

Chemistry

1. Which of the following reactions will yield 2,2-dibromopropane?

- A) $CH_3 - CH = CH_2 + HBr \rightarrow$
 B) $C \equiv CH + 2HBr \rightarrow$
 C) $CH_3CH = CHBr + HBr \rightarrow$
 D) $CH_3CH_2C \equiv CH + 2HBr \rightarrow$

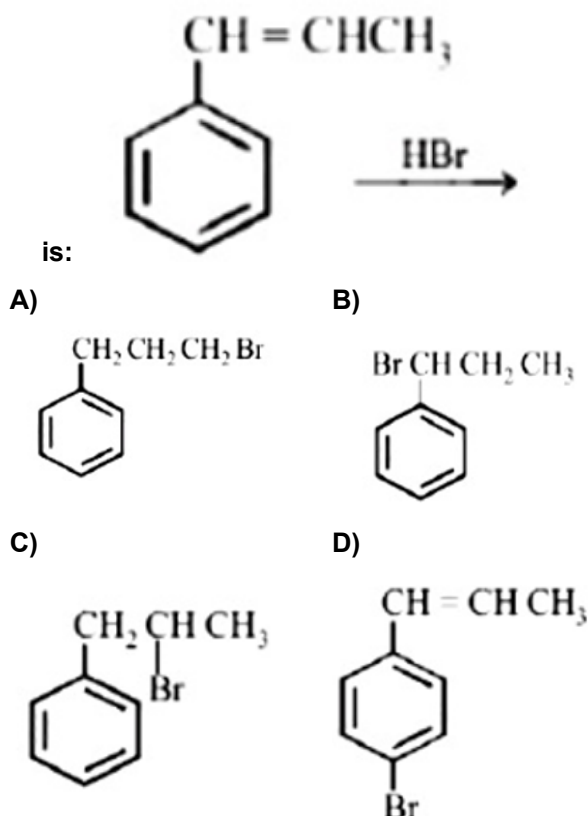
2. The hydrocarbon which can react with sodium in liquid ammonia is

- A) $CH_3CH_2CH_2C \equiv CH$
 B) $CH_3CH_2C \equiv CH$
 C) $CH_3CH = CHCH_3$
 D) $CH_3CH_2C \equiv CCH_2CH_3$

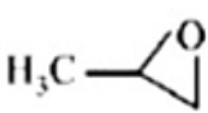
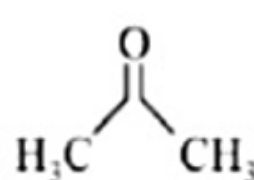
3. In the hydroboration - oxidation reaction of propene with diborane, H_2O_2 and NaOH, the organic compound formed is

- A) CH_3CH_2OH
 B) $CH_3CHOHCH_3$
 C) $CH_3CH_2CH_2OH$
 D) $(CH_3)_3COH$

4. The major product of the following reaction



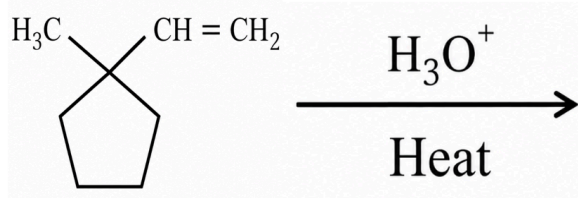
5. The major product of the following addition reaction is: $H_3C - CH = CH_2 \xrightarrow{Cl_2/H_2O}$

- A) $H_3C - \underset{\text{Cl}}{CH} - \underset{OH}{CH_2}$
 B) $H_3C - \underset{OH}{CH} - \underset{Cl}{CH_2}$
 C) 
 D) 

6. But-2-ene on reaction with alkaline KMnO_4 at elevated temperature followed by acidification will give:

- A) $\text{CH}_3 - \underset{\text{OH}}{\text{CH}} - \underset{\text{OH}}{\text{CH}} - \text{CH}_3$ B) One molecule of CH_3CHO and one molecule of CH_3COOH
- C) 2 molecules of CH_2COOH D) 2 molecules of CH_3CHO

7. The major product in the following reaction is:

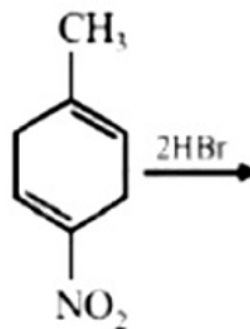


- A)
- B)
- C)
- D)

8. The major product formed in the following reaction is: $\text{CH}_3\text{CH}=\text{CHCH}(\text{CH}_3)_2 \xrightarrow{\text{HBr}}$

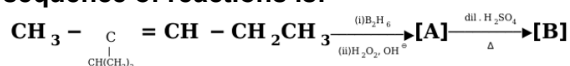
- A) $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}(\text{CH}_3)_2$ B) $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{CH}(\text{CH}_3)_2$
- C) $\text{Br}(\text{CH}_2)_3\text{CH}(\text{CH}_3)_2$ D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{Br})(\text{CH}_3)_2$

9. The major product of the following reaction is



- A)
- B)
- C)
- D)

10. The major product [B] in the following sequence of reactions is:



- A) $\text{CH}_2 = \underset{\text{CH}(\text{CH}_3)_2}{\text{C}} - \text{CH}_2\text{CH}_2\text{CH}_3$ B) $\text{CH}_3 - \underset{\text{C}(\text{CH}_3)_2}{\text{C}} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
- C) $\text{CH}_3 - \underset{\text{CH}(\text{CH}_3)_2}{\text{C}} = \text{CH} - \text{CH}_2\text{CH}_3$ D) $\text{CH}_3 - \underset{\text{CH}(\text{CH}_3)_2}{\text{CH}} - \text{CH} = \text{CH} - \text{CH}_3$

11. The correct order of heat of combustion for the following alkadienes is:

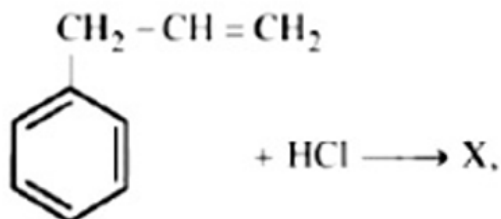


- A) (A) < (B) < (C) B) (A) < (C) < (B)
C) (C) < (B) < (A) D) (B) < (C) < (A)

12. Which one of the following alkenes when treated with HCl yields majorly an anti-Markovnikov product?

- A) $\text{CH}_3\text{O}-\text{CH}=\text{CH}_2$ B) $\text{Cl}-\text{CH}=\text{CH}_2$
C) $\text{H}_2\text{N}-\text{CH}=\text{CH}_2$ D) $\text{F}_3\text{C}-\text{CH}=\text{CH}_2$

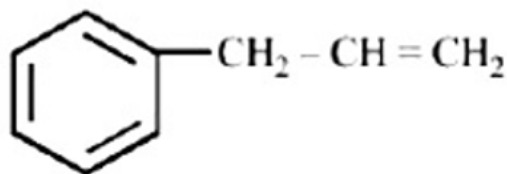
13.



