विद्या सर्वार्थि साधिका

ANANDALAYA

PERIODIC TEST -1

Class: XII

Subject: Physics (042) MM : 40

Date : 19-07-2025 Time: 1 Hr. 30 min.

General Instructions:

1. There are 20 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. All the sections are compulsory.
3. Section A consists of twelve MCQs of 1 mark each, Section B consists of two questions of 2 marks each, Section C consists of two questions of 3 marks each, Section D consists of two long questions of 5 marks each and Section E consists two case study-based questions of 4 marks each.
4. There is no overall choice. However, internal choices have been provided in section D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

SECTION A

1. An electron experiences a force $(1.6 \times 10^{-16}\hat{\imath})$ N in an electric field $\vec{E}$. The electric field $\vec{E}$ is _____ . (1)

(A) $(1.0 \times 10^{3})\hat{\imath}\ N/C$ (B) $-(1.0 \times 10^{3})\hat{\imath}\ N/C$

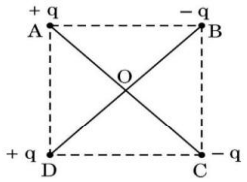
(C) $(1.0 \times 10^{-3})\hat{\imath}\ N/C$ (D) $-(1.0 \times 10^{-3})\hat{\imath}\ N/C$

2. In an experiment three microscopic latex spheres are, sprayed into a chamber and became charged with charges $+3e, +5e$ and $-3e$ respectively. All the three spheres came in contact simultaneously for a moment and got separated. Which one of the following are possible values for the final charge on the spheres? (1)

(A) $+5e, -4e, +5e$ (B) $+6e, +6e, -7e$

(C) $+4e, -4.5e, +5.5e$ (D) $+5e, -8e, +7e$

3. Two identical electric dipoles are placed along the diagonals of a square ABCD of side 2 m as shown in the figure. The net dipole moment $(\vec{p})$ is _____. (1)



(A) $-4q\hat{\imath}\ Cm$ (B) $4q\hat{\imath}\ Cm$

(B) $-2\sqrt{2}q\ \hat{\imath}\ Cm$ (D) $2\sqrt{2}q\ \hat{\imath}\ Cm$

4. Two conducting wires P and Q of same material have radii r and $\frac{r}{2}$. The current flowing through them is I and 2I, respectively. The ratio of current density of the conducting wire P with respect to Q is _____. (1)

(A) 1: 1 (B) 1: 2 (C) 1: 4 (D) 1: 8

5. The plates P_1 and P_2 of a 2μF capacitor are at potentials 25 V and -25 V respectively. The charge on plate P_1 will be _____. (1)

(A) 2 μC (B) 25 μC (C) 50 μC (D) 100 μC

6. A point P lies at a distance x from the mid-point of an electric dipole on its axis. The electric potential at point P is proportional to _____. (1)

(A) $\frac{1}{x^2}$ (B) $\frac{1}{x^3}$ (C) $\frac{1}{x}$ (D) $\frac{1}{\sqrt{x}}$

7. The equipotential surfaces in a uniform electric field acting along + Y direction are ___. (1)

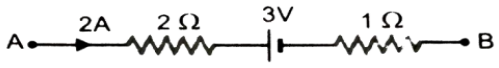
(A) planes parallel to the XY plane (C) planes parallel to the YZ plane

(B) concentric spherical surfaces (D) planes parallel to the XZ plane

8. A spherical shell of radius R has a charge +q units. The electric field due to the shell at a point inside is _____. (1)

(A) zero and varies as r^{-1} outside it
(B) zero and varies as r^{-2} outside it
(C) constant and varies as r^{-1} outside it
(D) constant and varies as r^{-2} outside it

9. Figure represents a part of closed circuit. What is the potential difference between the points A and B? (1)



(A) 3V (B) 6 V (C) 9 V (D) 12 V

10. The temperature (T) dependence of resistivity of material P and Q is represented by fig (i) and fig (ii) respectively. Identify the material P and Q. (1)

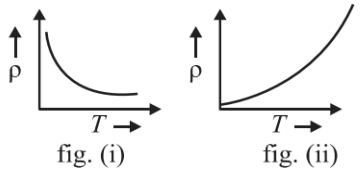


fig. (i) fig. (ii)

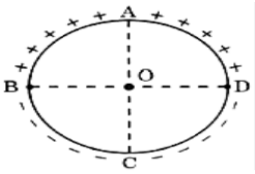
(A) material P is copper and material Q is germanium.
(B) material P is germanium and material Q is copper.
(C) material P is copper and material Q is nichrome.
(D) material P is germanium and material Q is nichrome.

