

# **ESR Amines and Phenols**

# **Question Bank**

# LEVEL 1

1. In the given reaction  $H_2N$   $\longrightarrow$   $CH_3 \xrightarrow{(CH_3CO)_2 O}$   $A \xrightarrow{Cl_2}$   $B \xrightarrow{H_3O^{\oplus}}$  C the product (C) will be

$$(a) \begin{array}{c|cccc} NH_2 & NH_2 & HNCl & NH_2 \\ \hline \\ Cl & CH_3 & CH_3 & CH_2Cl & CH_2Cl & CH_2Cl \\ \hline \end{array}$$

**2.** Rank the following compounds in order of decreasing reactivity for nitration.

(ii) 
$$H - \overset{\square}{C} - \overset{\square}{C} - CH_3$$
 (ii)  $H_3C - O - \overset{\square}{C} - OCH_3$  (iii)  $Br - \overset{\square}{C} - COCH_3$  (iv)  $H_3C - O - \overset{\square}{C} - OCH_3$ 

Select the correct answer from the following:

(a) iv > ii > i > iii

(b) ii > iv > iii > i

(c) ii > iv > i > iii

(d) i > ii > iii > iv

3. In the given reaction major product (P) will be

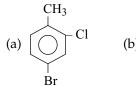
**4.** The major product [X] of the given reaction is

**5.** In the given reaction sequence, identify (B)

$$\begin{array}{c} C_{6}H_{6}+Cl-CH_{2}-\overbrace{\bigcirc} - CH_{2}-Cl \xrightarrow{anhy.AlCl_{3}} (A) \xrightarrow{NBS/hv} (B) \\ \\ \text{(a)} & \bigcirc - CH_{2}-\overbrace{\bigcirc} - CH_{2}-\overbrace{\bigcirc} \\ \text{(b)} & \xrightarrow{Br} - CH_{2}-\overbrace{\bigcirc} - CH_{2}-\overbrace{\bigcirc} \\ \\ \text{(c)} & C_{6}H_{5}-CH_{2}-\overbrace{\bigcirc} - CH_{2}-\overbrace{\bigcirc} \\ \end{array}$$

**6.** The final product of the given reaction is

$$\begin{array}{c}
CH3 \\
& \downarrow \\
\hline
 & KMnO_4 \\
\hline
 & H^+
\end{array} [X] \xrightarrow{Br_2} [Y]$$
(small quantity)



7. 
$$\underbrace{ \begin{array}{c} \text{NO}_2 \\ \text{H}_2\text{SO}_4 \end{array}} \underbrace{ \begin{array}{c} \text{NO}_2 \\ \text{(i)} \end{array}} + \underbrace{ \begin{array}{c} \text{NO}_2 \\ \text{(ii)} \end{array}}$$

Which statement is correct?

- (a) i form in large quantity
- (c) i, ii form in equal quantity
- (b) ii form in large quantity
- (d) naphthalene does not show nitration

8. 
$$(CH_3)_2C = CH_2/H^{\oplus}$$

CH<sub>3</sub>

Major product is

(a) 
$$C(CH_3)_3$$
  $CH_3$ 

$$(b) \begin{picture}(60,0) \put(0,0){\line(1,0){100}} \put(0,0){\line(1,0)$$

$$\begin{array}{c} OCH_2 - CH(CH_3)_2 \\ \hline \\ CH_3 \end{array}$$

$$(d) \begin{tabular}{c} CH_3 \\ O-C-CH_3 \\ CH_3 \\ CH_3 \\ \end{tabular}$$

9. Nitration of the compound 
$$CH_3$$
 gives  $H_3CO$ 

(a) 
$$CH_3$$
  $NO_2$   $NO_2$ 

(b) 
$$CH_3$$
  $NO_2$   $NO_2$   $NO_2$ 

$$(d) \begin{array}{c} NO_2 \\ O \\ H_3CO \end{array}$$

OH

OH

CHO

$$CHO$$
 $H_3C$ 

OH

 $H_3C$ 

OH

 $CHO$ 
 $Br$ 
 $CHO$ 
 $Br$ 

11. The major product of the following reaction is

(a) 
$$\begin{array}{c} CH_3 \\ | \\ -C-CH_3 \\ | \\ CH_3 \end{array}$$

(c) 
$$H_3C - C$$
  $CH_3$   $CH_3$ 

CH<sub>3</sub>

$$H \\ \downarrow \\ CH_3 - C - CH_2 - CH_2 - OH$$

$$CH_3$$

12. 
$$HNO_3 \rightarrow Major product is$$

(d) 
$$NO_2$$

13. 
$$CH_3$$
 NH<sub>2</sub>  $Br_2/CCl_4$  Major product is

(a) 
$$Br$$
 $CH_3$ 
 $CH_3$ 

#### 14. The product of the following reaction is

$$(a) \begin{array}{c} H_{3}C - C - NH \\ O \\ \end{array} \begin{array}{c} BF_{3} \\ H_{2}O \\ \end{array}$$

$$(b) \begin{array}{c} O \\ H_{3}C - C - NH \\ O \\ \end{array} \begin{array}{c} O \\ H_{3}C - C - NH \\ \end{array} \begin{array}{c}$$

#### 15. Which has equal carbon–carbon bond length?

(a) 
$$O_2N$$
  $O_2N$   $O_2$ 

#### **16.** Product of the reaction is

C1 — C – O – OH 
$$\xrightarrow{H^{\oplus}}$$
 Product

CH<sub>3</sub>

(a) 
$$HO - CI + CI - CI - CII - CIII - CIII - CIII - CIII - CIIII - CIII - CIII$$

$$\begin{array}{c} \text{C} & \text{C} & \text{C} & \text{C} & \text{C} \\ \text{C} & \text{C} \\ \text{C} & \text{C} & \text{C} \\ \text{C} & \text{C} & \text{C} \\ \text{C} & \text{C} \\ \text{C} & \text{C} & \text{C} \\ \text{C} \\ \text{C} & \text{C} \\ \text{C} & \text{C} \\ \text{$$

#### 17. For the following reaction, correct options are

$$A + \bigcup_{O} \xrightarrow{PhMgBr} A + B \text{ (salt)}$$

$$A + \bigcup_{O} \xrightarrow{AlCl_3} \frac{i. \text{ SOCl}_2}{ii. \text{ AlCl}_3} C$$

(a) 
$$B (salt) + H_3O^{\oplus} \longrightarrow O$$
 (b)  $B (salt) + H_3O^{\oplus} \longrightarrow Ph$   $CH_2OH$ 

(c) 
$$B (salt) + H_3O^{\oplus} \xrightarrow{Me} O$$
 (d)  $C is$ 

#### 18. Consider the following ions

The reactivities of these ions in azo-coupling reactions (under similar conditions) will be such that

(a) 
$$i < iv < ii < iii$$
 (b)  $i < iii < iv < ii$  (c)  $iii < i < iv < ii$  (d)  $iii < i < iv < ii$ 

19. 
$$CH_3 \xrightarrow{H^{\oplus}} [A]; [A] \text{ is}$$

$$CH_3$$

$$(a) \bigcirc OH \\ (b) \bigcirc CH_3 \\ (c) \bigcirc CH_3$$

$$(d) \bigcirc CH_3$$

#### **20.** Which of the following is/are more reactive towards nitration than benzene?

(a) 
$$CH_3$$
 (b)  $CH_3$  (c)  $CH_3$  (d) All of these

 $CH(CH_3)_2$ 

is; where the reagent 'X' is

(a)  $CH_2 = CH - CH_3 / HF$ 

- (b) CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>Cl/Anh. AlCl<sub>3</sub>
- (c)  $CH_3$ - $CHCH_3$ /Anh.  $AlCl_3$  Cl
- (d) All of these
- **22.** In the given reaction sequence

$$C_6H_5OCOCH_3 \xrightarrow{AICI_3/\Delta} (A) \xrightarrow{I_2/NaOH} (B) + CHI_3$$
, (B) is

- (a) C<sub>6</sub>H<sub>5</sub>COONa (b) C<sub>6</sub>H<sub>5</sub>COOH
- $COCH_3$  (d)

23. The major product formed in the reaction is

$$\begin{array}{c|c}
O \\
\parallel \\
C - O - 
\end{array}$$
Conc. HNO<sub>3</sub>/Conc. H<sub>2</sub>SO<sub>4</sub>
(mononitration)

- $\xrightarrow{\text{Fe/HCl}}$  (A)  $\xrightarrow{\text{HNO}_3}$  (B). The major product (b) is

- 25. Arrange the following in the order of their nucleophilic substitution reaction



- (a) ii > iv > i > iii (b) i > iv > ii > iii
- (c) iv > i > ii > iii
- (d) iv > ii > i > iii

#### **26.** For the following reaction

(i) 
$$NO_2$$
  $CH_3NH_2$   $NO_2$   $NO_2$ 

(iii) 
$$NO_2$$
  $CH_3NH_2$   $NO_2$   $NO_2$   $NO_2$   $NO_2$   $NO_2$   $NO_2$   $NO_2$   $NO_2$   $NO_3$ 

Correct order of reactivity

- (a) i = ii = iii
- (b) i > ii > iii
- (c) i < ii < iii
- (d) ii > iii > i

#### 27. What is correct order of rate of nitration of the following compounds?

- (i)  $C_6H_5CH_3$
- (ii) C<sub>6</sub>H<sub>6</sub>

(iii) C<sub>6</sub>H<sub>5</sub>Br

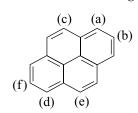
- (iv)  $C_6H_5NR_3$
- (v)  $C_6H_5NMe_2$
- (a) iv > iii > ii > v
- (b) v > iii > ii > i > iv
- (c) v > i > ii > iii > iv
- (d) v > iv > ii > i > iii

28. Identify the product 
$$\frac{\text{HNO}_3}{\text{H}_2\text{SO}_4, \Delta}$$

(a) 
$$NO_2$$

(c) 
$$NO_2$$
  $NO_2$ 

#### 29. Which centre (s) more reactive towards EAS in the given molecule?



- (a) a
- (b) d
- (c) c
- (d) e

(i) 
$$SH SH BF_3$$

(ii) BuLi

- $(iii) \overset{O}{/} H_2O \longrightarrow Product is?$
- (iv) Raney Ni +  $H_2$
- (v) T<sub>S</sub>Cl/Py
- (vi) LiBr/Acetone
- (vii) AlBr<sub>3</sub>

31. 
$$CH_3 \xrightarrow{H^{\oplus}} [A]; [A] \text{ is}$$

$$(d) \bigcirc C - C - C$$

32. 
$$H_3C$$
  $\longrightarrow$   $O$   $\longrightarrow$  Products?

(d) No Reaction

33. 
$$CH_3 \xrightarrow{NaNH_2/NH_3(\ell)} Product.$$

Product is

(a) 
$$CH_3$$
  $NH_2$ 

(d) Mixture of (a) and (b)

34. Which compound on oxidation with acidified  $KMnO_4$  solution gives benzoic acid?

(a) 
$$\left\langle \begin{array}{c} Me \\ Me \end{array} \right\rangle$$

(c) 
$$\langle C \rangle = C - CH_3$$

(d) All of these

**35.** In the given reaction

$$H - \overset{O}{\overset{\parallel}{C}} - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CI \xrightarrow{AlCl_3} (X) \xrightarrow{Zn - Hg/HCl} (Y); The final product$$

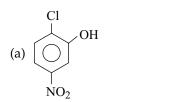
(Y) is

**36.** Based on the following reaction, the major product would be

Cl
NO<sub>2</sub>

$$\downarrow (i) HO^{\Theta/\Delta}$$

$$\downarrow (ii) H^{\oplus}$$
P
(major)



- (c) Both in equal proportions
- (d) None of these
- 37. Give the major product from the following reaction sequence

38. Which one of the following compounds will be most readily hydrolyzed in aqueous alkali?

(a) 
$$V_{NO_2}$$
 (b)  $V_{NO_2}$  (c)  $V_{NO_2}$  (d)  $V_{NO_2}$ 

39. Which of the following is most reactive towards the reaction with NaOMe?

(a) 
$$\bigvee_{NO_2}^F$$
 (b)  $\bigvee_{NO_2}^{Cl}$  (c)  $\bigvee_{NO_2}^{Br}$   $\bigvee_{NO_2}^{NO_2}$  (d)  $\bigvee_{NO_2}^F$   $\bigvee_{NO_2}^{NO_2}$ 

**40.** An aromatic compound 'A'  $C_7H_6Cl_2$ , gives AgCl on boiling with alcoholic AgNO<sub>3</sub> solution and yields  $C_7H_7OCl$  on treatment with NaOH. 'A' on oxidation gives monochloro benzoic acid which affords only one mononitro derivative. The compound 'A' is

41. 
$$\langle O \rangle$$
 NH - C -  $\langle CI \rangle$  AlCl<sub>3</sub> [A]  $\xrightarrow{H_3O\oplus}$  [B]  $\xrightarrow{NaNO_2/HCI}$  [C]  $\xrightarrow{NH_4CI/H_2O}$  [D]

Product [D] is

(a) 
$$H_3C$$
  $N = N - NH_2$ 

(b) 
$$H_3C$$
  $N = N$   $CH_3$   $CH_3$ 

(c) 
$$\langle N = N - \langle N \rangle - N \langle CH_3 \rangle$$

42. Identify B, X and R respectively in the following sequence of reactions

$$C_2H_5MgBr \xrightarrow{CICN} A \xrightarrow{H_3O^+} \boxed{B}$$
,

$$CH_3COCH_3 \xrightarrow{I_2} \overline{X} \xrightarrow{Ag} Y$$

$$C_{_{6}}H_{_{5}}NH_{_{2}} \xrightarrow{NaNO_{_{2}}} P \xrightarrow{CuCN} Q \xrightarrow{_{+4H}} \boxed{R}$$

- (a)  $C_2H_5COOH$ ,  $CHI_3$ ,  $C_6H_5CH_2NH_2$  (b)  $C_2H_5COOH$ ,  $CH_3I$ ,  $C_6H_5COOH$  (c)  $C_2H_5CH_2NH_2$ ,  $CH_3I$ ,  $C_6H_5COOH$  (d)  $C_2H_5COOH$ ,  $C_2H_5I$ ,  $C_6H_5CONH_2$

**43.** p-nitrotoluene on further nitration gives

$$(a) \begin{picture}(200,10) \put(0,0){\line(1,0){1000}} \put(0,0){\line($$

44. Which of the following structures correspond to the product expected, when excess of toluene reacts with CH<sub>2</sub>Cl<sub>2</sub> in presence of anhydrous AlCl<sub>3</sub>?

(a) 
$$CH_3$$
  $CH_3$  (b)  $H_3C$ — $CHC1$ 

(c) 
$$H_3C$$
—CH<sub>3</sub> (d)  $H_3C$ —CH<sub>2</sub>—CH<sub>2</sub>—CH<sub>3</sub>

45. In the sulphonation, acetylation and formylation of benzene the group of effective electrophiles would be

- (a)  $SO_3^{\oplus}$ ,  $CH_3C \equiv O$ , HCO
- (b)  $SO_3$ ,  $CH_3C \equiv \overset{\oplus}{O}$ ,  $H\overset{\oplus}{C}O$
- (c) SO<sub>3</sub>, CH<sub>3</sub>CHO, CO + HCl
- (d) HSO<sub>3</sub>, CH<sub>3</sub>CO, HCO

- 46. When benzene is heated with acetic anhydride in the presence of anhydrous aluminium chloride at 80°C, the product formed is?
  - (a) Benzoic acid

(b) Benzophenone

(c) Acetophenone

HO

- (d) Ethyl phenyl ketone
- 47. Which of the following is not the structural formulae of benzene?







(d) None of these

**48.** Most reactive towards nitration is

(a) 
$$D$$
  $O$   $O$   $Me$   $O$   $Me$   $O$   $O$ 

$$(d) D D C OM$$

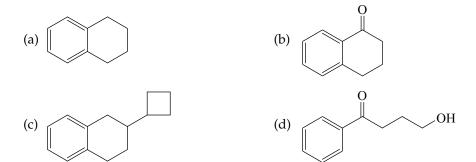
49. MeO CH CH CH OMe 
$$\frac{H_2O}{(10 \text{ min.})}$$
 Major Products is?

**50.** What reagents (conditions) are needed for the following reaction?

$$\begin{array}{c|c} & & \text{Reagent A} & & \text{Reagent B} \\ \hline \end{array}$$

- (a) reagent A: CH<sub>3</sub>COCl/AlCl<sub>3</sub>; reagent B: Sn, HCl, heat
- (b) reagent A: CH<sub>3</sub>CH<sub>2</sub>Cl/AlCl<sub>3</sub>; reagent B: KMnO<sub>4</sub>, heat
- (c) reagent A: CH<sub>3</sub>COCl/AlCl<sub>3</sub>; reagent B: H<sub>2</sub>NNH<sub>2</sub>, KOH, H<sub>2</sub>O, heat
- (d) reagent A: HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>; reagent B: Sn, HCl, heat
- **51.** What could be the product for the following reaction?

$$\begin{array}{c}
O \\
Cl \\
(ii) AlCl_3 \\
(iii) H_2O
\end{array}$$
Products



$$CH_{3}$$

$$NH_{2}$$

$$NaNO_{2}, HCI$$

$$CH_{3}$$

$$CH_{3}$$

$$N CH_{3}$$

$$N CH_{3}$$

$$CH_{3}$$

$$N CH_{3}$$

$$N CH_{4}$$

$$N CH_{3}$$

$$N CH_{4}$$

$$N CH_{4}$$

$$N CH_{4}$$

$$N CH_{5}$$

$$(a) \qquad \qquad \begin{array}{c} NaNO_2, HCl \\ \\ CuBr \\ \\ CH_3 \\ \\$$

- 54. What could be the product for the following reaction Ph NH  $NaNO_2 \rightarrow ?$  HCI
  - (a) NO NCH<sub>3</sub>
- (b)  $N_2^+$

(c) | NO | NCH<sub>3</sub>

- (d) H | NO CH<sub>3</sub>
- 55. What could be the major product for the following reaction?
  - OMe O  $H_2NNH_2$ KOH,  $H_2O$ Heating  $H_2NNH_2$ AlCl<sub>3</sub>

    Heating  $H_2NNH_2$
  - OMe O

(b) OMe

(c) OMe

- (d) OMe
- **56.** What could be the product for the following reaction?
  - Zn(Hg)
    HCl, heating
    OH

    Najor product?
  - (a) OH OH
- (р)
- (c) Cl
- (d) CI

57. For the following compound, which nitrogen is most apt to be protonated?

- (a) Nitrogen indicated by arrow 'a'
- (b) Nitrogen indicated by arrow 'b'
- (c) Nitrogen indicated by arrow 'c'
- (d) Nitrogen indicated by arrow 'd'
- **58.** What could be the product for the following reaction?

**59.** What is the correct order of decreasing basicity for the following anions (from the most to the least)?

MeO

$$(i) \qquad (ii) \qquad (iii) \qquad (iv) \qquad Br \qquad O \qquad CH_3$$

$$(i) \qquad (ii) \qquad (iv) \qquad (v) \qquad O \qquad O$$

(a) i > ii > iii > iv > v

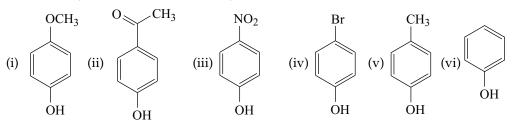
OCH<sub>3</sub>

(b) i > ii > iii > v > iv

(c) i > ii > iv > iii > v

(d) v > iv > iii > ii > i

**60.** What is the correct order of decreasing acidity for the following phenol and phenol derivatives (from the most to the least)?



- (a) i > ii > iii > iv > v > vi
- (c) iii > ii > iv > vi > v > i

- (b) ii > iii > iv > vi > v > i
- (d) ii > iii > iv > vi > i > v
- **61.** What is the correct order of decreasing reactivity (fastest to slowest) toward nucleophilic aromatic substitution for the following compounds?

(iii) 
$$O_2N$$
  $NO_2$ 

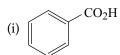
(iv) 
$$O_2N$$
  $O_2$   $O_2N$   $O_2$ 

- (a) i > ii > iii > iv
- (b) ii > iii > iv > i
- (c) iii > ii > iv > i
- (d) iv > iii > ii > i
- **62.** What could be the product for the following reaction?

$$N(CH_3)_2$$

$$NaNO_2, HCl \rightarrow Product?$$

**63.** What is the correct order of decreasing reactivity (fastest to slowest) toward electrophilic aromatic substitution for the following compounds?





- (a) i > ii > iii > iv
- (c) iii > ii > iv > i

- (b) ii > i > iv > iii
- (d) iv > iii > ii > i

- **64.** What could be the reagent for the following reaction?
  - $\begin{array}{c|c}
     & NaNH_2 \\
    \hline
     & NH_3(liq) \\
    \hline
     & (a) \\
    \hline
     & (b) \\
    \hline
     & (c) \\
    \hline
     & (d) \\
     & (d) \\
    \hline
     & (d)$
- **65.** What could be the product for the following reaction?
  - (i) NH<sub>3</sub>, heat (ii)  $OH^{I}/H_{2}O$ Product?  $O_2N$  $NO_2$ NH<sub>2</sub> OH (b) (a)  $O_2N$  $NO_2$ NO<sub>2</sub>  $O_2N$  $NH_2$ (c) (d) NH<sub>2</sub>  $O_2N$  $NO_2$  $O_2N$
- **66.** Which could be the major product of the following reaction?

$$CF_{3} \xrightarrow{Cl_{2}, FeCl_{3}} Product?$$
(a) 
$$Cl \xrightarrow{CF_{3}} CI_{2}, FeCl_{3} \Rightarrow Product?$$
(b) 
$$Cl \xrightarrow{CG_{3}} CI_{2}, FeCl_{3} \Rightarrow Product?$$
(c) 
$$CI \xrightarrow{CG_{3}} CI_{2}, FeCl_{3} \Rightarrow Product?$$
(d) 
$$Cl \xrightarrow{CG_{3}} CI_{2}, FeCl_{3} \Rightarrow Product?$$

67. Which could be the major product of the following reaction?

$$\begin{array}{c} \text{Br}_2\\ \text{(1 equivalence)} & \text{K}_2\text{Cr}_2\text{O}_7\\ \hline \\ \text{FeCl}_3 & \text{H}_2\text{SO}_4\\ \hline \\ \text{Heating} & \text{Product} \end{array}$$

68.

НО

(c)

**69.** Choose the order that has the following compounds correctly arranged with respect to increasing basicity.

(d)

OH

(a) 
$$NH_2$$
  $NH_2$   $NH_2$   $NH_2$   $NH_2$   $NH_2$   $NH_2$   $NH_2$   $NH_2$   $NO_2$   $NO_$ 

#### 70. What could be the reagent and reaction condition for the following transformation?

(a) ethanol, NaOH

(b) ethanol, H<sup>+</sup>

(c) methanol, NaOH

(d) methanol, H+

#### 71. What could be the product for the following reaction?

$$\begin{array}{ccc}
H & K_2Cr_2O_7 \\
& H_2SO_4 \\
& & \text{Heat}
\end{array}$$
Product

(a) 
$$CO_2H$$

#### **72.** What could be the reagent to complete the following reaction?

- (a) HCrO<sub>4</sub>
- (b)  $K_2Cr_2O_7$
- (c) PCC in dried CH<sub>2</sub>Cl<sub>2</sub>
- (d)  $OsO_4$

- (i) Cl<sub>2</sub>, AlCl<sub>3</sub>
- (ii) Mg, Et<sub>2</sub>O

$$(iii) H_2C = O \text{ then } H_2O$$

$$(iv) PCC$$
Product

- (a) CH<sub>2</sub>OH
- (c) CH<sub>3</sub>COCH<sub>3</sub>

- (b) CH<sub>3</sub>CH<sub>2</sub>OH
- (d) HOCH,CH,OH

#### **75.** What is the expected product for the following reaction?

$$Cl_{2}(1 \text{ equiv.})$$

$$FeCl_{3}$$

$$Cl$$

$$(a)$$

$$Cl$$

$$(b)$$

$$Cl$$

$$Cl$$

$$(c)$$

$$Cl$$

$$(d)$$

$$CH_{3}$$

#### **76.** What could be the product for the following reaction?

$$CO_{2}H \xrightarrow{P_{2}O_{5}} Product$$

$$CH_{2}OH \qquad (b) \qquad O$$

$$CH_{2}OH \qquad (d) \qquad O$$

$$CO_{2}H \qquad O$$

$$CO_{2}H \qquad O$$

$$O$$

$$O$$

$$O$$

$$O$$

$$O$$

$$O$$

$$O$$

$$O$$

$$O$$

#### 77. What is the name of the following compound?

- (a) 2,6-Dimethylphenol
- (c) 2,6-Dimethylanisole

- (b) 1,5-Dimethylphenol
- (d) 1,5-Dimethylanisole

78. What is the name of the following compound?

- (a) p-aminotoluene
- (c) p-nitrostyrene

- (b) p-nitrotoluene
- (d) 3-aminostyrene
- 79. What should be the major product for the following reaction?

**80.** What is the name of the following compound?

- (a) p-methylphenol
- (c) o-methylanisole

- (b) m-methylphenol
- (d) m-methylanisole
- **81.** What is the name of the following compound?

- (a) benzylcarbonyl
- (c) phenylaldehyde

- (b) benzaldehyde
- (d) phenylketone
- **82.** What is the name of the following compound?

- (a) benzyl phenoate
- (c) benzyl benzoate

- (b) phenyl benzoate
- (d) phenyl phenoate
- **83.** What could be the product for the following reaction?

- **84.** Which of the following structures is benzoic acid?
  - (a)  $CO_2H$  (b)  $O_2CH$  (c)  $O_2CH$  (d)  $O_2HC$
- **85.** Which of the following reaction sequences would be the best for synthesizing the compound, 1-bromo-3-propylbenzene?

1-Bromo-3-propylbenzene

- **86.** What is the expected product for the following reaction?
  - $(a) \qquad (b) \qquad (d) \qquad (c) \qquad (d) \qquad (d)$
- 87. What is the expected product for the following reaction?

$$\begin{array}{c|c} & Cl_2(1 \text{ equi.}) \text{ FeCl}_3 \\ \hline \\ \text{(a)} & Cl \\ \hline \\ \text{(b)} & Cl \\ \hline \\ \text{(c)} & Cl \\ \hline \\ \text{(d)} & Cl \\ \hline \\ \end{array}$$

 $NaNH_2$ 

88. What could be the product for the following reaction?

 $CH_3$ 

Br

91. 
$$OH$$
 (i)  $H_2SO_4$ , heat ?

(iii) CH<sub>3</sub>MgBr, then H<sub>3</sub>O<sup>+</sup>

(b)

(d)

(b)

(d)

ÓН

ОН

OCH<sub>3</sub>

ЮН

92. 
$$\frac{1. \text{ Benzyl bromide}}{2. \text{ Hg}^{2+}, \text{H}_3\text{O}^+}$$

(a) 
$$H_3C$$
  $Cl$  (b)  $H_3C$   $Cl$  (c)  $O$  (d)  $H-C \equiv C$ :

 $NO_2$ 

 $NO_2$ 

97. 
$$OH \xrightarrow{(i) \text{Na}_2\text{CO}_3, \text{CH}_3\text{Br}} \text{possible products?}$$

- (i) Ethanoyl chloride, pyridine
- (ii) Excess NH<sub>3</sub>
- (iii) LiAlH<sub>4</sub>, then H<sub>3</sub>O<sup>+</sup>

(a) 
$$H_2N$$

# LEVEL 2

#### **Single and Multiple-choice Type**

1. What should be the major product for the following reaction?

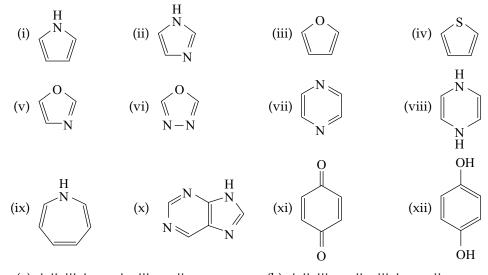
$$\begin{array}{c}
Cl \\
\hline
AlCl_3
\end{array}$$
Major product?

(a)
$$\begin{array}{c}
O \\
O \\
\end{array}$$

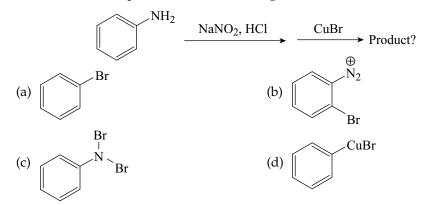
**2.** Which of the following is not the resonance structure of intermediate from the listed electrophilic aromatic substitution?

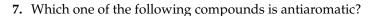
$$\begin{array}{c|c} & & & \\ & & \\ \hline & & \\ & & \\ \hline & & \\ & & \\ \hline & & \\ &$$

#### **5.** Which of the following compounds are aromatic compounds?



- (a) i, ii, iii, iv, v, vi, viii, x, xii
- (b) i, ii, iii, v, vii, viii, ix, x, xii
- (c) i, ii, iii, vi, viii, x, xi, xii
- (d) i, ii, iii, iv, v, vi, vii, x, xii



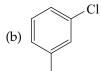






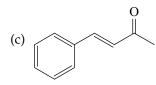
#### **8.** What is the expected product for the following reaction?

$$\frac{\text{Cl}_2 \text{ (1 equivalent)}}{\text{FeCl}_3} \text{ Product is ?}$$



#### **9.** What could be the product for the following reaction?

$$\begin{array}{ccc}
O & & & \\
& & & \\
+ & & & \\
O & & & \\
O & & & \\
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#### **10.** What could be the product for the following reaction?

$$(i) Cl_2 / FeCl_3$$

$$(ii) Na_2Cr_2O_7$$

$$(iii) PCl_3$$

### (iii) PCl<sub>3</sub>

(a) 
$$OCH_3$$

- 11. What could be the product for the following reaction?
  - (i) Cl<sub>2</sub>, AlCl<sub>3</sub>
  - (ii) Mg, Et<sub>2</sub>O

$$(iii) O \\ (iv) H^+/\Delta \longrightarrow Product?$$

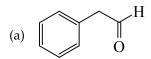
$$Cl \xrightarrow{(i) \text{AlCl}_3} Product?$$

$$(d) \qquad \qquad OH$$

- **13.** What could be the product for the following reaction?
  - (i) Cl<sub>2</sub>, AlCl<sub>3</sub>
  - (ii) Mg, Et<sub>2</sub>O

(iii) O then 
$$H_2O$$

$$(iv) K_2Cr_2O_7, H^+$$
room temp



$$(d) \qquad OH$$

- (a) PhCO<sub>2</sub>H
- (b) PhCO<sub>3</sub>H
- (c) OsO<sub>4</sub>
- (d) Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>
- **15.** Which of the indicated compounds would be the major product in the following Friedel Crafts reaction?

$$(a) \qquad \begin{array}{c} CH_3 \\ O \\ \hline \\ NO_2 \end{array}$$

(c) 
$$\stackrel{\text{CH}_3}{\stackrel{\downarrow}{\bigcirc}}$$
  $\stackrel{\text{CH}_3}{\stackrel{\downarrow}{\bigcirc}}$   $\stackrel{\text{NO}_2}{\stackrel{\text{NO}_2}{\bigcirc}}$ 

$$CH_{3}O$$
 $O$ 
 $NO_{2}$ 

**16.** The following reaction yields compound T predominately.

Predict the main product T.

**17.** The compound isopentylnitrite is a source of NO<sup>+</sup> ions and will react with an amine to generate a diazonium cation. Predict the product of the following reaction sequence.

$$(a) \qquad (b) \qquad (c) \qquad (d) \qquad (d)$$

18. What could be the major product for the following Reaction?

19. The following reaction gives two main products. Identify the products.

$$(a) \begin{array}{c} CH_3 \\ NaNH_2 \\ NH_3 \end{array}$$

$$(b) \begin{array}{c} CH_3 \\ CH_3 \\ NH_2 \end{array}$$

$$(c) \begin{array}{c} CH_3 \\ NH_2 \end{array}$$

$$(d) \begin{array}{c} CH_3 \\ NH_2 \end{array}$$

$$(d) \begin{array}{c} CH_3 \\ NH_2 \end{array}$$

$$(d) \begin{array}{c} CH_3 \\ NH_2 \end{array}$$

$$(a) \qquad \qquad Mg, Et_2O \qquad D_2O \qquad Product?$$

$$(b) \qquad \qquad H_3C \qquad OH$$

$$(c) \qquad D \qquad (d) \qquad \qquad MgBr$$

21. The following reaction gives two main products. Identify the products.

OH
$$CH_{3} \xrightarrow{\text{(i) PCC}} \text{Product?}$$

$$(ii) CH_{3}CH_{2}OH, H^{+}$$
Removal of water

(a) 
$$CH_3$$
  $H_3CH_2CO$   $OCH_2CH_3$   $CH_3$ 

(c) 
$$OCH_2CH_3$$
 (d)  $CH_3$ 

$$CH_{3} \xrightarrow{\text{(i) Na}_{2}\text{Cr}_{2}\text{O}_{7}, \text{ H}^{+}, \text{ heat}} \text{Product?}$$

$$(ii) \text{ CH}_{3}\text{CH}_{2}\text{OH}, \text{ H}^{+}$$

$$\text{removal of water}$$

$$(b) \xrightarrow{\text{CH}_{3}} \text{CH}_{3}$$

$$(c) \xrightarrow{\text{OCH}_{2}\text{CH}_{3}} \text{CH}_{3}$$

$$(d) \xrightarrow{\text{CH}_{3}} \text{CH}_{3}$$

**24.** What could be the product for the following reaction?

$$(a) \qquad (b) \qquad (i) MnO_2$$

$$(ii) CH_3MgBr$$

$$(iii) H^+/H_2O$$

$$OH$$

$$(c) \qquad O$$

$$(d) \qquad O$$

$$CH_{3} \xrightarrow{\text{CH}_{3}} \xrightarrow{\text{CH}_{3}} CH_{3} \xrightarrow{\text{CH}_{3}} Product?$$

$$(a) \qquad CH_{3} \qquad (b) \qquad CH_{3}$$

$$(c) \qquad OCH_{3} \qquad (d) \qquad CI$$

$$O_2N$$
 $O_2N$ 
 $O_2N$ 
 $O_2N$ 
 $O_3$ 
 $O_4$ 
 $O_4$ 
 $O_4$ 
 $O_4$ 
 $O_4$ 
 $O_5$ 
 $O_7$ 
 $O_8$ 
 $O_8$ 

(a)  $O_2N$ 

(b) O<sub>2</sub>N

(c) O<sub>2</sub>N

(d)  $O_2N$ 

27. What could be the major product for the following reaction?

$$\begin{array}{c}
\text{HN} & \text{O} \\
\hline
 & \text{H}^+ \\
\text{Removal of water}
\end{array}$$

(a) N

(b) N

(c) N

(d) N

$$\begin{array}{c}
OH \\
OH \\
\hline
H^+ \\
Removal of water
\end{array}$$
Product?

29. What could be the product for the following reaction?

$$Cl_{2} \text{ (excess)} \longrightarrow Product + CHCl_{3}$$
(a) HO

(b) HO

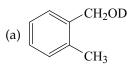
(c) Cl

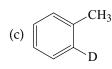
(d)  $\Theta$ 

**30.** Predict the product of the following reaction sequence.

(a) 
$$NO_2$$
 (b)  $NO_2$  (c)  $NO_2$  (d)  $NO_2$ 

**31.** What could be the product for the following reaction?





**32.** For the given reaction:

$$(R) \longrightarrow (R) \longrightarrow (R) \text{ (R) will be}$$

$$CH_3 \cap C \to CH_3 \cap CH_3$$

(a) 
$$CH_3$$
 $CH_3$ 
 $CH_3$ 
 $CH_3$ 

(b) 
$$CH_3$$
- $C$ - $OH$ / $H$  $\oplus$   $CH_3$ 

33. Which of the following compound will not give Friedel-Crafts reaction?

(a) 
$$O_2N-\langle O_2 \rangle -NO_2$$

(b) 
$$\left\langle \begin{array}{c} \text{CHO} \\ \oplus \\ NR_3 \end{array} \right\rangle$$

(d) 
$$C_5H_5N$$

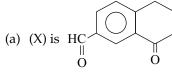
34. In the given reaction, electrophilic substitution will take place readily at the carbon?

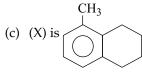
- (a) 1'
- (b) 1

- (c) 3
- (d) 3'

35. In the given reaction

$$\begin{array}{c} O \\ H-C- \end{array} \\ \begin{array}{c} O \\ H-C- \end{array} \\ \begin{array}{c} CH_2-CH_2-CH_2-C-Cl \\ \end{array} \\ \begin{array}{c} AlCl_3 \\ \end{array} \\ \begin{array}{c} Zn-Hg/HCl \\ \end{array} \\ \end{array} \\ \begin{array}{c} (Y); \text{ Choose the correct options.} \\ \end{array}$$



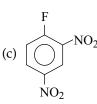


- **36.** The type of substitution reactions of benzenoid hydrocarbons are
  - (a) elimination

(b) electrophilic

(c) nucleophilic

- (d) free radical
- **37.** Among the following compounds, which liberates F<sup>-</sup> on reaction with MeO<sup>-</sup>?



**38.** Among the following reactions, which form salicylic acid (after acidification)?

(a) 
$$+ \text{CHCl}_3 + \text{NaOH} \rightarrow$$

$$(b) \bigcirc + CCl_4 + NaOH \longrightarrow$$

(c) 
$$+ CO_2 + NaOH \rightarrow$$

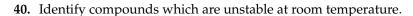
39. Me 
$$\longrightarrow$$
  $P_1 + P_2$ ;  $(P_2 + \text{FeCl}_3 \longrightarrow \text{Violet colour})$ 

$$\begin{array}{ccc} P_1 + NaOI {\longrightarrow} P_3 \downarrow & + & P_4 \\ & Yellow \end{array}$$

Correct statement for the above sequence is

- (a) P<sub>3</sub> on reaction with Ag gives acetylene

- (b) P<sub>4</sub> on reaction with sodalime gives toluene
  (c) P<sub>4</sub> on reaction with sodalime gives benzene
  (d) P<sub>1</sub> on reaction with 2,4-DNP gives yellow compound









(d) 
$$\begin{bmatrix} & & & \\ & & & \\ & & & \end{bmatrix}$$

#### **41.** Identify reactions which give aromatic product.

(b) 
$$O O + H_2N - NH_2 \xrightarrow{H^+}$$

(c) 
$$O O + H_2N - OH \xrightarrow{H^+}$$

(d) 
$$\left(\begin{array}{c} -H_2 \\ \end{array}\right)$$

#### **42.** Identify reactions which are not feasible.

(a) 
$$\underbrace{\begin{array}{c} NH_2 \\ Me-Cl \\ AlCl_3 \end{array}}$$
  $\underbrace{\begin{array}{c} NH_2 \\ Me \end{array}}$ 

(b) 
$$NO_2$$
  $O$   $NO_2$   $Me-C-Cl$   $AlCl_3$   $C-Me$   $O$ 

(c) 
$$Cl_2$$
  $Fe$ 

$$(d) \qquad \begin{array}{c} F \\ \hline \\ Fe \\ \hline \\ Cl \\ \end{array}$$

#### **43.** Identify reactions that give tribromo substituted product.

(a) 
$$\xrightarrow{\text{OH}}$$
  $\xrightarrow{\text{Br}_2}$   $\xrightarrow{\text{NaOH}}$ 

(b) 
$$COOH \longrightarrow Br_2 \longrightarrow H_2O$$

(c) 
$$\xrightarrow{OH}$$
  $\xrightarrow{Br_2}$   $\xrightarrow{CS_2}$ 

$$(d) \qquad \xrightarrow{\text{OH}} \qquad \xrightarrow{\text{Br}_2} \qquad \xrightarrow{\text{SO}_3\text{H}} \qquad \xrightarrow{\text{SO}_3\text{H}} \qquad \xrightarrow{\text{SO}_3\text{H}} \qquad \xrightarrow{\text{OH}} \qquad \xrightarrow{\text{O$$

#### 44. Identify coupling reactions.

(a) 
$$\bigcirc$$
  $\bigcirc$   $\bigcirc$   $\bigcirc$   $\bigcirc$  Phenol + NaOH  $\longrightarrow$   $T < 5^{\circ}C$ 

(b) 
$$N_2C1 \xrightarrow{H_3PO_2}$$

(c) 
$$N_2CI \xrightarrow{T < 5^{\circ}C} OH / OH^{\Theta}$$

$$(d) \qquad \stackrel{\text{Me}}{\underbrace{\qquad \qquad }} \qquad \underbrace{\qquad \qquad }$$

**45.** Identify reactions which give phenol product.

(a) Fused NaOH (b) FeSO<sub>4</sub> 
$$H_2O_2$$
 (c)  $V_2O_5$   $S_0O^\circ C$  (d)  $(1) O_2/hv$   $(2) Conc. H_2SO_4$ 

**46.** Identify correctly matched reactions with their products.

47. Identify method of prepration of benzene.

(a) 
$$3CH = CH \xrightarrow{Red hot} CH \xrightarrow{Set tube}$$

(b)  $CH_3 \xrightarrow{CH_3} CT_2O_3 \xrightarrow{\Delta} CT_2O_3 \xrightarrow{\Delta}$ 

48. Identify correctly matched reactions with their products.

(a) 
$$(a)$$
  $(b)$   $(b)$   $(b)$   $(c)$   $(c)$ 

**49.** Identify correctly matched reactions with their products.

(a) 
$$Cl$$
  $SbCl_5$   $\oplus$   $+ 2SbCl_6^{\ominus}$ 

(b)  $2Na$   $\ominus$   $\ominus$   $\ominus$ 

(c)  $2Na$   $\bigcirc$ 

Dry ether

Cl

COONa

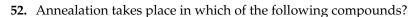
Electrolysis

COONa

**50.** Identify correctly matched reaction with their products.

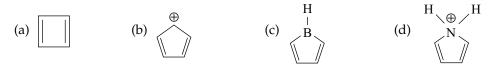
$$(a) \qquad Na/Liq. \qquad No_2 \qquad No_2$$

**51.** Identify reactions that give aromatic products.

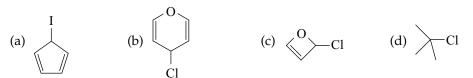




53. Which of the following is an anti-aromatic compound?



**54.** Which compound does not give SN'/solvolysis reaction?



### **Comprehension Type**

#### Passage 1

The conversion of an amide into an amine with one carbon atom less by the action of alkaline hydrohalite is known as Hofmann bromamide rearrangement:

$$RCONH_2 \xrightarrow{Br_2/KOH} R-NH_2$$

The most important feature of the reaction is the rearrangement of N-bromamide anion to isocyanate:

**55.** The product of the reaction

$$C_6H_5 \xrightarrow{H} CONH_2 \xrightarrow{Br_2/KOH} Product$$

$$CH_3$$

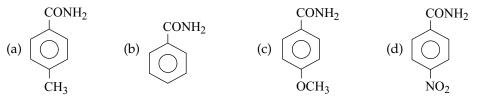
Product amine will be

- (a) S-amine
- (b) R-amine
- (c) 50:50 mixture of (+) and (-) amine (d) 30:70 mixture of (+) and (-) amine

**56.** Predit the product in the following reaction

$$(i) \qquad (ii) \qquad (iii) \qquad (iii) \qquad (iv) \qquad$$

57. Which of the following can undergo Hofmann bromamide reaction most easily?



#### Passage 2

A general equation for a Friedel-Crafts alkylation reaction is the following

$$+R-X$$
  $\xrightarrow{AlCl_3}$   $+HX$ 

Alkyl halides by themselves are insufficiently electrophilic to react with benzene. Further, AlCl<sub>3</sub> serves as a Lewis acid catalyst to enhance the electrophilicity of the alkylating agent. The mechanism for the reaction is shown in the following steps

Mechanism for the reaction:

With R–X is a primary halide, the carbon halogen bond is nearly broken and one in which the carbon atom has a considerable +ve charge.

$$R-CH_2$$
 —  $CI$ :— $AlCl_3$ 

this complex acts as the electrophile. The Friedel-Crafts acylation reaction is an effective means of introducing an acyl group into an aromatic ring. The reaction is often carried out by treating the aromatic compound with an acyl halide.

$$\begin{array}{c} O \\ CH_2 - CH_3 \\ \end{array}$$

- **58.** Consider the following statements for the given reaction
  - (i) The Friedel-Crafts reaction is an electrophilic aromatic substitution.
  - (ii) First step of the reaction is the rate-determining step.
  - (iii) Second step of the reaction is the rate-determining step.
  - (iv) Third step is an acid-base reaction.

Now, of these statements

(a) i and ii are correct

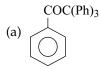
- (b) i, ii and iii are correct
- (c) i, iii and iv are correct
- (d) i, ii, iii and iv are correct

59. 
$$\bigcirc \underbrace{\text{CH}_3 - \text{Cl}}_{\text{AlCl}_3} ; \bigcirc \underbrace{\text{(CH}_3)_2 \text{CHCl}}_{\text{AlCl}_3}$$

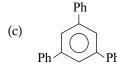
What is the reason for trisubstituted product in the second case?

- (a) less positive inductive effect
- (b) more steric effect
- (c) less hyperconjugation
- (d) more mesomeric effect

**60.** Ph<sub>3</sub>C COCl + AlCl<sub>3</sub> + 
$$\underbrace{\qquad}_{\text{(strong heating)}}^{\Delta}$$
 The major product is









#### Passage 3

Nitration of benzene or any aromatic system is done by treating it with a mixture of Conc.  $HNO_3$  and Conc.  $H_2SO_4$  (called nitrating mixture). These two acids react together according to the equation given below, to form nitronium ion which act as an electrophile:

$$2H_2SO_4 + HNO_3 \longrightarrow 2HSO_4 + H_3O + NO_2$$

 $\stackrel{\oplus}{NO}_2$  ion, an electrophile then attacks benzene or any aromatic system to accomplish nitration in the following two steps with arenium ion as the reaction intermediate:

The direct nitration of aniline or phenol with nitrating mixture gives very poor yield of nitro product because benzene ring attached to -NH<sub>2</sub> or -OH group is very sensitive to oxidation and major part of aniline or phenol is oxidized to give a black tar mass that contains mainly

benzoquinone, O=O. Although -NH<sub>2</sub> group is o/p-orienting, m-nitro derivative is also

formed. The ring is protected from oxidation by acetylating  $-\mathrm{NH}_2$  group before subjecting it to nitration. After nitration, product is hydrolyzed to get deacetylated product (o- and p-nitro derivatives). Nitration of phenol is carried out by Dil.  $\mathrm{HNO}_3$ . It is believed that nitrous acid (present as an impurity) interacts with  $\mathrm{HNO}_3$  to give nitrosonium ion, an electrophile which reacts with phenol to give o- and p-nitrosophenol, the latter being the principal product, according to the same mechanism as that of nitration mentioned above. Nitrosophenol is then oxidized by  $\mathrm{HNO}_3$  to nitrophenol while  $\mathrm{HNO}_3$  is itself reduced to  $\mathrm{HNO}_2$ .

- **61.** Regarding the nitration of phenol with Dil. HNO<sub>3</sub> as described above, the incorrect statement is
  - (a) HNO<sub>3</sub> acts as an acid and also as an oxidant.
  - (b) Nitrous acid acts as a base.
  - (c) The reaction intermediate is an arenium ion.
  - (d) Amount of HNO, goes on decreasing with the progress of nitration.
- **62.** Correct statement is/are

- (b) Rate of nitration of benzene and that of hexa deuterated benzene occur almost at the same rate
- (c) By increasing the concentration of acids (HNO<sub>3</sub> + H<sub>2</sub>SO<sub>4</sub>), the rate of nitration increases
- (d) All of the above

63. 
$$\frac{\text{H}_2\text{SO}_4}{\text{HNO}_3}$$
 Major product is:

Passage 4

It is very well known that when a compound reacts with an electrophile then we either get

ortho- or para-substituted product, i.e., E + C or we get a meta-substituted product, E

This depends on the electron-releasing or electron-withdrawing power of the group, i.e., +R/-R or +M/-M effect of group G. There is another theory that is the electrophile attacks the ring carbon where the substituent G is a already attached.

This is called ipso substitution reaction.

- **64.** The factor which is expected to promote ipso substitution is
  - (a) The group G should be a strong electron withdrawing group
  - (b) A group which is highly electron withdrawing should be attached at ortho or para position with respect to the group G
  - (c) The group G should leave as G<sup>+</sup> easily, i.e., G<sup>+</sup> should be highly stable
  - (d) The group G should leave easily, i.e., G<sup>+</sup> should be highly unstable

65. In the reaction 
$$HNO_3 + H_2SO_4$$

$$Me \longrightarrow A + B$$

$$Me \longrightarrow CH \longrightarrow Me$$

A and B are respectively

**66.** In which of the following can you expect ipso addition?

#### Passage 5

When a second substituent is introduced in benzene ring, it is directed by group already present on benzene ring. Electron-releasing groups are activating, therefore o and p-directing, whereas electron-withdrawing groups are deactivating, therefore m-directing. Halogens, although they are electron withdrawing due to -I effect but still o- and p-directing due to +R effect. -N=O

group is also deactivating but o- and p-directing due to presence of long pair of electrons like halogens it shows +R effect. When a third substituent is introduced into a disubstituted product, the o-isomer gives two, the m-isomer gives three while p-isomer gives only one product. This method is called Korner's method. The major product is formed such that it has minimum steric hindrance.

#### **67.** Which of the following is not formed at all?

CI 
$$+HNO_3$$
 Conc.  $H_2SO_4$  CI  $+HNO_3$  Conc.  $H_2SO_4$  CI  $+HNO_3$  Conc.  $H_2SO_4$  CI  $+HNO_3$  CI  $+H_2SO_4$  CI

**69.** 
$$CH_3$$
 (o-xylene) on mononitration gives

NHOH

(a) two products (b) three products (c) one product (d) four products

NO<sub>2</sub>

#### Passage 6

When a mono substituted benzene derivative,  $C_6H_5Y$ , undergoes further electrophilic substitution, e.g., nitration, the incoming substituent may be incorporated at the o-, m- or p- position and the overall rate at which substitution takes place may be faster or slower than with benzene itself. It has been observed that substitution occurs so as to yield either predominantly the m-isomer or a mixture of o- and p-isomers, in the former case the overall rate of attack is always

slower than on benzene itself, in the latter case the overall rate of attack is usually faster than on benzene itself. This is due to electronic effects that Y can exert.

Substituent, Y is thus classified as m- or o-/p-directing; if the substituent induces faster overall attack than on benzene itself then the substituent is said to be activating, if slower then deactivating.

71. 
$$PhN_2^{\oplus} \xrightarrow{pH = 9 - 10} X$$
 (major product). X will be NH<sub>2</sub>

$$(a) \begin{picture}(200,10) \put(0,0){\ovalph} \put(0,0){\ovalph}$$

72. Which among the following will give highest yield of p-isomer during nitration?

$$(a) \begin{picture}(60,0) \put(0,0){\line(1,0){100}} \put(0,0){\line(1,0)$$

#### Passage 7

Me 
$$\rightarrow$$
 CH  $\rightarrow$  NO<sub>2</sub>  $\rightarrow$  NO<sub>2</sub>  $\rightarrow$  (Y)  $\rightarrow$  P-nitro cummene

$$(Y) \xrightarrow{H_2O/\Delta} (P)$$

$$CuCN \rightarrow (Q) \xrightarrow{(i) SnCl_2 + HCl} (T)$$

$$HCN \rightarrow (R)$$

$$H_3PO_2 \rightarrow (R)$$

$$(S) \rightarrow (S)$$

For the given reaction sequence, answer the following

73. (Y) 
$$\xrightarrow{\text{HBF}_4} \xrightarrow{\text{KMnO}_4/\text{H}^{\oplus}} \xrightarrow{\text{M}_3\text{H}} \text{Final product; final product is}$$

(a) 
$$F - C > O$$
 (b)  $F - NH_2$ 

(c) 
$$\frac{Me}{Me}$$
 CH  $\frac{NH_2}{Me}$  (d)  $\frac{Me}{Me}$  N  $\frac{N}{Me}$  F

74. (R) 
$$\frac{\text{(i) CH}_3\text{COCl/AlCl}_3}{\text{(ii) NaOH} + I_2}$$
 (A) + (B)  $\downarrow$  Yellow ppt.

$$(A) \frac{(i) H_2O/H^{\oplus}}{(ii) SOCl_2} Product (L)$$

$$(iii) (R)/AlCl_3$$

$$(iv) H^{\oplus}, \Delta$$

The correct statement about the product (L) is

- (a) Product (L) on reaction with Tollen's reagent gives silver mirror
- (b) Product (L) on reaction with  $H_2N-NH_2/OH$ ,  $\Delta$  gives diphenyl methane
- (c) Product (L) on reaction with HCN gives a compound which contains a chiral centre
- (d) All of these

# 75. Compound (T) $\xrightarrow{\text{Alc.}}$ Product is

(a) 
$$OH$$
 $-CH-CN$ 
(b)  $CH_2CN$ 

$$\begin{array}{c} OH \\ C \\ C \end{array}$$

#### Passage 8

Consider the aromatic anthracene molecule,  $C_{14}H_{10}$ , shown in the figure:

Approximate calculation of the  $\pi$ -bond order for C–C bonds yield the following results

Bond	π-bond orde
1–2	0.738
1–11	0.535
2–3	0.586
9–11	0.606
11–12	0.485

Also, considering the electron displacement effect in combination with bond order data, answer the following questions.

- **76.** Which of the following carbon is most likely to be attacked by an electrophile ( $NO_2^+$  in acetic anhydride at 15–20°C)?
  - (a) C-1

(b) C-9

(c) C-2

(d) C-11

- 77. Which of the following C–C bond has least percentage of single bond character?
  - (a)  $C_1 C_2$

(b)  $C_1 - C_{11}$ 

(c)  $C_{11}-C_{12}$ 

(d)  $C_2 - C_3$ 

- 78. Which of the following (C–C) bonds are shortest and longest respectively?
  - (a) 11–12 and 1–2

(b) 1–2 and 11–12

(c) 9–11 and 1–2

(d) 2-3 and 9-11

#### Passage 9

Benzene gives electrophilic substitution reaction with strong electrophilic. The leaving group of this reaction is H in the form of  $H^{\oplus}$ , –COOH in the form of  $CO_2$  and – $SO_3H$  in the form of  $SO_2$ . The reaction is known as aromatic electrophilic substitution (ArSE) reaction.

- 79. Benzene can be obtained by
  - (a) Conc. HNO<sub>3</sub>/Conc. H<sub>2</sub>SO<sub>4</sub>/Benzene
  - (b) NO<sub>2</sub>BF<sub>4</sub>/Benzene
  - (c) NO<sub>2</sub>ClO<sub>4</sub>/Benzene
  - (d) Phenol/Zn
- **80.** Consider the following statements
  - (i) Benzene reacts with electrophile to form reaction intermediate known as cyclohexadienyl cation.
  - (ii) Formation of carbon-electrophilic bond is rate-determining step in ArSE reaction.
  - (iii) Breaking of C H bond is rate-determining step
  - (iv) Sulphonation of benzene is a reversible reaction

The correct statements from the above are

(a) i, ii, iii and iv

(b) i, ii and iv

(c) i, iii and iv

(d) ii, iii and iv

**81.** In the given reaction

COOH 
$$\xrightarrow{Br_2}$$
  $\xrightarrow{Br}$   $\xrightarrow{Br}$   $\xrightarrow{Br}$   $\xrightarrow{Br}$ 

The leaving group(s) in the form of electrolphile is

(a) 2H<sup>⊕</sup> only

(b) One H<sup>⊕</sup> and one CO,

(c)  $2H^{\oplus}$  and one CO,

(d) One CO, only

#### Passage 10

Based on the Lewis structure of benzene

Benzene

- 82. What is the bond angle for each H-C-C and each C-C-C on benzene?
  - (a) 120° and 120° (b) 109.5° and 120°
- (c) 120° and 109.5°

- (d)  $180^{\circ}$  and  $120^{\circ}$  (e) None of these
- 83. What one of the following is the best description for the overall shape of benzene molecule?
  - (a) Linear
- (b) Triangular
- (c) Tetrahedron

Column II (o/p ratio in nitration)

- (d) Planar
- (e) Goofy

## **Matrix Type**

84. Match the columns.

#### Column I (alkene)

# (p) 0.22

CH<sub>2</sub>CH<sub>3</sub>

(q) 0.92

CHMe<sub>2</sub>

(r) 1.57

 $CMe_3$ 

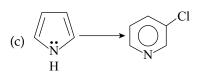
(s) 0.48

85. Match the columns.

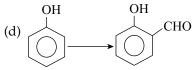
#### Column I

### Column II (reagents used for the desired product in major amount)

(q) CCl<sub>4</sub>/NaOH



(r) NaOH followed by CO<sub>2</sub>



(s) KOH followed by CO<sub>2</sub>

**86.** Identify reaction correct match with its reagent

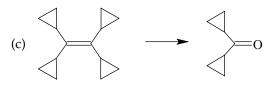
Reaction

Reagent

(a) OMe 
$$C \equiv N$$
  $C = H$ 

(p) DIBAL-H/H<sub>3</sub>O<sup>+</sup>

(q) T<sub>s</sub>Cl/LAH



 $(r) O_3/Zn$ 

$$(d) \begin{picture}(60,0) \put(0,0){\line(1,0){100}} \put(0,0){\line(1,0)$$

(s) Zn-Hg/HCl

87. Match the reduction in Column I with their products listed in Column II.

Column I

(a) 
$$\underbrace{\begin{array}{c} NO_2 \\ (i) \ Sn/HCl \\ \hline (ii) \ OH^\Theta \end{array}}$$

(b) 
$$Zn/NaOH/C_2H_5OH$$

(c) 
$$Zn/NH_4Cl$$

$$(d) \qquad \qquad Fe/H_2O$$

$$N = N - Ph$$

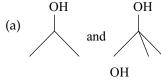
88. Match the processes in Column I with properties in Column II.

#### Column I

#### Column II

#### (pair of compounds)

# (reagent used to distinguish pair of compounds)



(p) Br<sub>2</sub>/H<sub>2</sub>O test

(b) and

(q) Tollen's reagent

(c) Me - C - H and O

- (r) Iodoform test
- (d)  $Me CH_2 C \equiv CH$  and  $Me C \equiv C Me$
- (s) Lucas reagent
- (t) Ammonical cuprous chloride
- 89. Match the Column I with Column II.

#### Column I Column II

- (a) Toluene
- (p) On oxidation by KMnO₄ in acid medium gives benzoic acid
- (b) Cumene
- (q) Used in the manufacture of phenol
- (c) Benzene
- (r) Symmetrical trimethyl benzene
- (d) Mesitylene
- (s) On oxidation  $(V_2O_5/O_2)$  at 250–450°C gives maleic anhydride
- **90.** Match the columns.

#### Column I

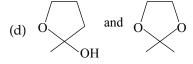
#### Column II

#### (pair of compounds)

(reagents used for identification)

(a) 
$$OH \qquad NH_2$$
 and  $OH \qquad OH$ 

- (p)  $Br_2 + H_2O$  test
- O  $\parallel$  (b) Et C H and Me C Me
- (q) CHCl<sub>3</sub> + NaOH test
- (c) Me-C≡C-H and Me-C≡C-Me
- (r) Iodoform test



(s) Tollen's reagent

#### **91.** Match the columns.

#### Column I (reaction)

(a) 
$$R - C - NH_2 \longrightarrow RNH_2$$

$$\begin{array}{ccc} & & & O \\ \parallel & & & \parallel \\ \text{(b)} & R - C - NH - R & \longrightarrow & RNH_2 \end{array}$$

(c) 
$$R - C - OH \longrightarrow RNH_2$$
 (r)  $N_3H/H^{\oplus}$ 

(d) 
$$R - C - NH - NH_2 \longrightarrow RNH_2$$
 (s)  $HNO_2/\Delta/H_3O^{\oplus}$ 

### **92.** Match the columns.

### Column I (pair)

(a) 
$$CH_3 - C - Cl/NaN_3$$

O O 
$$\parallel$$
 (d)  $C_6H_5 - C - NH - O - C - CH_3/Base$ 

#### 93. Match the Column I with Column II.

#### Column I

(a) 
$$CH_3 - C - NH_2 \xrightarrow{KOH + Br_2}$$

(b) 
$$CH_3 - \overset{O}{C} - OH \xrightarrow{N_3H} \xrightarrow{H_2SO_4}$$

(c) 
$$CH_3 - C - OH \xrightarrow{NH_3}$$

(d) 
$$CH_3 - \overset{O}{C} - C1 \xrightarrow{(i) N_3 N_3} \overset{(i)}{\oplus} H_3O \overset{\oplus}{\oplus}$$

#### 94. Match Column I with Column II.

### Column I (elements/compounds)

(a) Halogens

#### Column II (reagents)

- (p) KOBr
- (q) OH-/H<sub>2</sub>O

#### Column II

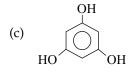
- (p) Lossen rearrangement
- (q) Schmidt rearrangement
- (r) Hofmann rearrangement
- (s) Curtius rearrangement

#### Column II

#### (Intermediate/Product)

#### Column II (tests)

- (p)  $Br_2/H_2O$
- (q) Baker-Mulliken test



(r) Iodoform test

(d)  $\bigvee_{}^{NO_2}$ 

(s) Beilstein test

#### 95. Match Column I with Column II.

### Column I [name of reaction]

- (a) Haloform reaction
- (b) Aldol addition
- (c) Witting reaction
- (d) Hofmann bromamide reaction

#### Column II [substrate(s) of reaction]

- (p) α-methyl carbonyl compound
- (q) Acid amide
- (r) Aldehyde
- (s) Halide and carbonyl

#### 96. Column I (reaction)

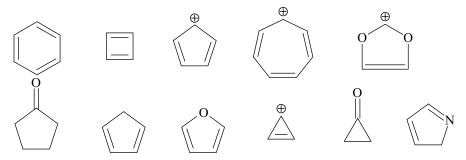
- (a) Wurtz reaction
- (b) Dehydration of alcohol with Conc. H<sub>3</sub>PO<sub>4</sub>
- (c) Kolbe's electrolysis
- (d) Diazotisation

#### **Column II (intermediate)**

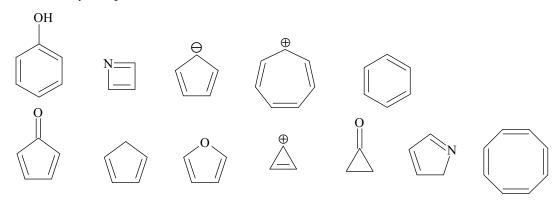
- (p) Carbocation
- (q) Electrophile (excluding free radicals)
- (r) Free radical
- (s) Carbanion
- (t) N<sub>2</sub> gas liberated in intermediate step

## **Integer Type**

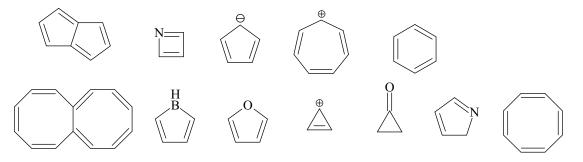
97. Identify compounds which are aromatic.



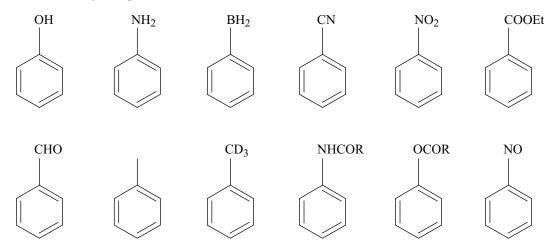
98. Identify compounds which are nonaromatic.



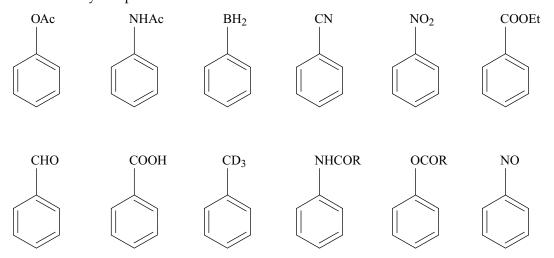
## 99. Identify compounds which are antiaromatic.



100. Identify compounds which react faster than benzene in ArSE reaction?



## 101. Identify compounds which react slower than benzene in ArSE reaction?



# **Answer Keys**

# LEVEL 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
b	b	С	с	С	b	a	a	с	b	с	с	С	с	b
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
b	a	b	с	d	d	d	d	b	d	b	с	b	cd	b
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
С	b	d	d	b	b	С	d	d	a	b	a	a	d	b
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
С	b	a	b	b	b	b	a	с	b	с	b	d	a	С
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
d	С	С	d	a	С	a	ac	С	b	a	с	d	d	a
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
b	a	С	с	d	b	b	С	a	b	b	a	b	b	b
91	92	93	94	95	96	97	98					-	-	
b	d	a	a	С	d	ab	С							

# LEVEL 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
С	a	b	b	d	а	d	а	С	а	b	b	b	b	С
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
d	a	a	С	с	С	b	b	a	b	a	a	a	d	b
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
d	abc	abc	bc	ab	bd	bc	bc	acd	acd	abcd	ab	abd	ac	abd
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
abcd	ab	abd	bd	ad	abc	bcd	abc	ac	a	b	С	С	b	b
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
b	d	С	С	d	С	d	d	a	d	a	d	b	b	d
76	77	78	79	80	81	82	83	84(a)	84(b)	84(c)	84(d)	85(a)	85(b)	85(c)
b	b	b	d	b	С	a	d	r	q	s	р	s	qr	р
85(d)	86(a)	86(b)	86(c)	86(d)	87(a)	87(b)	87(c)	87(d)	88(a)	88(b)	88(c)	88(d)	89(a)	89(b)
р	р	q	r	s	р	s	r	q	rs	pq	qr	qt	р	pq
89(c)	89(d)	90(a)	90(b)	90(c)	90(d)	91(a)	91(b)	91(c)	91(d)	92(a)	92(b)	92(c)	92(d)	93(a)
s	r	q	rs	s	r	p	q	r	s	s	r	q	p	pqs
93(b)	93(c)	93(d)	94(a)	94(b)	94(c)	94(d)	95(a)	95(b)	95(c)	95(d)	96(a)	96(b)	96(c)	96(d)
ps	r	ps	s	r	p	q	prs	pr	prs	q	rs	pq	r	pqt
97	98	99	100	101			·	·						
5	4	3	6	7										

# **WORKBOOK EXERCISES**

# **EXERCISE 1**

## Identify complete reaction sequence

1. 
$$H_3C$$
  $CH_3$   $SO_3/H_2SO_4$ 

3. 
$$O_2N$$
 CI NaSMe / MeSH

7. 
$$HO$$
  $\longrightarrow$   $Br_2/NaOH$   $\longrightarrow$   $SO_3H$ 

9. HO 
$$\xrightarrow{\text{COOH}}$$
  $\xrightarrow{\text{Br}_2 / \text{NaOH}}$ 

CH<sub>3</sub>

$$CH_3$$

$$I_2 / CuCl_2$$

$$SO_3H$$

13. 
$$NO_2$$
 NaSMe / MeSH

$$\begin{array}{c|c} & \text{Con. } H_2SO_4 \\ \hline & \Delta \end{array}$$

6. HO 
$$\xrightarrow{\text{Br}_2 / \text{NaOH}}$$

8. 
$$HO_3S$$
  $Br_2/NaOH$   $COOH$ 

10. 
$$H_3C$$
  $CH_3$   $Br_2/Fe$ 

12. 
$$CH_3$$
  $HNO_3/H_2SO_4$ 

21. 
$$Cl$$
  $I_2/CuCl_2$   $SO_3H$ 

23. 
$$\begin{array}{c} Cl & H_3C \xrightarrow{O} \\ NO_2 & AlCl_3 \end{array}$$

25. 
$$\begin{array}{c} O & (1) OH^{-}/\Delta \\ O & (2) PhN_2C1 \end{array}$$

27. 
$$V_2O_5/500^{\circ}C$$

24. 
$$\begin{array}{c} O \\ \hline \\ CH_3 \\ CH_3 \end{array}$$

28. Conc. 
$$H_2SO_4$$

# **EXERCISE 2**

# Identify reagent used and intermediate products in the following conversion.

## A. Multiple-step synthesis

$$\begin{array}{c} CH_{3}Br \\ AlCl_{3} \end{array} \qquad i$$

$$\downarrow A$$

$$\begin{array}{c} HNO_{3} \\ H_{2}SO_{4} \end{array} \qquad ii \qquad (a) \qquad NH_{2} \\ Heat \qquad (b) HO^{-} \end{array} \qquad iiii \qquad H_{2}Pt/C \qquad NH_{2}$$

## B. Multiple-step synthesis

# **EXERCISE 3**

Identify reagent used and intermediate products in the following conversion.

$$\begin{array}{c} CH_{3} \\ \hline \\ A \\ \hline \\ CH_{3} \\ \hline \\ CH_{2}CH_{3} \\ \hline \\ CH_{2}CH_{3} \\ \hline \\ CH_{2}CH_{3} \\ \hline \\ CH_{2}CH_{3} \\ \hline \\ CH_{3} \\ \hline \\ CH_{2}CH_{3} \\ \hline \\ CH_{3} \\ CH_{3} \\ \hline \\ CH_{4} \\ CH_{3} \\ \hline \\ CH_{5} \\ CH_{5}$$

# **EXERCISE 4**

Identify reagent used and intermediate products in the following conversion.

# SOLUTION FOR WORKBOOK EXERCISES

# **EXERCISE 1**

## Identify complete reaction sequence.

Вr

COOH

SO <sub>3</sub>H

OH

$$V_2O_5 / 500 \, ^{\circ}C$$

OH

 $V_2O_5 / 500 \, ^{\circ}C$ 

OEt
$$\begin{array}{c} OEt \\ OEt \\ SO_3H \end{array}$$

$$\begin{array}{c} OOE \\ SO_3H \end{array}$$

$$\begin{array}{c} OOE \\ SO_3H \end{array}$$

$$\begin{array}{c} OOE \\ SO_3H \end{array}$$

30. 
$$CH_3$$
  $CH_3$   $Con. KMnO_4$   $COOH$ 

# **EXERCISE 2**

# A. Multiple-step Synthesis

# **B.** Multiple-step Synthesis

# **EXERCISE 3**

Identify reagent used and intermediate products in following conversion.

# **EXERCISE 4**

Identify reagent used and intermediate products in following conversion.

A and F are a pair of enatiomers

OH

OH

OH

OH

OH

OH

OH

OH

$$CH_3$$
 $Br$ 
 $Br$ 
 $Br$ 
 $Br$ 
 $CH_3$ 
 $Br$ 
 $CH_3$ 
 $Br$ 
 $CH_3$ 
 $CH_3$ 

# **Reaction Mechanism Chart**

