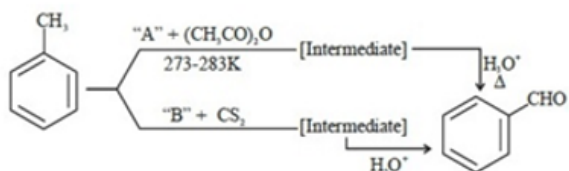


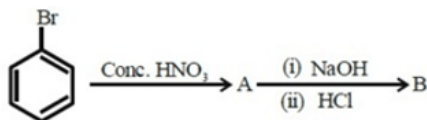
Chemistry

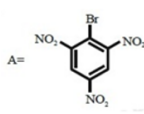
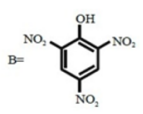
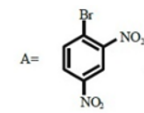
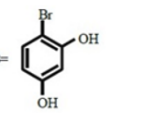
1. In the given reactions, identify the reagent *A* and reagent *B*.

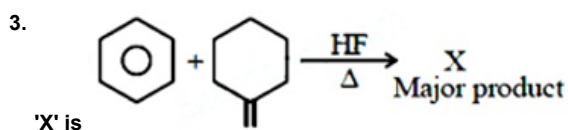


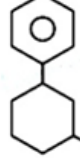
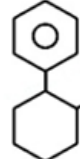
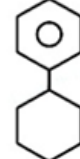
- A) $A - CrO_3, B - CrO_3$ B) $A - CrO_3, B - CrO_2Cl_2$
 C) $A - CrO_2Cl_2, B - CrO_3$ D) $A - CrO_2Cl_2, B - CrO_2Cl_2$

2. Identify *A* and *B* in the following reaction sequence:

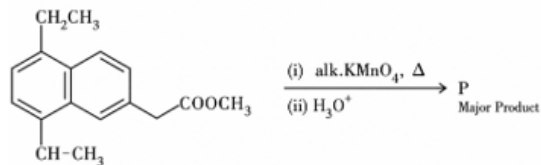


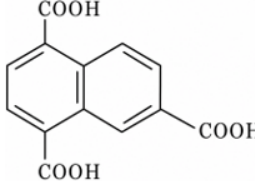
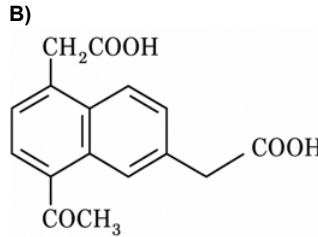
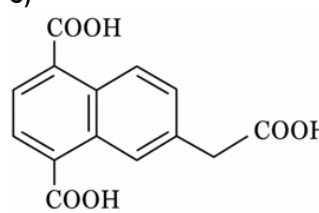
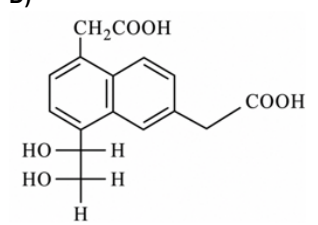
- A)  B) 
 C)  D) 



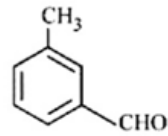
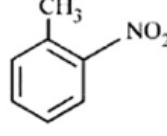
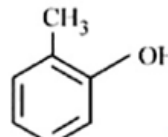
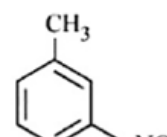
- A)  B) 
 C)  D) 

4. The major product 'P' formed in the given reaction is:

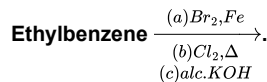


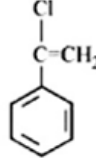
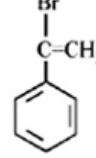
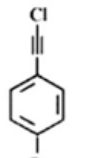
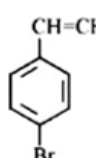
- A)  B) 
 C)  D) 

5. Halogenation of which one of the following will yield an *m*-substituted product with respect to the methyl group as a major product?

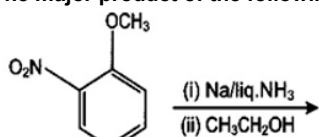
- A)  B) 
 C)  D) 

6. Product 'A' of the following sequence of reactions is:



- A)  B) 
 C)  D) 

7. The major product of the following reaction is:



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

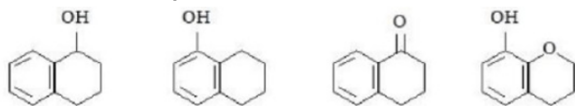
8. Which of the following compound will most easily be attacked by an electrophile?

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

9. The compound which will have the lowest rate towards nucleophilic aromatic substitution on treatment with OH^- is:

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

10. Arrange the following compounds in increasing order of rate of aromatic electrophilic substitution reaction:

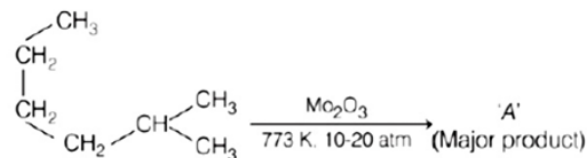


- A) c, a, b, d
- B) d, b, c, a
- C) d, b, a, c
- D) b, c, a, d

11. Which of the following is not an example of benzenoid compound?

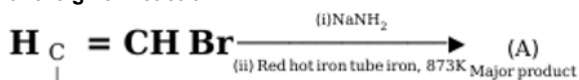
- A)
- B)
- C)
- D)

12. Identify A in the given chemical reaction:



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

13. For the given reaction

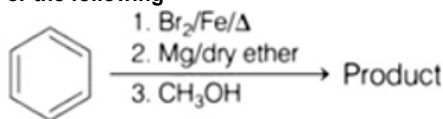


- A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
- B)
- C)
- D)

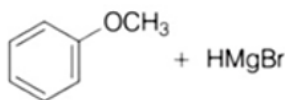
14. the correct sequence of reagents used in the preparation of 4-bromo-2-nitroethyl benzene from benzene is.

