केंद्रीय विद्यालय संगठन, अहमदाबाद संभाग

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कक्षा बारहवीं के लिए संभागीय स्तर प्रथम परीक्षा (2024 -25)

First Common Monthly Test for Class XII

Subject : Physics
Class : XII

M.M. 40
Time : 90 minutes

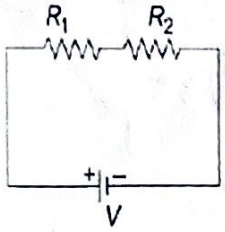
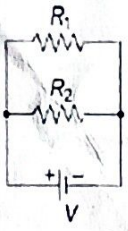
General Instructions:

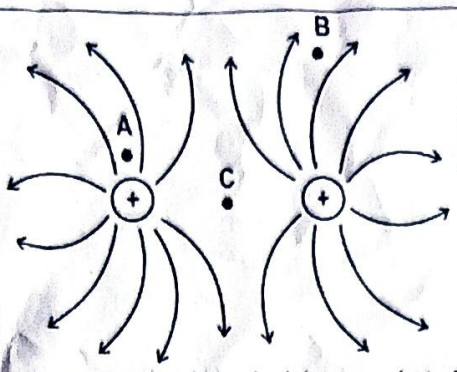
(1) There are 21 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains 8 MCQ and Six Assertion Reasoning based of 1 mark each, Section B contains one question of two marks each, Section C contains Two questions of three marks each, Section D contains Two case study based questions of four marks each and Section E contains two long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section C and in one question of Section E. You have to attempt only one of the choices in such questions.
(6) You may use the following values of physical constants where ever necessary $c = 3 \times 10^8$ m/s, $m_e = 9.1 \times 10^{-31}$ kg , $e = 1.6 \times 10^{-19}$ C, $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1} , $\varepsilon_0 = 8.854 \times 10^{-12}$ C^2/Nm^2

		SECTION –A	
1.		15 charged particles with the same charge (q) are placed on the x-axis. They are symmetrically distributed on both sides of the y-axis. The distance between any two consecutive particles is R/3 and one of the charges is at the origin. What is the electric flux through a sphere centred at the origin having a radius of 1.5R? (a) $15q/\varepsilon_0$ (b) $8q/\varepsilon_0$ (c) $9q/\varepsilon_0$ (d) $5q/\varepsilon_0$	1
2.		For a Gaussian surface through which the net flux is zero, the following statements COULD be true. P) No charges are inside the Gaussian surface. Q) The net charge inside the surface is zero. R) The electric field is zero everywhere on the surface. S) The number of field lines entering is equal to the number of lines exiting the surface. Which of the statements is/are DEFINITELY true? (A) Only statement Q (B) Both statements P and S (C) Both statements Q and R (D) Both statements Q and S	1

3.		A charge particle is free to move in an electric field. It will travel (a) Always along an electric field line. (b) Along an electric field line, if its initial velocity is zero (c) Along an electric field line, if it has some initial velocity in the direction of an acute angle with the electric field (d) None of the above	1
4.		The electric potential V is given as a function of distance x (in m) by $V = (5x^2 + 10x - 9)volt.$ Value of electric field in V/m at x = 1 is (a) 20 (b) 6 (c) 11 (d) -23	1
5.		A hollow charged metal sphere has radius r. If the potential difference between its surface and a point at a distance 3r from the centre is V, then the electric field intensity at distance 3r from the centre is – (a) V/3r (b) V/4r (c) V/6r (d) V/2r	1
6.		A light bulb is rated at 44 W, 220 V, and a table fan is rated at 60 W, 110 V. Which statement is correct if each of the two devices is connected to a power supply of 220 V separately? (a) The light bulb has a greater resistance and draws a greater current than the table fan. (b) The light bulb has a greater resistance and draws a smaller current than the table fan. (c) The light bulb has a smaller resistance and draws a greater current than the table fan. (d) The light bulb has a smaller resistance and draws a smaller current than the table fan.	1
7		What happens to the terminal voltage of a cell with an internal resistor as the current drawn from the cell increases? (a) The terminal voltage remains constant. (b) The terminal voltage decreases linearly. (c) The terminal voltage increases linearly. (d) The terminal voltage initially remains constant and then increases.	1
8.		The internal resistance of a cell depends on (a) The distance between the plates/Electrodes (b) The common area of the plates/electrodes immersed in electrolyte (c) The concentration of the electrolyte (d) All of the above	1