X is

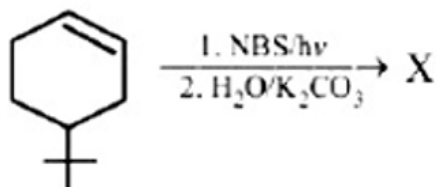
- A) B)
C) D)

14. On mercuration-demercuration produces the major product :



- A) B)
C) D)

15. The product of the reaction given below is:



- A) B)
C) D)

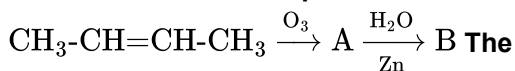
16. The reaction of propene with HOCl(
 $\text{Cl}_2 + \text{H}_2\text{O}$) proceeds through the intermediate:

- A) $\text{CH}_3-\text{CH}(\text{OH})-\text{CH}_2^+$ B) $\text{CH}_3-\text{CHCl}-\text{CH}_2^+$
C) $\text{CH}_3-\text{CH}^+-\text{CH}_2-$ D) $\text{CH}_3-\text{CH}^+-\text{CH}_2-\text{Cl}$

17. Reaction of one molecule of HBr with one molecule of 1,3-butadiene at 40°C gives predominantly

- A) 1-bromo-2-butene under kinetically controlled conditions
 B) 3-bromobutene under thermodynamically controlled conditions
 C) 1-bromo-2-butene under thermodynamically controlled conditions
 D) 3-bromobutene under kinetically controlled conditions

18. In the following sequence of reactions, the alkene affords the compound B:



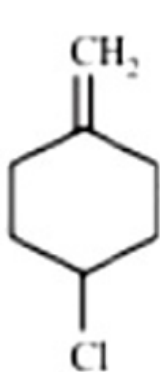
The compound B is

- A) $\text{CH}_3\text{CH}_2\text{CHO}$ B) CH_3COCH_3
 C) $\text{CH}_3\text{CH}_2\text{COCH}_3$ D) CH_3CHO

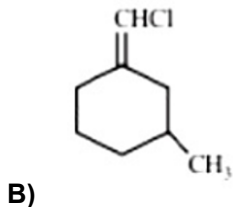
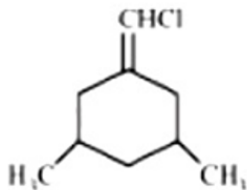
19. The addition of HI in the presence of peroxide catalyst does not follow anti-Markovnikov's rule because:

- A) HI is a strong reducing agent.
 B) H-I bond is too strong to be broken homolytically.
 C) I atom combines with H atom to give back HI.
 D) Iodine atom is not reactive enough to add across a double bond.

20. Among the following compounds, geometrical isomerism is exhibited by:

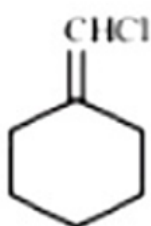


A)
C)



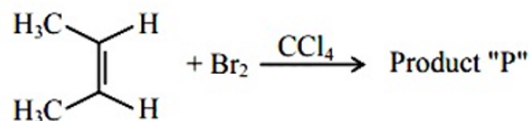
B)

D)



21. An alkene A on ozonolysis gives only ethanal as the carbonyl product. The total number of secondary carbon atoms present in alkene A is _____.

22.



Consider the above chemical reaction. The total number of stereoisomers possible for Product 'P' is _____.

23. How many structural isomers (excluding cis-trans isomerism) are possible for the molecular formula C_5H_{10} considering only acyclic alkenes?

24. One mole of an alkene completely reacts with hydrogen in the presence of Ni catalyst. If exactly 22.4 L of hydrogen is consumed at STP, the number of carbon-carbon double bonds present in the alkene molecule is _____.

25. The total number of π bonds present in all the products formed after complete ozonolysis of one molecule of buta-1,3-diene is _____.

Maths

26. The number of permutations that can be made out of the letters of the word "MATHEMATICS" When no two vowels come together is

- A) $7! \times {}^8P_4$ B) $\frac{7!}{2!2!} \times \frac{{}^8P_4}{2!}$
 C) $\frac{7! \times {}^8P_4}{(2!)^3}$ D) $\frac{{}^8P_4}{2!}$

27. The number of ways of permuting the letters of the word DEVIL so that neither D is the first letter nor L is the last letter is:

- A) 36 B) 114
 C) 42 D) 78

28. How many nine-digit numbers can be formed by using the digits 2, 2, 3, 3, 5, 5, 8, 8, 8 so that the odd digits occupy even positions?

- A) 7560 B) 180
 C) 16 D) 60

29. The number of ways in which two Americans, two British, one Chinese, one Dutch, and one Indian can sit on a round table so that persons of the same nationality are separated is:
- A) 344 B) 246
C) 336 D) 384
30. The number of ways to give away 20 apples to 3 boys, each boy receiving at least 4 apples, is:
- A) 90 B) ${}^{22}C_{20}$
C) ${}^{12}C_4$ D) ${}^{10}C_8$
31. The number of permutations of the letters of the word H I N D U S T A N such that neither the pattern 'H I N' nor 'D U S' nor 'T A N' appears are:
- A) 166680 B) 181434
C) 166674 D) 169194
32. The number of different words that can be formed using all the letters of the word 'SHASHANK' such that in any word the vowels are separated by at least two consonants is:
- A) 2700 B) 1800
C) 900 D) 600
33. The number of ways a mixed double game can be arranged from amongst 9 couples if no husband and wife play in the same game is:
- A) 756 B) 1512
C) 3024 D) none of these
34. The number of ways in which one can post 5 letters in 7 letters boxes is:
- A) 35 B) 7P_5
C) 7^5 D) 5^7
35. A man has 7 friends. In how many ways he can invite one or more of them for a tea party?
- A) 128 B) 256
C) 127 D) 130
36. The number of 4-digit even numbers that can be formed using 0, 1, 2, 3, 4, 5, 6 without repetition is:
- A) 120 B) 300
C) 420 D) 20
37. The letters of the word RANDOM are written in all possible orders and these words are written out as in a dictionary, then the rank of the word RANDOM is:
- A) 614 B) 615
C) 613 D) 616
38. The number of ways of arranging 8 men and 4 women around a circular table such that no two women can sit together, is:
- A) 8! B) 4!
C) $8! \cdot 4!$ D) $7! \cdot {}^8P_4$
39. How many words can be made from the letters of the word 'COMMITTEE'?
- A) $\frac{9!}{(2!)^2}$ B) $\frac{9!}{(2!)^3}$
C) $\frac{9!}{2!}$ D) 9!
40. If the letters of the word 'SACHIN' are arranged in all possible ways and these words are written out as in dictionary, then the word 'SACHIN' appears at serial number:
- A) 602 B) 603
C) 600 D) 601
41. How many words can be formed from the letters of the word ARTICLE, if vowels always comes at the odd places?
- A) 60 B) 576
C) $\frac{7!}{3!}$ D) 120
42. The number of ways in which seven persons can be arranged at a round table, if two particular persons may not sit together is:
- A) 480 B) 120
C) 80 D) None of these
43. The number of ways in which a committee can be formed of 5 members from 6 men and 4 women if the committee has at least one woman, is:
- A) 186 B) 246
C) 252 D) 244
44. The number of arrangements which can be made using all the letters of the word LAUGH, if the vowels are adjacent, is:
- A) 10 B) 24
C) 48 D) 120

45. Eleven books consisting of 5 Mathematics, 4 Physics and 2 Chemistry are placed on a shelf. The number of possible ways of arranging them on the assumption that the books of the same subject are all together, is:

- A) $4! \cdot 2!$ B) $11!$
C) $5! \cdot 4! \cdot 3! \cdot 2!$ D) None of these

46. No of ways of arranging the letters of the word BANANA so that letters of the same kind are together is:

47. The number of ways that all the letters of the word SWORD can be arranged such that no letter is in its original position is:

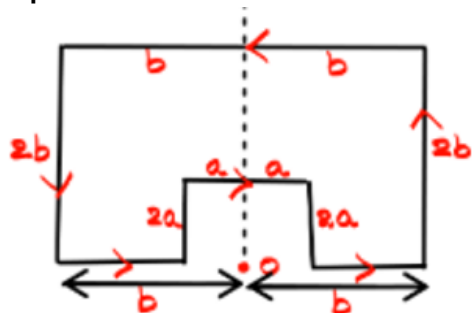
48. The number of divisors of the number 38808(excluding 1 and the number itself) is:

49. The number of ways of forming an arrangement of 5 letters from the letters of the word "IITJEE" is:

50. There are 5 letters and 5 different envelopes. The number of ways in which all the letters can be put in wrong envelope, is:

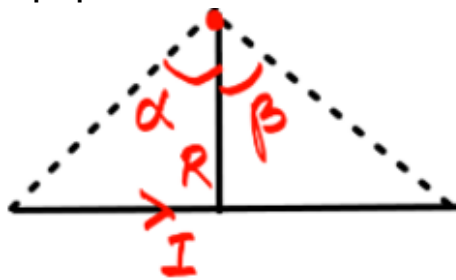
Physics

51. A constant current I is flowing in a piece of wire that is bent into a loop as shown in the figure. The magnitude of the magnetic field at the point 'O' is



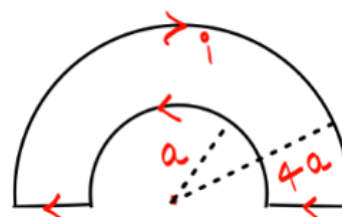
- A) $\frac{\mu_0 I \sqrt{5}}{4\pi} \ln \frac{a}{b}$ B) $\frac{\mu_0 I \sqrt{5}}{4\pi} \left(\frac{1}{a} - \frac{1}{b} \right)$
C) $\frac{\mu_0 I}{4\pi \sqrt{5}} \left(\frac{1}{a} - \frac{1}{b} \right)$ D) $\frac{\mu_0 I}{4\pi} \left(1 + \frac{1}{\sqrt{5}} \right) \ln \frac{a}{b}$

52. The magnetic field at a distance R from a long straight wire carrying a steady current I is proportional to



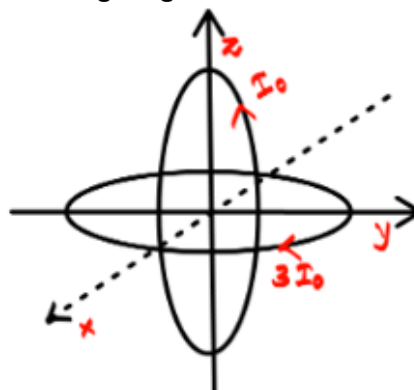
- A) IR B) $\frac{I}{R^2}$
C) $\frac{I^2}{R^2}$ D) $\frac{I}{R}$

53. The loop shown in the figure below carries a steady current I . The magnitude of magnetic field at the point 'O' is.



- A) $\frac{5\mu_0 I}{16a} \otimes$ B) $\frac{\mu_0 I}{4a} \odot$
C) $\frac{\mu_0 I}{16a} \otimes$ D) $\frac{3\mu_0 I}{16a} \odot$

54. Two current carrying circular loops, each of radius R , are placed perpendicular to each other as shown in the figure below. The loop in the xy -plane carries a current $3I_0$ while that in the xz plane carries a current I_0 . The resulting magnetic field $\vec{B}$ at the origin is.

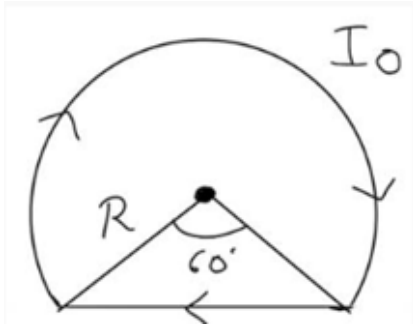


- A) $\frac{\mu_0 I_0}{2R} (-3\hat{z} + \hat{y})$ B) $\frac{\mu_0 I_0}{2R} (-3\hat{z} - \hat{y})$
C) $\frac{\mu_0 I_0}{2R} (3\hat{z} - \hat{y})$ D) $\frac{(\mu_0 I_0)}{2R} (3\hat{z} + \hat{y})$

55. The force between two long and parallel wires carrying current I_1 and I_2 separated by a distance D is proportional to

- A) $\frac{I_1 I_2}{D}$ B) $\frac{(I_1 + I_2)}{D}$
C) $\left(\frac{I_1 I_2}{D} \right)^2$ D) $\frac{I_1 I_2}{D^2}$

56. A conducting wire carrying current I_0 is bent in the shape of a loop as shown in the figure. The magnetic field at point o is given by

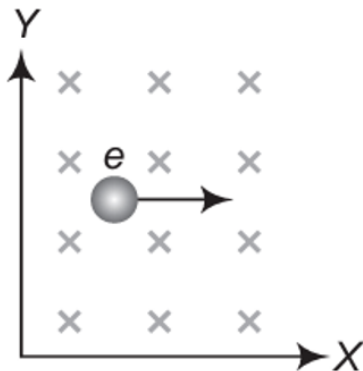


- A) $\frac{\mu_0 I_0}{4R}$ B) $\frac{5\mu_0 I_0}{12R} \left[1 + \frac{2\sqrt{3}}{5\pi} \right]$
 C) $\frac{3\mu_0 I_0}{5R} \left[1 + \frac{\sqrt{3}}{10\pi} \right]$ D) $\frac{3\mu_0 I_0}{5R} \left[1 - \frac{\sqrt{3}}{10\pi} \right]$

57. A charged particle of mass m and charge q describes circular motion of radius r in a uniform magnetic field of strength B . The frequency of revolution is

- A) $\frac{Bq}{2\pi m}$ B) $\frac{Bq}{2\pi r m}$
 C) $\frac{2\pi m}{Bq}$ D) $\frac{Bm}{2\pi q}$

58. In the given figure, the electron enters into the magnetic field. It will deflect in:

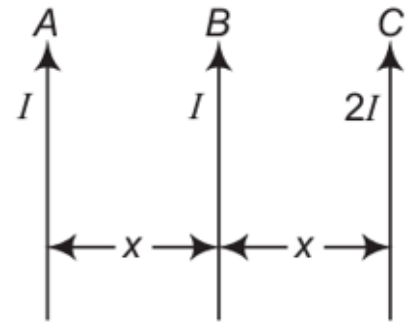


- A) Positive Y-direction B) Negative Y-direction
 C) Positive X-direction D) Negative X-direction

59. A proton, a deuteron and an α -particle, having the same kinetic energy, are moving in circular trajectories in a constant magnetic field. If r_p , r_d and r_α denote, respectively the radii of the trajectories of these particles, then

- A) $r_\alpha = r_p < r_d$ B) $r_\alpha > r_d > r_p$
 C) $r_\alpha = r_d > r_p$ D) $r_p = r_d = r_\alpha$

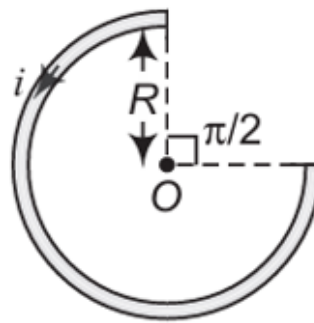
60. A, B and C are parallel conductors of equal length carrying currents I , I and $2I$ respectively. Distance between A and B is x . Distance between B and C is also x . F_1 is the force exerted by B on A. F_2 is the force exerted by C on A. Choose the correct



answer.

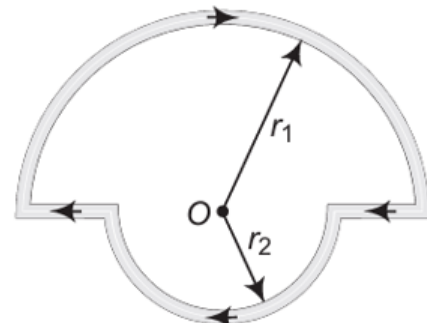
- A) $F_1 = 2F_2$ B) $F_2 = 2F_1$
 C) $F_1 = F_2$ D) $F_1 = -F_2$

61. A current i ampere flows in a circular arc of wire whose radius is R , which subtend an angle $3\pi/2$ radian at its centre. The magnetic induction B at the centre is



- A) $\frac{\mu_0 i}{R}$ B) $\frac{\mu_0 i}{2R}$
 C) $\frac{2\mu_0 i}{R}$ D) $\frac{3\mu_0 i}{8R}$

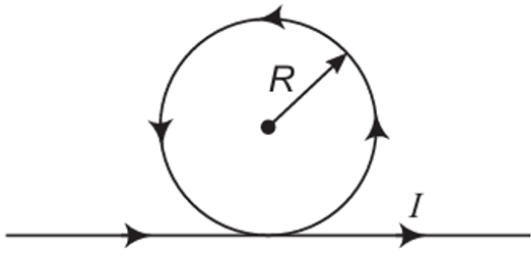
62. In the figure shown there are two semicircles of radii r_1 and r_2 which a current i is flowing. The magnetic induction at the centre O will



be

- A) $\frac{\mu_0 i (r_1 + r_2)}{4}$ B) $\frac{\mu_0 i (r_1 - r_2)}{4}$
 C) $\frac{\mu_0 i}{4} \left(\frac{1}{r_1} + \frac{1}{r_2} \right)$ D) $\frac{\mu_0 i}{4} \left(\frac{1}{r_2} - \frac{1}{r_1} \right)$

63. An infinitely long conductor is bent into a circle as shown in figure. It carries a current I ampere and the radius of loop is R metre. The magnetic induction at the centre of loop is

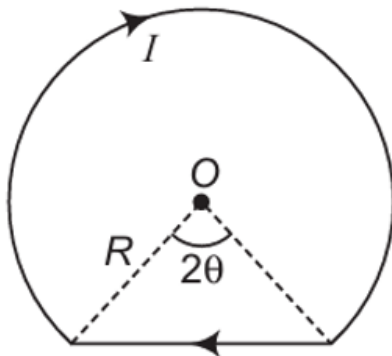


- A) $\frac{\mu_0 2I}{4\pi R} (\pi + 1)$ B) $\frac{\mu_0 2I}{4\pi R} (\pi - 1)$
 C) $\frac{\mu_0 I}{8\pi R} (\pi + 1)$ D) zero

64. A circular current carrying coil has a radius R . The distance from the centre of the coil on the axis of the coil, where the magnetic induction is $1/8$ th of its value at the centre of coil is

- A) $\sqrt{3}R$ B) $R/\sqrt{3}$
 C) $(2/3)R$ D) $R/2\sqrt{3}$

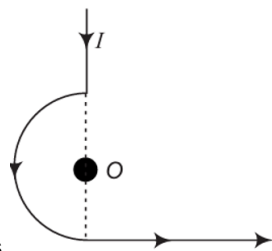
65. A current I flows through a closed loop shown in figure. The magnetic field at the



centre O is

- A) $\frac{\mu_0 I}{2\pi R} (\pi - \theta + \tan \theta)$ B) $\frac{\mu_0 I}{2\pi R} (\pi - \theta + \sin \theta)$
 C) $\frac{\mu_0 I}{2\pi R} (\pi + \sin \theta)$ D) None of these

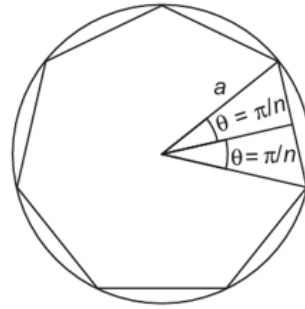
66. Magnetic field induction at the point O due to current flowing in an infinite wire shaped as



shown in the figure is

- A) $\frac{\mu_0 I}{4\pi R}$ B) $\frac{\mu_0 I}{4R} - \frac{\mu_0 I}{4\pi R}$
 C) $\frac{\mu_0 I}{4R} + \frac{\mu_0 I}{2\pi R}$ D) $\frac{\mu_0 I}{4R} + \frac{\mu_0 I}{4\pi R}$

67. A wire bent in the form of a regular polygon of n sides, is inscribed in a circle of radius a . If i ampere is the current flowing in the wire, then the magnetic flux density (magnetic field) at the centre of the circle is

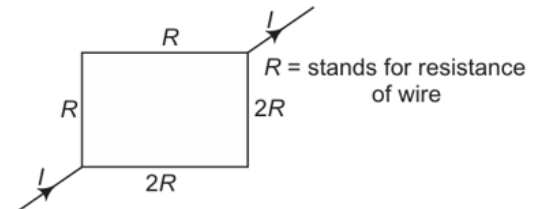


- A) $\frac{\mu_0 i}{2\pi a} \tan \left(\frac{\pi}{n} \right)$ B) $\frac{\mu_0 n i}{2\pi a} \tan \left(\frac{\pi}{n} \right)$
 C) $\frac{2}{\pi} \frac{n i}{a} \mu_0 \tan \left(\frac{\pi}{n} \right)$ D) $\frac{n i}{2a} \mu_0 \tan \left(\frac{\pi}{n} \right)$

68. A square frame of side 1 m carries a current I , produces a magnetic field B at its centre. The same current is passed through a circular coil having the same perimeter as the square. The magnetic field at the centre of the circular coil is B' . The ratio B/B' is:

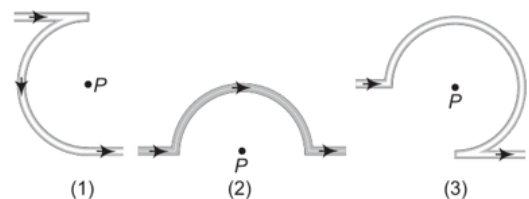
- A) $\frac{8\sqrt{2}}{\pi^2}$ B) $\frac{8}{\sqrt{2}\pi^2}$
 C) $\frac{16}{\pi^2}$ D) $\frac{16}{2\sqrt{2}\pi^2}$

69. The magnetic field at the centre of square of side a is



- A) $2\mu_0 \pi a$ B) $\frac{\sqrt{2}\mu_0 I}{3\pi a}$
 C) $\frac{2\sqrt{2}\mu_0 I}{3a}$ D) zero

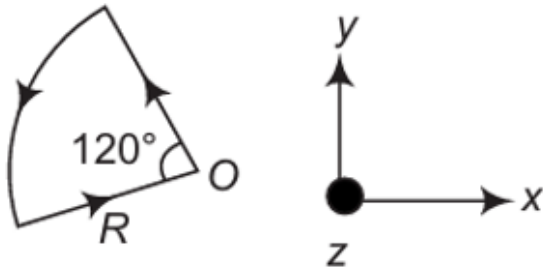
70. Figure here shows three cases : in all cases the circular path has radius r and straight ones are infinitely long. For same current the magnetic field at the centre P in cases 1, 2, 3 have the ratio



- A) $\left(-\frac{\pi}{2} \right) : \left(\frac{\pi}{2} \right) : \left(\frac{3\pi}{4} - \frac{1}{2} \right)$ B) $\left(-\frac{\pi}{2} + 1 \right) : \left(\frac{\pi}{2} + 1 \right) : \left(\frac{3\pi}{4} + \dots \right)$
 C) $-\frac{\pi}{2} : \frac{\pi}{2} : 3\frac{\pi}{4}$ D) $\left(-\frac{\pi}{2} - 1 \right) : \left(\frac{\pi}{2} - \frac{1}{4} \right) : \left(\frac{3\pi}{4} + \dots \right)$

71. The magnetic field at the centre of a circular coil of radius r carrying current I is B_1 . The field at the centre of another coil of radius $2r$ carrying same current I is B_2 . The ratio B_1/B_2 is _____

72. The magnetic field B at O due to current carrying loop placed in the $x - y$ plane as shown in the figure is $\frac{\mu_0 I}{xR} \hat{k}$, where x is?



73. Consider a planar wire loop having a square shape with side length a . If a steady current I flows through the wire, the magnitude of magnetic field at the centre of the loop is $\frac{2\sqrt{x}\mu_0 I}{\pi a}$, where x is?

74. A wire of length 4 m carrying a current of 1 A is bent to form a circle. The magnetic moment of the coil is (in A m^2) is x/π , where x is:

75. A circular current carrying coil has a radius R . The distance from the centre of the coil on the axis of the coil, where the magnetic induction is $1/(5\sqrt{5})$ of its value at the centre of coil is x times R , where x is?

ANSWER KEY

Chemistry

1.	2	8.	4	15.	4	22.	2
2.	2	9.	4	16.	4	23.	5
3.	3	10.	2	17.	3	24.	1
4.	2	11.	1	18.	4	25.	4
5.	2	12.	4	19.	4		
6.	3	13.	3	20.	3		
7.	2	14.	1	21.	2		

Maths

26.	2	33.	2	40.	4	47.	44
27.	4	34.	3	41.	2	48.	70
28.	4	35.	3	42.	1	49.	180
29.	3	36.	3	43.	2	50.	44
30.	4	37.	1	44.	3		
31.	4	38.	4	45.	3		
32.	1	39.	2	46.	6		

Physics

51.	2	58.	2	65.	1	72.	6
52.	4	59.	1	66.	4	73.	2
53.	4	60.	3	67.	2	74.	4
54.	1	61.	4	68.	1	75.	2
55.	1	62.	3	69.	2		
56.	2	63.	1	70.	2		
57.	1	64.	1	71.	2		

SOLUTIONS

Q1.

Answer: B

Explanation:

Addition of two equivalents of HBr to propyne follows Markovnikov's rule for both additions, placing both bromine atoms on the central carbon.

Q2.

Answer: B

Explanation:

Terminal alkynes possess acidic hydrogens that react with sodium in liquid ammonia to liberate hydrogen gas.

Q3.

Answer: C

Explanation:

Hydroboration-oxidation results in the overall anti-Markovnikov addition of water across a double bond, placing the hydroxyl group on the less substituted carbon.

Q4.

Answer: B

Explanation:

Hydrogen bromide adds to the double bond according to Markovnikov's rule. Protonation forms the more stable benzylic carbocation, which is then attacked by Br^- to give 1-bromo-1-phenylpropane.

Q5.

Answer: B

Explanation:

The reaction of an alkene with chlorine water ($\text{Cl}_2/\text{H}_2\text{O}$) forms a halohydrin. The addition is regioselective, following a Markovnikov-like path where the nucleophile (OH from water) attacks the more stable (more substituted) carbocation-like center.

Q6.

Answer: C

Explanation:

Hot alkaline potassium permanganate followed by acidification causes oxidative cleavage of the double bond. Since but-2-ene is a symmetrical alkene, it produces two molecules of acetic acid.

Q7.

Answer: B

Q8.

Answer: D

Explanation:

The reaction follows an ionic mechanism starting with the formation of a secondary carbocation, which then undergoes a 1,2-hydride shift to form a more stable tertiary carbocation before the bromide ion attacks.

Q9.

Answer: D

Q10.

Answer: B

Explanation:

Hydroboration-oxidation converts the alkene into an alcohol via anti-Markovnikov hydration. On heating with dilute sulfuric acid, the alcohol undergoes acid-catalyzed dehydration/rearrangement, yielding the major alkene shown as Option B.

Q11.

Answer: A

Explanation:

Heat of combustion is inversely proportional to the stability of the isomer. Trans-isomers are generally more stable than cis-isomers due to less steric hindrance.

Q12.

Answer: D

Explanation:

The strongly electron-withdrawing CF_3 group destabilizes the carbocation expected from Markovnikov addition. As a result, protonation occurs in the opposite direction, leading predominantly to the anti-Markovnikov product.

Q13.

Answer: C

Explanation:

The reaction involves the electrophilic addition of HCl to allyl benzene. It proceeds via a carbocation intermediate that undergoes a 1,2-hydride shift to form a more stable benzylic carbocation before the final attachment of the chloride ion.

Q14.

Answer: A

Explanation:

Oxymercuration-demercuration results in the Markovnikov addition of water across a double bond. Unlike standard acid-catalyzed hydration, this method avoids carbocation rearrangements.

Q15.

Answer: D

Q16.

Answer: D

Explanation:

The addition of hypochlorous acid (HOCl) to an alkene follows Markovnikov regioselectivity. The electrophile (Cl^+) adds to the terminal carbon to form the more stable secondary carbocation intermediate.

Q17.

Answer: C

Explanation:

At higher temperatures ($40^\circ C$), the 1,4-addition product is favored as it is the more stable thermodynamic product.

Q18.

Answer: D

Explanation:

The given alkene is 2-butene. On ozonolysis followed by reductive workup using zinc and water, the double bond is cleaved, producing two molecules of acetaldehyde (CH_3CHO).

Q19.

Answer: D

Explanation:

HI does not exhibit the peroxide effect (Kharasch effect) because the addition of the iodine radical to the double bond is endothermic. Instead of adding, iodine radicals prefer to recombine into molecular iodine.

Q20.

Answer: C

Explanation:

Geometrical (E/Z) isomerism is possible only when each carbon of the double bond is attached to two different groups. Among the given compounds, Option C satisfies this condition because the ring carbon of the exocyclic double bond is attached to two non-equivalent paths due to the two methyl substituents on the ring.

Q21.

Answer: 2

Explanation:

Only but-2-ene gives two molecules of ethanal on ozonolysis.

Q22.

Answer: 2

Explanation:

The addition of bromine to cis-but-2-ene is an anti-addition, which yields a racemic mixture of two enantiomers.

Q23.

Answer: 5

Explanation:

There are five constitutional isomers of acyclic alkenes with formula C_5H_{10} .

Q24.

Answer: 1

Explanation:

Each double bond consumes one mole of hydrogen during catalytic hydrogenation.

Q25.

Answer: 4

Explanation:

Complete ozonolysis converts each double bond into carbonyl groups.

Q26.

Answer: B

Explanation:

The word MATHEMATICS contains: 7 consonants: M, M, T, T, H, C, S 4 vowels: A, A, E, I Arrange the consonants first, creating 8 gaps. Then place the vowels in these gaps so that no two vowels are adjacent. Since there are repeated letters (M, M, T, T, and A, A), divide by the corresponding factorials.

Q27.

Answer: D

Explanation:

The solution uses the Principle of Inclusion-Exclusion by subtracting the restricted cases (starting with *D* or ending with *L*) from the total possible arrangements.

Q28.

Answer: D

Explanation:

Odd digits (3, 3, 5, 5) are placed in the four even positions of a nine-digit number, while even digits are placed in the remaining five positions.

Q29.

Answer: C

Explanation:

Subtract the cases where persons of the same nationality (American pairs or British pairs) sit together from the total circular arrangements.

Q30.

Answer: D

Explanation:

After satisfying the minimum requirement of 4 apples per boy, the remaining apples are distributed using the non-negative integral solution formula.

Q31.

Answer: D

Explanation:

Calculate total permutations (noting the repeated 'N') and subtract all cases where any of the three patterns occur using the Inclusion-Exclusion principle.

Q32.

Answer: A

Explanation:

Arrange the consonants first and then calculate the possible gap positions for the vowels such that the separation condition is met.

Q33.

Answer: B

Explanation:

Select two women, then select two men from the remaining couples such that no spouse is selected for the same game.

Q34.

Answer: C

Explanation:

Each of the 5 letters has 7 independent choices for a mailbox.

Q35.

Answer: C

Explanation:

For each friend, there are 2 choices (invite or not). Subtract the case where no one is invited.

Q36.

Answer: C

Explanation:

Calculate even numbers ending in 0 separately from those ending in 2, 4, or 6 to handle the zero-at-the-start restriction.

Q37.

Answer: A

Explanation:

List and count all words appearing alphabetically before the word "RANDOM."

Q38.

Answer: D

Explanation:

Arrange the men in a circle first, then place the women in the gaps between the men.

Q39.

Answer: B

Explanation:

The number of permutations of a word with repeated letters is the total factorial divided by the product of factorials of repeated letters.

Q40.

Answer: D

Explanation:

Count the words starting with letters that appear alphabetically before 'S'.

Q41.

Answer: B

Explanation:

Place the 3 vowels in the 4 available odd positions and the 4 consonants in the remaining 4 positions.

Q42.

Answer: A

Explanation:

Arrange the other 5 people first, then place the 2 restricted people into the gaps.

Q43.

Answer: B

Explanation:

Sum the ways of choosing (1 woman, 4 men), (2 women, 3 men), (3 women, 2 men), and (4 women, 1 man).

Q44.

Answer: C

Explanation:

Treat the adjacent vowels as a single block and arrange it with the other letters, then arrange vowels within the block.

Q45.

Answer: C

Explanation:

Arrange the three subject blocks, then arrange the individual books within each block.

Q46.

Answer: 6

Explanation:

Group the identical letters into blocks: $\{B\}$, $\{NN\}$, $\{AAA\}$. Arrange these blocks.

Q47.

Answer: 44

Explanation:

This is a derangement problem for 5 items (D_5).

Q48.

Answer: 70

Explanation:

Prime factorize the number and use the divisor formula, then subtract the two excluded cases.

Q49.

Answer: 180

Explanation:

Consider two cases: (2 identical pairs + 1 different) and (1 identical pair + 3 different).

Q50.

Answer: 44

Explanation:

This is a standard derangement problem for $n = 5$ letters.

Q51.

Answer: B

Explanation:

The horizontal wire segments lying on the axis passing through point 'O' produce zero magnetic field because the angle between the current element and position vector is 0° or 180° ($d\vec{l} \times \vec{r} = 0$). The net magnetic field is solely due to the vertical segments. Using the Biot-Savart law for finite wires, the field is calculated for the inner vertical segments (at distance a) and outer vertical segments (at distance b). Since the currents in the inner and outer loops flow in opposite directions relative to the center, their magnetic fields subtract. The geometric factor $\sqrt{5}$ arises from the specific ratio of the vertical segment lengths to their perpendicular distances from 'O', resulting in the net field expression: $B_{net} \propto \left(\frac{1}{a} - \frac{1}{b}\right)$

Q52.

Answer: D

Explanation:

The magnetic field (B) produced by a long, straight wire carrying a steady current (I) at a perpendicular distance (R) is given by Ampere's Law (or derived from the Biot-Savart Law). The formula is: $B = \frac{\mu_0 I}{2\pi R}$ Where: μ_0 is the permeability of free space (a constant). I is the current flowing through the wire. R is the distance from the wire. 2π is a constant. From this equation, we can see the relationship of proportionality: The magnetic field B is directly proportional to the current I ($B \propto I$). The magnetic field B is inversely proportional to the distance R ($B \propto \frac{1}{R}$). Combining these relationships, the magnetic field is proportional to the ratio of current to distance: $B \propto \frac{I}{R}$. Therefore, the correct option is D.

Q53.

Answer: D

Explanation:

Magnetic field due to straight segments The straight segments lie along the radial lines passing through the center 'O'. For these segments, the angle between the current element $d\vec{l}$ and the position vector $\vec{r}$ is either 0° or 180° . Since $d\vec{B} \propto d\vec{l} \times \vec{r} = 0$, the magnetic field contribution from the straight segments is zero. Magnetic field due to semicircular arcs The magnitude of the magnetic field at the center of a circular arc carrying current I with radius r and subtending angle θ is given by: $B = \frac{\mu_0 I \theta}{4\pi r}$ For a semicircle, $\theta = \pi$, so the formula simplifies to: $B = \frac{\mu_0 I}{4r}$ Field due to inner arc (B_1): Radius $r = a$. $B_1 = \frac{\mu_0 I}{4a}$ Field due to outer arc (B_2): Radius $r = 4a$. $B_2 = \frac{\mu_0 I}{4(4a)} = \frac{\mu_0 I}{16a}$ Direction and Net Magnetic Field Since the loop is a closed circuit, the current must flow in opposite rotational directions along the two arcs (e.g., if it flows counter-clockwise on the inner arc, it must flow clockwise on the outer arc to return). Therefore, the magnetic fields produced by the two arcs at the center 'O' will be in opposite directions. The field from the inner arc is stronger ($1/4a > 1/16a$). The net magnetic field magnitude is the difference between the two fields:

$$B_{net} = B_1 - B_2 = \frac{\mu_0 I}{4a} - \frac{\mu_0 I}{16a}$$
$$B_{net} = \frac{4\mu_0 I - \mu_0 I}{16a} = \frac{3\mu_0 I}{16a}$$

Q54.

Answer: A

Explanation:

The magnetic field at the center of a circular current loop is given by the formula: $B = \frac{\mu_0 I}{2R}$ The direction is determined by the right-hand rule (perpendicular to the plane of the loop). 1. Loop in the xy-plane (Current $3I_0$): This loop lies in the horizontal plane, so its magnetic field at the origin will be along the z-axis. Magnitude:

$$B_1 = \frac{\mu_0 (3I_0)}{2R}. \text{ Direction: Based on the current direction shown (and consistent with the correct answer), the field points in the negative z-direction } (-\hat{z}). \vec{B}_1 = -\frac{3\mu_0 I_0}{2R} \hat{z}$$

2. Loop in the xz-plane (Current I_0): This loop lies in the vertical plane, so its magnetic field at the origin will be along the y-axis (the normal to the xz-plane). Magnitude:

$$B_2 = \frac{\mu_0 I_0}{2R}. \text{ Direction: Based on the current direction, the field points in the positive y-direction } (+\hat{y}). \vec{B}_2 = \frac{\mu_0 I_0}{2R} \hat{y}$$

3. Resultant Magnetic Field ($\vec{B}$): Adding the two vector components: $\vec{B} = \vec{B}_1 + \vec{B}_2$ $\vec{B} = -\frac{3\mu_0 I_0}{2R} \hat{z} + \frac{\mu_0 I_0}{2R} \hat{y}$ $\vec{B} = \frac{\mu_0 I_0}{2R} (-3\hat{z} + \hat{y})$ This matches Option A.

Q55.

Answer: A

Explanation:

The magnitude of the magnetic force per unit length (F/L) between two long, parallel current-carrying wires is given by the formula: $\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi D}$. From this equation, we can see that the force is directly proportional to the product of the currents ($I_1 I_2$) and inversely proportional to the distance separating them (D). Therefore, the force is proportional to: $\frac{I_1 I_2}{D}$. This corresponds to Option A.

Q56.

Answer: B

Explanation:

The magnetic field at point 'O' is the vector sum of the fields produced by the major circular arc and the straight chord.

1. Magnetic Field due to the Major Arc (B_1): The arc subtends an angle of $360^\circ - 60^\circ = 300^\circ = \frac{5\pi}{3}$ radians at the center. $B_1 = \frac{\mu_0 I_0}{4\pi R} \left(\frac{5\pi}{3} \right) = \frac{5\mu_0 I_0}{12R}$ Direction: Into the page (based on clockwise current flow).

2. Magnetic Field due to the Straight Chord (B_2): The chord forms an equilateral triangle with the center (since the angle is 60° and radii are equal). The perpendicular distance from 'O' to the wire is $d = R \sin(60^\circ) = \frac{\sqrt{3}R}{2}$. The angles subtended by the ends of the wire at the perpendicular are 30° each.

$$B_2 = \frac{\mu_0 I_0}{4\pi d} (\sin 30^\circ + \sin 30^\circ) = \frac{\mu_0 I_0}{4\pi \left(\frac{\sqrt{3}R}{2} \right)} (1) = \frac{\mu_0 I_0}{2\sqrt{3}\pi R}$$

Direction: Into the page (current flows right to left, point O is above).

3. Total Magnetic Field (B_{net}):

Since both fields are in the same direction, we add them:

$$B_{net} = B_1 + B_2 = \frac{5\mu_0 I_0}{12R} + \frac{\mu_0 I_0}{2\sqrt{3}\pi R} \text{ Factoring out } \frac{5\mu_0 I_0}{12R} :$$

$$B_{net} = \frac{5\mu_0 I_0}{12R} \left[1 + \frac{12R}{5\mu_0 I_0} \cdot \frac{\mu_0 I_0}{2\sqrt{3}\pi R} \right] = \frac{5\mu_0 I_0}{12R} \left[1 + \frac{6}{5\sqrt{3}\pi} \right]$$

$$\text{Rationalizing } \frac{6}{5\sqrt{3}} = \frac{2\sqrt{3}}{5} : B_{net} = \frac{5\mu_0 I_0}{12R} \left[1 + \frac{2\sqrt{3}}{5\pi} \right]$$

Therefore, the correct option is B.

Q57.

Answer: A

Explanation:

The frequency of revolution is the inverse of the time period. Since the time period is independent of the speed and radius, the frequency depends only on the charge-to-mass ratio and the magnetic field strength.

Q58.

Answer: B

Explanation:

Using Fleming's Left-Hand Rule, we can determine the direction of the force on a moving charge. For an electron, the force is opposite to the direction predicted for a positive current.

Q59.

Answer: A

Explanation:

For a charged particle moving in a magnetic field, the radius of the circular path is $r = \frac{mv}{qB}$. Given the same

kinetic energy $K = \frac{1}{2}mv^2$, we have $v = \sqrt{\frac{2K}{m}}$, so

$$r = \frac{\sqrt{2mK}}{qB} \propto \frac{\sqrt{m}}{q}. \text{ For proton: } m_p, q_p = e, \text{ so}$$

$$r_p \propto \frac{\sqrt{m_p}}{e} \text{ For deuteron: } m_d = 2m_p, q_d = e, \text{ so}$$

$$r_d \propto \frac{\sqrt{2m_p}}{e} = \sqrt{2} \frac{\sqrt{m_p}}{e} \text{ For } \alpha\text{-particle:}$$

$$m_\alpha = 4m_p, q_\alpha = 2e, \text{ so } r_\alpha \propto \frac{\sqrt{4m_p}}{2e} = \frac{2\sqrt{m_p}}{2e} = \frac{\sqrt{m_p}}{e}$$

Therefore, $r_\alpha = r_p < r_d$

Q60.

Answer: C

Explanation:

The magnetic force between two parallel wires depends on the product of their currents and inversely on the distance between them. Calculating the force for both pairs shows they are equal.

Q61.

Answer: D

Explanation:

The magnetic field at the center of a circular arc is a fraction of the field produced by a full circle, determined by the ratio of the subtended angle to 2π .

Q62.

Answer: C

Explanation:

The total field is the sum of the fields produced by each semicircle. Since the currents flow such that both fields point into the page, their magnitudes add.

Q63.

Answer: A

Explanation:

The magnetic field at the center of the loop is the vector sum of the magnetic field due to the infinitely long straight wire and the magnetic field due to the circular loop. 1. Straight Wire: The conductor acts as an infinitely long straight wire carrying current I . The center of the loop is at a perpendicular distance R from this wire. The magnetic field is $B_1 = \frac{\mu_0 I}{2\pi R}$. By the right-hand rule (current to the right), the field at the center (above the wire) is directed out of the page. 2. Circular Loop: The loop carries current I in a counter-clockwise direction (indicated by arrows). The magnetic field at the center is $B_2 = \frac{\mu_0 I}{2R}$. By the right-hand rule, this field is also directed out of the page. Since both fields are in the same direction, they add up:

$$B_{total} = B_1 + B_2 = \frac{\mu_0 I}{2\pi R} + \frac{\mu_0 I}{2R} = \frac{\mu_0 I}{2\pi R} (1 + \pi).$$

Rewriting the coefficient: $\frac{\mu_0 I}{2\pi R} = \frac{\mu_0 2I}{4\pi R}$. So,

$$B_{total} = \frac{\mu_0 2I}{4\pi R} (\pi + 1).$$

Q64.

Answer: A

Explanation:

By equating the formula for the magnetic field on the axis to $1/8$ of the center field value, we can solve for the axial distance x .

Q65.

Answer: A

Explanation:

The loop consists of a major circular arc and a straight chord. The total field is the vector sum of fields from both segments.

Q66.

Answer: D

Explanation:

The magnetic field at point O is the vector sum of the fields produced by three segments of the wire: 1. The vertical straight segment: The current flows along the line passing through O . Since the angle between the current element $d\vec{l}$ and position vector $\vec{r}$ is 0 or 180° , the magnetic field contribution is zero ($B_1 = 0$). 2. The semi-circular arc: This is a semi-circle of radius R (implied). The magnetic field at the center of a semi-circle is half that of a full circle. $B_2 = \frac{1}{2} \left(\frac{\mu_0 I}{2R} \right) = \frac{\mu_0 I}{4R}$. By the right-hand rule (current is counter-clockwise), the direction is out of the page. 3. The horizontal straight segment: This is a semi-infinite wire starting at a distance R from O (tangent to the circle at the bottom) and extending to infinity. The magnetic field due to a semi-infinite wire at a perpendicular distance R from its end is

$$B_3 = \frac{1}{2} \left(\frac{\mu_0 I}{2\pi R} \right) = \frac{\mu_0 I}{4\pi R}.$$

By the right-hand rule (current to the right, point above), the direction is out of the page. Since B_2 and B_3 are in the same direction, they add up:

$$B_{total} = \frac{\mu_0 I}{4R} + \frac{\mu_0 I}{4\pi R}.$$

Q67.

Answer: B

Explanation:

The total magnetic field at the center is the sum of the fields produced by each of the n sides of the polygon. Since the polygon is regular, each side contributes equally. For one side of length L , the perpendicular distance from the center is $d = a \cos(\pi/n)$. The angle subtended by half the side at the center is $\theta = \pi/n$. Using the formula for the magnetic field due to a finite straight wire: $B_{side} = \frac{\mu_0 i}{4\pi d} (\sin \theta + \sin \theta)$. Substituting the values and multiplying by n gives the total field.

Q68.

Answer: A

Explanation:

Calculate the magnetic field at the center of the square and the circle using their respective formulas, ensuring the perimeter (total length of wire) remains constant to find the relationship between the square side and circle radius.

Q69.

Answer: B

Explanation:

The total current divides between the two parallel paths of the square based on their total resistance. The magnetic fields produced at the center by these two paths point in opposite directions, and their vector difference provides the net magnetic field.

Q70.

Answer: B

Explanation:

The magnetic field at the center P is the superposition of fields due to the circular arcs and the straight wire segments. We use the unit $B_0 = \frac{\mu_0 I}{2\pi r}$. - For a circular arc subtending angle θ at the center, $B = \frac{\theta}{2} B_0$. - For a semi-infinite straight wire tangent to the circle (distance r), $B = \frac{1}{2} B_0$. - For a straight wire pointing radially towards/away from the center, $B = 0$. Case 1: The shape consists of a semi-circle (angle π) and two semi-infinite straight wires. Based on the direction (clockwise arc, straight wires contributing positively), the field is proportional to $-\frac{\pi}{2} + \frac{1}{2} + \frac{1}{2} = -\frac{\pi}{2} + 1$. Case 2: The shape consists of a semi-circle (angle π) and two semi-infinite straight wires. The field is proportional to $\frac{\pi}{2} + \frac{1}{2} + \frac{1}{2} = \frac{\pi}{2} + 1$. Case 3: The shape consists of a $\frac{3}{4}$ circle (angle $\frac{3\pi}{2}$) and one semi-infinite straight wire (the other is radial). The field is proportional to $\frac{3\pi/2}{2} + \frac{1}{2} = \frac{3\pi}{4} + \frac{1}{2}$.

Q71.

Answer: 2

Explanation:

For a circular coil, the magnetic field at the center is inversely proportional to the radius. Doubling the radius reduces the field by half.

Q72.

Answer: 6

Explanation:

The radial segments contribute no field at the center. The only contribution is from the circular arc, calculated by its angle (120°).

Q73.

Answer: 2

Explanation:

The magnetic field at the center is the vector sum of the fields produced by the 4 sides of the square. For one side of length a , the perpendicular distance from the center is $d = a/2$. The angles subtended by the ends of the wire at the center are $\theta_1 = \theta_2 = 45^\circ$. Using the formula $B = \frac{\mu_0 I}{4\pi d} (\sin \theta_1 + \sin \theta_2)$, the field due to one side is $B_1 = \frac{\mu_0 I}{4\pi(a/2)} (2 \sin 45^\circ) = \frac{\sqrt{2}\mu_0 I}{2\pi a}$. The total field is $B_{total} = 4 \times B_1 = \frac{2\sqrt{2}\mu_0 I}{\pi a}$.

Q74.

Answer: 4

Explanation:

The length of the wire forms the circumference of the circle: $2\pi r = 4 \Rightarrow r = \frac{2}{\pi}$. The area of the circle is $A = \pi r^2 = \pi \left(\frac{2}{\pi}\right)^2 = \frac{4}{\pi}$. The magnetic moment is $M = I \cdot A = 1 \cdot \frac{4}{\pi} = \frac{4}{\pi}$.

Q75.

Answer: 2

Explanation:

The magnetic field at the center is $B_0 = \frac{\mu_0 I}{2R}$. The magnetic field on the axis at distance x is $B_x = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$. Given $B_x = \frac{1}{5\sqrt{5}} B_0$. Substituting the formulas: $\frac{R^2}{(R^2 + x^2)^{3/2}} = \frac{1}{5\sqrt{5}R}$. This simplifies to $(R^2 + x^2)^{3/2} = 5\sqrt{5}R^3 = (\sqrt{5})^3 R^3$. Taking the cube root and squaring leads to $x = 2R$.