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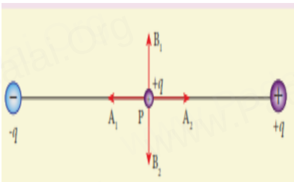
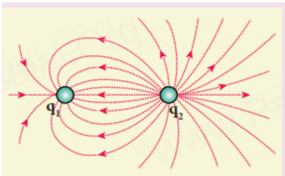
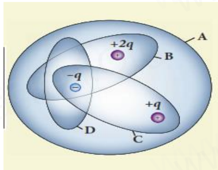
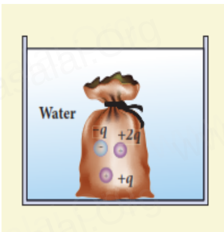
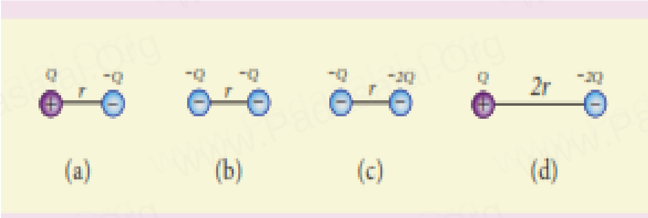
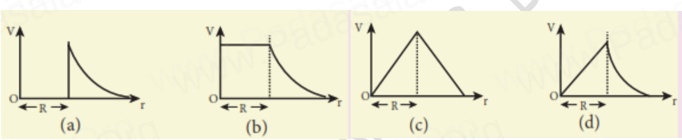
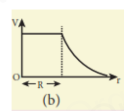
UNIT-1 ELECTROSTATICS ***** **_ONE MARK QUESTIONS WITH SOLUTIONS_** *****

S.NO	1 MARK QUESTIONS	SOLUTIONS
1.	Two identical point charges of magnitude –q are fixed as shown in the figure below. A third charge +q is placed midway between the two charges at the point P. Suppose this charge +q is displaced a small distance from the point P in the directions indicated by the arrows, in which direction(s) will +q be stable with respect to the displacement?  (a) A_1 and A_2 (b) B_1 and B_2 (c) both directions (d) No stable	Angle between B_1 and B_2 is 90^0 $V=\frac{1}{4\pi\epsilon_o}\frac{P\cos\theta}{r^2}=\frac{1}{4\pi\epsilon_o}\frac{P\cos 90}{r^2}=0$ W= V.q =0 + q is stable along B_1 and B_2 **ANSWER: (b) B_1 and B_2**
2	Which charge configuration produces a uniform electric field? (a) point Charge (b) infinite uniform line charge (c) uniformly charged infinite plane (d) uniformly charged spherical shell	
3	What is the ratio of the charges $\left\lvert\frac{q_1}{q_2}\right\rvert$ for the following electric field line pattern?  (a) $\frac{1}{5}$ b) $\frac{25}{11}$ (c) 5 (d) $\frac{11}{25}$	q_1= 11 ; q_2=25 $\frac{No.of\ lines\ entering\ (q1)}{No.of\ lines\ leaving\ (q2)}=\left\lvert\frac{q_1}{q_2}\right\rvert$ $\left\lvert\frac{q_1}{q_2}\right\rvert=\frac{11}{25}$ **ANSWER :(d) $\frac{11}{25}$**
4	An electric dipole is placed at an alignment angle of 30^o with an electric field of 2×10^5 N C^{-1}.It experiences a torque equal to 8Nm. The charge on the dipole if the dipole length is 1 cm is (a) 4 mC (b) 8 mC (c) 5 mC (d) 7 mC	τ=pEsinθ=(2qa)E sinθ $q=\frac{\tau}{2aE\sin\theta}=\frac{8}{2x10^5 10^{-2}\sin 30^0}$ $q=\frac{8x2}{2x10^3}$=8x10^{-3} C q=8mc **ANSWER:(b) 8 mC**

5	Four Gaussian surfaces are given below with charges inside each Gaussian surface. Rank the electric flux through each Gaussian surface in increasing order.  (a) D < C < B < A (b) A < B = C < D (c) C < A = B < D (d) D > C > B > A	Net charge A=3q-q=2q, Net charge B=2q-q=q Net charge C=-q+q=0, Net charge D=-q $\boldsymbol{\Phi = \frac{q}{\varepsilon_0}}$; $\boldsymbol{\Phi \propto q}$ **ANSWER: d) D>C>B>A**
6	The total electric flux for the following closed surface which is kept inside water.  a) $\frac{80q}{\varepsilon_0}$ **b)** $\frac{q}{40\varepsilon_0}$ *c)* $\frac{q}{80\varepsilon_0}$ **d)** $\frac{q}{160\varepsilon_0}$	Net charge Q=-q+q+2q=2q $\boldsymbol{\Phi = \frac{Q}{\varepsilon} = \frac{Q}{\varepsilon_0 \varepsilon_r} = \frac{2q}{80\varepsilon_0} = \frac{q}{40\varepsilon_0}}$ **ANSWER: b)** $\frac{q}{40\varepsilon_0}$
7	Two identical conducting balls having positive charges q_1 and q_2 are separated by a center to center distance r. If they are made to touch each other and then separated to the same distance, the force between them will be a)less than before b) same as before (c) more than before (d) zero	**<u>When before contact</u>** According to the Coulomb's law, F= $\frac{1}{4\pi\epsilon_o}\frac{q_1 q_2}{r^2}$ **<u>After contact</u>** when the charged spheres A and B are bought in contact, each sphere will attain equal charge q q = $\frac{q_1+q_2}{2}$ The force of repulsion between them at same distance r $F' = \frac{1}{4\pi\epsilon_o}\frac{\left(\frac{q_1+q_2}{2}.\frac{q_1+q_2}{2}\right)}{r^2} = \frac{1}{4\pi\epsilon_o}\frac{\left(\frac{q_1+q_2}{2}\right)^2}{r^2}$ when compare F and F' $$\frac{1}{4\pi\epsilon_o}\frac{q_1 q_2}{r^2} = \frac{1}{4\pi\epsilon_o}\frac{\left(\frac{q_1+q_2}{2}\right)^2}{r^2}$$ $$q_1 q_2 \leq \left(\frac{q_1+q_2}{2}\right)^2$$ F $\leq$ F'

