# QB365 <br> Important Questions - Electrostatics 

12th Standard CBSE
Physics

Reg.No.:

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Time : 01:00:00 Hrs

Total Marks : 50

## Section - A

1) At a particular point, electric field depends upon
(a) Source charge Q only
(b) test charge $\mathrm{q}_{\mathrm{o}}$ only
(c) both Q and $\mathrm{q}_{0}$
(d) neither Q nor $\mathrm{q}_{\mathrm{o}}$
2) Electric field due to a single charge is
(a) asymmetric
(b) cylindrically symmetric
(c) spherically symmetric
(d) None of the above
3) Electric dipole moment is
(a) scalar
(b) neither scalar vector
(c) a vector directed from -q to +q
(d) a vector directed from $+q$ to $-q$
4) Electric field intensity (E) due to an electric dipole varies with distance ( $r$ ) of the point from the centre of dipole as:
(a) $E \alpha \frac{1}{r}$
(b) $E \alpha \frac{1}{r^{4}}$
(c) $E \alpha \frac{1}{r^{2}}$
(d) $E \propto \frac{1}{r^{3}}$
5) At a given distance from the centre of electic dipole, field intensity on axial line is $k$ times the field intensity on equatorial line, where $K=$
(a) 2
(b) 3
(c) 4
(d) 1
6) When an electric dipole is held at an angle in a uniform electric field, the net force F and torque $\tau$ on the dipole are
(a) $\mathrm{F}=0, \tau=0$
(b) $F \neq 0, \tau \neq 0$
(c) $\mathrm{F}=0, \tau \neq 0$
(d) $F \neq 0, \tau=0$
7) Potential energy of an electric dipole held at an angle $\theta$ in a uniform electric field is zero when $\theta=$
(a) $0^{\circ}$
(b) $90^{\circ}$
(c) $180^{\circ}$
(d) $360^{\circ}$
8) Force $\vec{F}$ acting on a test charge $\mathrm{q}_{\mathrm{o}}$ in a uniform electric field $\vec{E}$ is
(a) $\vec{F}=q_{o} \vec{E}$
(b) $\vec{F}=\frac{\vec{E}}{q_{o}}$
(c) $\vec{F}=\frac{q_{o}}{\vec{E}}$
(d) $\vec{F}=q_{o}^{2} \vec{E}$
9) Work done in carrying an electron from $A$ to $B$ lying on an equipotential surface of one volt potential is
(a) 1 eV
(b) 10 eV
(c) 1 volt
(d) Zero
10) The correct relation between electric intensity $E$ and electric potential $V$ is
(a) $E=-\frac{d V}{d r}$
(b) $E=\frac{d V}{d r}$
(c) $V=-\frac{d E}{d r}$
(d) $V=\frac{d E}{d r}$

## Section - B

11) A copper sphere of mass 2 g contains nearly $2 \times 10^{22}$ atoms. The charge on the nucleus of each atom is 29 e .
12) Two point charges of $+2 \mu C$ and $+6 \mu C$ repel each other with a force of 12 N . If each is given an additional charge of $-4 \mu C$, what will be the new force?
13) State superposition principle for electrostatic force on a charge due to a number of charges.
14) When an electric dipole is suspended in a uniform electric field, then under what conditions the dipole is in (i)
stable equilibrium and (ii) unstable equilibrium
15) When a proton approaches another fixed proton, what happens to :
(a)the kinetic energy of the approaching proton
(b)the electric potential energy of the system and
(c)the total energy of the system?
16) Equipotential surfaces are perpendicular to field lines. Why?
17) An uncharged insulated conductor $A$ is brought near a charged insulated conductor $B$. What happens to charge and potential of $B$ ?
18) On charging a parallel-plate capacitor to a potential $V$, the spacing between the plates is halved and a dielectric medium of $\epsilon_{r}=10$ is introduced between the plates, without disconnecting the dc source. Explain using suitable expression how the (a)capacitance (b)electric field (c)energy density of the capacitor change.
19) Two identical parallel plate (air) capacitors $C_{1}$ and $C_{2}$ have capacitance $C$ each. The space between their plates is now filled with dielectrics as shown in the figure. If the two capacitors still have equal capacitance, obtain the relation between dielectric constants

