B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

MID-APRIL TEST 2025-26

PHYSICS

MARKING SCHEME

Class: XII **Time: 1hr**
Date: 19.04.25 **Max Marks: 25**

Section A

1. (a) Electric field intensity 1
2. (d) Zero 1
3. (c) Zero 1

Section B

4. The conservation of charge is a fundamental principle in physics stating that the total electric charge in an isolated system remains constant over time. This means that charge cannot be created or destroyed, only transferred from one object to another. 2

5. The surface, the locus of all points at the same potential, is known as the **equipotential surface**. No work is required to move a charge from one point to another on the equipotential surface. In other words, any surface with the same electric potential at every point is termed as an equipotential surface. 1

(i) Two equipotential surfaces can never intersect. (.5)

(ii) Always, the electric field is perpendicular to an equipotential surface. (.5)

6. If the point is a distance x from the +3Q charge, then it is x-4 away from the -Q charge. If we define right as positive, we can write this as:

$k\,(3Q / x^2) - k\,(Q / (x - 4)^2) = 0$ 1

where the minus sign in front of the second term is not the one associated with the charge but the one associated with the direction of the field from the charge.

The k's and Q's cancel. Re-arranging gives:

$3 / x^2 = 1 / (x - 4)^2$

$3(x^2 - 8x + 16) = x^2$

$x^2 - 12x + 24 = 0$ 1

Solving this using the quadratic equation gives two answers: x = 2.54 cm and x = 9.46 cm. 1

7. Since both the points P and Q are on the equatorial line of the dipole and V = 0 at every point on it, work done will be zero. Also the force on any charge is perpendicular to the equatorial line, so work done is zero. 2

8.

$$F = \frac{kq_1q_2}{r^2}$$

$$F = \frac{q_1q_2}{4\pi\epsilon_0 r^2} = \frac{9\times10^9\times2\times10^{-7}\times3\times10^{-7}}{0.3^2}$$

Solving, we get,

$$F = 6\times10^{-3}\ N$$

2

Section C

9.

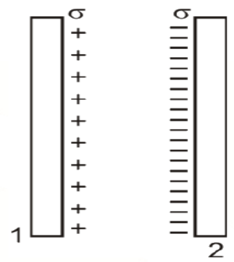
$$\tau = PE\sin\theta$$
$$= q(2a)E\sin\theta$$
$$8\sqrt{3} = q\times0.02\times10^5\times\sin60^\circ$$
$$\Rightarrow q = 8\times10^{-3}\ C$$
$$P.E. = -pE\cos\theta$$
$$= -q(2a)\cos\theta$$
$$= -8\times10^{-3}\times0.02\times10^5\times\cos60^\circ$$
$$= -8\ J$$

3

10. A parallel plate capacitor is a type of capacitor that is constructed by two parallel conducting plates and a dielectric material between them?

We know electric field due to charged metallic plate

$E_1 = \frac{\sigma}{2\epsilon_0}$ (as charge present only one surface)



Similarly $E_2 = \frac{\sigma}{2\epsilon_0}$

Hence net field between two plate

$$E = E_1 + E_2 = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0}$$

Now potential difference between two plate

$$V = Ed = \frac{\sigma}{\epsilon_0}d$$

$$\Rightarrow q = CV \Rightarrow C = \frac{q}{V} = \frac{\sigma A}{\frac{\sigma d}{\epsilon_0}} = \frac{A\epsilon_0}{d}$$

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

The capacitance of a capacitance increases when a dielectric is introduced between its plates because the capacitance is related to the dielectric constant k by the equation: $C=k\epsilon_0 A/d$. 3

11.

ANSWER

Coulomb's law states that the electrostatic force between two point charges is directly proportional to the product of charges and inversely proportional to the square of distance between them.

$$\overrightarrow{F}_{12} = \frac{1}{4\pi\epsilon_o}\frac{q_1 q_2}{r_{12}^2}\widehat{r_{12}}$$

$$\overrightarrow{r_{12}} = \overrightarrow{r_2} - \overrightarrow{r_1}$$

and $|\overrightarrow{r_{12}}| = |\overrightarrow{r_2} - \overrightarrow{r_1}|$

According to Coulomb's law, electric force on charge q_2 due to charge q_1,

$$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{|\overrightarrow{r_{21}}|^2}\hat{r_{12}}$$

Here, $\hat{r_{21}}$ is a unit vector moving from q_1 to q_2. Then,

$$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{|\overrightarrow{r_{21}}|^3}\overrightarrow{r_{12}}$$

or $$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{|\overrightarrow{r_2} - \overrightarrow{r_1}|^3}(\overrightarrow{r_2} - \overrightarrow{r_1}) \qquad \ldots(1)$$

(3)

12.

Gauss's law in electrostatics : "The surface integral of electrostatic field $\overrightarrow{E}$ produced by any source over any closed surface S enclosing a volume V in vacuum, *i.e.*, total electric flux over the closed surface S in vacuum, is $\frac{1}{\varepsilon_0}$ times the total charge (Q) contained inside S, *i.e.*

$$\phi_E = \oint \overrightarrow{E}.d\overrightarrow{S} = \frac{Q_{enclosed}}{\varepsilon_0}$$ 1

$$\oint_S \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0} \Rightarrow \oint_E \vec{E}.\hat{n}\,ds = \frac{q}{\varepsilon_0}$$

$$\therefore \quad E\oint ds = \frac{q}{\varepsilon_0} \Rightarrow E.4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$\therefore \quad E_r = \frac{1}{4\pi\varepsilon_0}.\frac{q}{r^2}$$

At any point on the surface of the shell,

$$r = R$$

$$\therefore \quad E_R = \frac{1}{4\pi\varepsilon_0}.\frac{q}{R^2}$$

If σ is charge density

$$\therefore \quad q = 4\pi R^2\sigma$$

$$\therefore \quad E_R = \frac{1}{4\pi\varepsilon_0}.\frac{4\pi R^2\sigma}{R^2}$$

Therefore, $$E_R = \frac{\sigma}{\varepsilon_0}$$ 1.5

Inside the surface of the shell Electric field will be Zero because q=o. 0.5
