**SAIVEERA ACADEMY – WE CARE FOR FUTURE**
**PEELAMEDU , COIMBATORE – 8098850809**

**12** **PHYSICS** **Max.Marks : 70**

**FIRST MIDTERM MODEL TEST** **Duration :** 2hours

## PART – A

**Answer all the questions .Each question carries one mark .**

**Choose the correct answer** **15×1 = 15**

1.If the charge 50C is uniformly distributed in a volume 10 $m^3$, then volume charge density is
a) 500 $Cm^{-3}$ b)50 $Cm^{-3}$ c) 5 $Cm^{-3}$ d)5 $Cm^3$

2.When the distance increases , the potential due to negative charge will be
a) decreases b)remain same c)increases d)none of these

3.If electric field lines enter the closed surface , then the electric flux will be
a) Positive b) negative c)both a and b d)none of these

4.The electric field due to a dipole can be easily found by
a) Gauss law b) Biot-savart law c)Ampere's circuital law d)Coulomb's law

5. The total charge stored in the capacitor will be
a) Positive b) negative c)both a and b d)Zero

6.If the two charges placed in the vacuum are transferred to water , then the force between them will be
a) Increased by 85 times b) increases by 80 times
c)decreased by 85 times d)decreased by 80 times

7.If the acceleration experienced by the electron is $1.001 \times 10^{14}$ $ms^{-2}$ , then the electric field applied in the copper wire will be
a) 57 $NC^{-1}$ b)5700 $NC^{-1}$ c)5.7 $NC^{-1}$ d)570 $NC^{-1}$

8. In semiconductors when temperature increases, then the overall resistivity becomes
a) decreases b)remain same c)increases d)none of these

9.Mercury & silver are examples ………………….. Types of Thomson effect
a) Positive & negative b) negative & negative
c)negative & positive d)none of these

10. Pole strength depends on the
a) nature of materials of the magnet
b) area of cross- section
c) state of magnetization
d)All of these

11. If a magnet is cut into two equal halves perpendicular to the length,then pole strength will
a)reduced to half b)reduced to ¾ c)remains same d)none of these

12. K is called reduction factor of tangent Galvanometer, where
a) $K = \frac{4RB_H}{N\mu_0}$ b) $K = \frac{RB_H}{N\mu_0}$ c) $K = \frac{B_H}{N\mu_r}$ d) $K = \frac{2RB_H}{N\mu_0}$

13. The direction of magnetic field due to solenoid is given by
a) Maxwell's cork screw rule  b)Fleming left hand rule
c) Right hand thumb rule  d)Right hand thumb rule (mnemonic )

14. An electron moving perpendicular to a uniform magnetic field 0.500 T undergoes circular motion of radius 2.80 mm. What will be a speed of electron?
a)$2.195 \times 10^{-8}$ $ms^{-1}$ b) $3.195 \times 10^{8}$ $ms^{-1}$ c) $3.195 \times 10^{-8}$ $ms^{-1}$ d) $2.195 \times 10^{8}$ $ms^{-1}$

15. In order to increase the range of an ammeter n times, the value of shunt resistance to be connected in parallel is
a)$S = \frac{G}{n+1}$ b) $S = \frac{G}{n-1}$ c) $S = \frac{G}{1-n}$ d) $S = \frac{G}{-n-1}$

## PART – B

**Answer any 6 questions in which Q.No .22 is compulsory** **$6 \times 2 = 12$**

16. The electric field lines never intersect .Justify
17. Define 'capacitance'. Give its unit.
18. Write a short note on superposition principle.
19. Distinguish between drift velocity and mobility.
20. State the principle of potentiometer
21. State Coulomb's inverse law.
22. A bar magnet having a magnetic moment $\vec{M}$ is cut into four pieces i.e., first cut in two pieces along the axis of the magnet and each piece is further cut into two pieces. Compute the magnetic moment of each piece
23. Define magnetic dipole moment
24. Calculate the magnetic field at the center of a square loop which carries a current of 1.5 A, length of each loop is 50 cm.

