DAV PUBLIC SCHOOL, POKHARIPUT, BHUBANESWAR

PSVT 2021 -22

STD - XII

SUBJECT – PHYSICS

M.M. – 35 **TIME – 1 ½ HR**

General Instructions:

(i) ***All*** *questions are* ***compulsory****. There are* ***16*** *questions in all.*

(ii) *This question paper has* ***five*** *sections: Section A, Section B, Section C , Section D and section E.*

(iii) *Section A contains* ***nine*** *questions of* ***one*** *mark each, Section B contains one case based question, Section C contains* ***four*** *questions of* ***two*** *marks each, Section D contains* ***two*** *questions of* ***three*** *marks each, and Section E contains* ***two*** *questions of* ***five*** *marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in* ***two*** *questions of one mark,* ***one*** *question of two marks and* ***two*** *questions of five marks weightage. You have to attempt only one of the choices in such questions.*

(v) *You may use the following values of physical constants wherever necessary:*

$c = 3\times10^{8}\ ms^{-1}$ $h = 6.63\times10^{-34}Js$,

$e = 1.6\times10^{-19}C$ $\mu_0 = 4\pi\times10^{-7}\ TmA^{-1}$

$\varepsilon_0 = 8.854x10^{-12}\ C^2N^{-1}\ m^{-2}$ Mass of electron $= 9.1\times10^{-31}kg$,

Mass of neutron $= 1.675\times10^{-27}kg$ Mass of proton $= 1.673\times10^{-27}kg$

Avogadro's number $= 6.023\ x\ 10^{23}$ per gram mole

Boltzmann constant $= 1.38\ x\ 10^{-23}\ JK^{-1}$

SECTION - A

1. What will be the total flux through the faces of the cube with the side of length a if a charge q is placed at center of a face of the cube.

OR

What is the number of electric field lines that radiate outwards from one coulomb of charge in vacuum?

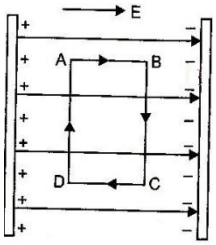
2. Consider three charged bodies P, Q and R. If P and Q repel each other and P attracts R, what is the nature of force between Q and R?

3. Draw an equipotential surface for a system consisting of two charges Q, -Q separated by a distance r in air. Locate the points where the potential due to the dipole is zero.

OR

Draw a schematically equipotential corresponding to a field that uniformly increases in magnitude but remains in a constant along Z -axis.

4. How does the energy stored in a capacitor change if the plates of a charged capacitor are moved farther, the battery remaining connected?
5. A uniform electric field exists between two charged plates as shown in the figure. What should be the work done in moving a charge q along the closed rectangular path ABCDA?



Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.

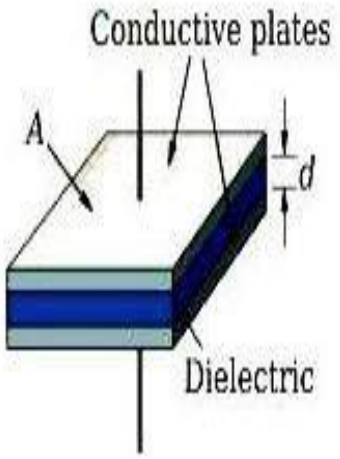
6. **Assertion (A**): The tires of aircrafts are slightly conducting.
   Reason (R): If a conductor is connected to ground, the extra charge induced on the conductor will flow to ground.
7. **Assertion (A**): Dielectric polarisation means formation of positive and negative charges inside the dielectric.
   Reason (R): Free electrons are formed in the process.

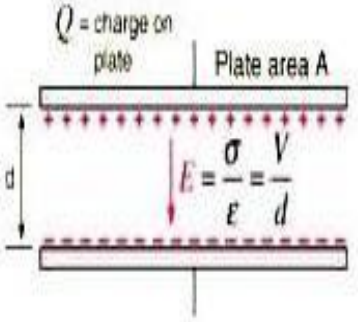
SECTION - B

Questions 08 is a Case Study based questions and are compulsory.

Attempt any 4 sub parts from each question. Each question carries 1 mark.

8. . Capacitance is the ratio of the change in the electric charge of a system to the corresponding change in its electrical potential. Capacitor consists of two metal plates which are filled with dielectric. When a voltage is applied to these plates an electric current flows charging up one plate with a positive charge with respect to the supply voltage and the other plate with an equal and opposite negative charge. The generalized equation for the charge stored in a capacitor is given by q=CV, where C is the capacitance of the capacitor.





