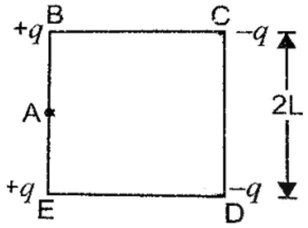
Ultimate KCET Crash Course 2026

PHYSICS

Electrostatic potential and capacitance

DPP: 1

Q1 Four charges -q, -q, +q and +q are placed at the corners of a square of side 2L is shown in figure. The electric potential at point A midway between the two charges +q and +q is



(A) $\frac{1}{4\pi\varepsilon_o}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

(B) $\frac{1}{4\pi\varepsilon_o}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

(C) $\frac{1}{4\pi\varepsilon_o}\frac{q}{2L}\left(1-\frac{1}{\sqrt{5}}\right)$

(D) Zero

Q2 The ratio of electric potential due to an electric dipole in the end on position to that in the broad side on position for the same distance from it, is

(A) ∞ (B) 2

(C) 1 (D) Zero

Q3 A $4\mu F$ capacitor is charged to 400V . If its plates are joined through resistance of 2 kilo ohm, then heat produced in the resistance is

(A) 0.64J (B) 1.28J

(C) 0.16J (D) 0.32J

Q4 An electric dipole has a dipole moment p. The electric potential at a point P on the perpendicular bisector and at a distance d from the dipole is

(A) 0

(B) $\frac{p}{4\pi\varepsilon_0 d^2}$

(C) $\frac{pd}{4\pi\varepsilon_0}$

(D) $\frac{3p}{4\pi\varepsilon_0 d^2}$

Q5 Which one of the following is known as an electrical energy tank?

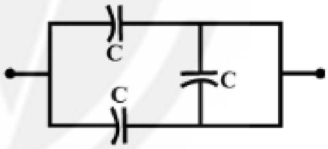
(A) Resistor

(B) Inductor

(C) Capacitor

(D) Transistor

Q6 The equivalent capacitance of the combination shown in figure is:



(A) C (B) 2C

(C) C/2 (D) None of these

Q7 A capacitor is charged by a battery and the energy stored is U. The battery is now removed and the separation distance between the plates is doubled. The energy stored now is:

(A) U/2 (B) U

(C) 2U (D) 4U

Q8 A capacitor of capacitance C charged by an amount Q is connected in parallel with an uncharged capacitor of capacitance 2C. The final charges on the capacitors are

(A) $\frac{Q}{4}, \frac{3Q}{4}$ (B) $\frac{Q}{5}, \frac{4Q}{5}$

(C) $\frac{Q}{2}, \frac{Q}{2}$ (D) $\frac{Q}{3}, \frac{2Q}{3}$

Q9 A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved further apart by means of insulating handles.
Which of the following statements is true?

1. The charge on the capacitor increases
2. The voltage across the plates increases
3. The capacitance increases
4. The electrostatic energy stored in the capacitor increases

(A) I only
(B) II and III only
(C) IV only
(D) II and IV only

Q10 In a region, the potential is represented by *V* (*x,y,z*) = 6*x*-8*xy*-8*y*+6*yz*, where V is in volts and *x,y,z* are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1,1,1) is

(A) $6\sqrt{5}N$ (B) 30 N

(C) 24 N (D) $4\sqrt{35}N$

Q11 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

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

(C) $\frac{1}{6}CV_0^2$ (D) $\frac{1}{2}CV_0^2$

Q12 Pick out the statement which is **incorrect**.
(A) The electric field lines form closed loop.
(B) Field lines never intersect.
(C) The tangent drawn to a line of force represents the direction of electric field.
(D) A negative test charge experiences a force opposite to the direction of the field.

