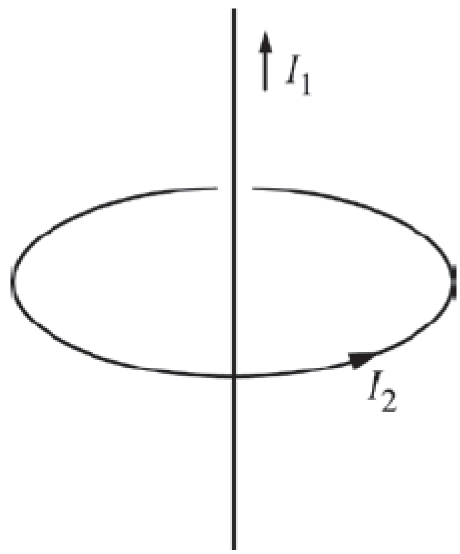
GRE Practice Questions — Electricity and Magnetism



4. An infinitely long, straight wire carrying current I_1 passes through the center of a circular loop of wire carrying current I_2, as shown above. The long wire is perpendicular to the plane of the loop. Which of the following describes the magnetic force on the loop?

   (A) Outward, along a radius of the loop.
   (B) Inward, along a radius of the loop.
   (C) Upward, along the axis of the loop.
   (D) Downward, along the axis of the loop.
   (E) There is no magnetic force on the loop.

17. A very long, thin, straight wire carries a uniform charge density of λ per unit length. Which of the following gives the magnitude of the electric field at a radial distance r from the wire?

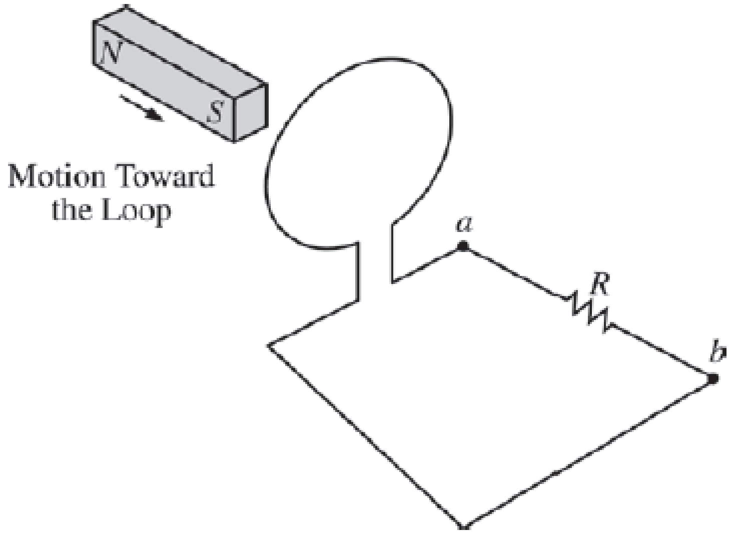
(A) $\frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$

(B) $\frac{1}{2\pi\varepsilon_0}\frac{r}{\lambda}$

(C) $\frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r^2}$

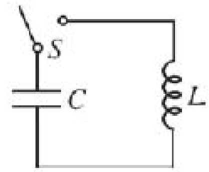
(D) $\frac{1}{4\pi\varepsilon_0}\frac{\lambda^2}{r^2}$

(E) $\frac{1}{4\pi\varepsilon_0}\lambda \ln r$

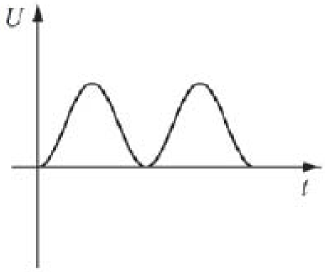


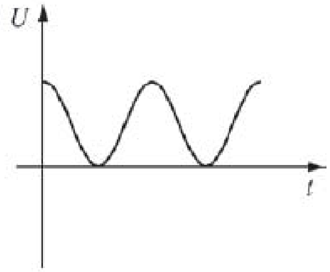
18. The bar magnet shown in the figure above is moved completely through the loop. Which of the following is a true statement about the direction of the current flow between the two points a and b in the circuit?