		ANSWER :(c) more than before
8	Rank the electrostatic potential energies for the given system of charges in increasing order.  (a)1=4 < 2 < 3 (b)2 = 4 < 3 < 1(c)2 =3 <1< 4 (d)3 < 1<2< 4	The electrostatic potential energy= $U=\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r}$ a)$U=K\frac{-Q^2}{r}$ b) $U=K\frac{Q^2}{r}$ c) $U=K\frac{2Q^2}{r}$ d) $U=K\frac{-2Q^2}{2r}=K\frac{-Q^2}{r}$ a=d<b<c ; **ANSWER: a) 1=4<2<3**
9	An electric field $\vec{E}$=10x $\hat{\imath}$ exists in a certain region of space. Then the potential difference V = V_o – V_A where V_o is the potential at the origin and V_A is the potential at x = 2 m is: (a)10 J (b) – 20 J (c) +20 J (d) -10J	$E=-\frac{dV}{dx}$; dv=-Edx dv=-10x dx $\int_{V_0}^{V_A} dV=\int_0^2 10xdx$ V_A-V_o=-5x$(2)^2$; V_A-V_o = -20V V_0-V_A = 20V **ANSWER :(c) 20 J**
10	A thin conducting spherical shell of radius R has a charge Q which is uniformly distributed on its surface. The correct plot for electrostatic potential due to this spherical shell is  	1)Potential is constant inside spherical shell V=constant 2) Potential decreased outside spherical shell as distance increase $V\propto\frac{1}{r}$ **ANSWER (b)** 
11	Two points A and B are maintained at a potential of 7 V and -4 V respectively. The work done in moving 50 electrons from A to B is (a) 8.80 × 10^{-17} J (b) -8.80 × 10^{-17} J (c) 4.40 × 10^{-17} J (d) 5.80 × 10^{-17} J	W_{AB}=7-(-4)=11V; n=50 W=qV=(ne)V W=50x1.6x10^{-19}x11=880x10^{-19} W=8.8x10^{-17}J **ANSWER: (a) 8.80 × 10^{-17} J**
12	If voltage applied on a capacitor is increased from V to 2V, choose the correct conclusion. (a) Q remains the same, C is doubled (b) Q is doubled, C doubled (c) C remains same, Q doubled (d) Both Q and C remain same	1)$Q\propto V$ • Charge depends on potential • If V is doubled Q also doubled 2)$C=\frac{\varepsilon_0 A}{d}$ • Capacitance is independent of C and V

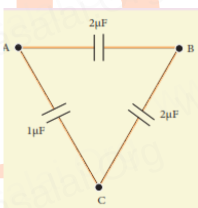
- Capacitance remain same if voltage is doubled

ANS : (c)C remains same,Q doubled

13 A parallel plate capacitor stores a charge Q at a voltage V. Suppose the area of the parallel plate capacitor and the distance between the plates are each doubled then which is the quantity that will change?

A→ 2A, d→2d			
$C=\frac{\varepsilon_0 A}{d}$	$Q \propto V$	$V=\frac{Q}{C}=\frac{Qd}{\varepsilon_0 A}$	$U_E=\frac{1}{2}\epsilon_o E^2Ad$
$C'=\frac{\varepsilon_0 2A}{2d}=\frac{\varepsilon_0 A}{d}$	V-doesn't change	$V'=\frac{Q2d}{\varepsilon_0 2A}=\frac{Qd}{\varepsilon_0 A}$	$U'_E=\frac{1}{2}\epsilon_o E^2 2A2d$ $=4\frac{1}{2}\epsilon_o E^2Ad$
C=C'	Q-same	V=V'	$U'_E=4U_E$
ANSWER d)Energy density only changed			

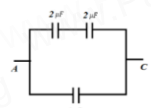
14 Three capacitors are connected in triangle as shown in the figure. The equivalent capacitance between the points A and C is



(a) 1μF (b) 2 μF

(c) 3 μF (d) $\frac{1}{4}$μF

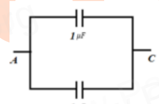
Step: 1



Equivalent capacitance are connetcted in series

$C_S=\frac{C}{n}=\frac{2}{2}=1\ \mu F$

step: 2



Equivalent capacitance are connsetctecd in parallel $C_P=nC_S=2x1=2\mu F$

ANS: (b) 2 μF

15 Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is

(a) 3×10^{-2} C

(b) 4×10^{-2} C

(c) 1×10^{-2} C

(d) 2×10^{-2} C

$V=\frac{KQ}{r}$

$V_1=\frac{KQ_1}{3}$; $V_2=\frac{KQ_2}{1}$;

$V_1=V_2$

$\frac{KQ_1}{3}=\frac{KQ_2}{1}$;

$3Q_2 = Q_1$ ----1

Two charges connected externally

$Q_1+Q_2=(5-1)x10^{-2}=4\ x10^{-2}C$

$Q_1+Q_2=4\ x10^{-2}C$----2

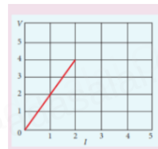
Sub eq 1 in eq 2

$3Q_2+Q_2=4\ x10^{-2}C$; $4Q_2=4\ x10^{-2}C$;

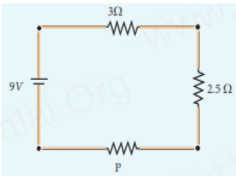
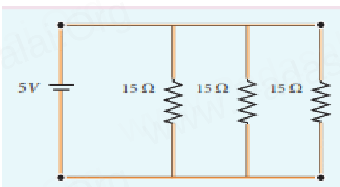
$Q_2=10^{-2}C$----3

