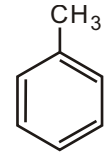
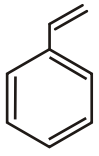
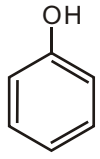
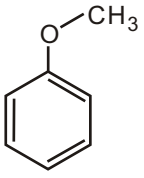
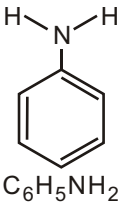
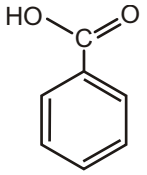
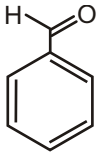
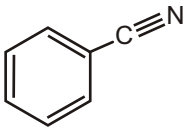
CHAPTER

12

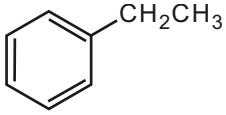
# Nomenclature of Aromatic Compounds

## COMMON SUBSTITUTED BENZENES

| Common name | Substituted benzene | Formula |
|---|---|---|
| Toluene | Methylbenzene |  $C_6H_5CH_3$ |
| Styrene | Ethenylbenzene |  $C_6H_5CH{=}CH_2$ |
| Phenol | |  $C_6H_5OH$ |
| Anisole | Methoxybenzene |  $C_6H_5OCH_3$ |

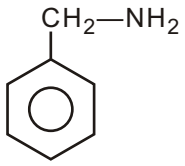
| | | |
|---|---|---|
| Aniline | Aminobenzene |  $C_6H_5NH_2$ |
| Benzoic acid | |  $C_6H_5COOH$ |
| Benzaldehyde | |  $C_6H_5CHO$ |
| Benzonitrile | Cyanobenzene |  $C_6H_5CN$ |

### *Solved Example*

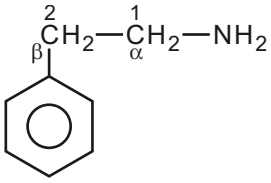
- 
  $C_6H_6CH_2CH_3$

  The substituent chain is C2 therefore **= ethylbenzene**

- When a benzene ring is attached to an aliphatic chain having a functional group, it is named as phenyl derivative of that aliphatic compound.
- **Aralkylamines :**

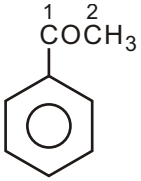


Phenylmethanamine (Benzylamine)

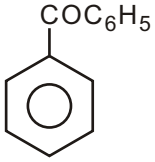


2-phenylethanamine (β-phenylethylamine)

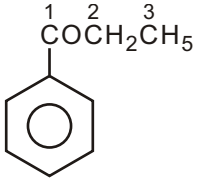
- **Ketones :**



1-phenylethan-1-one
(Accetophenone or methyl phenyl ketone)



diphenylmethanone
(Benzophenone or Diphenyl ketone)

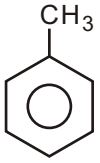


1-phenylpropan-1-one
(Propiophenone)

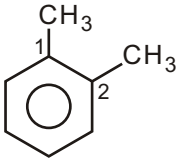
☞ **Aromatic hydrocarbons (Arenes) :**

Hydrocarbons which contain both alphatic and aromatic units are called arenes.

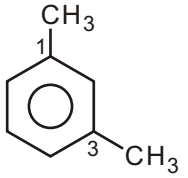
benzene



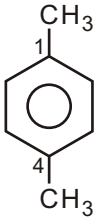
methylbenzene
(toluene)



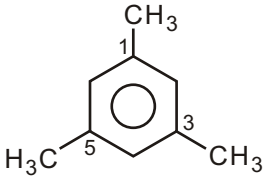
1,2-dimethylbenzene
(o-xylene)



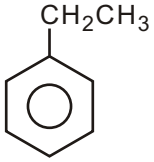
1,3-dimethylbenzene
(m-xylene)



1,4-dimethylbenzene (p-xylene)