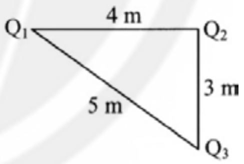
Q13 A parallel plate capacitor is charged by connecting a 2V battery across it. It is then disconnected form the battery and a glass slab is introduced between plates. Which of the following pairs of quantities decrease?
(A) Energy stored and capacitance
(B) Capacitance and charge
(C) Charge and potential difference
(D) Potential difference and energy stored

Q14 SI unit of potential gradient is ________

(A) Vcm (B) $\frac{V}{cm^2}$

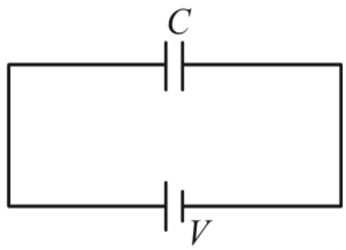
(C) V m (D) $\frac{V}{m}$

Q15 **In the figure given below, Q_1 = +8 μC, Q_2 = -4 μC, Q_3 = +5 μC Then the potential energy of charge Q_1 is**



(A) 1 J
(B) 0 J
(C) 6×10^{-2} J
(D) 2×10^{-2} J

Q16 Consider parallel plate capacitor connected across battery as shown in figure. If distance between plates is decreased then, (Assume battery remains connected)



(A) Capacitance will decrease
(B) Charge on each plate of capacitor will decrease
(C) Energy stored in capacitor will increase
(D) Potential difference between plates will increase

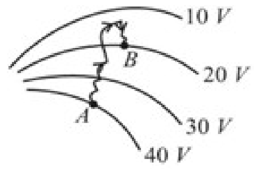
Q17 A ball of mass 5gm carrying a charge $10^{-2}\mu C$ moves from a point A at potential 600V to a point B at potential 200V. The change in its kinetic energy is
(A) 40 erg
(B) –40 erg
(C) –50 erg
(D) 50 erg

Q18 A charge q is placed at the centre of a cube of side length a. What is the electric potential at any corner of the square?

(A) $\frac{kq}{a}$ (B) $\frac{2kq}{\sqrt{3}a}$
(C) $\frac{kq}{a^2}$ (D) $\sqrt{\frac{2kq}{a^2}}$

Q19 here are two capacitances C and $2C$ connected in parallel with a battery of voltage V. Find the voltage ratio across C and $2C$.
(A) 1:2 (B) 2:1
(C) 1:1 (D) 4:1

Q20 A point charge of 0.5 C is taken from point A to B as shown in the diagram, where some equipotential surfaces are drawn. The work done by the electric field is:



(A) 5 J (B) –10 J
(C) 10 J (D) 20 J

Q21 The potential energy of a particle varies with position x according to the relation
$U(x) = 2x^4 - 27x$, the point $x = 3/2$ is point of
(A) unstable equilibrium
(B) neutral equilibrium
(C) stable equilibrium
(D) none of these

Q22 If the dielectric constant K , what is the new capacitance when dielectric is inserted (battery is disconnected)?
(A) C (B) K/C
(C) KC (D) C/K

Q23 For a charged capacitor (battery disconnected), inserting a dielectric will cause energy stored in the capacitor to:
(A) Increase
(B) Decrease
(C) Remain same
(D) First increase then decrease

Q24 The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre ; a, b are constant. Then the charge density inside the ball is
(A) $-24\pi a\varepsilon_0 r$
(B) $-6a\varepsilon_0 r$
(C) $-24\pi a\varepsilon_0$
(D) $-6a\varepsilon_0$

Q25 Three capacitors of capacitance $1\mu F$,$2\mu F$ and $3\mu F$ are connected in parallel. Find the total capacitance of combination.