		Sub 3 in eq 1 ; Q_1 *=3x10*$^{-2}$*C* **ANSWER(a) 3 × 10^{-2} C**

UNIT-2 CURRENT ELECTRICITY

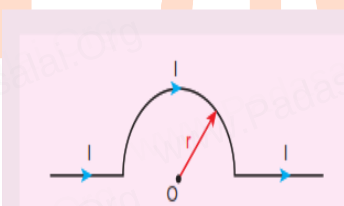
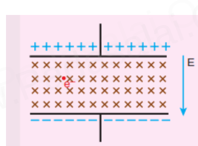
S.NO	QUESTIONS	SOLUTIONS
1)	The following graph shows current versus voltage values of some unknown Conductor. What is the resistance of this conductor?  (a)2 ohm (b) 4 ohm(c) 8 ohm (d)1 ohm	R=$\frac{dV}{dI}$ =$\frac{4-0}{2-0}$=2 **ANSWER**: (a)2 ohm
2)	A wire of resistance 2 ohms per meter is bent to form a circle of radius 1m.The equivalent resistance between its two diametrically opposite points, A and B as shown in the figure is  a)π Ω b) $\frac{\pi}{2}$ Ω c) 2 π Ω d) $\frac{\pi}{4}$ Ω	L=2 πR =2 πx1 =2 π Total resistance R=2 π x2=4 π Ω Resistance in each part=$\frac{4\pi}{2}$=2 π Ω Equivalent resistance are connected in parallel R_P=$\frac{R}{n}$= $\frac{2\pi}{2}$ R_P = π Ω **ANSWER: a)π Ω**
3)	A toaster operating at 240 V has a resistance of 120 Ω. The power is a) 400 W b) 2 W c) 480 W d) 240 W	P=$\frac{V^2}{R}$ =$\frac{240\ x240}{120}$ P=480W **ANSWER** : c) 480 W
4)	A carbon resistor of (47 ± 4.7) k Ω to be marked with rings of different colours for its identification. The colour code sequence will be a) Yellow – Green – Violet – Gold b) Yellow – Violet – Orange – Silver c) Violet – Yellow – Orange – Silver d) Green – Orange – Violet – Gold	Yellow – Violet – Orange – Silver (47x10^3) ±10%= Tolerance in % =47000x10%= 4700x0.1=470 (47000±470) ohm 0r (47 ±4.7)1000 ohm **ANSWER**: b) Yellow – Violet – Orange – Silver
5)	What is the value of resistance of the following resistor?  (a)100 k Ω (b)10 k Ω (c) 1k Ω (d)1000 k Ω	Brown: 1 Black:0 Yellow:10^4 or 10000 Value of resistance : 10x10^4 **ANSWER** : (a)100 k Ω
6)	Two wires of A and B with circular cross section made	R_A = 3 R_B

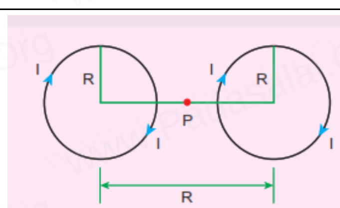
	up of the same material with equal lengths. Suppose R_A = 3 R_B ,then what is the ratio of radius of wire A to that of B? (a)3 (b)$\sqrt{3}$ c)$\frac{1}{\sqrt{3}}$ d)$\frac{1}{3}$	R∝ $\frac{l}{A}$; length are common $\frac{R_A}{R_B}=\frac{\pi r_2^2}{\pi r_1^2}$ $\frac{r_1}{r_2}=\sqrt{\frac{R_B}{R_A}}$ $=\sqrt{\frac{R_B}{3R_B}}=\frac{1}{\sqrt{3}}$ **ANSWER:** c)$\frac{1}{\sqrt{3}}$
7)	A wire connected to a power supply of 230 V has power dissipation P_1. Suppose the wire is cut into two equal pieces and connected parallel to the same power supply. In this case power dissipation is P_2. The ratio $\frac{P_2}{P_1}$ is (a)1 (b) 2 (c) 3 (d) 4	Before cutting the wire, resistance- R After cutting the wire, resistance of each pieces- $\frac{R}{2}$ Two equal pieces are connected parallel is $R_P=\frac{R_1 R_2}{R_1+R_2}$ $R_P=\frac{\frac{R}{2} X \frac{R}{2}}{\frac{R}{2}+\frac{R}{2}} = \frac{\frac{R^2}{4}}{R} = \frac{R^2}{4R} = \frac{R}{4}$ Power P=$\frac{V^2}{R}$ potential is common ratio $\frac{P_2}{P_1} = \frac{R}{R_P} = \frac{4R}{R}$=4 **ANSWER : (d) 4**
8)	In India electricity is supplied for domestic use at 220 V. It is supplied at 110 V in USA. If the resistance of a 60W bulb for use in India is R, the resistance of a 60W bulb for use in USA will be (a) R (b) 2R (c) $\frac{R}{4}$ (c) $\frac{R}{2}$	Power P=$\frac{V^2}{R}$ For india $P_1=\frac{V_1^2}{R_1} = \frac{V_1^2}{R}$ For USA $P_2=\frac{V_2^2}{R_2}$ $P_1= P_2$ $\frac{V_1^2}{R}=\frac{V_2^2}{R_2}$ $R_2 = \frac{V_2^2}{V_1^2}$xR $=\frac{110x110x R}{220x220} = \frac{R}{4}$ **ANSWER: (c)** $\frac{R}{4}$
9)	In a large building, there are 15 bulbs of 40W, 5 bulbs of 100W, 5 fans of 80W and 1 heater of 1kW are connected.	Total power consumed P =(15x40)+(5x100)+(5x80)+(1x100)

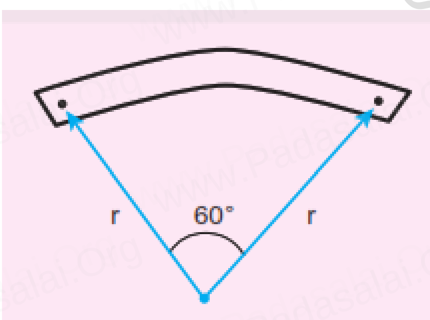
	The voltage of electric mains is 220V. The minimum capacity of the main fuse of the building will be a) 14 A (b) 8 A (c) 10 A (d) 12 A	P=2500W Current $I=\frac{P}{V}=\frac{2500}{220}$ I=11.36 A **ANSWER: (d) 12 A**
10)	There is a current of 1.0 A in the circuit shown below. What is the resistance of P ?  a) 1.5 Ω b) 2.5 Ω c) 3.5 Ω d) 4.5 Ω	Resistance $R=\frac{V}{I}=\frac{9}{1}=9\ \Omega$ Three resistance are connected in series $R= R_1+R_2+P$ 9=3+2.5+P P=9-5.5=3.5 Ω **ANSWER: (c) 3.5**
11)	What is the current out of the battery?  a)1A b) 2A c) 3A d) 4A	The equivalent resistance are connected in parallel $R_P=\frac{R}{n}$ $R_P=\frac{15}{3}=5\ \Omega$ Current $I=\frac{V}{R_P}=\frac{5}{5}=1A$ **ANSWER: (a)** 1A
12)	The temperature coefficient of resistance of a wire is 0.00125 per °C. At 300 K, its resistance is 1 Ω. The Resistance of the wire will be 2 Ω at a) 1154 K b) 1100 K c) 1400 K d) 1127 K	Temperature coefficient $\alpha = \frac{R_2-R_1}{R_1(T_2-T_1)}$ $(T_2-T_1)=\frac{R_2-R_1}{R_1\alpha}$ 300 K=27^0C $(T_2-27^0)=\frac{2-1}{1X0.00125}$ $(T_2-27^0=\frac{1}{0.00125}=800^0C$ $T_2=800^0C+27^0C=827^0C$ In kelvin scale T_2=827+273=1100 K **ANSWER : b) 1100 K**
13)	The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is a) 0.2 Ω b) 0.5 Ω c) 0.8 Ω d) 1.0 Ω	$r=\left(\frac{\xi-V}{V}\right)R$ V=IR=0.2X10=2V $r=\left(\frac{2.1-2}{2}\right)10=\left(\frac{1}{2}\right)=0.5\ \Omega$ **ANSWER :** b) 0.5 Ω
14)	A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of a) each of them increases b) each of them decreases	For conductors, resistivity is directly proportional to temperature, $\rho \propto T$ **For copper, Temperature cooled**

