ITL PUBLIC SCHOOL
SUMMER ENGAGEMENT PROGRAMME -2023-24
CLASS XII
PHYSICS

A. Final Softcopy of the CBSE Project file to be prepared, complete with the following elements

- Title Page – aim of the project
- Acknowledgement
- Certificate
- Index
- Theory -with relevant graphs and examples
- Procedure
- Observation and Data
- Result / Inference
- Precautions
- Bibliography

Some examples of Projects that can be done by class XII students:

(i) Demonstration of Self and Mutual Induction
(ii) Step Down Transformer
(iii) Logic Gates
(iv) Magnetic Levitation Train / elevator
(v) Dependence of EMF of a cell on different factors
(vi) Half –wave / Full wave rectifier
(vii) Full Wave Bridge rectifier
(viii) To light an LED lamp using a thermistor
(ix) To demonstrate the working of an electrolytic capacitor by means of its charging and discharging with the help of an audio oscillator.
(x) To study and construct a portable mobile charger
(xi) To determine refractive indices of different liquids using hollow glass prism / hollow lens
(xii) Motion sensing lights and fan to save electricity

You can also select any other project relevant to the syllabus.

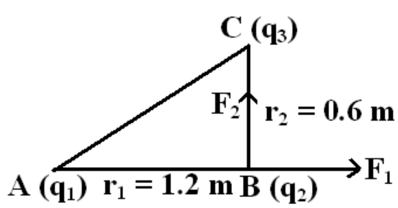
B. All examples and exercise questions from NCERT to be done in a separate register.

C. Attempt the following assignment on electrostatics and current electricity.

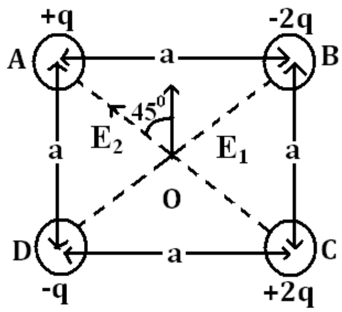
1. A charge q is placed at the centre of the line joining two equal charges Q. Show that the system of three charges Q. Show that the system of three charges will be in equilibrium if q = -Q/4.
2. Find the magnitude of the resultant force on a charge of 1μC held at P due to two charges of + 2×10^{-8} C and -10^{-8} C at A and B respectively.
3. Two fixed point charges + 4e and +e units are separated by a distance a. Where should the third point charge be placed for it to be in equilibrium?
4. Three equal charges, 2.0×10^{-6} C each, are held fixed at the three corners of an equilateral triangle of side 5 cm. Find the coulomb force experienced by one of the charges due to the rest two.
5. How many electrons must be removed from a piece of metal to give it a positive charge of 1.0×10^{-7}?
6. Two small spheres each of mass 'm' kg and charge q coulomb are suspended from a point by insulating threads each of l metre length, but of negligible mass. If θ is the angle which each string makes with the vertical when equilibrium has been reached , show that

   $$Q^2 = 4\ mg\ l^2 \sin^2\theta \tan\theta\ (4\pi\epsilon_0)$$

7. Two opposite corners of a square carry Q charge each and the other two opposite corners of the same square carry q charge each. If the resultant force on q is zero, how are Q and q related?
8. Charges q_1 = 1.5 mC, q_2 = 0.2 mC and q_3 = -0.5 mC, are placed at points A, B, C respectively as shown in figure. If r_1 = 1.2 m and r_2 = 0.6 m, calculate the magnitude of resultant force on q_2.



9. Two similarly and equally charged identical metal spheres A and B repel each other with a force of 2×10^{-5} N. A third identical, uncharged sphere C is touched with A and then placed at the mid-point between A and B, What is the net electric force on C?
10. Two positive point charges which are 0.1 m apart repel each other with a force of 18N. If the sum of the charges be 9μC, calculate their separate values.
11. Two point charges of $+5 \times 10^{-19}$C and $+20 \times 10^{-19}$C are separated by a distance of 2m. Find the point on the line joining them at which electric field intensity is zero.
12. What are the magnitude and direction of the electric field at centre of the square in figure, if $q = 1.0 \times 10^{-8}$C and a = 5.0 cm?