## PART – C

**Answer any 6 questions in which Q.No .28 is compulsory** **$6 \times 3 = 18$**

25. Obtain the expression for capacitance and energy stored for a parallel plate capacitor
26. Define 'Electric field' and discuss its various aspects
27. Obtain an expression for potential energy due to a collection of three point charges which are separated by finite distances.
28. An electron and a proton are allowed to fall through the separation between the plates of a parallel plate capacitor of voltage 5 V and separation distance h = 1 mm Calculate the time of flight for both electron and proton (b) Suppose if a neutron is allowed to fall, what is the time of flight? (Take $m_p = 1.6 \times 10^{-27}$ kg, $m_e = 9.1 \times 10^{-31}$ kg and $g = 10$ m $s^{-2}$)
29. When two resistances connected in series and parallel their equivalent resistances are 15 Ω and 56/15 Ω respectively. Find the individual resistances.
30. State and explain Kirchhoff's rules
31.Define i) Joule's law of heating ii) Thomson effect iii) Peltier effect
32. Discuss the conversion of galvanometer into an ammeter

33. Discuss the working of cyclotron in detail

**PART – D**

**Answer the following questions .** **5 × 5 = 25**

34.a) Explain in detail the principle & working of a Van de Graaff generator with neat diagram,

**OR**

b)Discuss Earth's magnetic field in detail.

35.a) i. Derive an expression for the torque experienced by a dipole due to a uniform electric field.

ii. Derive the expression for resultant capacitance, when capacitors are connected in series

**OR**

b) Explain the principle and working of a moving coil galvanometer

36.a) Derive an expression for electrostatic potential due to an electric dipole with three cases

**OR**

b)Obtain a relation for the magnetic induction at a point along the axis of a circular coil carrying current.

37.a) i.Obtain the condition for bridge balance in Wheatstone's bridge

ii. State the applications of Seebeck effect

**OR**

b)Obtain the magnetic induction at a point on the equatorial line of a bar magnet.

38.a) Deduce the relation for the magnetic induction at a point due to an infinitely long straight conductor carrying current.

**OR**

b)Calculate the magnetic induction at a point on the axial line of a bar magnet

*" My best successes came on the heels of failures"*

*– Barbara Corcoran*

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# 12TH PHYSICS FIRST MIDTERM MODEL TEST KEY

## Part-A

**1.c 5 C m$^{-3}$**

Volume charge density = Q/V

= 50C / 10 m$^3$

= 5 Cm$^{-3}$

**2.c) increases**

For negative charge V = - q / 4 π $\varepsilon_0$ r

When distance increases v increases

**3.b)Negative**

**4.d) coulomb's law ( Because it has no symmetry )**

**5.d) Zero**

**6.d) decreased by 80 times**

Because relative permeabilty of water is 80

**7.d) 570 NC$^{-1}$**

$a = \frac{eE}{m}$

$E = \frac{ma}{e}$ = 9.1 × 10$^{-31}$ × 1.001 × 10$^{14}$ / 1.6 × 10$^{-19}$

= 570 NC$^{-1}$

**8.a) decreases**

Temperature decreases , n increases , τ decreases , but n is dominant so decreases

The resistivity of material is inversely proportional to number density (n) of electrons

**9.c) negative & positive**

**10.d)All of these**

**11.c) remains same**

**12.d)** $K = \frac{2RB_H}{N\mu_0}$

**13.d) right hand rule (mnemonic rule )**

**14.d)2.195 × 10$^8$ m/s**

$v = |q|\frac{rB}{m}$ = 1.6 × 10$^{-19}$ × 0.500 / 9.1 × 10$^{-31}$

= 2.195× 10$^8$ m/s

**15.b) S = G / n-1**

## Part – B

**16.**charge placed in intersection point ½

It move in two different direction **1**

physically imposible . ½

17. ratio of the magnitude of charge on either of the conductor plates to the potential difference **1**

**$C=\frac{Q}{V}$** ½

**Unit** ; coulomb per volt or farad (F) ½

18. The total force acting on a given charge is equal to the vector sum of forces exerted on it by all the other charges. **2m**

19.

| Drift velocity | Mobility |
|---|---|
| It is defined as velocity with which electrons get drifted towards positive terminal when electric field is applied **.. 1m** | It is defined as the magnitude of the drift velocity per unit electric field **....1m** |
| $v_d = a\tau$ .. ½ | $\mu = \frac{v_d}{E}$ .... ½ |
| **Unit** : m/s ... ½ | **Unit :** m$^2$V$^{-1}$s$^{-1}$.. ½ |

