Roll Number		

SET NO. 2

INDIAN SCHOOL MUSCAT
FIRST TERM EXAMINATION
PHYSICS

CLASS: XII Sub. Code: 042 Time Allotted: 3 Hrs

30.04.2018 Max. Marks: 70

General Instructions:

1. All questions are compulsory. There are 27 questions in all.

2. This question paper has five sections: Section A, Section B, Section C and Section D.

3. Section A contains five questions of one mark each, Section B contains seven questions of two marks each, Section C contains twelve questions of three marks each, Section D contains three questions of five marks each.

4. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.

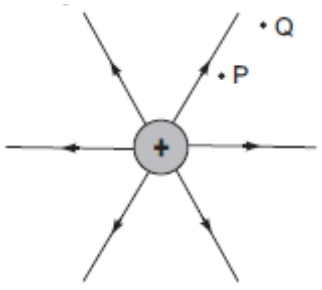
5. You may use the following values of physical constants wherever necessary.
$\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$

SECTION A

1 Why is it necessary that the field lines from a point charge placed in the vicinity of a conductor must be normal to the surface of the conductor at every point? 1

2 Two equal balls having equal positive charge ‘q’ coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two? 1

3 Figure shows the field lines of a positive point charge. Give the sign of the work done by the field in moving a small positive charge from Q to P. 1



4 Name the dielectric whose molecules have (i) non-zero and (ii) zero dipolemoment. 1

5 A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square. 1

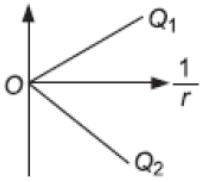
SECTION B

6 Draw a free body diagram to show a charged particle of mass 'm' and charge 'q' whose weight is balanced in between two plates of equal and opposite charge densities. Write the equation for its equilibrium. 2

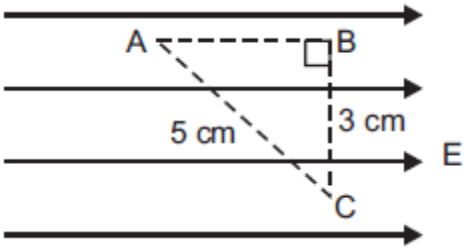
7 Obtain the expression for the potential energy of an electric dipole of dipole moment $\vec{p}$ placed in an electric field $\vec{E}$. 2

8 (i) Can two equi-potential surfaces intersect each other? Give reasons. 2

(ii) Figure shows potential due to a point charge (V) vs 1/r graphs for two point charges Q_1 and Q_2. What can you say about the sign and relative magnitude of Q_1 and Q_2?



9 Three points A, B and C lie in a uniform electric field (E) of 5×10^{3} NC^{-1} as shown in the figure. Find the potential difference between A and C. 2



OR

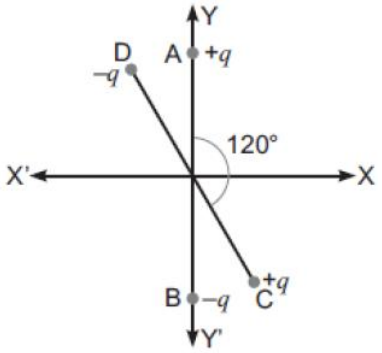
The sum of two point charges is 7 μC. They repel each other with a force of 1 N when kept 30 cm apart in free space. Calculate the value of each charge.

10 Sketch the electric field lines for two positive point charges q_1 and q_2 for 2

(i) $q_1=q_2$ and

(ii) $q_1>q_2$ separated by a distance 'd'.

11 Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination? If this system is subjected to electric field ($\vec{E}$) directed along + X direction, what will be the magnitude and direction of the torque acting on this? 2



12 Define the term polarisation of a dielectric and write its relation with susceptibility. 2

SECTION C

13 (i) An infinitely long positively charged straight wire has a linear charge density λ Cm^{-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. 3
(b) Plot a graph of the kinetic energy as a function of charge density λ.