For question numbers 11 and 12, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is NOT the correct explanation of A.
(C) A is true but R is false
(D) A is false and R is also false.

11. A: The mobility of electrons in a metal increases when temperature of a conductor is decreased at constant potential difference. (1)
R: The relaxation time of a free electron is inversely proportional to the temperature of the conductor.

12. A: Equal amount of positive and negative charges is distributed uniformly on two halves of a thin circular ring as shown in figure. The resultant electric field at the centre O of the ring is along OC. (1)



R: It is so because the net potential at O is not zero.

SECTION B

13. Draw the circuit diagram of a Wheatstone bridge. Obtain the condition when no current flows through the galvanometer in it. (2)

14. Consider two identical point charges located at points (0,0) and (a,0). (2)
(a) Is there a point on the line joining them at which the electric field is zero?
(b) Is there a point on the line joining them at which electric potential is zero?
Justify your answers for each case.

SECTION C

15. Three point charges $Q_1\,(-15\mu C)$, $Q_2\,(10\mu C)$ and $Q_3(16\mu C)$ are located at (0cm, 0cm), (0cm, 3cm) and (4cm, 3cm) respectively. Calculate potential energy of this system of charges. Given that $\varepsilon_0 = 8.85 \times 10^{-12}$ $m^{-3}\,kg^{-1}\,s^4\,A^2$. (3)

OR

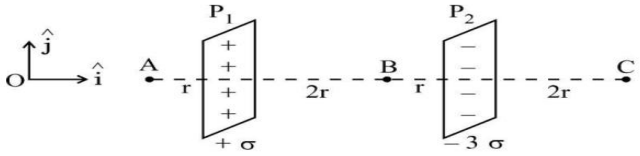
An electric dipole of length 10cm having charges ± 6×10^{-3}C, placed at 30^0 with respect to a uniform electric field experiences a torque of magnitude $6\sqrt{3}$ Nm. Calculate (i) magnitude of electric field and (ii) the potential energy of dipole.

16. Derive an expression for the electric field at a point on the equatorial plane of an electric dipole consisting of charges q and -q separated by a distance 2a. (3)

SECTION D

17. (a) (i) State Gauss's law in electrostatics. Using this law, derive an expression for the electric field due to a uniformly charged infinite plane sheet. (5)

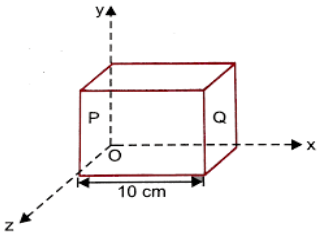
(ii) Two large plane sheets P_1 and P_2 having charge densities $+\sigma$ and -3σ respectively are arranged parallel to each other as shown in the figure. Find the net electric field ($\vec{E}$) at B.



OR

(b) (i) Define electric flux. Write its dimensions.

(ii) The electric field components in the given figure are $E_x = \beta x^2$, $E_y = E_z = 0$, in which $\beta = 800\ N/Cm^2$. Calculate the flux through the cube and the charge within the cube. Assume that $a = 0.1\ m$.



18. (a) (i) Explain how free electrons in a metal at constant temperature attain an average velocity under the action of an electric field. Hence obtain an expression for it. (5)

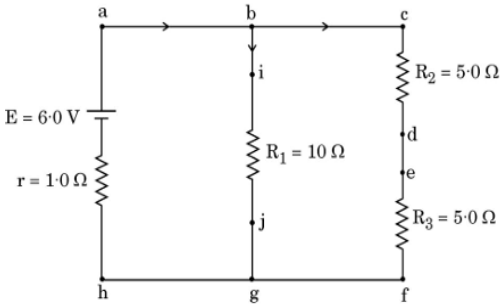
(ii) Consider two conducting wires A and B of the same diameter but different materials joined in series across a battery. The number density of electrons in A is 1.5 times that in B. Find the ratio of drift velocity of electrons in wire A to that in wire B.

OR

(b) (i) State Kirchhoff's laws for an electrical network.