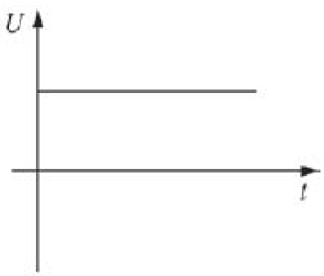
(A) No current flows between a and b as the magnet passes through the loop.
(B) Current flows from a to b as the magnet passes through the loop.
(C) Current flows from b to a as the magnet passes through the loop.
(D) Current flows from a to b as the magnet enters the loop and from b to a as the magnet leaves the loop.
(E) Current flows from b to a as the magnet enters the loop and from a to b as the magnet leaves the loop.

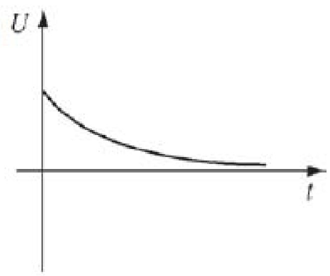


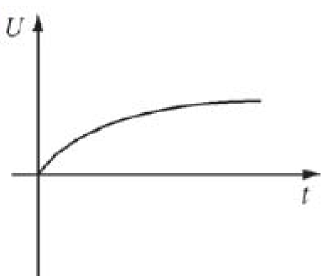
36. The capacitor in the circuit above is charged. If switch S is closed at time $t = 0$, which of the following represents the magnetic energy, U, in the inductor as a function of time? (Assume that the capacitor and inductor are ideal.)

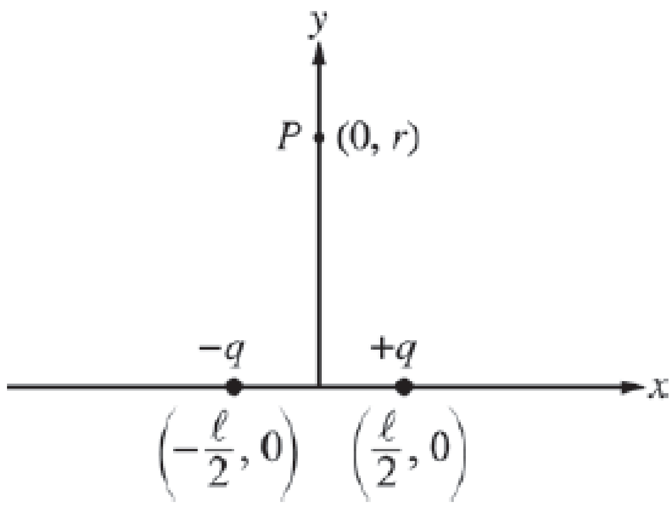
(A) 

(B) 

(C) 

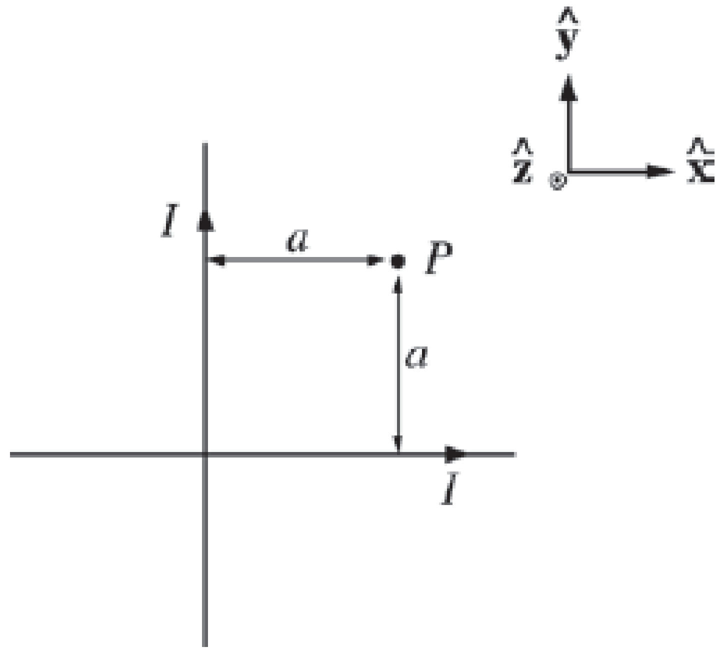
(D) 

