Roll Number		

SET NO. 42/1

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 four sections: Section A , Section B , Section C , 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 and 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 questions of five marks weightage. You have to attempt only one of choices in such questions.**
5. **You may use the following values of physical constants wherever necessary.**

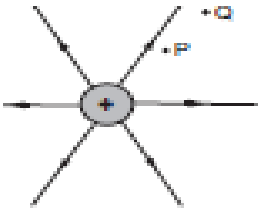
$c = 3 \times 10^8$ m/s , $h = 6.63 \times 10^{-34}$ Js , $e = 1.6 \times 10^{-19}$ C , $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2} , $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2} , $m_e = 9.1 \times 10^{-31}$ kg

SECTION- A

1. Which of the following physical quantity does not represent electric field? 1
   (i) V/m
   (ii) J/C

2. Figure shows the field lines due to a positive point charge. Give the sign of potential energy difference of a small negative charge taken between the points **Q** and **P**. 1



3. A charge **q** is placed at the centre of a cube of side ***l***. What is the electric flux passing through each face of the cube? 1

4. Electric field is always normal to the surface of a conductor, justify. 1

5. What happens if the plates of a charged capacitor are suddenly connected by a conducting wire? 1

SECTION- B

6. Two fixed point charges **+4e and +e** units are separated by a distance **a**. where should a third point charge **q** be placed on the line joining the two charges so that it is in equilibrium? 2

7. Draw schematically equipotential surfaces corresponding to 2

(i) a constant electric field in Z-direction.

(ii) a field that uniformly increases in magnitude but remains in a constant Z-direction.

8. Two charges **5nC** and **-2nC** are placed at a points (**5cm**, 0, 0) and (**23cm**, 0, 0) in a region of space where there is no electric field. Calculate the electrostatic potential energy of this charge system. 2

9 In a type of charge configuration electric field at a point due to it is 2

(i) independent of distance from the point

(ii) inversely proportional to the distance from the point

(iii) inversely proportional to the square of distance from the point

(iv)) inversely proportional to the cube of distance from the point

10. Three capacitors each of capacitance **9 pF** are connected in series. What is the effective capacitance of combination? What is the potential difference across each capacitor if combination is connected to a **120V** supply? 2

OR

Three capacitors each of capacitance **3 pF** are connected in parallel. What is effective capacitance of the combination? What is charge on each capacitor if combination is connected to **120 V** supply?

11. (i) If the distance between two equal point charges is doubled and their individual charges are also doubled, what would happen to the force between them? 1+1

(ii) How does the force between two point charges change, if dielectric constant of the medium in which they kept, increases?

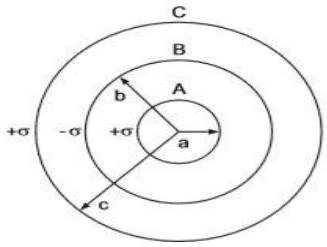
12. (i) Sketch a graph to show how the charge **Q** acquired by a capacitor of capacitance **C** varies with increase in potential difference between its plates. 1+1

(ii) No work is done in moving a test charge over an equipotential surface. Why?

SECTION- C

13. Charges of **+5μC** , **+10μC** and **-10μC** are placed in air at the corners **A , B** and **C** of an equilateral triangle **ABC**, having each side equal to **5** cm. Determine the resultant force on the charge at **A**. 3

14. Three concentric metallic shells **A, B** and **C** of radii **a, b** and **c** (a < b < c) have surface charge densities **+σ, - σ** and **+σ** as shown in the figure. If shells **A** and **C** are at the same potential, then obtain the relation between radii **a, b** and **c.** 3



15. Derive an expression for the electric field **E** due to an electric dipole of length **2a** at a point distant **r** from the centre of the dipole on the axial line. 3

Draw a graph of **E** versus **r** for **r >> a**.

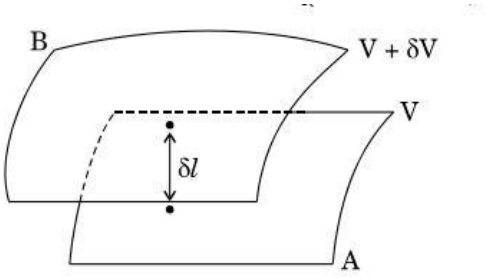
16. A parallel plate capacitor is charged to a potential difference **V** by a d. c. source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following will change: 3

(i) electric field between the plates,

(ii) capacitance and

(iii) energy stored in the capacitor.