(ii) Observe the circuit given and answer the following questions using Kirchhoff's laws.

1. Which points are at the same potential in the circuit?
2. What is the current through the arm bg?
3. Find the potential difference across the resistor R_3.



SECTION E

Questions 19 and 20 are Case Study Based questions and are compulsory. Each question carries 4 marks.

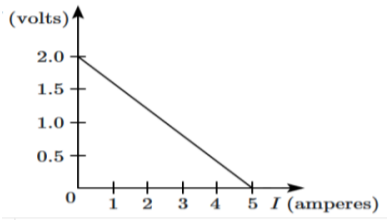
19. When the terminals of a cell are connected to a conductor of resistance R, an electric current flows through the circuit. The electrolyte of the cell also offers some resistance in the path of the current, like the conductor. This resistance offered by the electrolyte is called internal resistance of the cell (r). It depends upon the nature of the electrolyte, the area of the electrodes immersed in the electrolyte and the temperature. Due to internal resistance, a part of the energy supplied by the cell is wasted in the form of heat. When no current is drawn from the cell, the potential difference between the two electrodes in known as emf of the cell (ε). With a current drawn from the cell, the potential difference between the two electrodes is termed as terminal potential difference (V).

(i) Effect of temperature on internal resistance of a cell is ____. (1)

(A) directly proportional (B) inversely proportional

(C) no effect (D) none of these

(ii) For a cell, the graph between the potential difference V across the terminals of the cell and the current I drawn from the cell is shown in the figure. The emf and the internal resistance of the cell are _____ respectively. (1)



(A) 2 V, 0.5 Ω (B) >2 V, 0.5 Ω

(C) 2 V, 0.4 Ω (D) > 2 V, 0.4 Ω

(iii) (a) Two cells of emf 2 V and 3 V, and internal resistance 1 Ω and 2 Ω, respectively are connected in parallel. Calculate the effective emf and internal resistance of the combination cell. (2)

OR

(iii) (b) A cell of emf 'ε' and internal resistance 'r' is connected across a variable load resistor R. It is found that when R=4Ω, the current is 1 A and when R is increased to 9Ω, the current reduces to 0.5 A. Find the values of the emf ε and internal resistance r.

20. Dielectrics play an important role in design of capacitors. The molecules of a dielectric may be polar or non-polar. When a dielectric slab is placed in an external electric field, opposite charges appear on the two surfaces of the slab perpendicular to electric field. Due to this an electric field is established inside the dielectric. The capacitance of a capacitor is determined by the dielectric constant of the material that fills the space between the plates. Consequently, the energy storage capacity of a capacitor is also affected. Like resistors, capacitors can also be arranged in series and/or parallel.

(i) Which of the following is a polar molecule? (1)

(A) H_2 (B) O_2 (C) N_2 (D) HCl

(ii) Which of the following statements about dielectrics is correct? (1)

(A) A polar dielectric has a net dipole moment in absence of an external electric field which gets modified due to the induced dipoles.

(B) The net dipole moment of induced dipoles is along the direction of the applied electric field.

(C) Dielectrics contain free charges.

(D) The electric field produced due to induced surface charges inside a dielectric is along the external electric field.

(iii) When a dielectric slab is inserted between the plates of an isolated charged capacitor, the energy stored (U) and the electric field (E) inside the slab _____. (1)

(A) Increase (C) U decreases and E increases

(B) Decrease (D) U increases and E decreases.

(iv) (a) An air-filled capacitor with plate area A and plate separation d has capacitance C_0. A slab of dielectric constant K, area A and thickness $\left(\frac{d}{5}\right)$ is inserted between the plates. The capacitance of the capacitor will become _____. (1)

(A) $\left[\frac{4K}{5K+1}\right]C_0$ (B) $\left[\frac{K+5}{4K}\right]C_0$ (C) $\left[\frac{5K}{4K+1}\right]C_0$ (D) $\left[\frac{K+4}{5K}\right]C_0$

OR

(iv) (b) Two capacitors of capacitances $2C_0$ and $6C_0$ are first connected in series and then in parallel across the same battery. The ratio of energies stored in series combination to that in parallel is ____.

(A) $\frac{1}{4}$ (B) $\frac{1}{6}$ (C) $\frac{2}{15}$ (D) $\frac{3}{16}$