(E) 



37. A pair of electric charges of equal magnitude q and opposite sign are separated by a distance ℓ, as shown in the figure above. Which of the following gives the approximate magnitude and direction of the electric field set up by the two charges at a point P on the y-axis, which is located a distance $r >> \ell$ from the x-axis?

	Magnitude	Direction
(A)	$\frac{1}{4\pi\epsilon_0}\frac{2q}{r^2}$	$+y$
(B)	$\frac{1}{4\pi\epsilon_0}\frac{2q}{r^2}$	$+x$
(C)	$\frac{1}{4\pi\epsilon_0}\frac{2q}{r^2}$	$-x$
(D)	$\frac{1}{4\pi\epsilon_0}\frac{q\ell}{r^3}$	$+x$
(E)	$\frac{1}{4\pi\epsilon_0}\frac{q\ell}{r^3}$	$-x$



38. Consider two very long, straight, insulated wires oriented at right angles. The wires carry currents of equal magnitude I in the directions shown in the figure above. What is the net magnetic field at point P ?

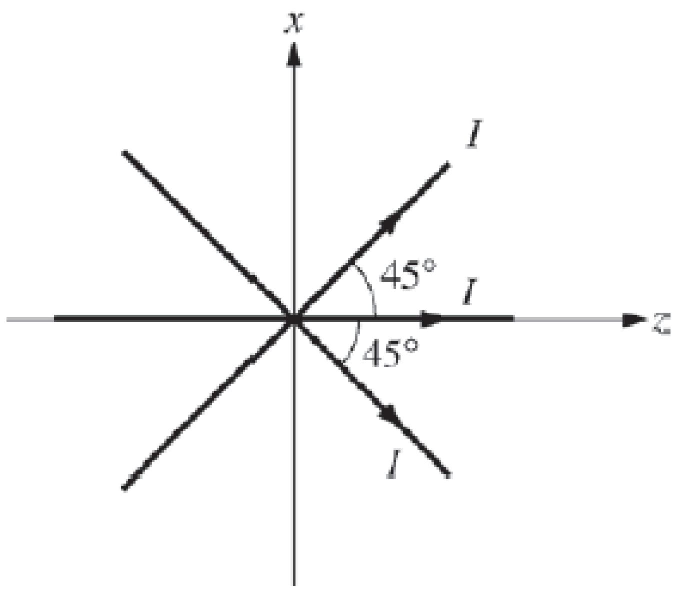
(A) $\dfrac{\mu_0 I}{2\pi a}(\hat{\mathbf{x}} + \hat{\mathbf{y}})$

(B) $-\dfrac{\mu_0 I}{2\pi a}(\hat{\mathbf{x}} + \hat{\mathbf{y}})$

(C) $\dfrac{\mu_0 I}{\pi a}\hat{\mathbf{z}}$

(D) $-\dfrac{\mu_0 I}{\pi a}\hat{\mathbf{z}}$

(E) $\mathbf{0}$



60. Three long, straight wires in the xz-plane, each carrying current I, cross at the origin of coordinates, as shown in the figure above. Let $\hat{\mathbf{x}}$, $\hat{\mathbf{y}}$, and $\hat{\mathbf{z}}$ denote the unit vectors in the x-, y-, and z-directions, respectively. The magnetic field $\mathbf{B}$ as a function of x, with $y = 0$ and $z = 0$, is