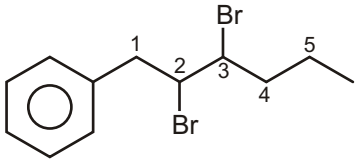


1,3,5-trimethylbenzene (mesitylene)

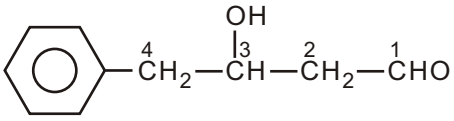


Ethylbenzene

***Solved Example***

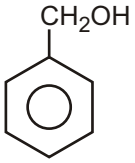


2, 3-Dibromo-1-phenylpentane

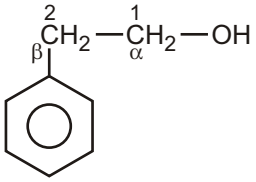


3-hydroxy-4-Phenylbutanal

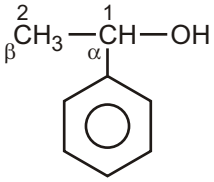
☞ **Aromatic alcohols :**



phenylmethanol
(benzyl alcohol)

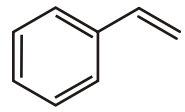


2-phenylethan-1-ol
(β-phenylethyl alcohol)



1-phenylethan-1-ol
(α-phenylethyl alcohol)

***Solved Example***

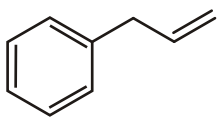


$C_6H_5CH{=}CH_2$ **Phenylethene**

***Solved Example***

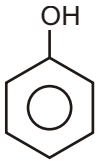
- Principal functional group is an alkene therefore suffix **= -ene**
- The longest continuous chain is C2 therefore root **= eth**
- The benzene ring is a substituent therefore **= phenyl**
- Numbering from the right as drawn to give the alkene the lowest locant **= 1**
- Phenyl locant **= 3**

**3-phenylpropene**

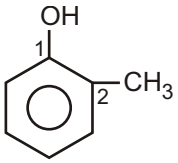


$C_6H_5{-}CH_2{-}CH{=}CH_2$

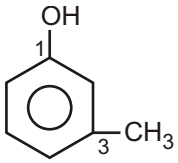
☞ **Phenols :**




phenol



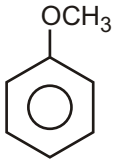

2-methylphenol (o-cresol)



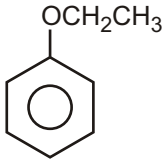

3-methylphenol (m-cresol)


4-methylphenol (p-cresol)

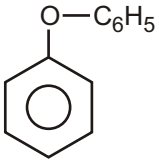
☞ **Aromatic ethers :**




methoxybenzene
(anisole or methyl phenyl ether)

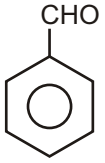



Ethoxybenzene
(phenetole or Ethyl phenyl ether)

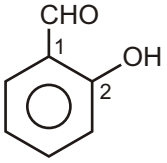



phenoxybenzene
(diphenyl ether)

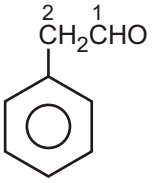
☞ **Aldehydes :**



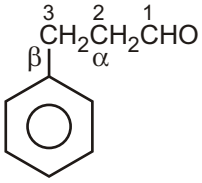

benzaldehyde




2-hydroxybenzaldehyde
(salicyladehyde)

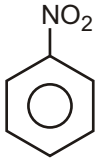



2-phenylethanal
(phenylacetaldehyde)

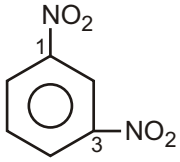



3-phenylpropanal
(β-phenylpropionaldehyde)

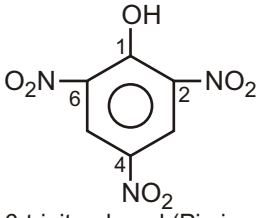
☞ **Nitro compounds :**




Nitrobenzene

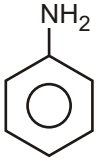



1,3-dinitrobenzene or m-dinitrobenzene

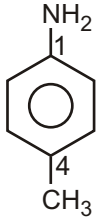



2,4,6-trinitrophenol (Picric acid)

