinite plane have a uniform surface charge distribution σ on its surface. All charges are fixed. On each of the three infinite planes, parallel to the y-z plane placed at $x = -a$, $x = 0$ and $x = a$, there is a uniform surface charge of the same density σ. The potential difference between A and C is

A. $\frac{\sigma}{2\varepsilon_0}$

B. $\frac{\sigma}{\varepsilon_0}$

C. $\frac{\sigma a}{4\varepsilon_0}$

D. zero

Answer: D

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21. A plastic disc is charged on one side with a uniform surface charge density σ and then three quadrant of the disk are removed. The remaining quadrant is shown in figure.

with $V=0$ at infinity the potential due to the remaining quadrant at point P is

A. $\frac{\sigma}{2\varepsilon_0}\left[\left(r^2+R\right)^{1/2}-r\right]$

B. $\frac{\sigma}{2\varepsilon_0}[R-r]$

C. $\frac{\sigma}{8\varepsilon_0}\left[\left(r^2+R^2\right)^{1/2}-r\right]$

D. None of these

Answer: C

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22. The capacities and connection of five capacitors are shown in the adjoining figure. The potential difference between the points A and B is 60 volts. Then the equivalent capacity between A and B and the charge on $5\mu F$ capacitance will be respectively.

A. $44\mu F, 300\mu C$

B. $16\mu F, 150\mu C$

C. $15\mu f, 200\mu C$

D. $4\mu F, 50\mu C$

Answer: D

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23. For the configuratio of media of permitivities $\varepsilon_0, \varepsilon$ and ε_0 between parallel plates each of area A, as shown in fig. The equivalent capacitance is

A. $\varepsilon_0 \frac{A}{d}$

B. $\varepsilon \varepsilon_0 A / d$

C. $\frac{\varepsilon \varepsilon_0 A}{d(\varepsilon + \varepsilon_0)}$

D. $\frac{\varepsilon \varepsilon_0 A}{(2\varepsilon + \varepsilon_0) d}$

Answer: D

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24. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance 2C is ismilarly charged to a potential difference 2V. The charging battery is now disconnected and the capacitors are connected in parallel to each other in such a way that the poistive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is

A. zero

B. $\frac{3}{2}CV^2$

C. $\frac{25}{6}CV^2$

D. $\frac{9}{2}CV^2$

Answer: B

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