- A) $\text{CH}_3\text{COCl}/\text{AlCl}_3$, $\text{Br}_2/\text{AlBr}_3$, $\text{HNO}_3/\text{H}_2\text{SO}_4$, $\text{HCl}/\text{H}_2\text{O}$
- B) $\text{HNO}_3/\text{H}_2\text{SO}_4$, $\text{Br}_2/\text{AlBr}_3$, $\text{CH}_3\text{COCl}/\text{AlCl}_3$, $\text{HCl}/\text{H}_2\text{O}$
- C) $\text{Br}_2/\text{AlBr}_3$, $\text{CH}_3\text{COCl}/\text{AlCl}_3$, $\text{HNO}_3/\text{H}_2\text{SO}_4$, $\text{Br}_2/\text{AlCl}_3$, CH_3CO
- D) $\text{HNO}_3/\text{H}_2\text{SO}_4$, $\text{Br}_2/\text{AlBr}_3$, $\text{CH}_3\text{COCl}/\text{AlCl}_3$, $\text{HCl}/\text{H}_2\text{O}$

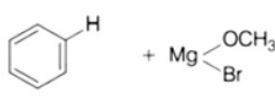
15. For the following



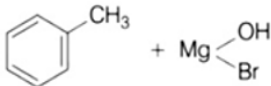
A)



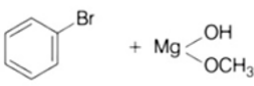
B)



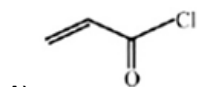
C)



D)



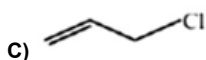
16. Which of the following compounds will not undergo Friedel Craft's reaction with benzene?



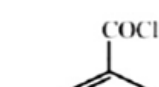
A)



B)



C)



D)

17. Which of the following would not give 2-phenyl butane as the major product in a Friedel-Crafts alkylation reaction?

A) 1-butene + HF

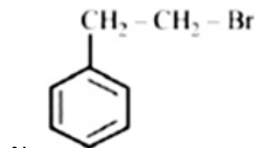
B) 2-butanol + H_2SO_4

C) Butanoyl chloride + $AlCl_3$

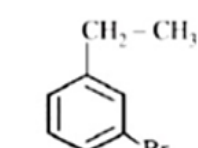
D) Butyl chloride + $AlCl_3$

then Zn, HCl

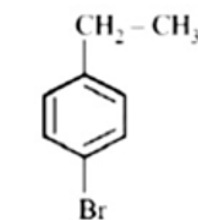
18. The product of the reaction between ethyl benzene and N-bromosuccinamide is:



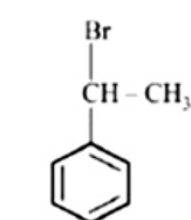
A)



B)



C)



D)

19. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotised and then heated with cuprous bromide. The reaction mixture so formed contains:

A) mixture of o- and p-bromotoluenes

B) mixture of o- and p-dibromobenzenes

C) mixture of o- and p-bromoanilines

D) mixture of o- and m-bromotoluenes

20. The compound formed as a result of oxidation of ethyl benzene by $KMnO_4$ is:

A) benzyl alcohol

B) benzophenone

C) acetophenone

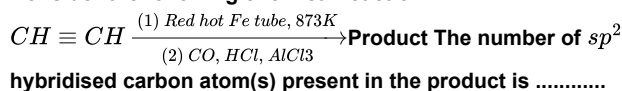
D) benzoic acid

21. How many ortho and para directing groups are present among the following groups?

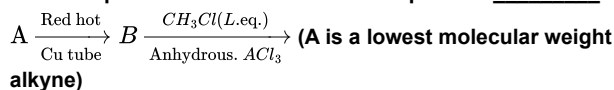
$-OH$, $-NH_2$, $-CH_3$, $-NO_2$, $-COOH$

22. How many meta-directing groups are present in the following set? $-NO_2$, $-COOH$, $-CHO$, $-NH_2$, $-Cl$

23. Consider the following chemical reaction.



24. In the following sequence of reactions, the maximum number of atoms present in molecule 'C' in one plane is



25. In the following reaction, $H_3C - C \equiv CH \xrightarrow[873K]{\text{red hot iron tube}} A$, the number of sigma (σ) bonds present in the product A, is

Maths

26. The letters of the word "FLOWER" are taken 4 at a time and arranged in all possible ways. The number of arrangements which begin with 'F' and end with 'R' is

A) 20

B) 18

C) 14

D) 12

27. A, B, C are three persons among 7 persons who speak at a function. The number of ways in which it can be done if 'A' speaks before 'B' and 'B' speaks before 'C' is

A) 820

B) 830

C) 840

D) 850

28. Number of ways of permuting the letters of the word "ENGINEERING" so that the order of the vowels is not changed is

A) ${}^{11}P_5$

B) $\frac{11!}{5!}$

C) $\frac{11!}{2!5!}$

D) $\frac{{}^{11}P_5}{2}$

29. The letters of the word CRICKET are permuted in all possible ways and the words thus formed are rearranged as in a dictionary. The rank of the word CRICKET is

A) 243

B) 452

C) 531

D) 729

30. The number of 4-digit numbers formed using the digits 1,2,3,4,5,6,7 which are divisible by 4 is:

A) 100

B) 150

C) 200

D) 250

31. The number of ways in which 7 distinct toys can be distributed among 3 children when each child is eligible to take all the toys is:

A) 3^7

B) 7^3

C) 7P_3

D) 7C_3

32. The number of ways of arranging 8 men and 4 women around a circular table such that no two women sit together is:

A) 8!

B) 4!

C) 8!4!