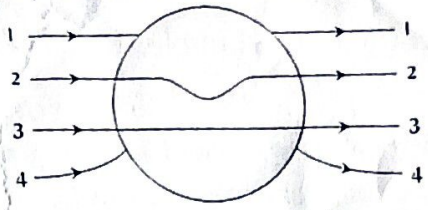
		In questions number 9 to 14, Two statements ,One is labelled Assertion (A) and the other is labelled Reason (R) are given. Read the statements carefully and choose the options given below that correctly describes statements A and R. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion. (b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (c) Assertion is true but Reason is false. (d) Both Assertion and Reason are false.	
9.		**Assertion (A):** The net current in an isolated conductor placed in a uniform electric field is zero. **Reason (R):** There is no motion of electrons inside an isolated conductor placed in a uniform electric field as all charges reside on the surface of the conductor.	1
10.		**Assertion (A):** The resistivity of conductors increases with an increase in temperature. **Reason (R):** The drift speed of electrons decreases with an increase in temperature.	1
11		**Assertion (A):** The charge-to-voltage ratio increases on insertion of a dielectric material between the capacitor plates, when either the voltage or charge is kept constant. **Reason (R):** The capacitance of a capacitor increases when it is filled with a dielectric material with a dielectric constant greater than 1.	1
12		**Assertion :** Electrons move away from a region of lower potential to a region of higher potential. **Reason :** An electron has a negative charge.	1
13		**Assertion (A):** An electric dipole is in stable equilibrium when placed in a uniform electric field with its dipole moment opposite to the field. **Reason (R):** No torque acts on an electric dipole when its dipole moment is in a direction perpendicular to the field.	1
14.		**Assertion:** Electrostatic force between two charges decreases when air separating the charges is replaced by water. **Reason :** Electrostatic force between two charges follows inverse square law.	1
		SECTION B	
15		(a) Define the term conductivity of a metallic wire. Write its SI unit. (b) Using the concept of free electrons in the conductor , derive the expression for the conductivity of a wire in terms of the number density and relaxation time.	2

		SECTION - C	
16		Using Gauss's law, obtain the expression for the electric field intensity due to a uniformly charged long wire at a point distant r away from it. Draw a graph showing the variation of electric field intensity E with r.	3
		OR	
		Define electric dipole moment. Is it a scalar or vector ? Derive the expression for the electric field of a dipole on the equatorial plane of the dipole.	3
17		Given two resistors R_1 and R_2 connected in series in circuit 1 and in parallel in circuit 2 across identical batteries of terminal voltage V with some internal resistance.   Circuit 1 Circuit 2 A third unknown resistor R_3 is added in series in circuit 1 and in parallel in circuit 2.	3
	(a)	Does the current in the battery increase, decrease, or remain the same in each of the two circuits? Give a reason for your answer.	
	(b)	Does the terminal voltage and emf (electromotive force) of the battery increase, decrease, or remain the same in each of the two circuits? Give a reason for your answer.	
		Section – D (Case Study Based Questions)	
18		**Read the following passage carefully and answer the questions that follow after paragraph-** **A field line** is a graphical visual aid for visualizing vector fields. It consists of an imaginary integral curve which is tangent to the field vector at each point along its length. A diagram showing a representative set of neighboring field lines is a common way of depicting a vector field in scientific and mathematical literature; this is called a field line diagram. They are used to show electric fields, magnetic fields, and gravitational fields among many other types.	4
	(i)	Study the given electric field representation and identify one **INCORRECT** qualitative impression given by this representation.	



(A) The electric field at point A is stronger than at point B.
(B)The electric field distribution is two-dimensional.
(C)The electric field at point C is zero.
(D)The electric field always points away from a positive charge.