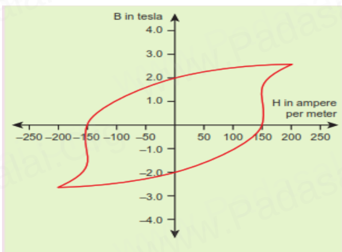
	c)copper increases and germanium Decreases d) copper decreases and germanium increases	**(decrease)-Resistance decrease** For semiconductor, resistivity is inversely proportional to temperature, $\rho \propto \frac{1}{T}$ **For germanium ,Temperature cooled (decrease)-Resistance increase** **ANSWER :** d) copper decreases and germanium increases
15)	In Joule's heating law, when R and t are constant, if the H is taken along the y axis and I^2 along the x axis, the graph is a) straight line b) parabola c) circle d) ellipse	when R and t are constant, $H \propto I^2$ Graph : straight line **ANSWER : a) straight line**

UNIT -3 EFFECTS OF ELECTRIC CURRENT AND MAGNETISM

S.NO	QUESTIONS	SOLUTIONS
1)	The magnetic field at the center O of the following current loop is  **a)** $\frac{\mu_0 I}{4r} \otimes$ b) $\frac{\mu_0 I}{4r} \odot$ c) $\frac{\mu_0 I}{2r} \otimes$ d) $\frac{\mu_0 I}{2r} \odot$	**B** $= \oint dB = \frac{\mu_0}{4\pi}\frac{Idl \sin\theta}{r^2}$ **B** $= \frac{\mu_0}{4\pi}\frac{I}{r^2}\int dl$ $(\theta = 90^o)$ $= \frac{\mu_0}{4\pi}\frac{I}{r^2}\int \pi r = \frac{\mu_0 I}{4r}$ **ANSWER :a)** $\frac{\mu_0 I}{4r} \otimes$ (According to right hand thumb rule B acts inwards)
2)	An electron moves straight inside a charged parallel plate capacitor of uniform charge density σ. The time taken by the electron to cross the parallel plate capacitor when the plates of the capacitor are kept under constant magnetic field of induction $\vec{B}$ is a) $\varepsilon_0 \frac{elB}{\sigma}$ b) $\varepsilon_0 \frac{lB}{\sigma l}$ c) $\varepsilon_0 \frac{lB}{e\sigma}$ d) $\varepsilon_0 \frac{lB}{\sigma}$ 	**Velocity =** $\frac{\textbf{displacement}}{time} = \frac{l}{t}$ $\frac{E}{B} = \frac{l}{t}$ $[E = \frac{\sigma}{\varepsilon_0}]$ t=$\frac{B}{E}$xl = $\frac{B\varepsilon_0}{\sigma}$xl t= $\varepsilon_0 \frac{lB}{\sigma}$ **ANSWER: d)** $\varepsilon_0 \frac{lB}{\sigma}$
3)	The force experienced by a particle having mass m and charge q accelerated through a potential difference V when it is kept under perpendicular magnetic field is $\vec{B}$	$\frac{1}{2}mv^2$=qV $v^2 = \frac{2qV}{m}$ =>$v = \sqrt{\frac{2qV}{m}}$

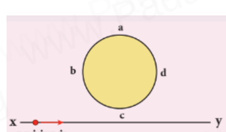
	a) $\sqrt{\frac{2q^3BV}{m}}$ b) $\sqrt{\frac{q^3B^2V}{2m}}$ c) $\sqrt{\frac{2q^3B^2V}{m}}$ d) $\sqrt{\frac{2q^3BV}{m^3}}$	$F=Bqv=Bq\sqrt{\frac{2qV}{m}}$ $F=\sqrt{\frac{2q^3B^2V}{m}}$ **ANSWER:** *c*) $\sqrt{\frac{2q^3B^2V}{m}}$
4)	A circular coil of radius 5 cm and 50 turns carries a current of 3 ampere. The magnetic dipole moment of the coil is (a) 1.0 amp – m² (b) 1.2 amp – m² (c) 0.5 amp – m² (d) 0.8 amp – m²	**P_m= NIA = N Iπr^2** **=50x3x3.14$(5x10^{-2})^2$** **$11775x10^{-4}$ = 1.2 am²** **ANSWER:** (b) 1.2 amp – m²
5)	A thin insulated wire forms a plane spiral of N = 100 tight turns carrying a current I = 8 m A (milli ampere). The radii of inside and outside turns are a = 50 mm and b = 100 mm respectively. The magnetic induction at the center of the spiral is (a) 5 µT (b) 7 µT (c) 8 µT (d) 10 µT	magnetic induction $B=\oint dB=\frac{\mu_0 NI}{2x}dx$ $dB=\int_a^b \frac{\mu_0 NI}{2x}dx=\frac{\mu_0 NI}{2x}\int_a^b dx$ $=\frac{\mu_0 NI}{2x}\ln\frac{b}{a}$ $n=\frac{N}{b-a}$ $\frac{4\pi x10^{-7}x100x8x10^{-3}x2.303xlog(2)}{2x10^{-7}x10^{-2}}$ $=6.96x10^{-6}T=7\ \mu T$ **ANSWER:** (b) 7 µT
6)	Three wires of equal lengths are bent in the form of loops. One of the loops is circle, another is a semi-circle and the third one is a square. They are placed in a uniform magnetic field and same electric current is passed through them. Which of the following loop configuration will experience greater torque? (a) circle (b) semi-circle (c) square (d) all of them	**Torque α Area ; τ α A** **Area of circle > Area of squre>** **Area of semi-circle** $\pi r^2 > r^2 > \frac{1}{2}\pi r^2$ **τ circle > τ squre >τ semi circle** **ANSWER:** a) circle
7)	Two identical coils, each with N turns and radius R are placed coaxially at a distance R as shown in the figure. If I is the current passing through the loops in the same direction, then the magnetic field at a point P which is at exactly at $\frac{R}{2}$ distance between two coils is 	$B_1=\frac{\mu_0 NI}{2}\frac{R^2}{(R^2+Z^2)^{3/2}}$ $[Z=\frac{R}{2}]$ $=\frac{\mu_0 NI}{2}\frac{R^2}{[(R^2+(\frac{R}{2})^2]^{3/2}}$ $=\frac{\mu_0 NI}{2}\frac{R^2}{[(R^2+\frac{R^2}{4}]^{3/2}}$ $=\frac{\mu_0 NI}{2}\frac{R^2}{[\frac{5R^2}{4}]^{3/2}}$