D) $7!^8P_4$

33. The number of different ways that three distinct rings can be worn on 4 fingers with at most one ring in each of the fingers is:

A) 4P_3

B) 5P_4

C) 5P_3

D) 4P_2

34. The letters of the word "RANDOM" are arranged in all possible ways. The number of arrangements in which there are 2 letters between R and D is:
- A) 36 B) 48
C) 144 D) 72
35. 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:
- A) 44 B) 32
C) 28 D) 20
36. The number of ways, in which 16 oranges can be distributed to four children such that each child gets at least one orange, is
- A) 384 B) 403
C) 429 D) 455
37. From a group of 7 batsmen and 6 bowlers, 10 players are to be chosen for a team, which should include at least 4 batsmen and at least 4 bowlers. One batsman and one bowler who are captain and vice-captain respectively of the team should be included. Then the total number of ways such a selection can be made, is
- A) 145 B) 165
C) 155 D) 135
38. The total number of positive integral solutions (x, y, z) such that $xyz = 24$ is :
- A) 36 B) 24
C) 45 D) 30
39. The number of triplets (x, y, z) , where x, y, z are distinct non negative integers satisfying $x + y + z = 15$, is :
- A) 136 B) 80
C) 92 D) 114
40. The number of ways five alphabets can be chosen from the alphabets of the word MATHEMATICS, where the chosen alphabets are not necessarily distinct, is equal to:
- A) 179 B) 177
C) 175 D) 181
41. The number of ways in which 5 boys and 3 girls can be seated on a round table if a particular boy B_1 and a particular girl G_1 never sit adjacent to each other, is :
- A) $5 \times 6!$ B) $6 \times 6!$
C) $7!$ D) $5 \times 7!$
42. If the sides AB, BC and CA of a triangle ABC have 3, 5 and 6 interior points respectively, then the total number of triangles that can be constructed using these points as vertices, is equal to :
- A) 240 B) 360
C) 333 D) 364
43. If all the words with or without meaning made using all the letters of the word "KANPUR" are arranged as in a dictionary, then the word at 440th position in this arrangement is :
- A) PRNAKU B) PRKAUN
C) PRKANU D) PRNAUK

44. The number of ways, in which the letters A, B, C, D, E can be placed in the 8 boxes of the figure below so that no row remains empty and at most one letter can be placed in a box,



is :

- A) 5880 B) 840
C) 960 D) 5760
45. The number of four letter words that can be formed using the letters of the word BARRACK is :
- A) 120 B) 144
C) 264 D) 270
46. There are 15 players in a cricket team, out of which 6 are bowlers, 7 are batsman and 2 are wicketkeepers. The number of ways, a team of 11 players be selected from them so as to include at least 4 bowlers, 5 batsman and 1 wicketkeeper, is _____
47. The number of 9 digit numbers, that can be formed using all the digits of the number 123412341 so that the even digits occupy only even places, is _____.
48. In an examination, 5 students have been allotted their seats as per their roll numbers. The number of ways, in which none of the students sits on the allotted seat, is _____.
49. The total number of words (with or without meaning) that can be formed out of the letters of the word 'DISTRIBUTION' taken four at a time, is equal to _____
50. If the letters of the word MATHS are permuted and all possible words so formed are arranged as in a dictionary with serial numbers, then the serial number of the word THAMS is _____:

Physics

51. A coil of area $A = 0.25 \text{ m}^2$ is situated in a uniform magnetic field $B = 4.0 \text{ wb/m}^2$ and the area vector makes an angle of 60° with respect to the magnetic field. The value of the magnetic flux through the area A would be equal to
- A) 0.5weber B) 1weber
C) 2weber D) $\frac{3}{2}$ weber
52. A square coil of 10^{-3} m^2 area is placed in a uniform magnetic field of intensity 10^3 wb/m^2 such that the plane of the coil makes an angle of 30° with the field. The magnetic flux through the coil is
- A) 1 weber B) $\frac{1}{2}$ weber
C) $\frac{\sqrt{3}}{2}$ weber D) 0 weber
53. A circular coil of 500 turns of a wire has an enclosed area of 0.1 m^2 per turn. It is kept perpendicular to a magnetic field of induction 0.2 T and rotated by 90° about a diameter perpendicular to the field. How much charge will pass when the coil is connected to a galvanometer with a combined resistance of 50Ω ?
- A) 0.4 C B) 0.2 C
C) 2 C D) 0.1 C

54. Flux ϕ (in weber) in a closed circuit of resistance $2\ \Omega$ varies with time t (in sec) according to the equation $\phi = 5t^2 - 4t + 1$. What is the magnitude of the induced current at $t = 0.5$ s?

- A) 0.5 A
B) 1 A
C) 0.25 A
D) 2 A

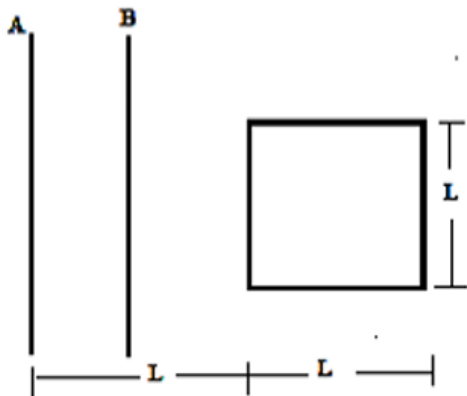
55. A circular loop of radius r and resistance R is placed in a transverse uniform magnetic field B . If it suddenly changes into square form in time t , then the magnitude of induced charge will be

- A) $\frac{B\pi r^2}{R} \left(1 - \frac{\pi}{4}\right)$
B) $\frac{B\pi r^2}{R} \left(\frac{\pi}{4} - 1\right)$
C) $\frac{B\pi r^2}{R} (4 - \pi)$
D) $\frac{B\pi r^2}{R} \left(1 + \frac{\pi}{4}\right)$

56. A conducting circular loop is placed in a uniform magnetic field $B = 20\text{ mT}$ with its plane perpendicular to the field. If the radius of the loop starts shrinking at a constant rate 0.2 mm/s , then the induced emf in the loop at an instant when its radius is 1.0 cm is