(A) $\frac{6}{11}\mu F$ (B) $6\mu F$

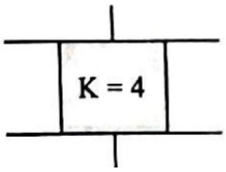
(C) $3\mu F$ (D) $11\mu F$

Q26 If the diameter of earth is 128 $\times 10^2$ km, then its capacitance will be

(A) $331\mu F$ (B) $771\mu F$

(C) $111\mu F$ (D) $211\mu F$

Q27 Consider a parallel plate capacitor of 10μF with air filled in the gap between the plates. Now, one-half of the space between the plates is filled with a dielectric of dielectric constant 4, as shown in the figure. The capacity of the capacitor changes to:



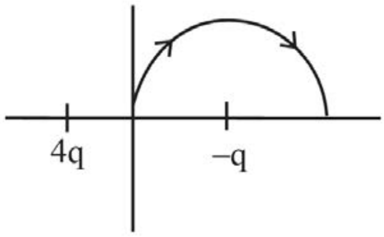
(A) 25 μF

(B) 20 μF

(C) 40 μF

(D) 5 μF

Q28 Two point charges 4 q 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:-



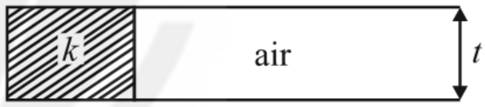
(A) Decrease by $\frac{q^2}{4\pi\varepsilon_o d}$

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

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

(D) Increase $\frac{3q^2}{4\pi\varepsilon_o d}$

Q29 A parallel plate capacitor with air as the dielectric has capacitance C. A slab of dielectric constant k and having the same thickness as the separation between the plates is introduced so as to fill one-fourth of the capacitor as shown in the figure. The new capacitance will be



(A) $(k+3)\frac{C}{4}$ (B) $(k+2)\frac{C}{4}$

(C) $(k+2)\frac{C}{4}$ (D) $\frac{kC}{4}$

Q30 The value of electric potential at any point at a distance r from electric dipole of diople moment p is;

(A) $\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\times\vec{r}}{r^2}$

(B) $\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\times\vec{r}}{r^3}$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}.\vec{r}}{r^2}$

(D) $\frac{1}{4\pi\varepsilon_0}\frac{\vec{p}.\vec{r}}{r^3}$

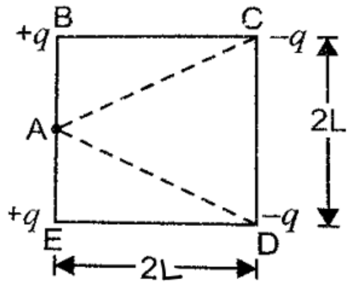
Answer Key

Q1	A
Q2	A
Q3	D
Q4	A
Q5	C
Q6	B
Q7	C
Q8	D
Q9	D
Q10	D
Q11	C
Q12	A
Q13	D
Q14	D
Q15	B
Q16	C
Q17	A
Q18	B
Q19	C
Q20	C
Q21	C
Q22	C
Q23	B
Q24	D
Q25	B
Q26	B
Q27	A
Q28	B
Q29	A
Q30	D

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:



Potential at point A

$V_A = V_1 + V_2 + V_3 + V_4$

$= \frac{kq}{L}\left[1 - \frac{1}{\sqrt{5}} - \frac{1}{\sqrt{5}} + 1\right]$

$V_A = \frac{kq}{L}\left[2 - \frac{2}{\sqrt{5}}\right] = \frac{2q}{4\pi\varepsilon_0 L}\left[1 - \frac{1}{\sqrt{5}}\right]$

Video Solution:

Q2 Text Solution:

For a dipole $V_{\text{end on postion}} = \frac{Kp}{x^2}$

$V_{\text{Broad side on position}} = 0,$

Their ratio $= \infty$.