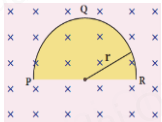
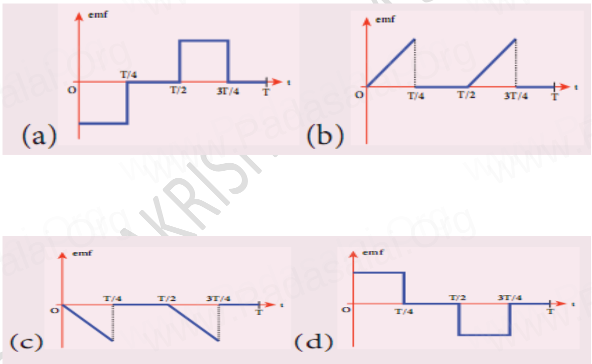
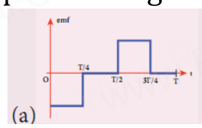
	a) $\frac{8\mu_0 NI}{\sqrt{5}R}$ b) $\frac{8N\mu_0 I}{5^{3/2}R}$ c) $\frac{8N\mu_0 I}{5R}$ d) $\frac{4N\mu_0 I}{\sqrt{5}R}$	$=\frac{\mu_0 NI}{2}\frac{R^2 X8}{R^3 5^{3/2}}$ $B_1 = \frac{4N\mu_0 I}{5^{3/2}R}$; $B_1 = B_2$ Total magnetic field at p B= $B_1 + B_2$ B=2B_1=2x $\frac{4\mu_0 NI}{R5^{3/2}}$ = $\frac{8N\mu_0 I}{5^{3/2}R}$ **ANSWER** : b) $\frac{8N\mu_0 I}{5^{3/2}R}$
8)	A wire of length l carries a current I along the Y direction and magnetic field is given by $\vec{B}=\frac{B}{\sqrt{3}}(\hat{\imath}+\hat{\jmath}+\hat{k})$The magnitude of Lorentz force acting on the wire is a) $\sqrt{\frac{2}{3}}$ BIl b) $\sqrt{\frac{1}{3}}$ BIl c) $\sqrt{2}$ BIl d) $\sqrt{\frac{1}{3}}$ BIl	Magnetic field $\vec{B}=\frac{B}{\sqrt{3}}(\hat{\imath}+\hat{\jmath}+\hat{k})$; F=$(I\vec{l}x\vec{B})$= $Il\hat{\jmath}$ x $\frac{B}{\sqrt{3}}(\hat{\imath}+\hat{\jmath}+\hat{k})$ =$\frac{BIl}{\sqrt{3}}(\hat{\jmath}x\hat{\imath}+\hat{\jmath}x\hat{\jmath}+\hat{\jmath}\,x\hat{k})$; =$\frac{BIl}{\sqrt{3}}$(-$\hat{k}$+0+$\hat{\imath}$) =$\frac{BIl}{\sqrt{3}}\sqrt{-1^2+1^2}$= F =$\frac{BIl}{\sqrt{3}}\sqrt{2}$= $\sqrt{\frac{2}{3}}$ BIl **ANSWER** : $(a)\sqrt{\frac{2}{3}}$ BIl
9)	A bar magnet of length l and magnetic moment M is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be  (a) M (b) $\frac{3}{\pi}$ M (c) $\frac{2}{\pi}$ M (c) $\frac{1}{2}$ M	For straight magnet, magnetic moment M=q_ml For new magnet, magnetic moment M'=q_ml' l'=2r sin30^0=r arc length =radius x $\boldsymbol{\theta}$ l=r $\boldsymbol{\theta}$; l= r $\frac{\pi}{3}$ r=$\frac{3l}{\pi}$=l' For new magnet, magnetic moment M'=q_ml'=$\frac{3q_m l}{\pi}$ =$\frac{3M}{\pi}$ **ANSWER** : (b) $\frac{3}{\pi}$ M
10)	A non-conducting charged ring of charge q, mass m and radius r is rotated with constant angular speed ω. Find the ratio of its magnetic moment with angular momentum is	Magnetic moment μ_L=I.A $\mu_L=\frac{q}{T}$ πr^2 $\left(T = \frac{2\pi}{\omega}\right)$ $\mu_L=\frac{q\omega\ \pi r^2}{2\pi}$