$\mathrm{K}, \mathrm{K}_{1}$ and $\mathrm{K}_{2}$.
The capacity of condenser is proportional to the area and inversely proportional to the distance between its plates. If a medium of dielectric constant K is filled in the space between the plates, its capacity becomes K times the capacity when there is air between the plates.
$\mathrm{C}_{2}$ acts as if two capacitors each of area $\mathrm{A} / 2$ and separation $d$ are connected in parallel combination.
20) plot a graph showing the variation of coulomb's force(F) versus $1 / r^{2}$, where $r$ is the distance between the two charges of each pair of charges $(1 \mu \mathrm{C}, 2 \mu \mathrm{C})$ and $(1 \mu \mathrm{C}-3 \mu \mathrm{C})$.Interpret the graphs obtained.

## Section - C

21) What is the force between two small charged spheres having charges of $2 \times 10^{-7} \mathrm{C}$ and $3 \times 10^{-7} \mathrm{C}$ placed 30 cm apart in air?
22) (a) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden break. Why not?
(b) Explain why two field lines never cross each other at any point.
23) Define electric field at a point.An electron moves a distance of 6.0 cm when accelerated from rest by an electric field of strength $2 \times 10^{4} N C^{-1}$.Calculate the times of travel.
24) Two point charges $q_{1}$ and $q_{2}$ at a separation $r$ in vacuum exert a force $F$ on each other. What should be their separation in an oil of a relative permittivity 16 so that the force between them remains F only?

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## Section - A

1) (a) Source charge Q only
2) (c) spherically symmetric
3) (c) a vector directed from -q to $+q$
4) (d) $E \alpha \frac{1}{r^{3}}$
5) (a) 2
6) (c) $\mathrm{F}=0, \tau \neq 0$
7) (b) $90^{\circ}$
(a) $\vec{F}=q_{o} \vec{E}$
8) (d) Zero
9) (a) $E=-\frac{d V}{d r}$

## Section - B

11) Total number of electrons in the sphere $=29 \times 2 \times 10^{22}$

No of electrons removed $=\frac{q}{e}=\frac{2 \times 10^{-6}}{1.6 \times 10^{-19}}=1.25 \times 10^{13}$
Fraction of electrons removed $=\frac{1.25 \times 10^{13}}{29 \times 2 \times 10^{23}}=2.16 \times 10^{-11}$
12) $\mathrm{q}_{1}=+\mu C, \mathrm{q}_{2}=+6 \mu C, \mathrm{~F}=12 \mathrm{~N}$
$q_{1}=+2-4=-2 \mu C ; q_{2}=+6-4=2 \mu C$
$\mathrm{F}^{\prime}=$ ?
$\frac{F^{\prime}}{F}=\frac{\left(q_{1}\right)\left(q_{2}\right)}{q_{1} q_{2}}=\frac{(-2)(2)}{(2)(6)}=-\frac{1}{3}$
$F^{\prime}=\frac{-F}{3}=\frac{-12}{3}=-4 N^{(\text {attractive })}$
13)

The principle of superposition states that total force on a given charge is the vector sum of the individual forces exerted on it by all other charges, the force between two charges being exerted in such a manner as if all other charges were absent
$\vec{F}=\overrightarrow{F_{12}}+\overrightarrow{F_{13}}+\ldots+\overrightarrow{F_{1 N}}$

The dipole is an electric field will be in stable equilibrium if the following conditions are satisfied:
(i) The resultant force in dipole is zero, i,e, there is no translatory motion of dipole. (ii) the torque on dipole is zero, ie,e there is no rotary motion of dipole. (iii) the potential energy of dipole is minimum.
It will be so when dipole is aligned along the direction of electric field.
The dipole will be in unstable equilibrium if (i) the resultant force on dipole is zero. (ii) The torque on the dipole is zero. (iii) the potential energy of dipole is maximum. it will be so when dipole is aligned opposite to the direction of electric filed.
15)
(a)The kinetic energy of the approaching proton decrease.
(b)The electric potential energy o the system increases because distance between the charges decreases.
(c)The total energy of the system remains the same because of the conservation of energy.
16)

No work is done in moving a charge from one point on equipotential surface to the other. Therefore, component of electric field intensity along the equipotential surface is zero it means, the electric field intensity is perpendicular to equipotential surface. Hence, the surface is perpendicular to field lines.