14 (i) In which orientation, a dipole placed in a uniform electric field is in (a) stable, (b) unstable equilibrium? 3
(ii) A point charge is placed at the centre of a closed Gaussian surface of radius 'r'. Electric flux passing through the surface is ϕ. How is the electric flux ϕ through the surface affected when the following changes are made in turn:
(a) The spherical surface is replaced by a cylindrical surface of the same radius?
(b) The point charge is replaced by an electric dipole?

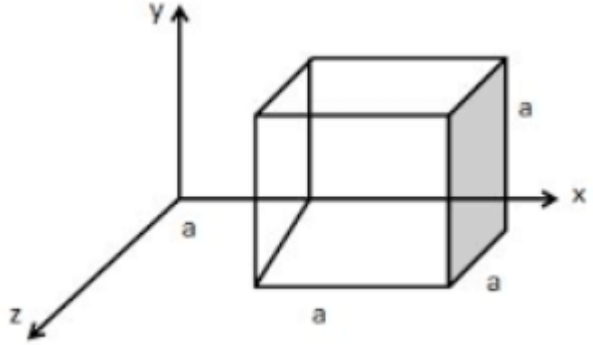
15 An electric dipole is held in a uniform electric field. 3
(*i*) Show that the net force acting on it is zero.
(ii) Derive an expression for torque acting on it and specify its direction.

OR

Obtain an expression for the electric field strength at a distant point situated along the equatorial line of an electric dipole.

16 (i) Using Gauss' theorem, derive an expression for the electric field intensity at any point due to a thin, infinitely long wire of linear charge density λ C/m. 3
(ii) Draw a graph showing the variation of electric field (E) with distance (r) due to a point charge.

17 The electric field components in the figure are $E_x = \alpha x^{1/2}$, $E_y = E_z = 0$, in which 3
α= 800 N/C $m^{1/2}$. Calculate (a) the flux through the cube, and (b) the charge within the cube. Assume that a = 0.1 m.



18 (i) Two electric dipoles made from charges ±q and ±Q respectively have equal dipolemoments. Find the (a) ratio between the separations of the two charges in the two dipoles and 3
(b) angle between the dipole axes of the two dipoles.
(ii) If the plates of a charged conductor be suddenly connected to each other by a copper wire, what will happen?

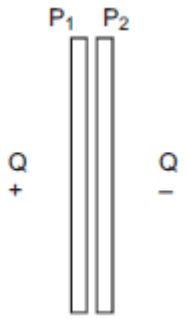
19 (i) A charge +Q is placed on a large spherical conducting shell of radius R. Another small conducting sphere of radius r carrying charge 'q' is introduced inside the large shell and is placed at its centre. Find the potential difference between two points, one lying on the sphere and the other on the shell. 3

(ii) How would the charge between the two flow if they are connected by a conducting wire?

20 Three charges each equal to q, are placed at the three corners of a square of side 'a'. Find the magnitude of electric field at the fourth corner? 3

21 (i) Define electric flux. Write its SI unit. 3

(ii) Figure shows two large metal plates P_1 and P_2, tightly held against each other and placed between two equal and unlike point charges perpendicular to the line joining them.



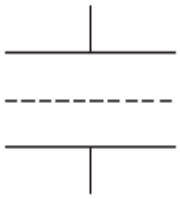
(a) What will happen to the plates when they are released?

(b) Draw the pattern of the electric field lines for the system.

22 (i) Figure shows a sheet of aluminium foil of negligible thickness placed between the plates of a capacitor. How will its capacitance be affected if: 3

(a) the foil is electrically insulated?

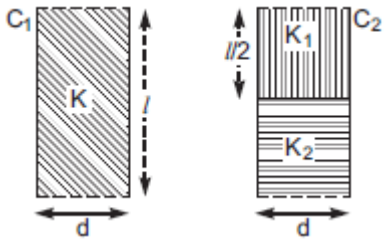
(b) the foil is connected to the upper plate with a conducting wire?



(ii) A bird perches on a bare high power line, and nothing happens to the bird. A man standing on the ground touches the same line and gets a fatal shock. Why?