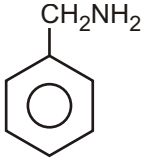
☞ **Amines :**



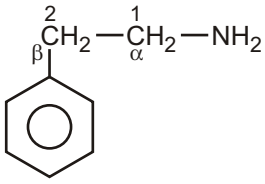

Benzenamine
(Aniline)




4-methylbenzenamine
(p-toluidine)

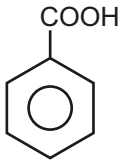



Phenylmethanamine
(Benzylamine)

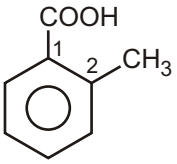



2-phenylethanamine
(β-phenylethylamine)

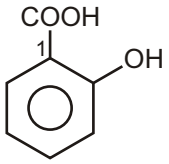
☞ **Carboxylic acids :**



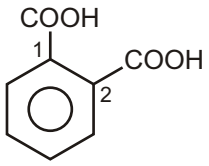

Benzoic acid
or benzenecarboxylic acid



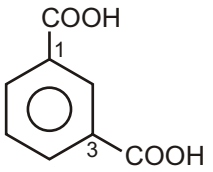

2-methylbenzoic acid
(o-Toluic acid)



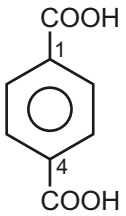

2-hydroxybenzoic acid
(Salicylic acid)




1,2-benzenedicarboxylic acid
(Phthalic acid)

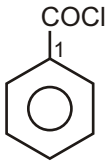



1,3-benzenedicarboxylic acid
(Isophthalic acdi)

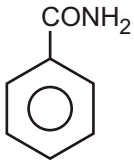



1,4-benzenedicarboxylic acid
(Terephthalic acid)

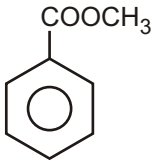
☞ **Acid derivatives :**



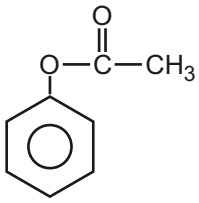

benzoyl chloride
or benzenecarbonylchloride



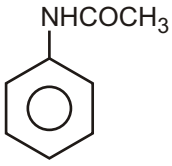

benzamide
or benzenecarboxamide



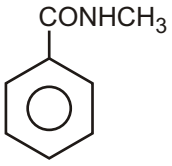

methyl benzoate
or methyl benzenecarboxylate



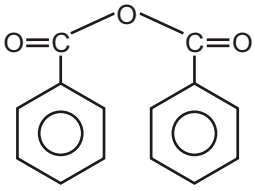

phenyl ethanoate
(Phenyl acetate)




N-phenylethanamide (N-phenylacetamide or Acetanilide)

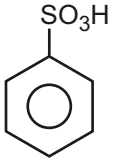



N-methylbenzamide

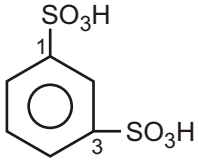



benzoic anhydride

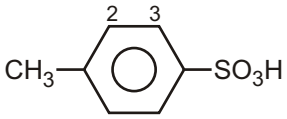
☞ **Sulphonic acids :**




benzenesulphonic acid

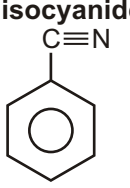



1,3-benzenedisulphonic acid

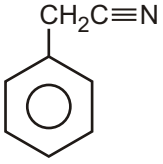



4-toluenesulphonic acid
(p-Toluenesulphonic acid)

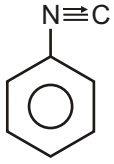
☞ **Cyanides and isocyanides :**




benzenenitrile
(Benzonitrile or Phenyl cyanide)



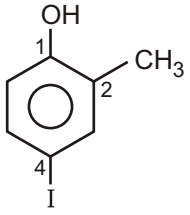

phenylethanenitrile
(Benzyl cyanide or Phenyl acetonitrile)



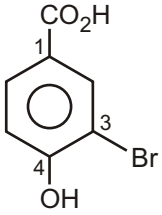

phenylisocyanide or
phenylcarbylamine

☞ When an aromatic compound contains two or more functional groups, it is named as a derivative of the compound with the principal functional group at position 1.