	a) $\frac{q}{m}$ b) $\frac{2q}{m}$ c) $\frac{q}{2m}$ d) $\frac{q}{4m}$	Angular momentum L= $mr^2\omega$ $\frac{\mu_L}{L}=\frac{q\omega\ \pi r^2}{2\pi\ \ mr^2\omega}=\frac{q}{2m}$ **ANSWER : c)** $\frac{q}{2m}$
11)	The BH curve for a ferromagnetic material is shown in the figure. The material is placed inside a long solenoid which contains 1000 turns/cm. The current that should be passed in the solenoid to demagnetize the ferromagnetic completely is  (a)1.00mA (milli ampere) (b)1.25mA (c)1.50 mA (d) 1.75 mA	n=1000 turns/cm, H=150(graph) H =nI I=$\frac{H}{n}$ = $\frac{150}{10^5}$ = $150\text{x }10^{-5}$ I=$1.50\text{x }10^{-3}$ A **ANSWER : (c)1.50 mA**
12)	Two short bar magnets have magnetic moments 1.20 Am^2 and 1.00 Am^2 respectively. They are kept on a horizontal table parallel to each other with their north poles pointing towards the south. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centers is (Horizontal components of Earth's magnetic induction is 3.6 × 10^{-5} Wb m^{-2}) (a) 3.60 × 10^{-5} Wb m^{-2} (b) 3.5 × 10^{-5} Wb m^{-2} (c) 2.56 × 10^{-4} Wb m^{-2} (d) 2.2 × 10^{-4} Wb m^{-2}	P_{m1}=1.20 Am^2 ; P_{m2}=1.00 Am^2 Distance from common magnetic equator =20cm/2=10cm=10^{-1}m $B_H = 3.6X10^{-5}$ Wb m^{-2} **Resultant magnetic field** **B=B_1+B_2+B_H** $=\frac{\mu_0 P_{m1}}{4\pi r^3}+\frac{\mu_0 P_{m2}}{4\pi r^3}+B_H$ B =$\frac{\mu_0}{4\pi r^3}(P_{m1}+P_{m2})+B_H$ $=\frac{4\pi X10^{-7}}{4\pi X10^{-3}}(1.2+1)+3.6X10^{-5}$ **$2.2\text{x}10^{-4}+0.36X10^{-4}$** **B** =2.56 × 10^{-4} Wb m^{-2} **ANSWER :** (c) 2.56 × 10^{-4} Wb m^{-2}
13)	The vertical component of Earth's magnetic field at a place is equal to the horizontal component. What is the value of angle of dip at this place? a) 30° (b) 45° (c) 60° (d) 90°	B_V= B_H Tan $\theta=\frac{B_V}{B_H}$=1 θ=Tan^{-1}(1)= 45° **ANSWER :** (b) 45°
14)	A flat dielectric disc of radius R carries an excess charge on its surface. The surface charge density is σ. The disc rotates about an axis perpendicular to its plane passing through the center with angular velocity ω. Find the magnitude of the torque on the disc if it is placed in a	Total charge on the disc $Q=\sigma A=\sigma 2\pi r dr$ Time period T= $\frac{2\pi}{\omega}$ Current in the ring dI= $\frac{dQ}{T}$

	uniform magnetic field whose strength is B which is directed perpendicular to the axis of rotation (a) $\frac{1}{4}\sigma\omega\pi BR$ (b) $\frac{1}{4}\sigma\omega\pi BR^2$ (c) $\frac{1}{4}\sigma\omega\pi BR^3$ (d) $\frac{1}{4}\sigma\omega\pi BR^4$	dI= $\frac{\sigma 2\pi r dr\ \omega}{2\pi} = \sigma\omega r dr$ magnetic moment of the ring dM =dI πr^2 M=$\int_0^R \pi\sigma\omega r^3 dr = \frac{\pi}{4}\sigma R^4\omega$ M=$\frac{1}{4}QR^2\omega$ $(Q = \sigma\pi R^2)$ $\tau = P_m B \sin\boldsymbol{\theta}$; $\boldsymbol{\theta}=90^{\circ}$ $\tau = P_m B = \frac{1}{4}\sigma A R^2\omega B$ $\tau = \frac{1}{4}\sigma\pi R^2 R^2\omega B$ **ANSWER :** (d) $\frac{1}{4}\sigma\omega\pi BR^4$
15)	A simple pendulum with charged bob is oscillating with time period T and let θ be the angular displacement. If the uniform magnetic field is switched ON in a direction perpendicular to the plane of oscillation then (a) time period will decrease but θ will remain constant (b) time period remain constant but θ will decrease (c) both T and θ will remain the same (d) both T and θ will decrease	Magnetic field is perpendicular to the plane of oscillation, there is no work. so both T and θ will remain the same **ANSWER: (C)** both T and θ will remain the same

UNIT -04 ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT

S.NO	QUESTIONS	SOLUTIONS
1)	An electron moves on a straight line path XY as shown in the figure. The coil abcd is adjacent to the path of the electron. What will be the direction of current, if any, induced in the coil? a)The current will reverse its direction as the electron goes past the coil (b) No current will be induced (c) abcd (d) adcb 	1. When electron moves towards the loop flux increases , induced current flows in anticlockwise direction(abcd) 2. When electron moves away flux decrease, induced current flows clock wise direction.(dcba). **ANSWER :** a)The current will reverse its direction as the electron goes past the coil

2)	A thin semi-circular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in the figure.The potential difference developed across the ring when its speed *v*, is (a) Zero b) $\frac{Bv\pi r^2}{2}$ and P is at higher potential c) πrBv and R is at higher potential d) $2rBv$ and R is at higher potential 	ε =B l and R are higher potential **ANSWER :** d) $2rBv$ and R is at higher potential
3)	The flux linked with a coil at any instant t is given by Φ_B =10t²-50t+250t . The induced emf at t = 3s is (a) -190 *V* (b) -10 *V* (c) 10 *V* (d) 190 *V*	$\varepsilon = -\frac{d\phi_B}{dt}$ $\varepsilon = -\frac{d}{dt}(10t^2-50t+250)=-[20t-50]$ *t=3s* ; ε =-[(20x3)-50]= =-60+50 = -10V **ANSWER :** (b) -10 *V*
4)	When the current changes from +2A to -2A in 0.05 s, an emf of 8 V is induced in a coil. The co-efficient of self-induction of the coil is (a) 0.2 H (b) 0.4 H (c) 0.8 H (d) 0.1 H	$\varepsilon = -L\frac{dI}{dt}$ $L=-\frac{\varepsilon}{\frac{dI}{dt}} = \frac{-8}{\frac{-4}{0.05}} = \frac{0.4}{4} = 0.1H$ **ANSWER :** (d) 0.1 H
5)	The current i flowing in a coil varies with time as shown in the figure. The variation of induced emf with time would be 	$\varepsilon \propto -\frac{dI}{dt}$ • 0 to T/4 –flux changes current induces opposite side • T/4 to T/2 –No change in flux,so no current induced • T/2 to 3T/4 – Flux change current induces positive region **ANSWER :** 
6)	A circular coil with a cross-sectional area of 4 cm² has 10 turns. It is placed at the centre of a long solenoid that has 15 turns/cm and a cross-sectional area of 10 cm². The axis of the coil coincides with the axis of the solenoid. What is their mutual inductance? (a) 7.54 μH (b) 8.54 μH (c) 9.54 μH (d) 10.54 μH	$M = \frac{\mu_0 n_1 n_2 A_2 l}{l} = \mu_0 N_1 N_2 A_2$ = 4πx 10⁻⁷x15x10²x10x4x10⁻⁴ =7.54x10⁻⁶H =7.54μH **ANSWER :** (a) 7.54 μH