Video Solution:

Q3 Text Solution:

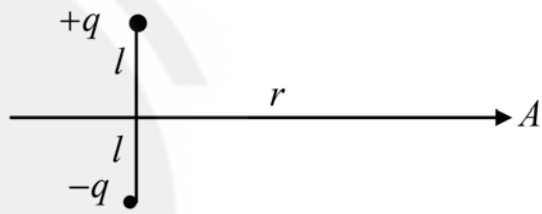
$\mu = \frac{1}{2}\text{CV}^2$

$= 0.5 \times 4 \times 10^{-6} \times (400)^2 = 2 \times 10^{-6} \times 16 \times 10^4$

$= 0.32\text{J}$

Video Solution:

Q4 Text Solution:



Potential at $A = \frac{+kq}{\sqrt{r^2+l^2}} - \frac{kq}{\sqrt{r^2+l^2}} = 0$

Video Solution:

Q5 Text Solution:

A capacitor stores the electric energy. Hence, it is known as an electric energy tank

Video Solution:

Q6 Text Solution:

Since the potential drop in both ends is the same, so no current will flow in the capacitor connected perpendicularly. So this capacitor does not contribute to the connection.

So the two parallel capacitors is working as a combination then the equivalent capacitance will be

$C_{eq} = C + C = 2C$

Hence, the correct option is (B)

Video Solution:

Q7 Text Solution:

(3)

Energy stored, *U* = 1/2 *qV*

As the distance *d* is increased between the two plates.

Now, stored energy,

$U' = \frac{1}{2}qV' = \frac{1}{2}q\left[q/C\right] = \frac{1}{2}\frac{q^2 d}{\varepsilon_0 A} \Rightarrow U' \propto d$

Hence, $U' = 2U$

Video Solution:

Q8 Video Solution:

Q9 Text Solution:

$\therefore C = \frac{\epsilon_0 A}{d} \Rightarrow C$

$and\ V^1 = \frac{Q}{c^1} = v^1$

$\therefore V = \frac{1}{2}QV \Rightarrow u \propto v \Rightarrow u'$

Video Solution:

Q10 Text Solution:

Here,

$V(x,\ y,\ z) = 6\ x - 8\ x\ y - 8\ y + 6\ y\ z$

The *x*, *y* and *z* components of electric field are

$\vec{E} = E_x\hat{i} + E_y\hat{j} + E_z\hat{k} = \left(-6 + 8y\right)\hat{i}$

$+ \left(8x + 8 - 6z\right)\hat{j} - 6y\hat{k}$

The maitude of electric field is

$E = \sqrt{E_x^2 + E_y^2 + E_z^2}$

$= \sqrt{(2)^2 + (10)^2 + (-6)^2}$

$= \sqrt{140} = 2\sqrt{35}\,NC^{-1}$

Electric force experienced by the charge

$F = qE = 2C \times 2\sqrt{35}\ NC^{-1} = 4\sqrt{35}\ N$

Video Solution:

Q11 **Text Solution:**

$$\Delta U = \frac{C_1 \times C_2}{2(C_1 + C_2)} (V_1 - V_2)^2$$

$$\Delta U = \frac{C \times {}^{C}\!/_{2}}{2\left(C + {}^{C}\!/_{2}\right)} (V_0)^2$$

$$\Delta U = \frac{1}{6} C V_0^2$$

Video Solution:

Q12 **Text Solution:**

(A)

The electric field lines do not form closed loop.

All other statements are correct.

Video Solution:

Q13 **Video Solution:**

Q14 **Text Solution:**

$\frac{V}{m}$

Video Solution:

Q15 **Text Solution:**

Potential energy = 0

Video Solution:

Q16 **Text Solution:**

(3)

Since capacitance of capacitor is

$C = \frac{\varepsilon_0 A}{d}$

So if d is decreased then capacitance will increase. Potential difference remains constant so, charge increases.

Energy stored in capacitor is $\frac{CV^2}{2}$ so energy stored in capacitor will increase.

