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# ST. LAWRENCE HIGH SCHOOL

**Model Answer**

**Pre-Test Exam – 2019**

**Sub: Physics** **Class: XII** **F. M. : 70**

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## PART-B

### Section - I

**1. MCQ Questions each of 1 mark.(Answer all the question)** **1x14=14**

i) Five point charges each of amount +q is placed on five vertices of a regular pentagon. What will be electric field intensity at the centre of the pentagon if only one charge is removed? ( distance of the centre from a vertex is '$x$')

a) $\frac{1}{\pi\epsilon_0}\frac{q}{x^2}$ b) zero **c)** $\frac{1}{4\pi\epsilon_0}\frac{q}{x^2}$ d) *None of* these

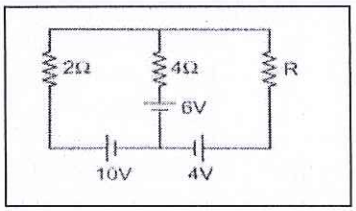
ii) A point charge q is placed at the centre of the line joining two equal positive free charges +Q and +Q. The system of three charges will be in equilibrium if q is equal to

a) $+\frac{Q}{4}$ **b)** $-\frac{Q}{4}$ c) $+\frac{Q}{2}$ d) $-\frac{Q}{2}$

iii) A conducting sphere of radius R is charged to a potential of V volts. Then the electric field at a distance 'r' ( r > R) from the centre of the sphere will be -

a) $\frac{V}{r}$ b) $\frac{R^2V}{r^3}$ **c)** $\frac{RV}{r^2}$ d) $\frac{rV}{R^2}$

iv) For what value of R in the circuit as shown, the current passing through 4 ohm resistance will be zero?

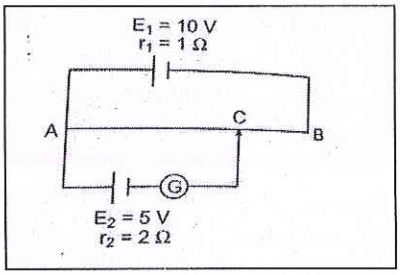



a) **1Ω** b) 2Ω c) 3Ω d) 4Ω

v) Two wires of same dimension but resistivities $\rho_1$ *and* $\rho_2$ are connected in series. The equivalent resistivity of the combination is -

a) $\rho_1 + \rho_2$ **b)** $\frac{1}{2}(\rho_1 + \rho_2)$ c) $\sqrt{\rho_1\rho_2}$ d) $2(\rho_1 + \rho_2)$

vi) The potentiometer wire of length 100cm and resistance 9 ohm is joined to a driving cell of emf 10 V and internal resistance 1 ohm. Another cell of emf 5 V and internal resistance 2 ohm is connected as shown. The galvanometer will show no deflection when the length AC is -




a) $50cm$ **b)** $\mathbf{55.55cm}$ c) $52.67cm$ d) 54.33cm

vii) The magnetic field at the centre of an equilateral triangular loop of side $2l$ and carrying a current $i$ is -

a) $\frac{9\mu_0 i}{4\pi l}$ b) $\frac{3\sqrt{3}\mu_0 i}{4\pi l}$ c) $\frac{2\sqrt{3}\mu_0 i}{\pi l}$ d) $\frac{3\mu_0 i}{4\pi l}$

viii) A non-conducting circular disc of radius R is rotating about an axis passing through its centre perpendicularly to its plane with an angular velocity . If +q amount of charge is uniformly distributed all over its surface, then the magnetic moment of the disc will be -

a) $\frac{1}{4}q\omega R^2$ b) $\frac{1}{2}q\omega R$ c) $q\omega R$ **d)** $\frac{1}{2}q\omega R^2$

ix) A particle of charge +q and mass 'm' starts moving from the origin with a velocity of $\vec{v} = v_0\hat{j}$. An electric field $\vec{E} = E\hat{\imath}$ *and magnetic field* $\vec{B} = B\hat{\imath}$ are present in that region. Then, the speed of the particle will become $2v_0$ after a time -