The charge on conductor $B$ remains same, but the potential of $B$ gets lowered because it induces charge of opposite sign on conductor A .
18)

As the d.c. source remains connected, p.d.(V) between the plates of capacitor remains unchanged even after dielectric is inserted between the plates.
(a)Original capacitance $C_{o}=\frac{\epsilon_{o} A}{d}$

New capacitance $C_{o}=\frac{\epsilon_{r} \epsilon_{o} A}{d / 2}=20 C_{o}$
(b)Changed electric field,
$E=\frac{V}{d / 2}=2(V / d)=2 E_{o}$
(c)Original energy density, $U_{o}=\frac{1}{2} \epsilon_{o} E^{2}$

New energy density, $U=\frac{1}{2} \epsilon E^{2}$
$\frac{1}{2}\left(\epsilon_{r} \epsilon_{o}\right)\left(2 E_{o}\right)^{2}=4 E_{r}\left(\frac{1}{2} \times \epsilon_{o} E_{o}^{2}\right)$
$=4 \times 10 U_{o}=40 U_{o}$
19) After inserting the dielectric medium, let their capacitances become $C_{1}$ ' and $C_{2}$ '.

$$
\begin{aligned}
\text { For } \mathrm{C}_{1}, \mathrm{C}_{1}{ }^{\prime} & =\mathrm{KC} \\
\text { For } \mathrm{C}_{2}, \mathrm{C}_{2}^{\prime} & =\frac{K_{1} \varepsilon_{0}(A / 2)}{d}+\frac{K_{2} \varepsilon_{0}(A / 2)}{d} \\
C_{2}^{\prime} & =\frac{\varepsilon_{0} A}{d}\left(\frac{K_{1}}{2}+\frac{K_{2}}{2}\right) C^{\prime}{ }_{2}=C\left(\frac{K_{1}+K_{2}}{2}\right)\left[\because C=\frac{\varepsilon_{0} A}{d}\right]
\end{aligned}
$$

According to the problem, $\mathrm{C}_{1}=\mathrm{C}^{\prime} 2$

$$
K C=C\left(\frac{K_{1}+K_{2}}{2}\right) \Rightarrow K=\frac{K_{1}+K_{2}}{2}
$$

According to Coulomb's law, the magnitude of force acting between two stationary point charges is given by

$$
F=\left(\frac{q_{1} q_{2}}{4 \pi \varepsilon_{0}}\right)\left(\frac{1}{r^{2}}\right)
$$

For give $\mathrm{q}_{1} \mathrm{a}_{2}, F \propto \quad \frac{1}{r^{2}}$
slope of $F-\frac{1}{r^{2}}$,graph depends on $\mathrm{q}_{1} \mathrm{q}_{2}$ is higher for second pair
For ( $1 \mu \mathrm{C},-3 \mu \mathrm{C}$ )

$\therefore$ slope of $F-\frac{1}{r^{2}}$ graph corresponding to second pair
$(1 \mu \mathrm{C}-3 \mu \mathrm{C})$ is greater. higher the magnitude of product of charges $\mathrm{q}_{1}$ and $\mathrm{q}_{2}$, higher will be the slope.

## Section - C

21) Given $\mathrm{q}_{1}=2 \times 10^{-7} \mathrm{C}, \mathrm{q}_{2}=3 \times 10^{-7} \mathrm{C}$,

$$
\mathrm{r}=30 \mathrm{~cm}=0.3 \mathrm{~m}
$$

Therefore, Force of repulsion, $\mathrm{F}=9 \times{ }^{10} 9 \times \frac{q_{1} q_{2}}{r^{2}}$

$$
\begin{gathered}
=9 \times 10^{9} \times \frac{2 \times 10^{-7} \times 3 \times 10^{-7}}{(0.3)^{2}}=\frac{54 \times 10^{-5}}{9 \times 10^{-2}} \\
=6 \times 10^{-3} \mathrm{~N}
\end{gathered}
$$

22) 

(a) The electric line of force starts from a positively charged body and at a negatively charged body and it carries information about the direction of electric field at different points in space, thus it cannot have sudden break.
(b) Because if any two lines cross each other at any point, then the electric field at the point of intersection will not have a unique directions, which is impossible. Hence no two electric lines of force can intersect each other.
23) $5.8 \times 10^{-9} s$
24) $r_{m}=r / 4$