20. The emf of the cell is directly proportional to the balancing length of wire between two points **...... 1m**

**E α l ..... 1m**

21. The force of attraction or repulsion between two magnetic poles is directly

proportional to the product of their pole strengths and inversely proportional to the square of the distance between them.... **1m**

$\vec{F} \alpha \frac{q_{mA}q_{mB}}{r^2}\hat{r}$ ....... **1m**

22.Bar magnet cut into two pieces

$q_m$ reduced to ½

M reduced to ½

Length remain same

When cut again into two pieces

So M = M/2 / 2 = M/4

23. product of its pole strength and magnetic length. ..... ½

$P_m = 2 q_m l$l...... ½

**Unit :** $Am^2$ ...... ½

**Quantity :** Vector .... ½

24. $B = \frac{\mu_0}{4\pi a}[\sin\Theta_1 + \sin\Theta_2]$

$\Theta_1 = 45^0$ $\Theta_2 = 45^0$

a = l/2

square has four sides

so $B = 4 \times \frac{\mu_0}{4\pi a}[\sin\Theta_1 + \sin\Theta_2]$

$B = 3.4 \times 10^{-6}$ T

## PART - C

25. $E = \frac{\sigma}{\varepsilon_0}$

($\sigma$ = Q/A)

$E = \frac{Q}{A\varepsilon_0}$

Since the electric field is uniform, the electric potential between the plates having separation d is

$V = Ed = \frac{Qd}{A\varepsilon_0}$ ........1m

capacitance of the capacitor is given by

$C = \frac{Q}{V} = \frac{Q}{\frac{Qd}{A\varepsilon_0}} = \frac{\varepsilon_0 A}{d}$ ..1m

$C \alpha A$ $C \alpha \frac{1}{d}$

**dW = V dQ**

$V = \frac{Q}{C}$

The total work done to charge a capacitor is

$W = \int_0^Q \frac{Q}{C}\, dQ = \frac{Q^2}{2C}$ ........1m

26. $E = F/q_0 = \frac{kq}{r^2}$

**Unit ;** $NC^{-1}$

**Quantity : vector ...1m**

charge $q$ is positive -electric field points away from the source charge $q$ is negative - electric field points towards the source charge $q$. ½

Force experienced by test charge placed at point P is $Eq_0$ 1/2

$E = F/q_0 = \frac{kq}{r^2}$ is valid only for point charges ½

Two kinds of the electric field: uniform (constant) electric field and non-uniform electric field ½

27. $V = \frac{1}{4\pi\varepsilon_o}\frac{q_1}{r}$ ...... ½

$W = q_2 V$ ........ ½

This work done is stored as the electrostatic potential energy U

$U = q_2 V = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$

$U = \frac{1}{4\pi\varepsilon_o}\left(\frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$

iv) Total electrostatic potential energy for the system of charges $q_1$, $q_2$, $q_3$ is

$U = \frac{1}{4\pi\varepsilon_o}\left(\frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}} + \frac{q_1 q_2}{r_{12}}\right)$ ..... ½

Diagram ...... ½

Explanation ...... 1

28. $t_e^2 = 2h\, m_e / Ee$

$= 1.5$ ns

$t_p = 63$ns

29. $R_s = R_1 + R_2 = 15$ ….. **(1)**

$R_P = R_1 R_2 / R_1 + R_2 = 56/15$ …. **(2)**

Solving 1 & 2

$R_1 R_2 = 56$

$R_2 = 56/R_1$

Sub above in 1

$R_1^2 + 56 = 15 R_1$

**$R_1$ = 8 OR 7 Ω**

**$R_2$ = 7 or 8Ω**

30. sum of the currents at any junction of a circuit is zero …… **1**

conservation of electric charge. …. ½

in a closed circuit the algebraic sum of the products of the current and resistance of each part of the circuit is equal to the total emf included in the circuit. **….1**

conservation of energy…… ½

31.i) **H = I²Rt**

ii) Just as current produces thermal energy, thermal energy may also be suitably used to produce an electromotive force.

iii) electric current is passed through a circuit of a thermocouple, heat is evolved at one junction and absorbed at the other junction

32.By connecting low resistance in parallel with galvanometer **½ m**

Diagram **½ m**

$V_{galvanometer} = V_{shunt}$

$I_g R_g = (I - I_g) S$

$S = \frac{I_g}{(I - I_G)} R_g$

$I_g = \frac{S}{S + R_g} I$ …….. *1m*

$I_g \propto I$

**Since, the deflection in the galvanometer is proportional to the current passing through it.**

**$\Theta = \frac{1}{G} I_g$ θ α $I_g$ θ α I …… 1m**

33. Ion ejected from source S is positively charged.

As soon as ion is ejected, it is accelerated towards a Dee (say, Dee – 1) which has negative potential at that time.