(ii) A metallic solid sphere is placed in a uniform electric field. The electric field lines follow the path(s) shown in the figure. Which among the four correctly describes electric field line-



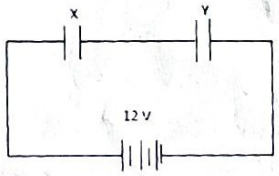
(a) 1 (b) 2 (c) 3 (d) 4

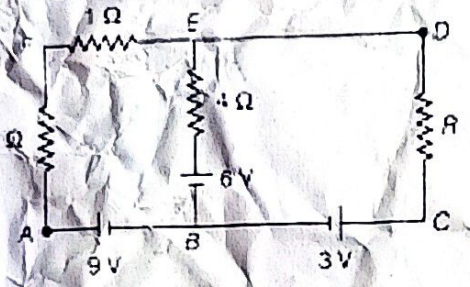
(iii) Which of the following is not the property of electric field lines
(a) Electric field line form closed loop.
(b) Electric field line emerges from positive charge.
(c) Electric field line can not have sudden breaks in charge free Region.
(d) No two Electric field lines can intersect each other.

(iv) Electric field lines about negative point charge are
(a) Circular, anticlockwise (b) Circular, clockwise
(c) Radial, inward (d) Radial, outward

19 **Read the following passage carefully and answer the questions that follow after paragraph-** 4

Electric potential (also called the electric field potential, potential drop, the electrostatic potential) is defined as the amount of work energy needed per unit of electric charge to move the charge from a reference point to a specific point in an electric field. More precisely, the electric potential is the energy per unit charge for a test charge that is so small that the disturbance of the field under consideration is negligible. The motion across the field is supposed to proceed with negligible acceleration, so as to avoid the test charge acquiring kinetic energy or producing radiation.

	(i)	A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. The potential at the centre of the sphere is (a) 0 V (b) 10 V (c) Same as at point 5 cm away from the surface (d) Same as at point 25 cm away from the surface	
	(ii)	If a unit positive charge is taken from one point to another over an equipotential surface, then (a) Work is done on the charge (b) Work is done by the charge (c) Work done is constant (d) No work is done	
	(iii)	Electric charges of +10 μC, +5 μC, - 3 μC and +8 μC are placed at the corners of a square of side $\sqrt{2}$ m. the potential at the centre of the square is (a) 1.8 V (b) 1.8×10^6 V (c) 1.8×10^5 V (d) 1.8×10^4 V	
	(iv)	The radius of a soap bubble whose potential is 16V is doubled. The new potential of the bubble will be (a) 2V (b) 4V (c) 8V (d) 16V	
		SECTION - E	
20.	(i)	Show that the electric field at the surface or at a point just outside the surface of a charged conductor is given by $E = \frac{\sigma}{\epsilon_0}$ **n** where σ is the surface charge density and **n** is unit vector normal to the surface in the outward direction.	2
	(ii)	Two parallel plate capacitor X and Y have the same area of plates and same separation between them. X has air between the plates while Y contain a dielectric medium (K = 4)  (a) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4 μF. (b) Calculate the potential difference between the plates of X and Y. (c) What is the ratio of electrostatic energy stored in X and Y ?	3
		OR	
		A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Q is the charge stored in the capacitor. The battery is then disconnected, and the distance between the plates of the capacitor is increased by a small amount.	5

		What changes will occur in each of the following quantities? Will they increase, decrease or remain the same? Give an explanation in each case. (a) Capacitance (b) Charge (c) Potential difference (d) Electric field and (e) Energy stored in the capacitor	
21	(i)	A potential difference V is applied across a Conductor of length L. How is the drift velocity ' v_d' of charge carriers in the conductor affected in each case when (a) V is halved and (b) temperature is increased ?	2
	(ii)	Using Kirchhoff's law, find the value of unknown resistance R so that no current flows through 4 Ω resistance. Also find potential difference between points A and D. 	3
		OR	
	(i)	Two cells of emf E_1 and E_2 have their internal resistance r_1 and r_2 respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other.	3
	(ii)	Two identical cells of emf 1.5 V ,each joined in parallel, supply energy to an external circuit consisting of two resistances of 7 Ω joined in parallel. A very high resistance voltmeter reads the terminal voltage of the cell to be 1.4 V. Calculate the internal resistance of each cell.	2