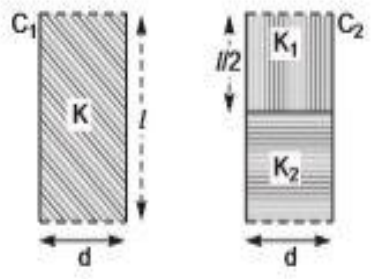
17. Two closely spaced equipotential surfaces **A** and **B** with potentials **V** and **V + δV**, (where **δV** is the change in **V**) are kept ***δl*** distance apart as shown in the figure. Deduce the relation between the electric field and the potential gradient between them. Write the two important conclusions concerning the relation between the electric field and electric potential. 3



18. An infinitely long positively charged straight wire has a linear charge density λ c/m. 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

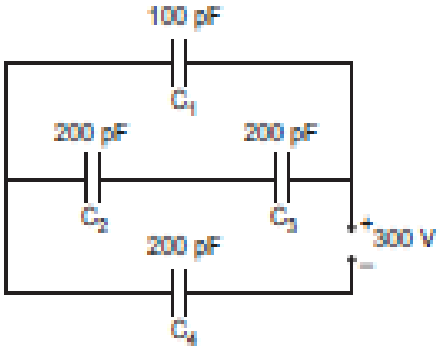
Plot a graph of the kinetic energy as function of charge density.

19. Two identical parallel plate (air) capacitors $\mathbf{C_1}$ and $\mathbf{C_2}$ have capacitances **C** each. The space between their plates is now filled with dielectrics as shown. If the two capacitors still have equal capacitance, obtain the relation between dielectric constants **K** , $\mathbf{K_1}$ and $\mathbf{K_2}$. 3



20. Derive an expression for electric potential at a point due to an electric dipole. Mention the contrasting features of electric potential of a dipole at a point as compared to that due to a single charge. 3

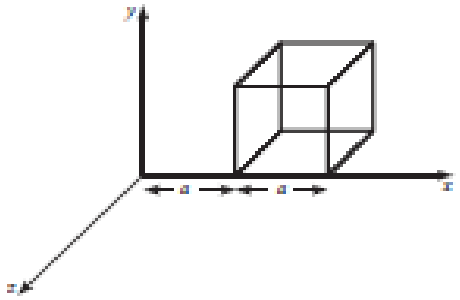
21. Obtain the equivalent capacitance of network given below. For a supply of **300V,** determine the charge and voltage across $\mathbf{C_4}$. 3



22. Use Gauss's theorem to derive an expression for the electric field due to a long straight wire of linear charge density λ C/m 3

23. Find the ratio of the potential differences that must be applied across the parallel and the series combination of two identical capacitors, so that the energy stored in two cases becomes the same. 3

24. A cube with each side **a** is kept in an electric field given by $\vec{E} = C \times \hat{\imath}$, (as shown in the figure) where **C** is a positive dimensional constant. Find out (i) the electric flux through the cube, and (ii) net charge inside the cube.

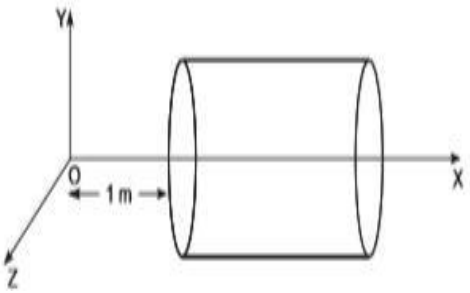


OR

A hollow cylindrical box of length **1**m and area of cross-section **25** cm^2 is placed in a three-dimensional coordinate system as shown in the figure. The eletric field in the region is given by $\boldsymbol{E = 50x\hat{\imath}}$, where **E** is in $NC^{-1}$and *x* is in metre.

Find: (i) net eletric flux through the cylinder.

(ii) charge enclosed by the cylinder.



SECTION- D

25. An electric dipole is placed in a uniform electric field. 3+2

(i) Show that no translatory force acts on it.

(ii) Derive an expression for the torque acting on it.

(iii) Find work done in rotating the dipole through $\mathbf{180^0}$.

OR

(i) Why do the electric field lines never cross each other?

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

(iii) Draw electric field lines for a system of two charges $\mathbf{q_1}$ and $\mathbf{q_2}$ such that $\mathbf{q_1.q_2 > 0}$; $\mathbf{q_1 > q_2 > 0}$

26. (i) State Gauss's law. Use it to deduce the expression for the electric field due to a uniformly charged thin spherical shell at points 3+2

(a) outside the shell and

(b) inside the shell.

(ii) Two identical metallic spheres **A** and **B** having charges **+ 4Q** and **-10Q** are kept a certain distance apart. A third identical uncharged sphere **C** is first placed in contact with sphere **A** and then with sphere **B.** Then, spheres **A** and **B** are brought in contact and then separated. Find the charges on spheres **A** and **B**.

OR

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

(ii) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.

How the field is directed if (i) the sheet is positively charged, (ii) negatively charged?

27. (i) How does the electric field inside a dielectric decreases when it is placed in an external electric field? 2+3

(ii) Derive an expression for the capacitance of a parallel plate capacitor when a dielectric slab of dielectric constant **K** and thickness **t = d/2** but of same area as that of the plates is inserted between the capacitor plates. (**d**= separation between the plates).

OR

(i) Distinguish between polar and non-polar dielectric.

(ii) Derive an expression for the energy stored in a parallel plate capacitor **C**, charged to a potential difference **V**. Hence derive an expression for the energy density of a capacitor.

End of the Question Paper