a) $t = \frac{2mv_0}{qE}$ b) $t = \frac{2Bq}{mv_0}$ c) $t = \frac{\sqrt{3}Bq}{mv_0}$ **d)** $t = \frac{\sqrt{3}mv_0}{qE}$

x) A magnetic needle is kept in a non uniform magnetic field. It experiences -

a) **A force and a torque** b) a force but not a torque

c) a torque but not a force d) neither a force nor a torque

Now, at the highest point $\frac{mv_h^2}{l} + \frac{kq^2}{l^2} = T_h + mg$

But, $T_h \geq 0 \quad i.e. v_h^2 \geq \left(mg - \frac{kq^2}{l^2}\right)\frac{l}{m}$ ..... (1)

If $v_l$ *be the required velocity at the lowest point, then*

$\frac{1}{2}mv_l^2 = \frac{1}{2}mv_h^2 + mg\,2l$

Tyhis $v = \sqrt{5gl - \frac{kq^2}{ml}}$ ( putting the value of $v_h^2$ from eqn (1))

3. A potentiometer consists of 10 identical wires each of length 1m is connected to a driving cell that provides a steady current. The balance length for an unknown e.m.f in this potentiometer is found to be 8.4m. If the length of the potentiometer is now increased by 1m, what will be new balanced length?

**Ans:** let resistance of 1m wire is r.

So, unknown e.m.f = $8.4 \times r \times \frac{E}{10r} = 0.84E$ where E is the emf of driving cell.

If 1m wire is added, then let 'l' m be the new null length.

Then, $\frac{E}{11r} \times lr = 0.84E$

Or, $l = 0.84 \times 11 = 9.24m$

4. Determine the magnetic moment of a moving charge of mass 'm', charge +q and angular velocity 'w' in a circular orbit of radius 'r'.

**Ans:** Refer to standard text book.

**Or**

A 20V a.c. is supplied to a circuit consisting a resistance and an inductive coil of zero internal resistance. If the voltage across the resistance is 12V, calculate the voltage across the inductor.

**Ans:** $If, V_L = p.d.across\ inductor\ and\ V_R = p.d.across\ resistor$, then $V_L^2 + V_R^2 = 20^2$

This gives, $V_L = 16\ volt$ .

5. What do you mean by Eddy current? Which type of magnetic material has negative magnetic susceptibility? 1+1

**Ans:** Refer to standard text book.

**Or**

Calculate the self inductance of a circular coil of radius 'r' and total number of turns 'N' when it is connected to a potential 'V'. The resistance per unit length of the wire of the coil is '$\rho$'.

**Ans:** The magnetic self flux = $B \times \pi r^2 N = \frac{\mu_0 NI}{2r} \times \pi r^2 N$

As, $B = \frac{\mu_0 NI}{2r}$ where $I = \frac{V}{2\pi rN\rho}$ (not needed for the calculation) .

So, self inductance L = $\frac{flux}{I} = \frac{\pi\mu_0 N^2 r}{2}$

## Group – C

**Answer the following questions. (Alternatives are to be noted)** **3x9=27**

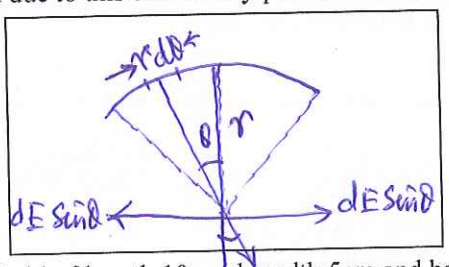
6. Calculate the electric field intensity at the centre of an arc element that subtend $\phi$ angle at its centre of curvature when the uniform linear charge density is '$\lambda$' and the radius of curvature is 'r'.

**Ans:** Consider an elementary portion as shown in the figure. The field due to this elementary portion will be $dE = \frac{k\,dq}{r^2}$.

Where $dq = \lambda.r.d\theta$

But only the $cos$ component will survive. So the net field will be –

$$E = \int_{\frac{-\emptyset}{2}}^{\frac{\emptyset}{2}} dE\ cos\theta = \int_{\frac{-\emptyset}{2}}^{\frac{\emptyset}{2}} \frac{k\,\lambda.r.cos\theta.d\theta}{r^2} = \frac{2k\lambda}{r}\sin\left(\frac{\emptyset}{2}\right)$$




**Or**

State Gauss's theorem. A 16μC charge is placed at one vertex of a cuboid of length 10cm, breadth 5cm and height 2.5cm. Calculate the net outward flux through surfaces of the cuboid. 1+2

**Ans:** If 8 such cuboids are arranged properly, then the vertex (where the charge is placed) will be the centre of the big cuboid (formed by assembling 8 small cuboids) .

Then, flux through one cuboid will be $\frac{1}{8}th$ of the total flux through bigger cuboid.

But, total flux = $\frac{q_{enc}}{\epsilon_0}$.

Hence flux through one small cuboid(i.e. flux through three surfaces of small cuboid)

$= \frac{1}{8}.\frac{q_{enc}}{\epsilon_0} = \frac{1}{8}.16.10^{-6}.36\pi.10^9\ N - m^2/C$

$= 72\pi \times 10^3\ N - m^2/C$

## Group – D

**Answer the following questions. (Alternatives are to be noted)**

15. What do you mean by electric dipole moment? Define polarization density vector. Determine the capacitance of a parallel plate capacitor of plate area 'A', plate separation 'd' , surface charge density $\sigma$ and filled by a dielectric medium of dielectric constant 'k' 1+1+3

**Ans:** Refer to standard text book

**Or**

Find out the electric field intensity at an equatorial point at a distance 'r' from the midpoint of a dipole of dipole moment $\vec{p}$ and dipole length '$2l$'. Prove that $k = 1 + \chi$. (symbols have their own significance). 2+3

**Ans:** Refer to standard text book

16. Prove that the average value of a.c. power over a complete cycle is $P_{av} = V_{rms} \, . I_{rms} \, . Cos\phi$. Where $\phi$ is phase difference between voltage and current.

An ac voltage $V = 100\, Sin(100t)$ volt is applied to a series L-R circuit. What will be the average power used up by the circuit? ( $L = \frac{1}{50}\, H, R = 2\sqrt{6}\, \Omega$). 3+2

**Ans:** The phase difference between voltage and current in this circuit is $\emptyset = \tan^{-1}\frac{wL}{R} = \tan^{-1}\frac{100}{50\times 2\sqrt{6}} = \tan^{-1}\frac{1}{\sqrt{6}}$

Hence the power factor = $cos\emptyset = \sqrt{\frac{6}{7}}$

$$P_{av} = \frac{100}{\sqrt{2}} \cdot \frac{100}{\sqrt{2}\sqrt{R^2 + w^2L^2}} \, . cos\emptyset = \frac{10000\sqrt{6}}{2\sqrt{28\times 7}} = 874.82\ watt$$

**Or**

State Biot – Savart law. Determine the magnetic field for a circular loop of radius 'R' carrying a current 'I', at an axial distance 'x' from the centre of the coil. 2+3

**Ans:** Refer to standard text book

17. Derive the expression for the radius of circular path of a point charge '+q' and of mass 'm' entering perpendicularly to a uniform magnetic field of intensity 'B', with a velocity 'v'. Hence find out the expression for angular frequency. 3+2

**Ans:** Refer to standard text book

**Or**

Calculate the electric field intensity at a distance 'r' from the centre of a solid spherical charged conductor of total charge +Q and of radius R ( for $r < R, r = R$ *and* $r > R$). Hence plot the electric field versus distance (from the centre) curve and potential versus distance (from the centre) curve in two different figure for this solid conducting charged spherical shell. 3+1+1

**Ans:** Refer to standard text book