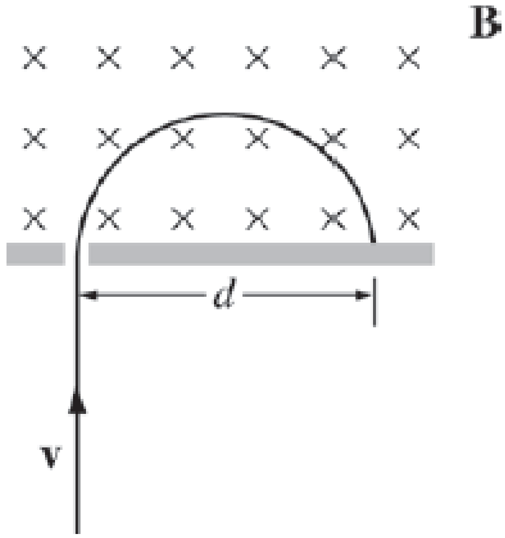
(A) $\mathbf{B} = \frac{3\mu_0 I}{2\pi x}\hat{\mathbf{x}}$

(B) $\mathbf{B} = \frac{3\mu_0 I}{2\pi x}\hat{\mathbf{y}}$

(C) $\mathbf{B} = \frac{\mu_0 I}{2\pi x}\left(1 + 2\sqrt{2}\right)\hat{\mathbf{y}}$

(D) $\mathbf{B} = \frac{\mu_0 I}{2\pi x}\hat{\mathbf{x}}$

(E) $\mathbf{B} = \frac{\mu_0 I}{2\pi x}\hat{\mathbf{y}}$



61. A particle with mass m and charge q, moving with a velocity $\mathbf{v}$, enters a region of uniform magnetic field $\mathbf{B}$, as shown in the figure above. The particle strikes the wall at a distance d from the entrance slit. If the particle's velocity stays the same but its charge-to-mass ratio is doubled, at what distance from the entrance slit will the particle strike the wall?

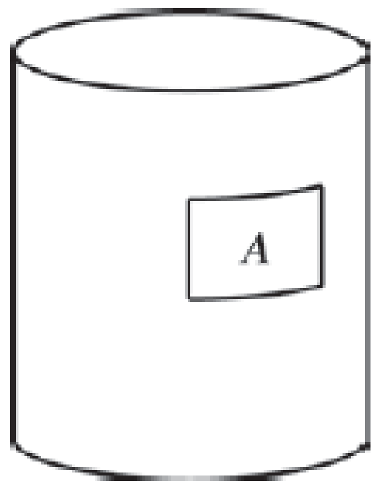
(A) $2d$

(B) $\sqrt{2}d$

(C) d

(D) $\frac{1}{\sqrt{2}}d$

(E) $\frac{1}{2}d$



62. Consider the closed cylindrical Gaussian surface above. Suppose that the net charge enclosed within this surface is $+1 \times 10^{-9}$ C and the electric flux out through the portion of the surface marked A is -100 N·m^2/C. The flux through the rest of the surface is most nearly given by which of the following?

(A) -100 N·m^2/C
(B) 0 N·m^2/C
(C) 10 N·m^2/C
(D) 100 N·m^2/C
(E) 200 N·m^2/C

67. A large, parallel-plate capacitor consists of two square plates that measure 0.5 m on each side. A charging current of 9 A is applied to the capacitor. Which of the following gives the approximate rate of change of the electric field between the plates?

(A) $2\ \frac{\text{V}}{\text{m}\cdot\text{s}}$

(B) $40\ \frac{\text{V}}{\text{m}\cdot\text{s}}$

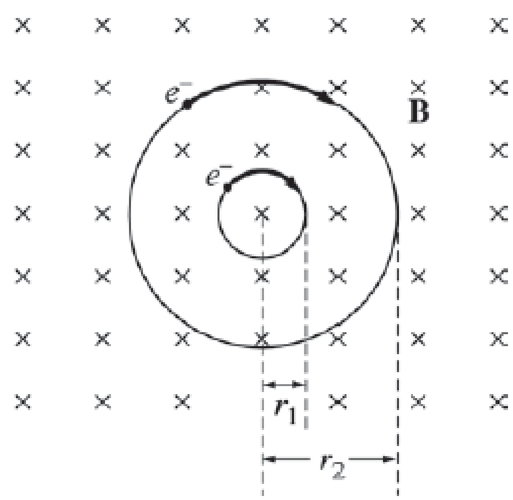
(C) $1 \times 10^{12}\ \frac{\text{V}}{\text{m}\cdot\text{s}}$