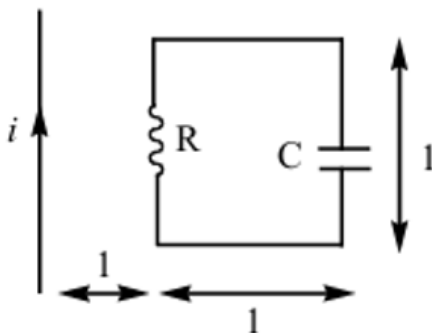
- A) $0.16\pi\ \mu\text{V}$
B) $0.08\pi\ \mu\text{V}$
C) $0.8\pi\ \mu\text{V}$
D) $0.04\pi\ \mu\text{V}$

57. Two long thin parallel wires and a square loop of side L are coplanar. The currents in the two wires A and B are 2 A and 1 A and total flux through the loop is zero. Nearer side of the loop is at a distance L from wire A . The separation between the wires is:



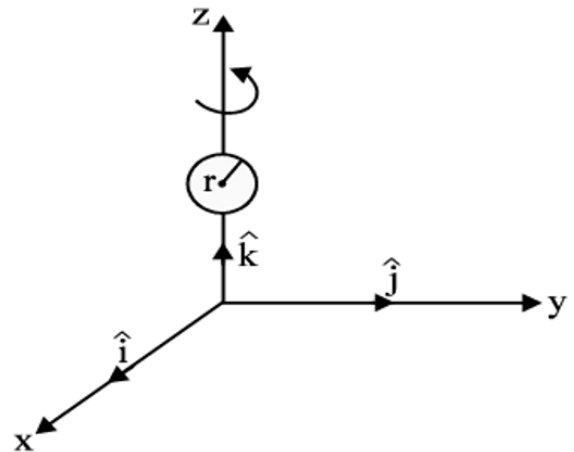
- A) $L/3$
B) $L/2$
C) $2L/3$
D) $3L/4$

58. A square loop of side l containing a resistance R , and a capacitance C is placed near an infinitely long current carrying wire as shown in figure. The current in the wire varies with time as $i = \left(\frac{i_0}{t_0}\right)t$. The charge stored in the capacitor at any time t equals:



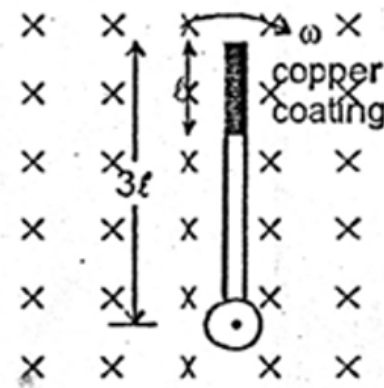
- A) $\frac{\mu_0 i_0 C l \ln 2}{2\pi t_0} (1 - e^{-t/CR})$
B) $\frac{\mu_0 i_0 C l \ln 4}{2\pi t_0} (1 - e^{-t/CR})$
C) $\frac{\mu_0 i_0 C l \ln 4}{4\pi t_0} (1 - e^{-t/CR})$
D) Zero

59. A circular loop wire of radius r rotates about the z -axis with angular velocity ω . The normal to the loop is always perpendicular to the z -axis. At time $t = 0$, the normal is parallel to the y -axis. An external magnetic field $\vec{B} = B_y \hat{j} + B_z \hat{k}$ is applied. The EMF $\epsilon(t)$ induced in the loop is:



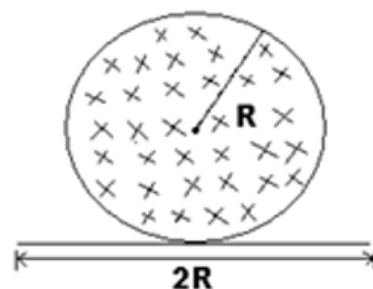
- A) $\pi r^2 \omega B_y \sin \omega t$
B) $\pi r^2 \omega B_z \cos \omega t$
C) $\pi r^2 \omega B_z \sin \omega t$
D) $\pi r^2 \omega B_y \cos \omega t$

60. A wooden stick of length $3l$ is rotated about an end with constant angular velocity ω in a uniform magnetic field B perpendicular to the plane of motion. If the upper one third of its length is coated with copper, the potential difference across the whole length of the stick is:



- A) $\frac{9B\omega l^2}{2}$
B) $\frac{4B\omega l^2}{2}$
C) $\frac{5B\omega l^2}{2}$
D) $\frac{B\omega l^2}{2}$

61. A uniform but time varying magnetic field is present in a circular region of radius R . The magnetic field is perpendicular and into the plane of the loop and the magnitude of the field is increasing at a constant rate α . There is a straight conducting rod of length $2R$ placed as shown in figure. The magnitude of induced emf across the



rod is:

- A) $\pi R^2 \alpha$
B) $\frac{\pi R^2 \alpha}{2}$
C) $\frac{R^2 \alpha}{\sqrt{2}}$
D) $\frac{\pi R^2 \alpha}{4}$

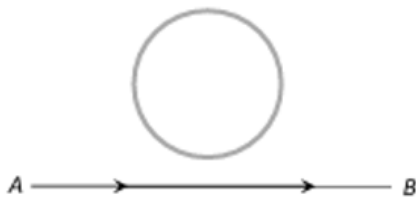
62. An equilateral triangular loop having a resistance R and length of each side l is placed in a magnetic field which is varying at $dB/dt = 1 \text{ T/s}$. The induced current in the loop



will be:

- A) $\frac{\sqrt{3}l^2}{4R}$ B) $\frac{4l^2}{\sqrt{3}R}$
C) $\frac{\sqrt{3}R}{4l^2}$ D) $\frac{4R}{\sqrt{3}l^2}$

63. An electron moves along the line AB, which lies in the same plane as a circular loop of conducting wires as shown in the diagram. What will be the direction of current induced if any, in the loop:



- A) No current will be induced B) The current will be clockwise
C) The current will be anticlockwise D) The current will change direction as the electron passes by

64. A copper rod of length l is rotated about one end perpendicular to the magnetic field B with constant angular velocity ω . The induced e.m.f. between the two ends is:

- A) $\frac{1}{2}B\omega l^2$ B) $\frac{3}{4}B\omega l^2$
C) $B\omega l^2$ D) $2B\omega l^2$

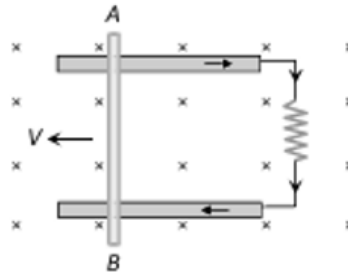
65. An e.m.f. of 15 volt is applied in a circuit containing 5 henry inductance and 10 ohm resistance. The ratio of the currents at time $t = \infty$ and at $t = 1$ second is:

- A) $\frac{e^{1/2}}{e^{1/2}-1}$ B) $\frac{e^2}{e^2-1}$
C) $1 - e^{-1}$ D) e^{-1}

66. At a place the value of horizontal component of the earth's magnetic field H is $3 \times 10^{-5} \text{ Weber/m}^2$. A metallic rod AB of length 2 m placed in east-west direction, having the end A towards east, falls vertically downward with a constant velocity of 50 m/s. Which end of the rod becomes positively charged and what is the value of induced potential difference between the two ends:

- A) End A, $3 \times 10^{-3} \text{ mV}$ B) End A, 3 mV
C) End B, $3 \times 10^{-3} \text{ mV}$ D) End B, 3 mV

67. Consider the situation shown in the figure. The wire AB is sliding on the fixed rails with a constant velocity. If the wire AB is replaced by semicircular wire, the magnitude of the induced current will:



- A) Increase B) Remain the same
C) Decrease D) Increase or decrease depending on whether the semicircle bulges towards the resistance or away from it

68. A circular loop of radius R carrying current I lies in x - y plane with its centre at origin. The total magnetic flux through x - y plane is:

- A) Directly proportional to I B) Directly proportional to R
C) Directly proportional to R^2 D) Zero

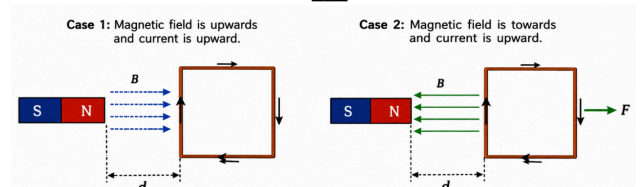
69. A conducting rod of length $2l$ is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The e.m.f. induced between two ends of the rod is:

- A) $B\omega l^2$ B) $\frac{1}{2}B\omega l^2$
C) $\frac{1}{8}B\omega l^2$ D) Zero

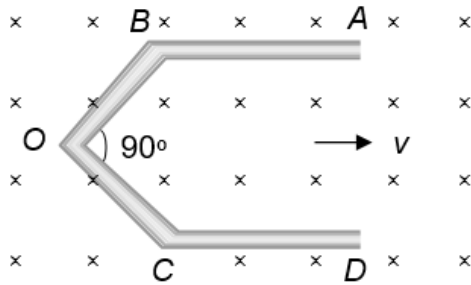
70. A coil of area 200 cm^2 has 100 turns. A magnetic field of $0.2 \text{ weber/metre}^2$ is perpendicular to the coil. The field is reduced to zero in 0.1 sec. The induced emf in the coil is ___ v

71. A coil has 1000 turns and 500 cm^2 as its area. The plane of the coil is placed at right angles to a magnetic induction field of $2 \times 10^{-5} \text{ wb/m}^2$. The coil is rotated through 90° in 0.2 sec. The average emf induced in the coil in mV is

72. In the following figure, the magnet is moved towards the coil with a speed v and induced emf is e . If magnet and coil recede away from one another each moving with speed v , the induced emf in the coil will be ___ e :

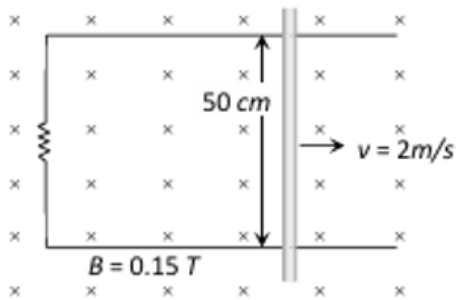


73. A conductor $ABOCD$ moves along its bisector with a velocity of 1 m/s through a perpendicular magnetic field of 1 Wb/m^2 , as shown in the figure. If all the four sides are of 1 m length each, then the induced emf between points A and D is _____ V:



74. A short magnet is allowed to fall along the axis of a horizontal plastic (insulating) ring. Starting from rest, the distance fallen by the magnet in one second is (take $g = 9.8 \text{ m/s}^2$) _____ m

75. As shown in the figure a metal rod makes contact and complete the circuit. The circuit is perpendicular to the magnetic field with $B = 0.15 \text{ T}$. If the resistance is 3Ω , force needed to move the rod as indicated with a constant speed of 2 m/s is:



- A) $3.75 \times 10^{-3} \text{ N}$ B) $3.75 \times 10^{-2} \text{ N}$
 C) $3.75 \times 10^2 \text{ N}$ D) $3.75 \times 10^{-4} \text{ N}$

ANSWER KEY

Chemistry.

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

Maths

26.	4	33.	1	40.	1	47.	60
27.	3	34.	3	41.	1	48.	44
28.	3	35.	1	42.	3	49.	3734
29.	3	36.	4	43.	2	50.	103
30.	3	37.	3	44.	4		
31.	1	38.	4	45.	4		
32.	4	39.	4	46.	777		

Physics

51.	1	58.	1	65.	2	72.	2
52.	2	59.	1	66.	2	73.	1.41
53.	2	60.	3	67.	2	74.	4.9
54.	1	61.	4	68.	4	75.	1
55.	1	62.	1	69.	4		
56.	2	63.	4	70.	4		
57.	3	64.	1	71.	5		

SOLUTIONS

Q1.