13. Calculate the magnitude of the electric field which can just balance a deuteron of mass 3.2×10^{-27} kg.

(Ans. 19.6×10^{-8} V/m)

14. Calculate the maximum torque experienced by a water molecule whose electric dipole moment is 6.2×10^{-30} C m, when it is placed in an electric field of intensity 10^6 N/C.

(Ans. 6.2×10^{-24} N m)

15. An electric dipole is placed at an angle of 60^0 with an electric field of intensity 10^5 N/C. It experiences a torque equal to $8\sqrt{3}$ N m. Calculate: the charge on the dipole, if dipole length is 2 cm.

(Ans. 8×10^{-3} C)

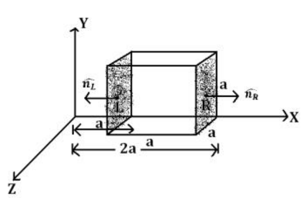
16. An electric dipole of length 2 cm is placed with its axis making an angle of 30^0 to a uniform electric field of 10^5 N/C. If it experiences a torque of $10\sqrt{3}$ N m, calculate :
    a. magnitude of charge on dipole and (b) potential energy of dipole.

(Ans. (a) $\sqrt{3} \times 10^{-2}$ C (b) – 30 J)

17. The electric field in a region can be expressed as $\vec{E} = (\frac{3}{5}\,\hat{\imath} + \frac{4}{5}\hat{\jmath})\ (2 \times 10^3 \text{ N/C})$. Determine the flux of the field through a rectangular surface of area 0.2 m^2, situated parallel to the Y-Z plane.

(Ans. 240 N m^2/C)

18. The electric field components in the following figure are $E_x = \propto x^{1/2}$, $E_y = E_z = 0$, where $\propto = 800$ N/C$m^{1/2}$.



19. Calculate:
    a. the flux through the cube and
    b. the charge within the cube. Assume that a = 0.1 m.

(Ans. (a) 1.05 N m^2/C (b) 9.29×10^{-12} C)

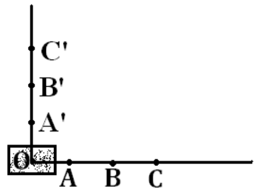
20. Three charges, each equal to q, are placed at the three corners of a square of side a. Find the electric field at the fourth corner.

(Ans. $\frac{(2\sqrt{2}+1)q}{8\pi\epsilon_0}$))

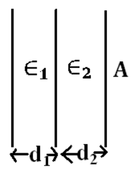
21. An electron is constrained to move along the axis of the ring of charge q and radius a. Show that the electron can perform oscillations whose frequency is given by $\omega = \sqrt{\frac{qe}{4\pi\epsilon_0 m a^3}}$.
22. An arbitrary surface encloses a dipole. What is the electric flux through this surface?
23. A metallic spherical shell has an inner radius R_1 and outer radius R_2. A charge Q is placed at the centre of the spherical cavity. What will be surface charge density on:
    a. the inner surface and (b) the outer surface?
24. On charging a parallel-plate capacitor to a potential V, the spacing between the plates is halved and a dielectric medium of $\in_r$ = 10 is introduced between the plates, without disconnecting the dc source. Explain using suitable expressions, how the: (a) capacitance (b) electric field and (c) energy density of the capacitor change.
25. A parallel-plate capacitor having a dielectric slab in between the plates is charged by a battery which is then disconnected. The dielectric slab is then taken out from between the plates. Explain what changes, if any, occur in the values of : (a) charge on the plates (b) potential difference between the plates (c) capacitance (d) electric field between the plates (e) energy stored In the capacitor.
26. Two charges q and -3q are placed fixed on X-axis separated by distance'd'. Where should a third charge 2q should be placed such that it will not experience any force?
27. The following data was obtained for the dependence of the magnitude of electric field with distance from a reference point O, within the charge distribution in the shaded region.

Field point	A	B	C	A'	B'	C'
Magnitude of electric field	E	E/8	E/27	E/2	E/16	E/54

   a. Identify the charge distribution and justify your answer.
   b. If the potential due to this charge distribution has a value V at the point A, what is its value at the point A'.