(i) The capacitance of a capacitor does not depend on

a. Area of plates
b. Separation between the plates
c. Applied potential difference
d. Dielectric constant

(ii) A parallel plate air capacitor with no dielectric between the plates is connected to the constant voltage source. How would capacitance and charge change if dielectric of dielectric constant K=2 is inserted between the plates. C_0 and Q_0 are the capacitance and charge of the capacitor before the introduction of the dielectric.

a. $C=C_0/2$; $Q=2Q_0$
b. $C=2C_0$; $Q=Q_0/2$
c. $C=C_0/2$; $Q=Q_0/2$
d. $C=2C_0$; $Q=2Q_0$

(iii) **Three capacitors, each of capacitance 4 μF, are to be connected in such a way that the effective capacitance is 6μF. This can be done by**

a. Connecting all of them in series.
b. Connecting all of them in parallel.
c. Connecting two in series and one in parallel.
d. Connecting two in parallel and one in series

(iv) Two capacitors of capacitance C are connected in series. If one of them filled with dielectric substance, what is the effective capacitance?

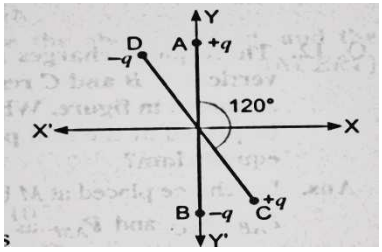
(a) $\frac{KC}{1+K}$ (b)C(K+1) (c) $\frac{2KC}{1+K}$ (d) None of these

(v) **Amount of energy stored in a capacitor of 5μF when it is charged to a potential of 100 V.**

a. 2.5 J
b. 2.5×10^{-3} J
c. 25×10^{-3} J
d. 250×10^{-3} J

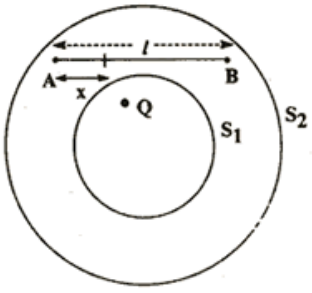
SECTION - C

9. Two small identical electric dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120^0 as shown in the figure. What is the resultant dipole moment of this combination? If this combination is subjected to electric field directed along x-direction, what will be the magnitude and direction of the torque acting on it?



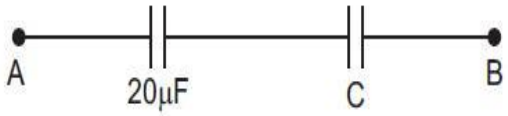
OR

Calculate the total flux of a electrostatics field through the sphere S1 and S2. The wire AB shown here has a linear charge density λ given by λ = kx, where x is distance measured along the wire from end A.



10. An infinite long positively charged straight wire has a linear charge density λCm^{-1}. An electron is revolving around the wire as its centre, with a constant velocity in a circular plane perpendicular to the wire. Deduce the expression for its kinetic energy.

11. The equivalent capacitance of the combination between A and B in the given figure is 4 μF.



(a) Calculate capacitance of the capacitor C.

(b) Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B.

12. N spherical droplets, each of radius r, have been charged to a potential V each. If all these droplets were to coalesce to form a single large drop, what would be the potential of this large drop?

SECTION -D

13. Obtain the expression for the potential energy of a system of two charges in an external electric field.

14. An early model of an atom considered it to have a positively charged point nucleus of charge Ze, surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance r from the nucleus?

SECTION - E

15. a) Derive the expression for electric field at a point on equatorial line of an electric dipole.

b) Two charges q and -3q are placed fixed on X-axis separated by distance d. Where a third charge 2q should be placed at a finite position on X-axis such that it will not experience any force.

OR

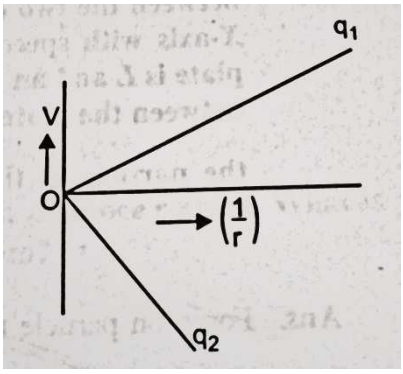
a) State Gauss's law in electrostatics. Show, with the help of a suitable example along with the figure, that the outward flux due to a point charge 'q' in vacuum within a closed surface is independent of its size or shape and is given by .$\frac{q}{\epsilon_0}$

b) Two parallel uniformly charged infinite plate sheets 1 and 2, have charge densities +σ and -2σ respectively. Give the magnitude and direction of the net electric field
at a point

(i) in between the two sheets and

(ii) Outside near the sheet1.

16. Derive an expression for the electric potential at a point due to an electric dipole. On the basis of this expression show that the potential, at any point on the perpendicular bisector of the dipole, is zero?



The two graphs given in figure, show the variation of

electrostatic potential V with 1/r where r is the distance of field point from the point charges q_1 and q_2.

i. Mention the signs of the two charges?

ii. Which of the two charges has larger magnitude, justify?

OR

(i) Deduce the expression for the capacitance of a parallel plate capacitor when a dielectric slab is inserted between its plates. Assume the slab thickness less than the plate separation.

(ii) Derive an expression for the energy density of an electric field.