(D) $4 \times 10^{12}\ \frac{\text{V}}{\text{m}\cdot\text{s}}$

(E) $2 \times 10^{13}\ \frac{\text{V}}{\text{m}\cdot\text{s}}$

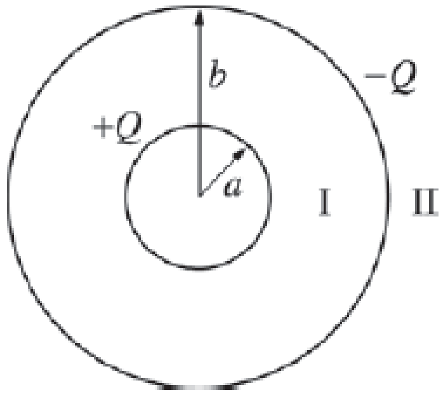
70. A wire loop that encloses an area of 10 cm^2 has a resistance of $5\,\Omega$. The loop is placed in a magnetic field of 0.5 T with its plane perpendicular to the field. The loop is suddenly removed from the field. How much charge flows past a given point in the wire?

(A) 10^{-4} C
(B) 10^{-3} C
(C) 10^{-2} C
(D) 10^{-1} C
(E) 1 C



71. Two nonrelativistic electrons move in circles under the influence of a uniform magnetic field **B**, as shown in the figure above. The ratio r_1/r_2 of the orbital radii is equal to 1/3. Which of the following is equal to the ratio υ_1/υ_2 of the speeds?

(A) 1/9
(B) 1/3
(C) 1
(D) 3
(E) 9



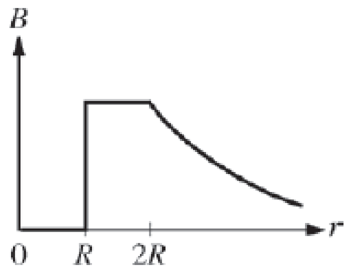
90. Two thin, concentric, spherical conducting shells are arranged as shown in the figure above. The inner shell has radius a, charge $+Q$, and is at zero electric potential. The outer shell has radius b and charge $-Q$. If r is the radial distance from the center of the spheres, what is the electric potential in region I $(a < r < b)$ and in region II $(r > b)$?

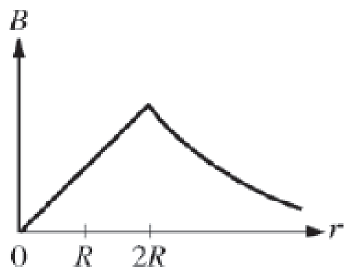
	Region I	Region II
(A)	$\frac{Q}{4\pi\varepsilon_0}\frac{1}{r}$	0
(B)	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{a}\right)$	0
(C)	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{b}\right)$	$-\frac{Q}{4\pi\varepsilon_0}\frac{1}{r}$
(D)	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{a}\right)$	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{b}-\frac{1}{a}\right)$
(E)	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r}-\frac{1}{b}\right)$	$\frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

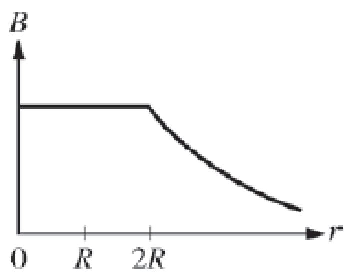
91. In static electromagnetism, let $\mathbf{E}$, $\mathbf{B}$, $\mathbf{J}$, and ρ be the electric field, magnetic field, current density, and charge density, respectively. Which of the following conditions allows the electric field to be written in the form $\mathbf{E} = -\nabla\phi$, where ϕ is the electrostatic potential?