Answer: B

Explanation:

The first path involves the oxidation of the methyl group to a gem-diacetate using chromic oxide (CrO_3) in acetic anhydride, followed by hydrolysis. The second path is the Etard reaction, which uses chromyl chloride (CrO_2Cl_2) in carbon disulfide (CS_2) to oxidize the methyl group to a chromium complex, which then yields benzaldehyde upon hydrolysis.

Q2.

Answer: A

Explanation:

Nitration of Bromobenzene with concentrated HNO_3 under vigorous conditions leads to the formation of 1-bromo-2,4,6-trinitrobenzene. Subsequent treatment with NaOH results in nucleophilic aromatic substitution (S_NAr), where the bromide is replaced by a hydroxyl group, yielding picric acid (2,4,6-trinitrophenol) after acidification.

Q3.

Answer: A

Explanation:

Hydrogen fluoride (HF) acts as a catalyst to protonate the exocyclic double bond of methylenecyclohexane, forming a stable tertiary carbocation. This carbocation then undergoes an Electrophilic Aromatic Substitution (EAS) reaction with the benzene ring to form 1-methyl-1-phenylcyclohexane.

Q4.

Answer: A

Explanation:

Alkaline $KMnO_4$ is a strong oxidizing agent that oxidizes side chains (alkyl or alkenyl) attached to aromatic rings into carboxylic acid ($-COOH$) groups, provided there is at least one benzylic hydrogen present.

Q5.

Answer: C

Explanation:

In m-nitrotoluene, the methyl group ($-CH_3$) is ortho/para directing, while the nitro group ($-NO_2$) is meta directing. The directing effects of both groups reinforce each other, leading the electrophile to the position that is meta to the methyl group (and para to the nitro group).

Q6.

Answer: D

Explanation:

The sequence involves: (1) Electrophilic aromatic bromination, (2) Benzylic free-radical chlorination, and (3) Elimination to form an alkene side chain.

Q7.

Answer: A

Explanation:

This reaction is a Birch reduction. Sodium in liquid ammonia reduces the aromatic ring to a non-conjugated diene. The orientation of the reduction is influenced by the substituents; electron-withdrawing groups (like $-NO_2$) are typically reduced at the positions ipso and para to the group.

Q8.

Answer: D

Explanation:

Electrophilic aromatic substitution is favored by high electron density in the benzene ring. Phenol has the highest electron density among the given compounds because the hydroxyl group ($-OH$) is a powerful activating group due to its strong resonance ($+M$) effect.

Q9.

Answer: D

Explanation:

Nucleophilic aromatic substitution (S_NAr) requires electron-withdrawing groups (EWGs) to stabilize the anionic intermediate through resonance. EWGs like the nitro group ($-NO_2$) are highly ineffective at this stabilization when placed at the meta position relative to the leaving group.

Q10.

Answer: A

Explanation:

The rate of aromatic electrophilic substitution (EAS) is determined by how much the substituents activate or deactivate the benzene ring. Activating groups (electron donors) increase the rate by raising electron density, while deactivating groups (electron withdrawers) decrease it.

Q11.

Answer: B

Explanation:

While standard chemistry identifies naphthalene and aniline as aromatic, the source designates option B as the correct answer for this specific problem. Aromatic compounds must be planar, conjugated, and possess $(4n + 2)\pi$ electrons.

Q12.

Answer: B

Explanation:

Heating alkanes with seven or more carbons in the presence of specific metal oxides like Mo_2O_3 at high temperatures and pressures leads to aromatization. 2-methylhexane, being a seven-carbon alkane, is converted into toluene.

Q13.

Answer: D

Explanation:

The reaction proceeds through a two-step process: (1) dehydrobromination of 1-bromo-prop-1-ene to form propyne, and (2) cyclic trimerization of propyne to form mesitylene (1,3,5-trimethylbenzene).

Q14.

Answer: B

Explanation:

Benzene is first converted to acetophenone via acylation, then reduced to ethylbenzene. Bromination provides the para product due to the directing effect of the ethyl group, followed by nitration ortho to the ethyl group.

Q15.

Answer: B

Explanation:

Benzene undergoes electrophilic substitution to form bromobenzene. This reacts with magnesium to form a Grignard reagent (phenylmagnesium bromide), which then reacts with methanol (a protic solvent) to regenerate benzene and form a magnesium salt.

Q16.

Answer: B

Explanation:

Friedel-Craft's alkylation/acylation requires the formation of a stable carbocation or a strong complex with a Lewis acid. Vinyl halides (like vinyl chloride) are unreactive because the $C - Cl$ bond has partial double bond character due to resonance, making it very difficult to break.

Q17.

Answer: C

Explanation:

Friedel-Crafts alkylation typically yields products via carbocation intermediates, which often rearrange to the more stable sec-butyl position, forming 2-phenylbutane. However, the sequence in Option C involves acylation followed by Clemmensen reduction, which avoids rearrangement and produces n-butylbenzene (1-phenylbutane) instead.

Q18.

Answer: D

Explanation:

N-bromosuccinimide (NBS) is a specific reagent used for free radical bromination at allylic or benzylic positions. In ethylbenzene, the hydrogen atoms on the carbon directly attached to the ring (benzylic position) are the most reactive.

Q19.

Answer: A

Explanation:

The sequence follows standard aromatic substitution: (1) Nitration of toluene yields ortho and para nitro isomers. (2) Reduction converts nitro groups to amino groups. (3) Diazotization followed by the Sandmeyer reaction replaces the amino groups with bromine atoms, maintaining the original ortho/para orientation.

Q20.

Answer: D

Explanation:

Powerful oxidizing agents like alkaline $KMnO_4$ oxidize alkyl side chains of benzene rings completely into carboxylic acid groups ($-COOH$), provided there is at least one benzylic hydrogen present. Ethylbenzene meets this criterion and is oxidized to benzoic acid.

Q21.

Answer: 3

Explanation:

$-OH$, $-NH_2$, and $-CH_3$ are ortho-para directing groups. $-NO_2$ and $-COOH$ are meta directing.

Q22.

Answer: 3

Explanation:

$-NO_2$, $-COOH$, and $-CHO$ are meta directing. $-NH_2$ and $-Cl$ are ortho-para directing.