28. An electrical technician requires a capacitance of 2 μF in a circuit across a potential difference of 1KV. A large number of 1μFcapacitors are available to him, each of which can withstand a potential difference of not more than 400V. Suggest a possible arrangement that requires a minimum number of capacitors.
29. Find the capacitance3 of three parallel plates, each of which A metre^2 and separated by d_1 and d_2 metre. The in between spaces are filled with dielectrics of relative permittivities $\in_1$ and $\in_2$. The permittivity of free space is $\in_0$.



30. Keeping the voltage of the charging source constant, what would be the percentage change in the energy stored in a parallel-plate capacitor if the separation between its plates were to be decreased by 10%?

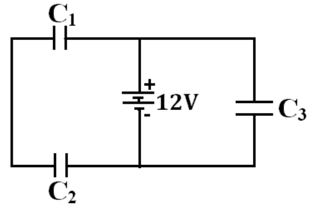
(Ans. 11.11%)

31. Two capacitors with capacitances C_1 and C_2 are charged to potentials V_1 and V_2 respectively. Calculate the common potential across the combination, the charge on each capacitor, the electrostatic energy stored in the system and the change in electrostatic from its initial value.
32. A parallel-plate capacitor has a capacitance C_0 in the absence of a dielectric. A slab of dielectric material of dielectric constant $\in_r$ and thickness d/3 is inserted between the plates. What is the new capacitance when the dielectric is present?

(Ans. $\left(\frac{3\in_r}{2\in_r+1}\right) C_0$)

33. Three capacitors C_1, C_2 and C_3 each of capacitance 6 μF, are connected to a 12V battery as shown in figure. Find: (a) charge on each capacitor (b) equivalent capacitance of the network (c) energy stored in the network of capacitors.

(Ans. (a) 36 μC, 36 μC, 72 μC (b) 9 μF (c) 648 μJ)



34. The following figure shows two identical parallel-plate capacitors A and B connected to a battery with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant 3. Find the ratio of the electrostatic energies stored in both the capacitors before and after the introduction of the dielectric.

(Ans. 3/5)

CURRENT ELECTRICITY

1. State any two limitations of Ohm's law.(1)

2. A wire of resistance 8R is bent in form of a circle. What is the effective resistance between any two diametrically opposite points? (1)

3. How many 27Ω resistors in parallel are required to carry 1A current from a 3V supply? (1)

4. A carbon resistor has a value of 62kΩ with a tolerance of 5%. Give the colour code for the resistor. (1)

5. Draw the graphs showing the variation of resistivity with temperature for (i) nichrome and (ii) silicon. (2)

6. Derive a mathematical expression for resistivity of a conductor in terms of number density of charge carriers in the conductor and relaxation time. (2)

7. If the length of a wire of resistance R is increased 10% by stretching it, then what is the percentage change in its resistance and resistivity?(2)

8. State Kirchhoff's laws of an electrical network. (2)

9. What is a Wheatstone bridge? Prove its balancing condition by using Kirchhoff's laws. (3)

10. With a circuit diagram, briefly explain how a meter bridge can be used to find the unknown resistance of a given wire. State the formula used. (3)

11. What is drift velocity of electrons and relaxation time for free electrons in a metallic conductor carrying a current? Establish a relation between them.(3)

12. Define resistivity and state its S.I. unit. State and explain how the resistivity of a conductor varies with temperature.(3)

13. Derive the formula for the equivalent e.m.f. and internal resistance for the parallel combination of two cells with e.m.f. E_1 and E_2 and internal resistances r_1 and r_2 respectively. What is the corresponding formula for the series combination? (5)

14. State the working principle of a potentiometer. What is potential gradient? Explain, with the help of a circuit diagram, how the e.m.f. of two primary cells are compared by using a potentiometer.(5)

15. Determine the current in each branch of the network shown in Fig. 1. (3)

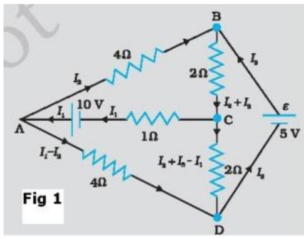


Fig 1