Video Solution:

Q17 **Text Solution:**

$q\left(V_i - V_f\right) = k_f - k_i$

$10^{-8}\left(600 - 200\right) = \Delta k$

$\Delta k = 400 \times 10^{-8}$ J

$= 400 \times 10^{-8} \times 10^{7}$ erg = 40 erg

Video Solution:

Q18 Text Solution:

(B)

Distance of corner from centre is $\frac{\sqrt{3}a}{2}$

$V = \frac{kq}{\frac{\sqrt{3}a}{2}} = \frac{2kq}{\sqrt{3}a}$

Video Solution:

Q19 Text Solution:

voltage drop is same since both are connected in parallel from defination of parallel combination.

Video Solution:

Q20 Text Solution:

$W_{AB} = q(V_1 - V_2) = 0.5(40 - 20) = 10$ J

Video Solution:

Q21 Text Solution:

$u = 2x^4 - 27x$

$\frac{du}{dx} = 8x^3 - 27 = 0$

$x = \frac{3}{2}$

$\frac{d^2u}{sx^2} = 24x^2$

$= 24 \times \left(\frac{3}{2}\right)^2 = 24 \times \frac{9}{7} = 54 > 0$

Stable equilibrium

Video Solution:

Q22 Video Solution:

Q23 Text Solution:

Decrease

Video Solution:

Q24 Text Solution:

$\phi = ar^2 + b$

$E = -\frac{d\phi}{dr} = -2ar \oint \vec{E}.\ d\vec{A} = \frac{q_{in}}{\epsilon_0}$

$-2ar\left(4\pi r^2\right) = \frac{q_{in}}{\epsilon_0}$

$q_{in} = -8\ \epsilon_0\ \pi ar^3$

charge density

$\rho = -\frac{8\epsilon_0 \times \pi ar^3}{\frac{4}{3}\pi r^3}$

$\rho = -6a\ \epsilon_0$

Video Solution:

Q25 Video Solution:

Q26 Text Solution:

The capacitance of a spherical conductor of radius R is

$C = 4\pi\varepsilon_0 R = 4 \times 3.14 \times 8.85 \times 10^{-12}$

$\times \frac{128 \times 10^5}{2}$

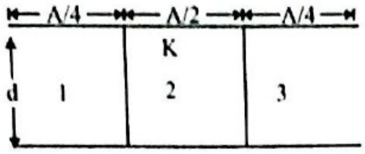
$= 7.11 \times 10^{-4} F = 711 \mu F$

Video Solution:

Q27 Text Solution:

Initially the capacitance of capacitor, C = 10mu*F After filling the dielectric, we have these capacitors of capacitance

$C_1 = \frac{\varepsilon_o\left(\frac{A}{4}\right)}{d}, C_2 = \frac{K\varepsilon_o\left(\frac{A}{2}\right)}{d}, C_3 \frac{\varepsilon_o\left(\frac{A}{4}\right)}{d}$



$\therefore$ Equivalent capacitatnce, $C_{eq} = C_1 + C_2 + C_3$

$= \frac{\varepsilon_o A}{4d} + \frac{K\varepsilon_o A}{2d} + \frac{\varepsilon_o A}{4d} = \frac{10}{4} C = 25\mu F$

Video Solution:

Q28 Text Solution:

(2)

Work done = change in potential energy.

Work done = $U_f - U_i$

$w = \left(\frac{4kqq}{3\,d/2} - \frac{kqq}{\frac{d}{2}}\right) - \left(\frac{k4qq}{\frac{d}{2}} - \frac{kqq}{\frac{d}{2}}\right)$

$w = \frac{8kq^2}{3d} - \frac{8kq^2}{d} = \frac{-16q^2}{3 \times 4\pi\varepsilon_0} = \frac{-4q^2}{3\pi\varepsilon_0 d}$

Hence energy decreases.

Video Solution:

Q29 Video Solution:

Q30 Text Solution:

(D)

The value of electric potential at any point due to electric dipole is

$$V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\,.\,\vec{r}}{r^3}$$

Here p is the dipole moment of the dipole, and r is the distance of the point from the centre of the dipole.

Video Solution: