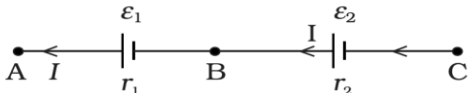
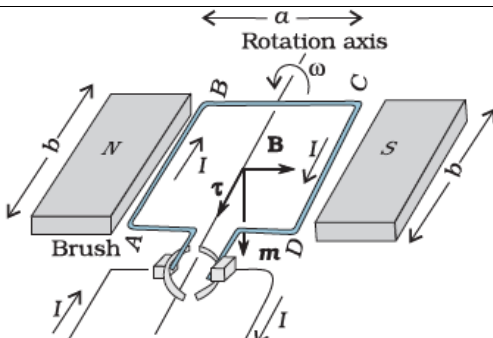


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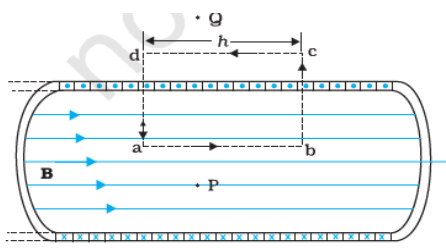
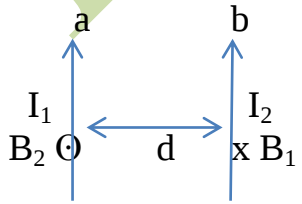
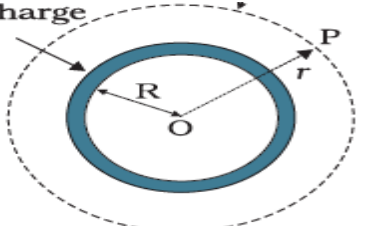
PHYSICS

Answer Any 5 from 1 to 7			Answer any 6 questions from 15 to 21										
1	Quantisation of charge	1	15	a)Statement of Coulomb's law	1								
2	Zero	1		b) $F=9 \times 10^9 \times \frac{q_1 q_2}{r^2}$	2								
3	Infinity	1		$= 9 \times 10^9 \times \frac{2 \times 10^{-6} \times 3 \times 10^{-6}}{(30 \times 10^{-2})^2} = 0.6 \text{N}$									
4	(iii)Electric field between the plates	1											
5	Remains the same	1											
6	$\Omega \text{ m}$	1											
7	a)Circular	1											
Answer any 5 questions from 8 to 14													
8	1. Field lines start from positive charges and end at negative charges. 2. In a charge-free region, electric field lines can be taken to be continuous curves without any breaks 3. Two field lines can never cross each other 4. Electrostatic field lines do not form any closed loops	2	16	a)Energy density is the energy stored per unit volume of space b) Energy $U= \frac{1}{2} CV^2$ $\frac{1}{2} \frac{\epsilon_0 A}{d} \times E^2 d^2$ volume = Ad Energy density = $\frac{\text{Energy}}{\text{volume}} = \frac{1}{2} \frac{\epsilon_0 A}{d} \frac{E^2 d^2}{Ad}$ $U_d = \frac{1}{2} \epsilon_0 E^2$	1 2								
9	a) $\phi_E = \frac{q}{\epsilon_0} = \frac{8.85 \times 10^{-6}}{8.85 \times 10^{-12}} = 10^6 \text{ Nm}^2/\text{C}$ b) $10^6 \text{ Nm}^2/\text{C}$ (No change)	1 1											
10	1. There is no potential difference between any two points on the surface 2. no work is required to move any charge on the surface from one point to another 3. The electric field must be normal to the equipotential surface at every point. (Any 2)	2	17	 $V_{AB} = V_B - V_A = \epsilon_1 - Ir_1 \dots \dots \dots (1)$ $V_{BC} = V_C - V_B = \epsilon_2 - Ir_2 \dots \dots \dots (2)$ Effective p.d, $V_{AC} = V_C - V_A = V_{AB} + V_{BC}$ $= \epsilon_1 - Ir_1 + \epsilon_2 - Ir_2$ $= \epsilon_1 + \epsilon_2 - I(r_1 + r_2) \dots (3)$ Equivalent p.d $V = V_{AC} = \epsilon_{eq} - Ir_{eq} \dots (4)$ From (3) and (4) $\epsilon_{eq} = \epsilon_1 + \epsilon_2$ $r_{eq} = r_1 + r_2$	3								
11	Statement of Ohm's law Limitations (Any one) 1) V ceases to be proportional to I 2) The relation between V and I depends on the sign of V.	1 1											
12	<table><tr><td>Polar</td><td>Non polar</td></tr><tr><td>Positive and negative charge centre does not coincide</td><td>Positive and negative charge centre coincide</td></tr><tr><td>Have permanenet dipole moment</td><td>Zero dipole moment</td></tr><tr><td>Eg: H₂O, HCl</td><td>Eg: O₂, H₂</td></tr></table> Any 1 difference	Polar	Non polar	Positive and negative charge centre does not coincide	Positive and negative charge centre coincide	Have permanenet dipole moment	Zero dipole moment	Eg: H ₂ O, HCl	Eg: O ₂ , H ₂	1 1	18	a)Drift speed is the average speed with which electrons are drifted in the presence of electric field through a conductor b) $I = neAV_d \rightarrow V_d = \frac{I}{neA}$ $= \frac{10}{10^{30} \times 1.6 \times 10^{-19} \times 2 \times 10^{-4}}$ $= 0.3125 \times 10^{-6} \text{ A}$ $= 0.3125 \mu \text{A}$	1 2
Polar	Non polar												
Positive and negative charge centre does not coincide	Positive and negative charge centre coincide												
Have permanenet dipole moment	Zero dipole moment												
Eg: H ₂ O, HCl	Eg: O ₂ , H ₂												
13	Magnitude of the drift velocity per unit electric field $\mu = \frac{Iv_d I}{E}$ $[\mu] = [\text{M}^{-1} \text{T}^2 \text{A}]$	1 1	19	 Let a rectangular loop ABCD is placed in a uniform magnetic field B making an angle θ with normal to the loop	3								
14	$I_g = 3 \times 10^{-3} \text{ A}$; $R_G = 12 \Omega$; $V = 18 \text{ V}$ Resistance to be connected in series to galvanometer, $R = \frac{V}{I_g} - R_G = \frac{18}{3 \times 10^{-3}} - 12$ $= 5988 \Omega$												

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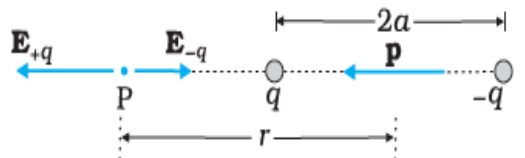
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	The forces on the two arms AD and BC are equal and opposite and along the axis of the loop cancel out. The forces on arms AB and CD are F_1 and F_2 are equal and opposite, with magnitude $F_1=F_2 = IbB$ but not collinear produces torque given by Torque $\tau= F_1 \times \frac{a}{2} \sin \theta + F_2 \times \frac{a}{2} \sin \theta$ $= I b B \frac{a}{2} \sin \theta + I b B \frac{a}{2} \sin \theta$ $= I b B a \sin \theta$ $= I A B \sin \theta$ $\tau = m B \sin \theta$				
20	a)Statement of Ampere's circuital law b) The field between two neighbouring turns vanishes since magnetic field due to one circular loop is opposite to that due to nearby loop. Also the field at the exterior mid-point Q is very weak and for a long solenoid the field approaches zero. 	1 2			
	For the rectangular Amperian loop abcd, along cd the field is zero and along bc and ad, component of field is zero. Let the field along ab be B and thus the relevant length of the Amperian loop is, $L = h$. Let n be the number of turns per unit length, then the total number of turns is nh. The enclosed current is, $I_e = I n h$, where I is the current in the solenoid. Now, Ampere circuital law $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_e \Rightarrow B L = \mu_0 I_e$ $B h = \mu_0 I n h$ $B = \mu_0 n I$		$B_1 = \frac{\mu_0 I_1}{2\pi d}$ away from observer. Now conductor 'b' will experience a force in a segment L is, $F_{ba} = I_2 l_2 B_1 = I_2 l_2 \times \frac{\mu_0 I_1}{2\pi d} = \frac{\mu_0 I_1 I_2}{2\pi d} L$ Force per unit length $f_{ba} = \frac{\mu_0 I_1 I_2}{2\pi d} \dots (1) \text{ towards left}$ The conductor 'b' produces a magnetic field $B_2 = \frac{\mu_0 I_2}{2\pi d} \text{ towards the observer.}$ Now conductor 'a' will experience a force in a segment L is, $F_{ab} = I_1 l_1 B_2 = I_1 l_1 \times \frac{\mu_0 I_2}{2\pi d} = \frac{\mu_0 I_1 I_2}{2\pi d} L$ Force per unit length $f_{ab} = \frac{\mu_0 I_1 I_2}{2\pi d} \dots (2) \text{ towards left}$ From (1) and (2) it is clear that magnitudes... $f_{ba} = f_{ab} = \frac{\mu_0 I_1 I_2}{2\pi d}$		
			Answer any 3 questions from 22 to 25		
		22	a) Electric field intensity is the electric force per unit charge. $E = F/q$ b) N/C or V/m c) Intensity $E = \frac{F}{q}$ For a point charge Q, the force acting on a charge q at a distance r is, $F = \frac{1}{4\pi\epsilon_0} \frac{Qq}{r^2}$ Now intensity $E = \frac{F}{q} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2}$	1 1 2	
21	 The conductor 'a' produces a magnetic field				
		23	a)Statement of Gauss' law b) Surface charge density σ 	1	

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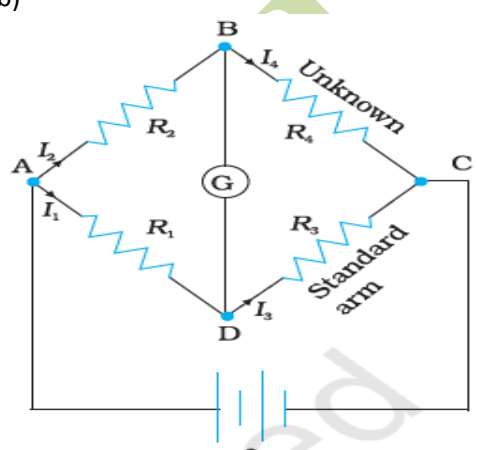
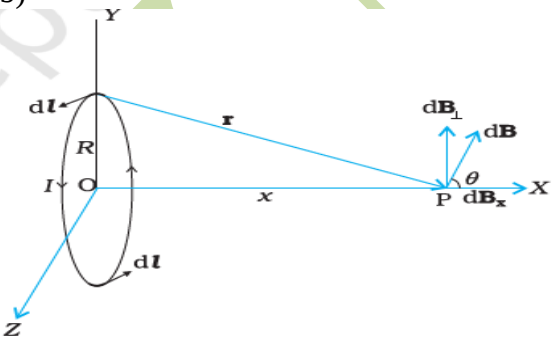
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Let σ be the uniform surface charge density of a thin spherical shell of radius R. <u>(i) Field outside the shell</u> Let P be appoint at distance r ($r > R$). The gaussian surface is a sphere with O as the centre. Electric field E and area ds are in the same direction. Then electric flux through the small area ds is, $d\phi = \vec{E} \cdot d\vec{s}$ Total electric flux through the Gaussian sphere, $\phi = \int_s \vec{E} \cdot d\vec{s} = \int_s E ds \cos 0 = E \int_s ds$ But $\int_s ds = 4\pi r^2$ $\phi = E \times 4\pi r^2 \dots\dots (1)$ Gauss law $\rightarrow \phi_0 = \frac{q}{\epsilon_0} = \frac{\sigma 4\pi R^2}{\epsilon_0} \dots\dots (2)$ (1) & (2) gives $E \times 4\pi r^2 = \frac{q}{\epsilon_0}$ ie, $E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$ or $E = \frac{\sigma}{\epsilon_0} \frac{R^2}{r^2} \dots\dots (3)$ <u>(i) Field on the surface $r = R$</u> (3) $\rightarrow E = \frac{1}{4\pi\epsilon_0} \frac{q}{R^2}$ or $E = \frac{\sigma}{\epsilon_0}$ <u>(i) Field inside the shell ($r < R$)</u> The gaussian surface is a sphere with O as the centre and $r < R$. No charge inside the Gaussian surface. $\phi = E \times 4\pi r^2 = \frac{1}{\epsilon_0} \times 0 = 0 \rightarrow E = 0$	3	a) Magnetic Lorentz force or Lorentz force b) We have $F_m = q v B \sin \theta$ When charge is at rest, $v=0$ Then $F_m = 0$ c) Consider a rod of a uniform cross-sectional area A and length l. Then total number of charge is nAl and total charge is $q = nAle$. When this conductor is placed in a magnetic field B, it experience a force given by, $F = q v B \sin \theta$ $= nAle v_d \sin \theta \dots\dots (1)$ But we have $I = neAv_d$ or $v_d = \frac{I}{neA}$ (1) $\rightarrow F = nAle \frac{I}{neA} \sin \theta$ $F = I l B \sin \theta$ Or $\vec{F} = I (\vec{l} \times \vec{B})$	1 1 2
24 a) medium between the plates, area of each plate, distance between the plates. (1 ½) b) $U = \frac{1}{2} CV^2 = \frac{1}{2} \frac{\epsilon_0 A}{d} V^2$ (2 ½) $U = \frac{1}{2} \frac{\epsilon_0 A}{d} V^2 = \frac{8.85 \times 10^{-12} \times 0.2}{2 \times 0.01} \times 10^6$ $= 8.85 \times 10^{-5} \text{ J}$ $d' = d - \frac{10}{100} \times d = 0.01 - 0.1 \times 0.01 = 0.009 \text{ m}$ $U' = \frac{1}{2} \frac{\epsilon_0 A}{d'} V^2 = \frac{8.85 \times 10^{-12} \times 0.2}{2 \times 0.009} \times 10^6$ $= 9.833 \times 10^{-5} \text{ J}$ Change in $U = U' - U = 0.983 \times 10^{-5} \text{ J}$		Answer any 3 questions from 26 to 29 26 a) Electric dipole b) For stable equilibrium, angle between $\vec{p}$ and $\vec{E}$ is 0°. For unstable equilibrium, angle between $\vec{p}$ and $\vec{E}$ is 180°. c) consider an electric dipole of magnitude of charge q, separation $2a$ and dipole moment p. Let the point P be at a distance r from the centre of dipole on its axial line.  Now electric field due to $-q$ charge and $+q$ at P are , $E_{-q} = \frac{1}{4\pi\epsilon_0} \frac{q}{(r+a)^2} \dots\dots (1) \text{ towards right}$ $E_{+q} = \frac{1}{4\pi\epsilon_0} \frac{q}{(r-a)^2} \dots\dots (1) \text{ towards left}$ Resultant intensity at P is $E = E_{+q} - E_{-q}$	1 1 3

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	$= \frac{1}{4\pi\epsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\epsilon_0} \frac{q}{(r+a)^2}$ $= \frac{q}{4\pi\epsilon_0} \left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2} \right]$ $= \frac{q}{4\pi\epsilon_0} \left[\frac{4rl}{(r^2-a^2)^2} \right]$ Since $a^2 \ll r^2$ $(r^2 - a^2)^2 = r^4$ $E = \frac{q}{4\pi\epsilon_0} \times \frac{4l}{r^3}$ $E = \frac{1}{4\pi\epsilon_0} \frac{2p}{r^3}$		
27	a) Zero. Work done = Potential difference = 0 b) i. $\frac{1}{C_{eff}} = \frac{1}{C_1} + \frac{1}{C_2} \rightarrow \frac{1}{4} = \frac{1}{20} + \frac{1}{C}$ $\frac{1}{C} = \frac{1}{4} - \frac{1}{20} \rightarrow C = \frac{20 \times 4}{20 - 4} = \frac{80}{16} = 5 \mu F$ b) ii. Since the capacitors are connected in series charge on both capacitors are same. $Q = \frac{C_{eff}}{V} = \frac{5 \times 10^{-6}}{12} = 0.416 \mu C$	1 1 3	
28	a) Statement of junction rule and Loop rule b)  For the loop ABDA, loop rule becomes, $I_2 R_2 + I_g R_G - I_1 R_1 = 0 \dots (1)$ For the loop BCDB, loop rule becomes, $I_4 R_4 - I_3 R_3 - I_g R_G = 0 \dots (2)$	2 2	
28	a) statement of Biot- Savart law b)  Consider circular loop carrying a steady current I having radius R in YZ plane. Let P be a point at a distance x from the centre of the loop. The magnitude dB of the magnetic field due to dl is given by the Biot-Savart law, $dB = \frac{\mu_0}{4\pi} \frac{I dl \sin \theta}{r^2} \text{ here } \theta = 90^\circ$ Now, $dB = \frac{\mu_0}{4\pi} \frac{I dl}{r^2} \dots (1)$ in the XY plane as shown in figure A current element diametrically opposite to above dl produces dB of same magnitude in the XY plane. The Vertical components $dB \sin \theta$ cancel out but horizontal components $dB \cos \theta$ adds up Now Total Magnetic field due to entire loop is $B = \sum dB \cos \theta$ $= \sum \frac{\mu_0}{4\pi} \frac{I dl}{r^2} \cos \theta = \frac{\mu_0}{4\pi} \frac{I}{r^2} \cos \theta \sum dl$ But $r^2 = x^2 + R^2$ and $\cos \theta = \frac{R}{(x^2 + R^2)^{\frac{1}{2}}}$ Also $\sum dl = 2\pi R$ Now $B = \frac{\mu_0}{4\pi} \frac{I}{(x^2 + R^2)^{\frac{3}{2}}} 2\pi R^2$ $B = \frac{\mu_0}{2} \frac{IR^2}{(x^2 + R^2)^{\frac{3}{2}}}$	1 4	