7)	In a transformer, the number of turns in the primary and the secondary are 410 and 1230 respectively. If the current in primary is 6A, then that in the secondary coil is (a) 2 A (b) 18 A (c) 12 A (d) 1 A	$\frac{i_p}{i_s}=\frac{N_s}{N_p}$ => $i_s=\frac{N_p}{N_s}i_p=\frac{410}{1230}$x6 =2A **ANSWER :** (a) 2 A
8)	A step-down transformer reduces the supply voltage from 220 V to 11 V and increase the current from 6 A to 100 A. Then its efficiency is (a) 1.2 (b) 0.83 (c) 0.12 (d) 0.9	$\eta=\frac{E_S I_S}{E_P I_P}=\frac{11X100}{220X6}=0.83$ **ANSWER :** (b) 0.83
9)	In an electrical circuit, R, L, C and AC voltage source are all connected in series. When L is removed from the circuit, the phase difference between the voltage and current in the circuit is $\frac{\pi}{3}$. Instead, if C is removed from the circuit, the phase difference is again $\frac{\pi}{3}$. The power factor of the circuit is (a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ c) 1 (d) $\frac{\sqrt{3}}{2}$	Phase by removing the inductor = Phase by removing the capacitor $X_L=X_C$; power factor cosϕ $=\frac{R}{Z}=\frac{R}{R}=1$ Z =R **ANSWER :** c)1
10)	In a series RL circuit, the resistance and inductive reactance are the same. Then the phase difference between the voltage and current in the circuit is (a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$ c) $\frac{\pi}{6}$ (d) 0	R $=X_L$ => tanϕ $=\frac{X_L}{R}=1$ Φ= $\tan^{-1}(1)=45^o=\frac{\pi}{4}$ **ANSWER :** (a) $\frac{\pi}{4}$
11)	In a series resonant RLC circuit, the voltage across 100 Ω resistor is 40 V. The resonant frequency ω is 250 rad/s. If the value of C is 4 μF, then the voltage across L is (a) 600 V (b) 4000 V (c) 400V (d) 1 V	At resonance $X_L=X_C$ $X_L=L\omega_r=\frac{1}{C\omega_r}=\frac{1}{4X10^{-6}X250}$ $X_L=10^3\Omega$ $I=\frac{V}{R}=\frac{40}{100}=0.4A$ Voltage across L $=IX_L$ $=0.4X10^3=400V$ **ANSWER :** (c) 400V
12)	An inductor 20 mH, a capacitor 50 μF and a resistor 40Ω are connected in series across a source of emf v = 10 sin 340 t. The power loss in AC circuit is (a) 0.76 W (b) 0.89 W (c) 0.46 W (d) 0.67 W	$X_L=L\omega=20X10^{-3}X340=6.8\Omega$ $V_{rms}=\frac{V_0}{\sqrt{2}}=10x0.707=7.07$ $X_C=\frac{1}{C\omega}=\frac{1}{50X10^{-6}X340}=58.8\Omega$ $X_L-X_C=58.8-6.8=52\Omega$

		Z = $\sqrt{R^2+(X_L-X_C)^2}$ = $\sqrt{40^2+52^2}$=$\sqrt{1600+2704}$ =65.6Ω P_{AV}=I_{Rms}^2.R = $\left[\frac{E_{Rms}}{Z}\right]^2$ x R = $\left[\frac{7.07}{65.6}\right]^2$ x 40 =(0.107)^2 x 40 =0.46W **ANSWER :** (c) 0.46 W
13)	The instantaneous values of alternating current and voltage in a circuit are i =$\frac{1}{\sqrt{2}}$ sin($100\pi t$)A and v=$\frac{1}{\sqrt{2}}$sin($100\pi t+\frac{\pi}{3}$)V. The average power in watts consumed in the circuit is (a) $\frac{1}{4}$ (b)$\frac{\sqrt{3}}{4}$ c) $\frac{1}{2}$ (d)$\frac{1}{8}$	P_{AV}= $\frac{I_0E_0}{2}$ cosϕ = $\frac{1}{2}$x$\frac{1}{\sqrt{2}}$x$\frac{1}{\sqrt{2}}$cos $\frac{\pi}{3}$ =$\frac{1}{2}$x$\frac{1}{2}$ x$\frac{1}{2}$= $\frac{1}{8}$ **ANSWER :** (d)$\frac{1}{8}$
14)	In an oscillating LC circuit, the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic fields is (a) $\frac{Q}{2}$ (b)$\frac{Q}{\sqrt{3}}$ c) $\frac{Q}{\sqrt{2}}$ (d)Q	U_E = $\frac{Q^2}{2C}$; U'_C= $\frac{Q^{2\prime}}{2C}$ Energy stored equally U'_C=$\frac{1}{2}$$U_C$ = $\frac{1}{2}$x $\frac{Q^2}{2C}$ $\frac{Q^{2\prime}}{2C}$ =$\frac{1}{2}$x $\frac{Q^2}{2C}$ =>$Q^{2\prime}$ =$\frac{Q^2}{2}$ Q' =$\frac{Q}{\sqrt{2}}$ **ANSWER :** c) $\frac{Q}{\sqrt{2}}$
15)	$\frac{20}{\pi^2}$ H inductor is connected to a capacitor of capacitance C. The value of C in order to impart maximum power at 50 Hz is (a) 50 µF (b) 0.5 µF (c) 500 µF (d) 5 µF	Maximum power, At resonance X_L =X_C Lω_r=$\frac{1}{C\omega_r}$ C=$\frac{1}{L\omega_r^2}$=$\frac{\pi^2}{20X4\pi^2X50^2}$ =$\frac{1}{20X4X2500}$ =$\frac{1}{200000}$ =0.5x10^{-5}F =5µF **ANSWER :** (d) 5 µF

UNIT 05- ELECTROMAGNETIC WAVES

S.NO	QUESTIONS	SOLUTIONS
1)	The dimension of $\frac{1}{\mu_0\varepsilon_0}$ is_________ a)[LT^{-1}] b) [L^{2}T^{-2}] c) [L^{-1}T] d) [L^{-2}T^{-2}]	c =$\frac{1}{\sqrt{\mu_0\varepsilon_0}}$ => c^2 =$\frac{1}{\mu_0\varepsilon_0}$ c^2 =$[LT^{-1}]^2$ =[L^{2}T^{-2}] **ANSWER :** b) [L^{2}T^{-2}]
2)	If the amplitude of the magnetic field is 3 × 10^{-6}T then	c =$\frac{E}{B}$ => E =Bxc = 3 × 10^{-6} x3 × 10^8