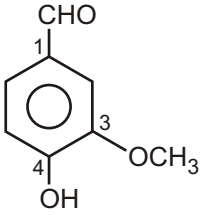
***Solved Example***




4-Iodo-2-methylphenol
(OH is the principal functional group)



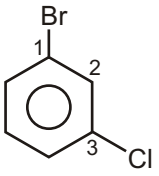

3-Bromo-4-hydroxybenzoic acid
(–COOH is the principal functional group)



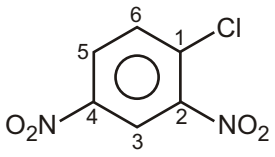

4-Hydroxy-3-methoxybenzaldehyde
(–CHO is the principal functional group)

☞ **Alphabatic Order Rule :** If lowest locant set rule is failed, give preference alphabetically.

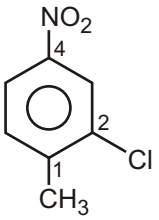
***Solved Example***



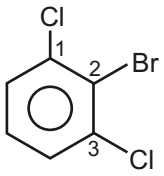

1-Bromo-3-Chlorobenzene
(not 1-chloro-3-bromobenzene)




1-Chloro-2, 4-dinitrobenzene
(and nor 4-chloro-1, 3-dinitrobenzene)



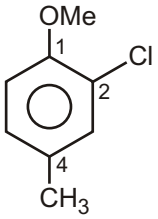

2-Chloro-1-methyl-4-nitrobenzene
(not 3-chloro-4-methylnitrobenzene)



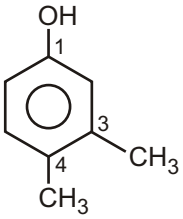

2-Bromo-1, 3-dichlorobenzene
(not 1-bromo-2, 6-dichlorobenzene)

☞ When a substituent is such which when taken together with the benzene ring gives a special name to the molecule, then it is named as a derivative of that molecule with the substituent at position 1.

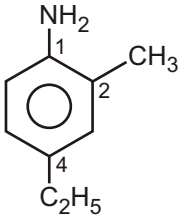
***Solved Example***




2-Chloro-4-methyl**anisole**




3, 4-Dimethyl**phenol**

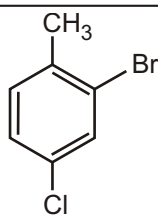



4-Ethyl-2-methyl**aniline**

***Solved Example***

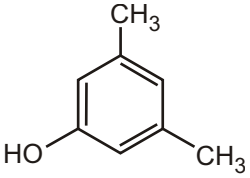
- Principal functional group is the methylbenzene therefore root **= toluene**
- There is a bromine substituent therefore **bromo**
- There is a chlorine substituent therefore **chloro**
- Numbering from the $-CH_3$ (priority group at C1) gives the substituents the locants **= 2** and **4**

  **2-bromo-4-chlorotoluene**




***Solved Example***

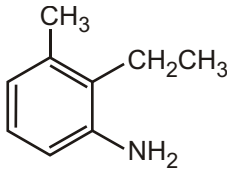
- Principal functional group is the aromatic alcohol therefore **phenol**
- There are two C1 substituents therefore dimethyl
- Numbering from the -OH (priority group at C1) gives the substituent the locant **= 3, 5**
- **3,5-dimethylphenol**