Since the magnetic field is normal to the plane of the Dees, the ion undergoes circular path. After one semi-circular path in Dee-1, the ion reaches the gap between Dees.

the increase in velocity increases the radius of circular path. This process continues and hence the particle undergoes spiral path of increasing radius. Once it reaches near the edge, it is taken out with the help of deflector plate and allowed to hit the target T

## Part – D

34.a) .Electrostatic induction and action at points **1m**

Working **3m**

Diagram **1m**

b) **The three elements of of the Earth's magnetic field are**

(a) magnetic declination (D)

(b) magnetic dip or inclination (I)

(c) the horizontal component of the Earth's magnetic field ($B_H$) **……. 1m**

Definition of elements **….. 3m**

Diagram **1m**

35.a i) τ = one of the forces × perpendicular distances between the forces…. **1/2 m**

= F×2dsinΘ

=qE× 2dsinΘ

= pEsinΘ ( p=2qd) ……. **½ m**

In vector notation $\vec{\tau} = \vec{p} \times \vec{E}$….. **½ m**

**Cases …….1m**

**a)When Θ = 0 τ = 0**

The dipole moment of dipole **parallel** to electric field – No torque

**b)When Θ = 90 τ = pE**

Dipole moment **perpendicular** to electric filed , torque is maximum

**c) Θ = 180⁰ τ = 0**

Dipole moment **antiparrallel** to electric filed , torque is zero

Diagram ….. **½ m**

ii)diagram **½m**

**C = Q/V ….. ½ m**

**Q – same V – different …. ½ m**

**$1/C_s = 1/C_1 + 1/C_2 + 1/C_3$ ….. ½ m**

**b)** When a current carrying loop is placed in a uniform magnetic field it experiences a torque …1m

Coil PQRS whose length be *l* and breadth b. PQ = RS = *l* and QR = SP = b.

The horse-shoe magnet has hemi - spherical magnetic poles which produces a radial magnetic field.

Due to this radial field, the sides QR and SP are always parallel to to the B-field (magnetic field) and experience no force.

The sides PQ and RS are always parallel to the B-field and experience force and due to this, torque is produced.

**Total explanation of working…… 2m**

For single turn, the deflection couple as

**τ = bF = bBI*l*= (*l*b) BI = ABI**

**A = *l*b**

For coil with N turns, we get

**τ = NABI ……….. ( ½ m)**

**τ = *K* θ …………( ½ m)**

*K* is the restoring couple per unit twist or torsional constant of the spring

At equilibrium, the deflection couple is equal to the restoring couple

$NABI = K\theta$

$I = K\frac{\theta}{NAB}$

I = G θ …….. **1m**

$G = \frac{K}{NAB}$ galvanometer constant or current reduction factor of the galvanometer.