	amplitude of the electric field for a electromagnetic waves is (a) 100 V m^{-1} (b) 300 V m^{-1} (c) 600 V m^{-1} (d) 900 V m^{-1}	=9× 10^2 =900 V m^{-1} **ANSWER :** (d) 900 V m^{-1}
3)	Which of the following electromagnetic radiation is used for viewing objects through fog (a) microwave (b) gamma rays (c) X- rays (d) infrared	**ANSWER :** (d) infrared
4)	Which of the following are false for electromagnetic waves (a) transverse (b) non mechanical waves (c) longitudinal (d) produced by accelerating charges	**ANSWER :** (c) longitudinal
5)	Consider an oscillator which has a charged particle and oscillates about its mean position with a frequency of 300 MHz. The wavelength of electromagnetic waves produced by this oscillator is (a) 1 m (b) 10 m (c) 100 m (d) 1000 m	$\upsilon = c\lambda \Rightarrow \lambda = \frac{\upsilon}{c} = \frac{3x10^8}{3x10^8}$ =1m **ANSWER :** (a) 1 m
6)	The electric and the magnetic field, associated with an electromagnetic wave, propagating along X axis can be represented by (a) $\vec{E}=E_0\hat{j}$ and $\vec{B}=B_0\,\hat{k}$ (b) $\vec{E}=E_0\hat{k}$ and $\vec{B}=B_0\,\hat{j}$ (c) $\vec{E}=E_0\hat{\imath}$ and $\vec{B}=B_0\,\hat{j}$ (d) $\vec{E}=E_0\hat{j}$ and $\vec{B}=B_0\,\hat{\imath}$	$\vec{E}X\vec{B} = E_0\hat{j}$ X $B_0\,\hat{k} = E_0$ X $B_0(\hat{j}\,\hat{k})$ = $E_0\,B_0(\hat{j}x\hat{k}) = E_0\,B_0(\hat{I})$ i – x direction **ANSWER :** (a) $\vec{E}=E_0\hat{j}$ and $\vec{B}=B_0\,\hat{k}$
7)	In an electromagnetic wave in free space the rms value of the electric field is 3 V m^{-1} . The peak value of the magnetic field is (a) 1.414 × 10^{-8} T (b) 1.0 × 10^{-8} T (c) 2.828 × 10^{-8} T (d) 2.0 × 10^{-8} T	$B_{Rms} = \frac{B_0}{\sqrt{2}}$ => $B_0 = B_{Rms}\sqrt{2}$ $c = \frac{E_{Rms}}{B_{Rms}}$ $B_{Rms} = \frac{E_{Rms}}{c}$ $B_0 = \frac{E_{Rms}}{c}\sqrt{2}$ $\frac{3}{3x10^8}$ x 1.414 =1.414 × 10^{-8}T **ANSWER :** (a) 1.414 × 10^{-8} T
8)	During the propagation of electromagnetic waves in a medium: (a) electric energy density is double of the magnetic energy density (b) electric energy density is half of the magnetic energy density (c) electric energy density is equal to the magnetic energy	Magnetic energy $u_B = \frac{B^2}{2\mu_0}$ Electric energy $u_E = \frac{1}{2}\varepsilon_0 E^2$ $u_E = \frac{1}{2}\varepsilon_0 (Bc)^2$ $u_E = \frac{1}{2}\varepsilon_0 B^2 c^2 = \frac{1}{2}\varepsilon_0 B^2 x\, c^2$ $c^2 = \frac{1}{\mu_0\varepsilon_0}$

	density (d) both electric and magnetic energy densities are zero	$=\frac{1}{2}\varepsilon_0 B^2 x \frac{1}{\mu_0\varepsilon_0}$ $u_E=\frac{B^2}{2\mu_0}$ $u_E= u_B$ **ANSWER :** (c) electric energy density is equal to the magnetic energy density
9)	If the magnetic monopole exists, then which of the Maxwell's equation to be modified?. (a) $\oint \vec{E}\, d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$ (b) $\oint \vec{E}\, d\vec{A} = 0$ (c) $\oint \vec{E}\, d\vec{A} = \mu_0 I_{enclosed} + \mu_0 \varepsilon_0 \frac{d}{dt}\int \vec{E}\, d\vec{A}$ (d) $\oint \vec{E}\, d\vec{l} = \frac{d}{dt}\phi_B$	The magnetic lines of force form a continuous closed path. No isolated magnetic monopole exists. Total magnetic flux=0 $\oint \vec{E}\, d\vec{A} = 0$ **ANSWER :** (b) $\oint \vec{E}\, d\vec{A} = 0$
10)	A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (a) $\frac{E}{c}$ (b) $2\frac{E}{c}$ (c) Ec (d) $\frac{E}{c^2}$	Change in momentum $p = p_f - p_i$ $= \frac{E}{c} - (-\frac{E}{c}) = \frac{E}{c} + \frac{E}{c} = 2\frac{E}{c}$ **ANSWER :** (b) $2\frac{E}{c}$
11)	Which of the following is an electromagnetic wave? (a) α - rays (b) β - rays (c) γ – rays (d) all of them	α – rays : helium nucleus, β – rays –electron, γ – rays- electromagnetic wave **ANSWER :** (c) γ – rays
12)	Which one of them is used to produce a propagating electromagnetic wave?. (a) an accelerating charge (b) a charge moving at constant velocity (c) a stationary charge (d) an uncharged particle	**ANSWER :** (a) an accelerating charge
13)	Let $E = E_0 \sin[10^6 x - \omega t]$ be the electric field of plane electromagnetic wave, the value of ω is (a) 0.3×10^{-14} rad s^{-1} (b) 3×10^{-14} rad s^{-1} (c) 0.3×10^{14} rad s^{-1} (d) 3×10^{14} rad s^{-1}	$E = E_0\sin[kx-\omega t]$---→ (1) $E = E_0\sin[10^6 x-\omega t]$ → (2) From eqn (1) and (2) $k= 10^6$ $k = \frac{\omega}{c}$ $\omega=kxc = 10^6 x 3x10^8$ $\omega = 3x10^{14}$ rad s^{-1}

		ANSWER : (d) 3×10^{14} rad s^{-1}
14)	Which of the following is NOT true for electromagnetic waves?. (a) it transport energy (b) it transport momentum (c) it transport angular momentum (d) in vacuum, it travels with different speeds which depend on their frequency	1)In vacuum, it travels with different speeds which depend on their frequency 2)Velocity of electromagnetic wave(light) is constant in vacuum. **ANSWER :** (d) in vacuum, it travels with different speeds which depend on their frequency
15)	The electric and magnetic fields of an electromagnetic wave are (a) in phase and perpendicular to each other (b) out of phase and not perpendicular to each other (c) in phase and not perpendicular to each other (d) out of phase and perpendicular to each other.	**ANSWER :** (a) in phase and perpendicular to each other

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