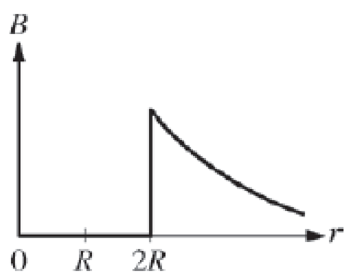
(A) $\nabla \cdot \mathbf{J} = 0$
(B) $\nabla \cdot \mathbf{E} = \rho/\epsilon_0$
(C) $\nabla \times \mathbf{E} = \mathbf{0}$
(D) $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$
(E) $\nabla \cdot \mathbf{B} = 0$

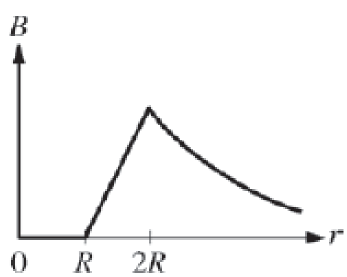
92. A long, straight, hollow cylindrical wire with an inner radius R and an outer radius $2R$ carries a uniform current density. Which of the following graphs best represents the magnitude of the magnetic field as a function of the distance from the center of the wire?

(A)


(B)


(C)


(D)


(E)


93. A parallel-plate capacitor has plate separation d. The space between the plates is empty. A battery supplying voltage V_0 is connected across the capacitor, resulting in electromagnetic energy U_0 stored in the capacitor. A dielectric, of dielectric constant κ, is inserted so that it just fills the space between the plates. If the battery is still connected, what are the electric field E and the energy U stored in the dielectric, in terms of V_0 and U_0?

	E	U
(A)	$\frac{V_0}{d}$	U_0
(B)	$\frac{V_0}{d}$	κU_0
(C)	$\frac{V_0}{d}$	$\kappa^2 U_0$
(D)	$\frac{V_0}{\kappa d}$	U_0
(E)	$\frac{V_0}{\kappa d}$	κU_0

QUESTION			TOTAL	
Number	Answer	P +	C	I
1	B	72		
2	D	88		
3	E	60		
4	E	72		
5	A	94		
6	E	73		
7	C	74		
8	D	59		
9	E	78		
10	B	85		
11	C	83		
12	C	36		
13	A	59		
14	B	11		
15	E	59		
16	D	74		
17	A	70		
18	E	42		
19	A	53		
20	A	35		
21	C	57		
22	C	76		
23	B	16		
24	B	52		
25	E	83		
26	D	64		
27	C	30		
28	D	63		
29	C	47		
30	D	51		
31	C	73		
32	A	19		
33	E	72		
34	C	45		
35	B	30		
36	A	50		
37	E	53		
38	E	83		
39	C	53		
40	B	20		
41	B	58		
42	E	47		
43	D	39		
44	D	27		
45	C	15		
46	D	25		
47	D	32		
48	C	39		
49	D	49		
50	C	39		

QUESTION			TOTAL	
Number	Answer	P +	C	I
51	D	69		
52	C	56		
53	D	50		
54	E	71		
55	A	45		
56	D	52		
57	B	59		
58	A	39		
59	C	60		
60	C	58		
61	E	73		
62	E	41		
63	D	47		
64	D	64		
65	C	66		
66	D	34		
67	D	26		
68	D	33		
69	D	51		
70	A	29		
71	B	65		
72	D	70		
73	D	11		
74	E	40		
75	B	19		
76	B	32		
77	C	39		
78	B	80		
79	D	49		
80	C	50		
81	B	60		
82	D	60		
83	E	48		
84	E	67		
85	B	56		
86	B	60		
87	D	74		
88	D	27		
89	D	49		
90	D	21		
91	C	60		
92	E	67		
93	B	21		
94	C	12		
95	D	51		
96	D	17		
97	E	20		
98	D	49		
99	E	40		
100	E	67		