36.a i) Diagram ½ m

Cases **1m**

$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_1}$ …….. ½

$V_2 = \frac{1}{4\pi\varepsilon_0}\frac{-q}{r_1}$ …….. ½

**$V = V_1 + V_2$ …….. ½**

**finding $r_1$ & $r_2$ ….. 1 ½**

$V = \frac{P\cos\theta}{4\pi\varepsilon_0 r^2}$ ……. **1m**

**b)** $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl}\times\hat{r}}{r^2}$

**PC = PD = r =** $\sqrt{R^2 + Z^2}$

Then the net magnetic field at point P is

$\vec{B} = \int \vec{dB} = \int dB\cos\theta\hat{k}$

$= \frac{\mu_0}{4\pi} I \int \frac{dB}{r^2}\cos\theta\hat{k}$

By triangle POD

$\cos\theta = \frac{R}{\sqrt{R^2+Z^2}}$

integrating line element from 0 to 2πR, we get

$\vec{B} = \frac{\mu_0}{2\pi} I \frac{R^2}{(R^2+z^2)^{\frac{3}{2}}} \hat{k}$

**Diagram**

37.a Diagram ½

Explanation …. ½ m

$I_G = 0$ … ½

**Kirchhoff's current rule to junction B**

$I_1 - I_G - I_3 = 0$

Applying **Kirchhoff's current rule to junction D,**

$I_2 - I_G - I_4 = 0$

Applying **Kirchhoff's voltage rule to loop ABDA,**

$I_1P + I_GG - I_2R = 0$

Applying Kirchhoff's voltage rule to loop ABCDA,

$I_1P + I_3Q - I_2R - I_4S = 0$

$\frac{P}{Q} = \frac{R}{S}$ …… 2

**ii)** thermoelectric generators (Seebeck generators). ½

This effect is utilized in automobiles as automotive thermoelectric generators for increasing fuel efficiency. ½

Seebeck effect is used in thermocouples and thermopiles to measure the temperature difference between the two objects. ½

b) $\vec{F_N} = -F_N\cos\theta\,\hat{i} - F_N\sin\theta\,\hat{j}$

$F_N = \frac{\mu_0}{4\pi}\frac{q_m}{(r')^2}$

$\vec{F_S} = -F_S\cos\theta\,\hat{i} - F_S\sin\theta\,\hat{j}$

$F_S = \frac{\mu_0}{4\pi}\frac{q_m}{(r')^2}$

$\vec{F} = \vec{F_N} + \vec{F_S}$

$\vec{B} = -(F_N + F_S)\cos\theta\,\hat{i}$

$F_N = F_S$

$\vec{B} = -2\frac{\mu_0}{4\pi}\frac{q_m}{(r')^2}\cos\theta\,\hat{i}$

$r'^2 = r^2 + l^2$

**In right angle triangle**

$\cos\theta = \frac{l}{(r^2+l^2)^{\frac{1}{2}}}$

$\vec{B} = -\frac{\mu_0}{4\pi}\frac{P_m}{r^3}\hat{i}$

Diagram

38.a) $\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\,\vec{dl}}{r^2}\sin\theta$

$l = \frac{a}{\tan\theta}$ $r = a\,\mathrm{cosec}\,\theta$

$dl = a\,\mathrm{cosec}^2\theta\,d\theta$

$\vec{dB} = \frac{\mu_0}{4\pi}\frac{a\,\mathrm{cosec}^2\theta\,d\theta}{(a\,\mathrm{cosec}\theta)^2}\sin\theta\,\hat{n}$

$\vec{B} = \frac{\mu_0}{4\pi a}\int_{\varphi_1}^{\varphi_2}\sin\theta\,d\theta\,\hat{n}$

$= \frac{\mu_0}{4\pi a}(\cos\varphi_1 - \cos\varphi_2)\,\hat{n}$

$\varphi_1 = 0$ $\varphi_2 = \pi$

The magnetic field is

$\vec{B} = \frac{\mu_0}{2\pi a}\hat{n}$

b) $\vec{F_N} = \frac{\mu_0}{4\pi}\frac{q_m}{(r-l)^2}\hat{i}$

$\vec{F_S} = -\frac{\mu_0}{4\pi}\frac{q_m}{(r+l)^2}\hat{i}$

$\vec{F} = \vec{F_N} + \vec{F_S}$

$\vec{F} = \vec{B}$

$\vec{B} = \frac{\mu_0}{4\pi}\frac{q_m}{(r-l)^2}\hat{i} - \frac{\mu_0}{4\pi}\frac{q_m}{(r+l)^2}\hat{i}$

$= \frac{\mu_0}{4\pi}2r\left(\frac{q_m\,2l}{(r^2-l^2)^2}\right)\hat{i}$

$= \frac{\mu_0}{4\pi}\frac{2r\,P_m}{(r^2-l^2)^2}\hat{i}$ $P_m = q_m \times 2l$

$r^2 >> l^2$ $l^2$ **can ne neglected**

$\vec{B} = \frac{\mu_0}{4\pi}\frac{2P_m}{r^3}\hat{i}$

$= \frac{\mu_0}{4\pi}\frac{2}{r^3}\vec{P_m}$

**Direction of magnetic field along the direction of magnetic moment**