Q23.

Answer: 7

Explanation:

Acetylene undergoes cyclic trimerization to form benzene. Benzene then undergoes the Gatterman-Koch reaction (CO , HCl , $AlCl_3$) to form benzaldehyde.

Q24.

Answer: 13

Explanation:

Acetylene trimerizes to form benzene (B), which then undergoes Friedel-Crafts alkylation to form toluene (C). In toluene, all ring atoms and the alpha-carbon of the methyl group are in the same plane, along with one of the methyl hydrogens.

Q25.

Answer: 21

Explanation:

There are 21σ bonds. (The source shows that propyne undergoes cyclic trimerization to form Mesitylene, 1,3,5-trimethylbenzene, which contains 21 sigma bonds).

Q26.

Answer: D

Explanation:

Since the 4-letter arrangement must begin with 'F' and end with 'R', the first and last positions are fixed. We only need to choose and arrange 2 more letters for the remaining two middle positions from the remaining 4 letters of the word "FLOWER".

Q27.

Answer: C

Explanation:

When three specific people (A , B , and C) must appear in a fixed relative order among all 7 speakers, we can first select the relative positions for A , B , and C in only 1 specific way (since their order $A \rightarrow B \rightarrow C$ is fixed). The remaining 4 positions are filled by the other 4 persons in $4!$ ways, and the 7 positions can be chosen out of the total speakers using permutations.

Q28.

Answer: C

Explanation:

The word "ENGINEERING" contains a total of 11 letters, where the letter E repeats 3 times, N repeats 3 times, G repeats 2 times, I appears 2 times, and R appears 1 time. Out of these, the vowels are E, I, E, I (a total of 4 vowels: two E 's and two I 's). When the relative order of the vowels must remain unchanged, we divide the total number of distinguishable permutations of all 11 letters by the number of ways to arrange the vowels and the number of identical consonants among themselves.

Q29.

Answer: C

Explanation:

To find the rank of the word "CRICKET", we first list its unique letters in alphabetical order (C, E, I, K, R, T). We then count how many words can be formed starting with letters that appear before each letter of "CRICKET" in alphabetical order, accounting for the frequency of duplicate letters (C:2, I:2, E:1, K:1, R:1, T:1). Summing these contributions gives the rank.

Q30.

Answer: C

Explanation:

A number is divisible by 4 if its last two digits form a number divisible by 4. There are 10 valid two-digit endings using distinct digits from 1 to 7. For each ending, the first two positions can be filled in $5 \times 4 = 20$ ways. Hence, the total is $10 \times 20 = 200$.

Q31.

Answer: A

Explanation:

Each of the 7 distinct toys can be given to any one of the 3 children. Therefore, each toy has 3 choices independently. Hence, the total number of ways is: $3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^7 = 2187$

Q32.

Answer: D

Explanation:

First arrange the 8 men around the circular table in $7!$ ways. This creates 8 gaps between consecutive men. Choose and arrange 4 women in 4 of these gaps, which can be done in 8P_4 ways.

Q33.

Answer: A

Explanation:

Since the 3 rings are distinct and must be placed on different fingers, we select and arrange 3 fingers out of 4. ${}^4P_3 = \frac{4!}{(4-3)!} = 24$

Q34.

Answer: C

Explanation:

For there to be exactly 2 letters between R and D, their positions must differ by 3. In 6 positions, there are 3 possible position-pairs. R and D can be arranged in either order, and the remaining 4 letters can be arranged in $4!$ ways.

Q35.

Answer: A

Explanation:

This is a derangement problem. Since there are 5 distinct letters, the number of arrangements in which no letter remains in its original position is: $!5=44$

Q36.

Answer: D

Explanation:

This is a standard problem of distributing n identical items into r distinct groups such that each group receives at least one item. The formula used is ${}^{n-1}C_{r-1}$.

Q37.

Answer: C

Explanation:

Since the captain (batsman) and vice-captain (bowler) are already fixed, we need to choose the remaining 8 players from the remaining 6 batsmen and 5 bowlers while satisfying the revised "at least" constraints.

Q38.

Answer: D

Explanation:

Prime factorize 24 and distribute the powers of each prime factor among the three variables using the stars and bars method.

Q39.

Answer: D

Explanation:

Calculate the total non-negative solutions and subtract cases where at least two integers are equal to find the count of distinct triplets.

Q40.

Answer: A

Explanation:

Categorize the letters into pairs and singles, then sum the ways to choose 5 letters based on how many pairs are selected.

Q41.

Answer: A

Explanation:

Use the total circular arrangements and subtract the cases where the two individuals are sitting together.

Q42.

Answer: C

Explanation:

Find the total combinations of 3 points and subtract the cases where the 3 chosen points are collinear (lying on the same side).

Q43.

Answer: B

Explanation:

Sort the letters alphabetically and count the number of words starting with each letter until reaching the target position.

Q44.

Answer: D

Explanation:

Calculate total arrangements in the grid and subtract cases where any row is left completely empty using the Principle of Inclusion-Exclusion.

Q45.

Answer: D

Explanation:

Categorize the available letters (A, A, R, R, B, C, K) and sum the arrangements for selecting 4 distinct letters, 1 pair, or 2 pairs.

Q46.

Answer: 777

Explanation:

Identify all combinations of the three types of players that sum to 11 while satisfying the minimum requirements for each category.

Q47.

Answer: 60

Explanation:

Arrange the available even digits in the specific even positions and the odd digits in the remaining odd positions.

Q48.

Answer: 44

Explanation:

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

Q49.

Answer: 3734

Explanation:

Break down the word into its components and consider four cases of selection: all distinct, one pair, two pairs, and one triplet.

Q50.

Answer: 103

Explanation:

Arrange the letters alphabetically (A, H, M, S, T) and count all permutations preceding the target word.

Q51.

Answer: A

Explanation:

$\Phi = BA \cos \theta = 4.0 \times 0.25 \times \cos 60^\circ = 1 \times 0.5 = 0.5 \text{ weber.}$

Q52.

Answer: B

Explanation:

Plane at 30° to $\vec{B} \Rightarrow$ area vector at $\theta = 90^\circ - 30^\circ = 60^\circ$ to $\vec{B}$, so $\Phi = BA \cos 60^\circ = 10^3 \times 10^{-3} \times \frac{1}{2} = \frac{1}{2} \text{ weber.}$

Q53.

Answer: B

Explanation:

$q = \frac{\Delta \Phi}{R} = \frac{NBA(\cos 0^\circ - \cos 90^\circ)}{R} = \frac{500 \times 0.2 \times 0.1}{50} = \frac{10}{50} = 0.2 \text{ C (charge is independent of time).}$

Q54.

Answer: A

Explanation:

$|\varepsilon| = \left| \frac{d\phi}{dt} \right| = |10t - 4| = |10(0.5) - 4| = 1 \text{ V, so } I = \frac{|\varepsilon|}{R} = \frac{1}{2} = 0.5 \text{ A.}$

Q55.

Answer: A

Explanation:

Wire length is conserved: $2\pi r = 4s \Rightarrow s = \frac{\pi r}{2}$; so

$q = \frac{B|\Delta A|}{R} = \frac{B}{R} \left(\pi r^2 - \frac{\pi^2 r^2}{4} \right) = \frac{B\pi r^2}{R} \left(1 - \frac{\pi}{4} \right).$

Q56.

Answer: B

Explanation:

$|\varepsilon| = B \frac{dA}{dt} = B(2\pi r) \frac{dr}{dt} = 20 \times 10^{-3} \times 2\pi(10^{-2}) \times 0.2 \times 10^{-3} = 8\pi \times 10^{-}$

Q57.

Answer: C

Explanation:

For the total flux to be zero, the flux produced by wire A must be equal and opposite to the flux produced by wire B . By equating the integral expressions for flux from both wires over the loop's area, the separation distance can be determined.

Q58.

Answer: A

Explanation:

The changing current in the long wire induces a constant EMF in the square loop. This EMF acts as a battery charging the capacitor in an RC circuit.

Q59.

Answer: A

Explanation:

Induced EMF is the negative rate of change of magnetic flux. Only the magnetic field component perpendicular to the axis of rotation (B_y) contributes to a change in flux as the loop rotates.

Q60.

Answer: C

Explanation:

EMF is only induced in conducting materials. The wooden portion generates no potential difference; therefore, the total potential difference is only the EMF induced across the copper-coated segment.

Q61.

Answer: D

Explanation:

The induced EMF across a rod in a time-varying circular magnetic field depends on the area of the segment "swept" or effectively linked by the rod relative to the center.

Q62.

Answer: A

Explanation:

Induced current is the induced EMF divided by the resistance. EMF is calculated as the rate of change of magnetic flux through the triangular area.

Q63.

Answer: D

Explanation:

As the electron approaches, the magnetic flux through the loop increases. As it moves away, the flux decreases. Lenz's law dictates that the induced current must reverse direction to oppose both the increase and the subsequent decrease in flux.

Q64.

Answer: A

Explanation:

The motional EMF induced in a rotating rod is found by integrating the potential difference across infinitesimal elements along its length.

Q65.

Answer: B

Explanation:

The current in an LR circuit grows according to $i(t) = \frac{V}{R}(1 - e^{-t/\tau})$, where $\tau = L/R$. The ratio is found by comparing the steady-state current to the current at $t = 1$.

Q66.

Answer: B

Explanation:

The induced EMF is $\mathcal{E} = Blv$. The polarity is determined using the right-hand rule ($\vec{v} \times \vec{B}$), which shows the direction of the force on positive charges.

Q67.

Answer: B

Explanation:

The induced motional EMF in a conductor moving through a uniform magnetic field depends on the shortest distance between its endpoints (the "effective length") perpendicular to its velocity. Since a semicircular wire connecting the same two points on the rails has the same effective length as a straight wire, the induced EMF and current do not change.

Q68.

Answer: D

Explanation:

Magnetic field lines are closed loops. For an infinite plane containing the current source, every field line passing through the plane in one direction must return through the plane in the opposite direction.

Q69.

Answer: D

Explanation:

EMF is induced between the center of the rod and each end. However, because the rod is rotating about its center, the potential at both ends is the same relative to the center, leading to zero potential difference between the ends.

Q70.

Answer: 4

Explanation:

$$|\mathcal{E}| = N A \frac{\Delta B}{\Delta t} = 100 \times (2 \times 10^{-2}) \times \frac{0.2}{0.1} = 100 \times 0.02 \times 2 = 4 \text{ V}.$$

Q71.

Answer: 5

Explanation:

$$\Phi_i = N B A = 10^{-3} \text{ Wb}; \text{ after } 90^\circ, \Phi_f = 0, \text{ so}$$

$$|\mathcal{E}| = \frac{10^{-3}}{0.2} = 5 \times 10^{-3} \text{ V} = 5 \text{ mV}.$$

Q72.

Answer: 2

Explanation:

Induced electromotive force (emf) is proportional to the rate of change of magnetic flux, which in this context depends on the relative speed between the magnet and the coil. When the relative speed doubles, the induced emf also doubles.

Q73.

Answer: 1.41

Explanation:

The induced electromotive force (emf) for a conductor moving in a magnetic field is determined by the effective length of the conductor perpendicular to both the magnetic field and the direction of motion. In this configuration, the effective length is the straight-line distance between the start point A and the end point D .

Q74.

Answer: 4.9

Explanation:

Plastic ring $\Rightarrow$ no induced current $\Rightarrow$ free fall:

$$h = \frac{1}{2} g t^2 = \frac{1}{2} \times 9.8 \times 1^2 = 4.9 \text{ m}.$$

Q75.

Answer: A

Explanation:

The force required to move the rod at constant speed is equal to the magnetic force $F = IlB$. The current I is generated by the motional EMF $\mathcal{E} = Blv$.