23 (i) Define dielectric strength. 3

(ii) 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 diagram. If the two capacitors still have equal capacitance, obtain the relation between dielectric constants K, K_1 and K_2.

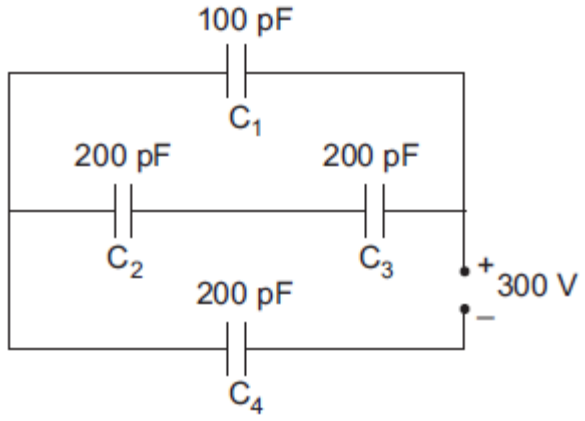


24 A 600pF capacitor is charged by a 200V supply. How much electrostatic energy is stored by the capacitor? It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. What is the electrostatic energy stored by the system? How much electrostatic energy is lost in the process? 3

SECTION D

25 (i) Derive an expression for the energy stored in a parallel plate capacitor *C*, charged to a potential difference *V*. 5

(ii) Obtain the equivalent capacitance of the network given below. For a supply of 300 V, determine the charge and voltage across C_4 .



OR

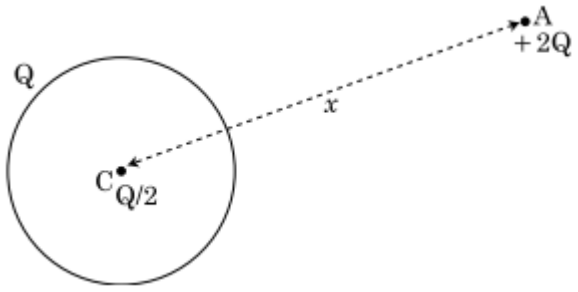
(i) Derive an expression for the electric potential at a point due to an electric dipole.

(ii)Determine the electrostatic potential energy of a system consisting of two charges 7 μC and –2 μC (and with no external field) placed at (–9 cm, 0, 0) and (9 cm, 0, 0) respectively.

(iii) How much work is required to separate the two charges infinitely away from each other?

26 (i) Use Gauss's law to find electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it. 5

(ii) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at the centre C and another charge +2Q is placed outside the shell at A at a distance *x* from the centre as shown in the figure.



(a) Find the electric flux through the shell.

(b) State the law used.

(c) Find the force on the charges at the centre C of the shell and at the point A.

OR

(i) Use Gauss's law to derive the expression for the electric field due to a uniformly charged thin spherical shell at a point

(a) inside the shell and

(b) outside the shell.

(ii) A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge 'Q'. A charge 'q' is placed at the centre of the shell. (a) What is the surface charge density on the (i) inner surface, (ii) outer surface of the shell?

(b) Write the expression for the electric field at a point $x > r_2$ from the centre of the shell.

27 (i) Obtain an expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points $\vec{r}_1$ and $\vec{r}_2$ respectively in the presence of external electric field $\vec{E}$. 5

(ii) Explain, using suitable diagram, the difference in the behaviour of a

(a) conductor and

(b) dielectric in the presence of external electric field.

OR

(i) Derive an equation for the capacitance of a parallel plate capacitor when a dielectric slab of thickness 't' is introduced between the plates, each of area 'A' separated by a distance 'd' for $t << d$.

(ii) A capacitor is charged with a battery and, which is then disconnected. A dielectric slab of dielectric constant 'K' is then inserted in the space between the plates. Explain what changes, if any, occur in the values of:

(a) capacitance

(b) potential difference between the plates

(c) electric field between the plates, and

(d) the energy stored in the capacitor.

End of the Question Paper