

1. Match List-I with List-II.

List-I		List-II	
Element detected		Reagent used/Product formed	
A	Nitrogen	I	$\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$
B	Sulphur	II	AgNO_3
C	Phosphorus	III	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
D	Halogen	IV	$(\text{NH}_4)_2\text{MoO}_4$

Choose the correct answer from the options given below:

[2023 (06 Apr Shift 1)]

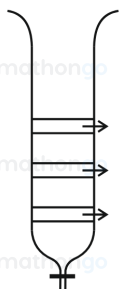
(1) A → III; B → I; C → IV; D → II

(2) A → II; B → IV; C → I; D → III

(3) A → IV; B → II; C → I; D → III

(4) A → II; B → I; C → IV; D → III

2. From the figure of column chromatography given below, identify incorrect statements.



A. Compound 'c' is more polar than 'a' and 'b'

B. Compound 'a' is least polar

C. Compound 'b' comes out of the column before 'c' and after 'a'

D. Compound 'a' spends more time in the column

Choose the correct answer from the options given below

[2023 (06 Apr Shift 2)]

(1) A, B and D only

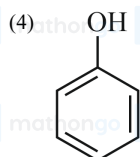
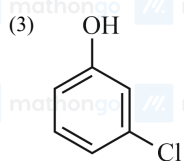
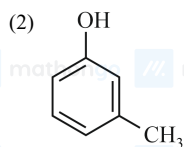
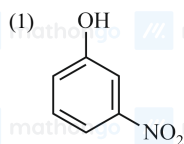
(2) A, B and C only

(3) B and D only

(4) B, C and D only

3. The strongest acid from the following is

[2023 (06 Apr Shift 2)]



4. The descending order of acidity for the following carboxylic acid is-

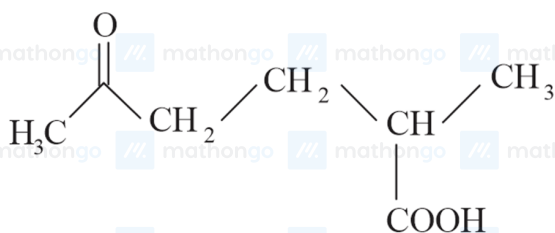
- (A) CH_3COOH
- (B) $\text{F}_3\text{C} - \text{COOH}$
- (C) $\text{ClCH}_2 - \text{COOH}$
- (D) $\text{FCH}_2 - \text{COOH}$
- (E) $\text{BrCH}_2 - \text{COOH}$

Choose the correct answer from the options given below:

[2023 (08 Apr Shift 2)]

- (1) $\text{B} > \text{C} > \text{D} > \text{E} > \text{A}$
- (2) $\text{E} > \text{D} > \text{B} > \text{A} > \text{C}$
- (3) $\text{B} > \text{D} > \text{C} > \text{E} > \text{A}$
- (4) $\text{D} > \text{B} > \text{A} > \text{E} > \text{C}$

5. The correct IUPAC nomenclature for the following compound is:



[2023 (08 Apr Shift 2)]

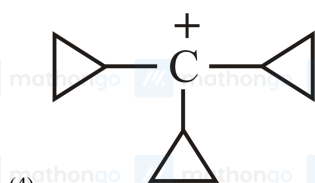
- (1) 2-Methyl-5-oxohexanoic acid
- (2) 2-Formyl-5-methylhexan-6-oic acid
- (3) 5-Methyl-2-oxohexan-6-oic acid
- (4) 5-Formyl-2-methylhexanoic acid

6. Using column chromatography, mixture of two compounds 'A' and 'B' was separated. 'A' eluted first, this indicates 'B' has

[2023 (10 Apr Shift 1)]

- (1) low R_f , stronger adsorption
- (2) high R_f , weaker adsorption
- (3) high R_f , stronger adsorption
- (4) low R_f , weaker adsorption

7. The decreasing order of hydride affinity for following carbocations is:



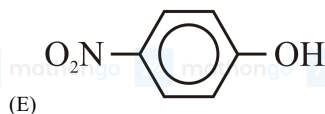
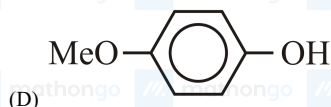
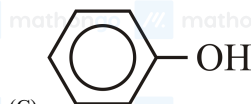
Choose the correct answer from the options given below:

[2023 (10 Apr Shift 2)]

- (1) C, A, D, B
- (2) C, A, B, D
- (3) A, C, D, B
- (4) A, C, B, D

8. The correct order for acidity of the following hydroxyl compound is

- (A) CH_3OH
- (B) $(\text{CH}_3)_3\text{COH}$



Choose the correct answer from the options given below:

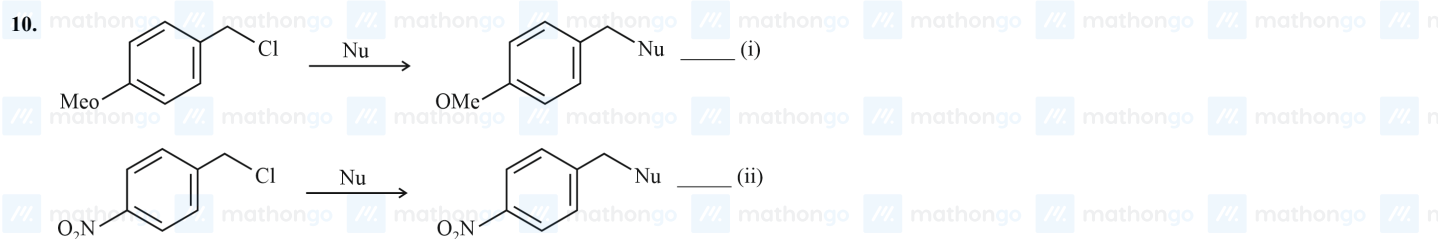
[2023 (10 Apr Shift 2)]

- (1) $\text{C} > \text{E} > \text{D} > \text{B} > \text{A}$
- (2) $\text{E} > \text{D} > \text{C} > \text{B} > \text{A}$
- (3) $\text{D} > \text{E} > \text{C} > \text{A} > \text{B}$
- (4) $\text{E} > \text{C} > \text{D} > \text{A} > \text{B}$

9. In Carius tube, an organic compound 'X' is treated with sodium peroxide to form a mineral acid 'Y'. The solution of BaCl_2 is added to 'Y' to form a precipitate 'Z'. 'Z' is used for the quantitative estimation of an extra element. 'X' could be

[2023 (10 Apr Shift 2)]

- (1) Cytosine
- (2) A nucleotide
- (3) Methionine
- (4) Chloroxylenol



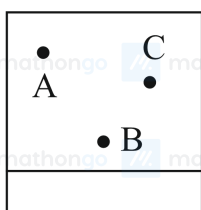
Where Nu = Nucleophile

Find out the correct statement from the options given below for the above two reactions.

[2023 (11 Apr Shift 1)]

- (1) Reaction (I) is of 2nd order and reaction (II) is of 1st order
- (2) Reactions (I) and (II) both are of 2nd order
- (3) Reaction (I) is of 1st order and reaction (II) is of 2nd order
- (4) Reaction (I) and (II) both are of 1st order

11. Thin layer chromatography of a mixture shows the following observation:



The correct order of elution in the silica gel column chromatography is

[2023 (11 Apr Shift 1)]

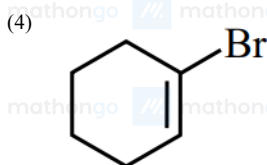
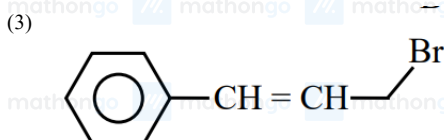
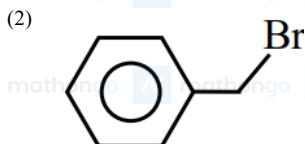
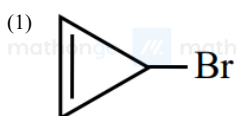
- (1) B, A, C
- (2) B, C, A
- (3) A, C, B
- (4) C, A, B

12. 

The number of hyperconjugation structures involved to stabilize carbocation formed in the above reaction is _____.

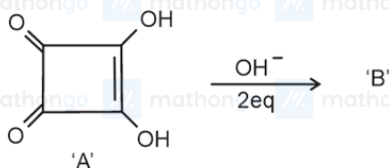
[2023 (11 Apr Shift 1)]

13. Compound from the following that will not produce precipitate on reaction with AgNO_3 is
[2023 (11 Apr Shift 2)]



14. The number of possible isomeric products formed when 3-chloro-1-butene reacts with HCl through carbocation formation is.....
[2023 (11 Apr Shift 2)]

15. Correct statements for the given reaction are:



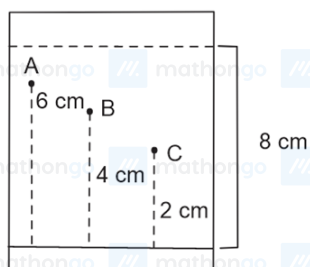
- A. Compound 'B' is aromatic
B. The completion of above reaction is very slow
C. 'A' shows tautomerism
D. The bond lengths of $\text{C}-\text{C}$ in compound B are found to be same

Choose the correct answer from the options given below.

[2023 (12 Apr Shift 1)]

- (1) B, C and D only
(2) A, B and C only
(3) A, C and D only
(4) A, B and D only

16. Three organic compounds A, B and C were allowed to run in thin layer chromatography using hexane and gave the following result (see figure). The R_f value of the most polar compound is $\underline{\hspace{2cm}} \times 10^{-2}$

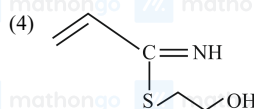
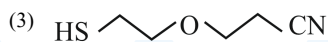
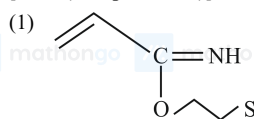


[2023 (12 Apr Shift 1)]

17. The major product for the following reaction is :

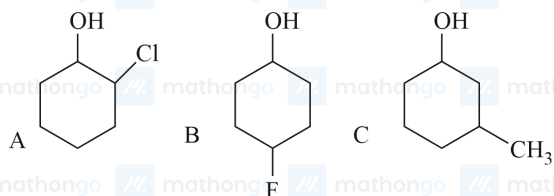


[2023 (13 Apr Shift 2)]



18. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Order of acidic nature of the following compounds is $A > B > C$.



Reason R: Fluoro is a stronger electron withdrawing group than Chloro group.

In the light of the above statements, choose the correct answer from the options given below :

[2023 (13 Apr Shift 2)]

- (1) A is false but R is true
- (2) Both A and R are correct and R is the correct explanation of A
- (3) A is true but R is false
- (4) Both A and R are correct but R is NOT the correct explanation of A

19. Given below are two statements :

Statement I : Tropolone is an aromatic compound and has 8π electrons.

Statement II : π electrons of $>C=O$ group in tropolone is involved in aromaticity. In the light of the above statements choose the correct answer from the options given below:

[2023 (13 Apr Shift 2)]

- (1) Statement I is true but Statement II is false
- (2) Statement I is false but Statement II is true
- (3) Both Statement I and Statement II are false
- (4) Both Statement I and Statement II are true

20. 0.400 g of an organic compound (X) gave 0.376 g of AgBr in Carius method for estimation of bromine. % of bromine in the compound (X) is (Given: Molar mass AgBr = 188 g mol^{-1} , Br = 80 g mol^{-1})

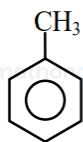
[2023 (13 Apr Shift 2)]

21. Which of the following statement is correct for paper chromatography?

[2023 (15 Apr Shift 1)]

- (1) Water present in the pores of the paper forms the stationary phase.
- (2) Paper sheet forms the stationary phase.
- (3) Water present in the mobile phase gets absorbed by the paper which then forms the stationary phase.
- (4) Paper and water present in its pores together form the stationary phase.

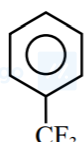
22. Decreasing order of reactivity towards electrophilic substitution for the following compounds is:



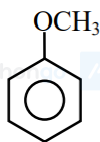
(a)



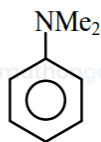
(b)



(c)



(d)



(e)

[2023 (15 Apr Shift 1)]

(1) $d > a > e > c > b$

(2) $e > d > a > b > c$

(3) $a > d > e > b > c$

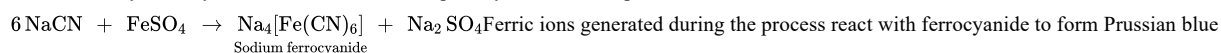
(4) $c > b > a > d > e$

ANSWER KEYS

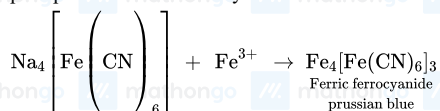
1. (1) 2. (2) 3. (1) 4. (3) 5. (1) 6. (1) 7. (2) 8. (4)
9. (3) 10. (3) 11. (3) 12. (7) 13. (4) 14. (4) 15. (3) 16. (25)
17. (2) 18. (4) 19. (1) 20. (40) 21. (1) 22. (2)

1. (1)

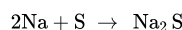
The nitrogen present in the organic compound on fusion with sodium metal gives sodium cyanide (NaCN) soluble in water. This is converted into sodium ferrocyanide by the addition of sufficient quantity of ferrous sulphate.



precipitate of ferric ferrocyanide.

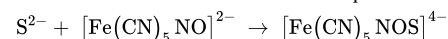


Sulphur present in organic compounds are detected by Lassaigne's test. Here, a small piece of Na metal is heated in a fusion tube with the organic compound. The principle is that, in doing so, Na converts all the elements present into ionic form.



Test of sulphur :

The extract is treated with sodium nitroprusside. The appearance of violet colour indicates the presence of sulphur. The following reaction occurs:



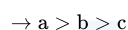
The phosphorus present in the compound is oxidised to phosphate. The solution is boiled with nitric acid and then treated with ammonium molybdate. A yellow colouration or precipitate indicates the presence of phosphorus.

The halogen present in the compound converted into sodium halide, and it will be precipitated with silver nitrate.

2. (2)

Column chromatography separates compounds based on their polarity. The more polar a compound is, the more it interacts with the stationary phase and the slower it moves through the column. The less polar a compound is, the faster it moves through the column.

As the chromatogram, degree of polarity



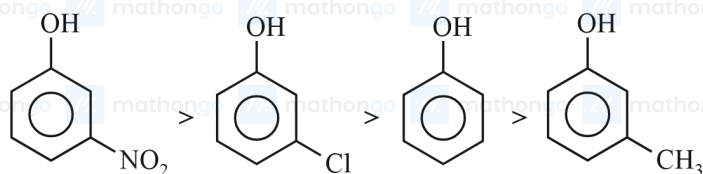
∴ Statements A, B are incorrect as b comes out before 'C' the statement C is also incorrect.

As a is most polar, it spends most time. Hence, A, B and C are incorrect statements.

3. (1)

In the case of substituted phenols, the acidity of phenols increases in the presence of the electron-withdrawing group. This is due to the stability of the phenoxide ion generated. In case of meta substituted phenols, the acidic nature can be explained on the basis of inductive effect. Among the given groups -NO₂ & -Cl groups are electron withdrawing groups and methyl group is electron releasing group.

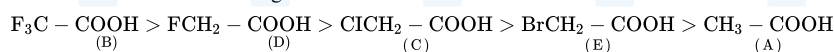
Acidic strength order is :



4. (3)

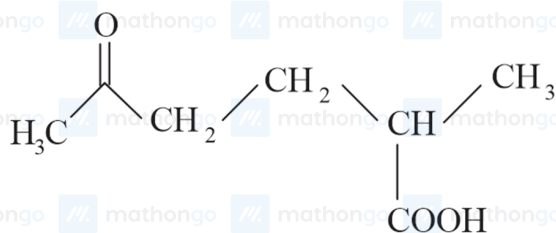
The correct order of acidic strength of the given carboxylic acids will be decided by the stability of their conjugate bases. The +I effect of CH₃ group destabilises the carboxylate anion. But the -I effect of halogen substituted methyl group stabilises the carboxylate anion. Higher the -I effect of the halogen substituted methyl group, higher the acidic strength of the corresponding acid.

∴ Correct order of acidic strength is



5. (1)

IUPAC name of the following compound is



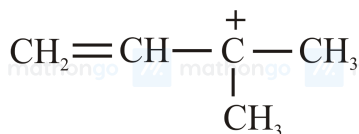
2-Methyl-5-oxo-hexanoic acid

1. Identify the longest continuous carbon chain that contains the carboxyl group (COOH). In this case, it is a six-carbon chain.
2. Number the carbon chain starting from the end closest to the carboxyl group. The carboxyl carbon is assigned the number 1.
3. Identify and name any substituents attached to the carbon chain. In this case, there is a methyl group attached to the second carbon atom of the chain.
4. Combine the substituent name with the parent chain name, with a hyphen in between. The resulting name is "2-methylhexanoic acid".
5. Finally, add the prefix "oxo" to indicate the presence of a ketone group (C = O) on the fifth carbon of the chain.

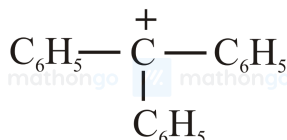
6. (1)

In chromatography, the retardation factor (Rf) is the fraction of an analyte in the mobile phase of a chromatographic system. In planar chromatography in particular, the retardation factor Rf is defined as the ratio of the distance travelled by the centre of a spot to the distance travelled by the solvent front. The more polar spot travels slower, and the less polar spot travels faster. Rf values, on the other hand, are directly related to the rate of movement. The fastest moving spot has the highest Rf value, least polar (fastest moving), and the spot with the lowest Rf value is the most polar (slowest moving). Hence, the compound B is strongly adsorbed and has low Rf value.

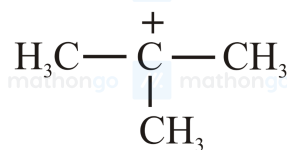
7. (2) The stability of a carbocation increases with the number of alkyl groups attached to the carbon atom, due to the inductive and hyperconjugation effects of the alkyl groups. The more the number of alkyl groups, the greater is the electron density on the positively charged carbon, and hence the more stable is the carbocation.



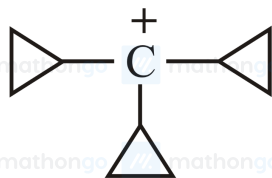
The above carbocation can be stabilised by resonance and hyperconjugation.



The above carbocation stabilised by resonance caused by three benzene rings. This carbocation is more stable than the previous carbocation.



The above carbocation stabilised by hyperconjugation. It is the least stable carbocation among the four carbocations given.



The above carbocation is the most stable carbocation among the four due to the resonance caused by bent orbitals.

From the given options Stability of carbocation; $D > B > A > C$

The least stable carbocation will have the highest hydride affinity, because it is the most electron deficient and has the highest positive charge density. As a result, it will have the strongest attraction for a negatively charged hydride ion.

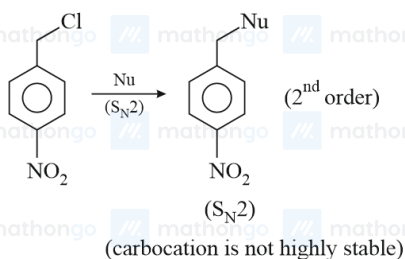
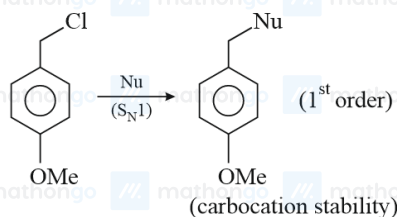
Hydride affinity order: $C > A > B > D$

8. (4) The compounds A & B are alcohols, and rest of the compounds are phenols. Phenols are more acidic than alcohols. Among the A & B, methyl alcohol is more acidic than tertiary butyl alcohol as alkyl groups decrease the acidic nature by electron releasing tendency. Among the phenols, the phenol with electron withdrawing group is more acidic. NO_2 (Electron withdrawing group) group will increase the acidity, OCH_3 (Electron releasing group) group at para position will decrease the acidity. So, Acidic strength $E > C > D > A > B$

9. (3) Barium chloride is used to estimate sulphur content in the molecule. In Carius tube test, a known mass of sulphur present in an organic compound with Silver Nitrate is heated into a sealed tube known as Carius tube with silver. The organic compound is then converted to Sulphuric acid which then reacts with excess Barium Chloride solution and produces a precipitate of Barium Sulphate. Z is BaSO_4 and Y is H_2SO_4 . It is clear that "X" must contain sulphur. Methionine is $\text{C}_5\text{H}_{11}\text{NO}_2\text{S}$, a sulphur containing amino acid

10. (3)

The S_N1 reactions takes place via formation of carbocation. The speed of the reaction depends on the stability of carbocation. Electron releasing groups supports the S_N1 reactions. The S_N2 reactions are takes place through the formation of transition state. The transition can be stabilised by electron withdrawing groups.



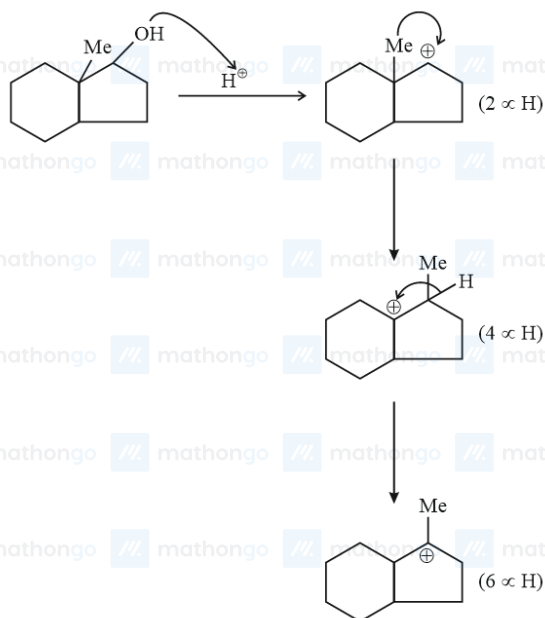
11. (3)

The process of extraction of different compounds absorbed on the column by means of a suitable solvent (eluent) is called 'elution'. Silica gel and solvent methylene chloride both are polar. The polar solvent and silica gel bind the polar compound, so it moves very slowly, whereas the non-polar compound moves faster on the silica gel.

Correct order of elution $\rightarrow A > C > B$

12. (7)

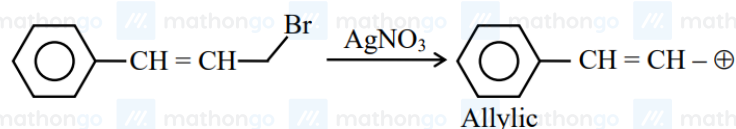
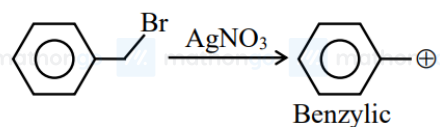
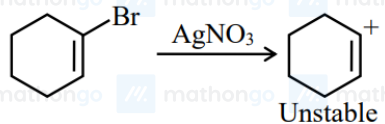
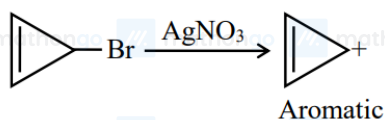
In the first step of the reaction, protonation of alcohol takes place and carbocation is formed after removal of water. The carbocation formed undergo rearrangement to get stability. In the given, methyl shift takes place to convert secondary carbocation to tertiary carbocation. The alpha hydrogen to the positive charged carbon are involved in hyperconjugation.



So, number of hyperconjugation structures in most stable carbocation
 $= 6 + 1 = 7$

13. (4)

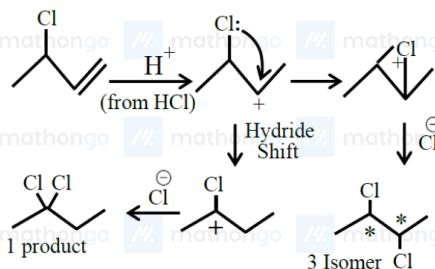
Compounds which results in the formation of stable carbocation upon treating with AgNO_3 will produce precipitate.



In the above carbocations, the second carbocation is unstable, hence, it cannot give precipitate with silver nitrate.

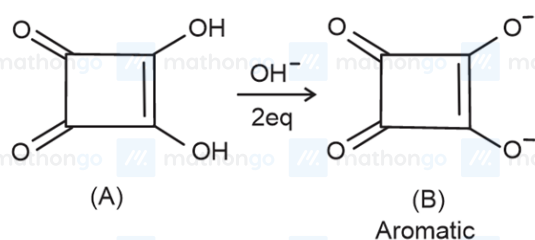
14. (4)

3-chloro-1-butene undergo protonation and gives secondary carbocation according to Markonikov's addition in the first step. In the second step the lone pair on the chlorine attacks the positively charged carbon to form cyclic intermediate. Now the nucleophile in the reaction i.e., chloride ion attacks cyclic intermediate and forms two structural products as shown below.



2,2-dichlorobutane exist in single isomer only, but 2,3-dichlorobutane exhibits three isomers.

15. (3)



Aromatic compounds are cyclic, planar and must obey Huckel's rule i.e. molecule must have $4n + 2$ pi-electrons where n is an integer (i.e. $n = 0, 1, 2, 3, 4 \dots$ etc.). The compound B follows the Huckel's rule. The acid-base reactions fast reactions. Compound (A), also called squaric acid is a strong acid. So, above reaction proceeds very fast. All C - C bond lengths in (B) are same due to resonance. (A) shows tautomerism. A

16. (25)

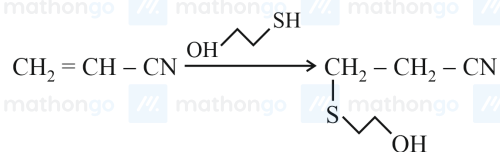
In thin layer chromatography using hexane, the least polar compound will rise to maximum height and most polar compound will rise to minimum height. The retardation factor of each spot can be determined by dividing the distance that a particular compound has travelled by the distance between solvent front and initial spotting site. This parameter is dependent on the thin layer chromatographic plate and the solvent.

$\therefore R_f$ value for most polar compound

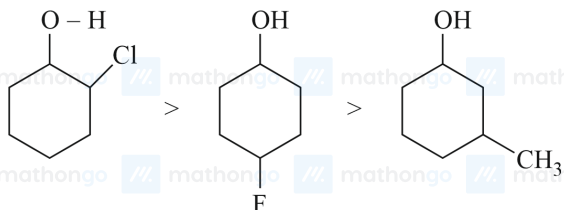
$$= \frac{2}{8} = 0.25$$

$$= 25 \times 10^{-2}$$

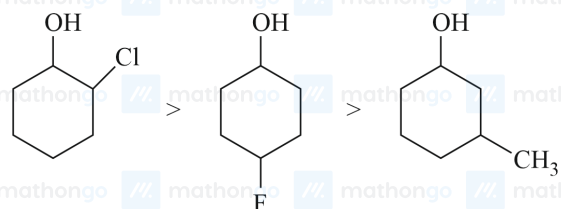
17. (2) Nucleophilicity of sulfur-containing nucleophiles (such as SH^-) is higher than that of oxygen-containing nucleophiles (such as OH^-). Here Sulphur containing nucleophile can donate its lone pair. A stable carbocation is formed next, stable carbocation will be that which is away from CN group.



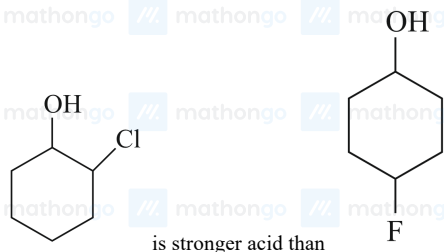
18. (4) The electron withdrawing groups decreases the acidic nature and The electron releasing groups increases the acidic nature.
The F & Cl are electron withdrawing while CH_3 is electron loosing hence acidic strength will be



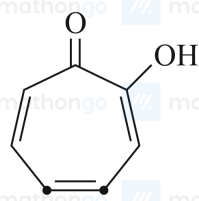
On further differentiation the $-I$ effect depends on most importantly over distance hence.



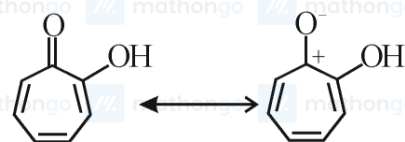
The F has higher $-I$ effect as compared to Cl hence reason is correct statement but the $-I$ effect depends more on distance as compared to power hence



19. (1)



Tropolone is an aromatic compound and has 8π electrons ($6\pi e^-$ are endocyclic and $2\pi e^-$ are exocyclic) and π electrons of $> \text{C} = \text{O}$ group in tropolone is not involved in aromaticity.



aromatic compound ($6\pi e^-$)

20. (40)

The percentage composition of element = $\frac{\text{mass of element}}{\text{mass of organic compound}} \times 100$

$$\text{Moles of AgBr} = \frac{0.376}{188}$$

$$\text{Moles of Br} = \frac{0.376}{188}$$

$$\text{Mass of Br} = \frac{0.376}{188} \times 80$$

$$\begin{aligned} \% \text{ of Br} &= \frac{0.376 \times 80}{188 \times (0.400)} \times 100 \\ &= 40\% \end{aligned}$$

21. (1) The principle of paper chromatography is partition. In paper chromatography there are two phases one is the stationary phase and the other is the mobile phase. Here, water trapped in the paper acts as the stationary phase and solvent acts as the mobile phase.

22. (2)

Reactivity of aromatic compounds towards electrophilic substitution depends on the electron density on benzene ring. Higher the electron density on benzene ring, more be the reactivity towards electrophilic substitution reaction. Hence, the correct decreasing order is