***Solved Example***

- Principle functional group is the aromatic amine therefore **= aniline**
- There is a C1 substituent therefore methyl
- There is a C2 substituent therefore ethyl
- Numbering from the -$NH_2$ (priority group at C1) gives the substituents the locants = 2 and 3

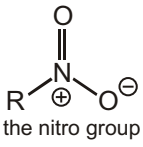
  **2-ethyl-3-methylaniline**




## ☑ SPECIAL TOPIC

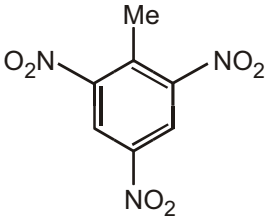
### NITRO COMPOUNDS (R–$NO_2$) CONTAIN THE NITRO GROUP ($NO_2$)

The nitro group ($NO_2$) is often incorrectly drawn with five bonds to nitrogen which you will see in Chapter 4, is impossible. Make sure you draw it correctly when you need to draw it out in detail. If you write just $NO_2$ you are all right!. Several nitro groups in one molecule can make it quite unstable and even explosive. Three nitro groups give the most famous explosive of all.

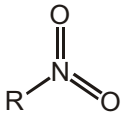


the nitro group

nitrogen cannot have five bonds!



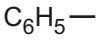
TNT (trinitrotoluene)



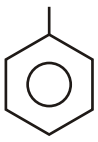
incorrect structure for the nitro group

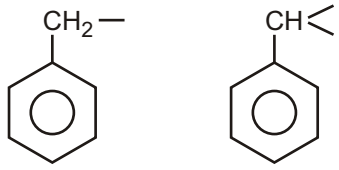
However, functional groups refuse to be stereotyped. Nitrazepam also contains a nitro group, but this compound is marketed as Mogadon®, the sleeping pill.

☞ **Aryl groups :**



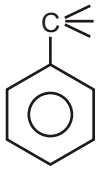
phenyl


benzyl

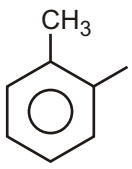





benzal



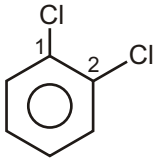
benzo



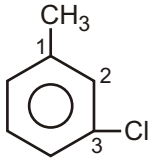
o–Tolyl

☞ **Halogen dervatives :**

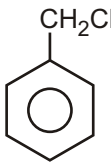
chlorobenzene



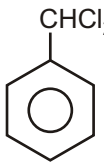
1,2-dichlorobenzene or
o-Dichlorobenzene



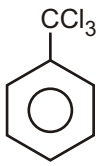
3-chlorotoluene or
m-chlorotoluene



phenylchloromethane
(benzyl chloride)

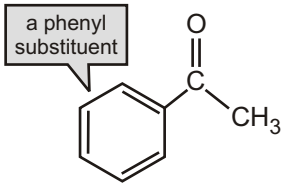


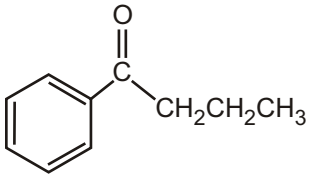
phenyldichloromethane
(benzal dichloride)

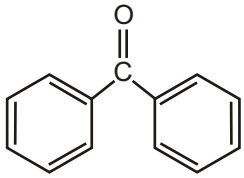


phenyltrichloromethane
(benzotrichloride)

Only a few ketones have common names. The smallest ketone, propanone, is usually referred to by its common name, acetone. Acetone is a widely used laboratory solvent. Common names are also used for some phenyl-substituted ketones; the number of carbons (other than those of the phenyl group) is indicated by the common name of the corresponding carboxylic acid, substituting "-ophenone" for "-ic acid."

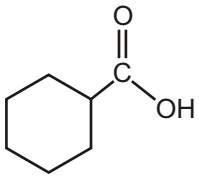


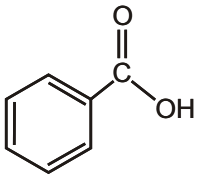




| | | | |
|---|---|---|---|
| **common name:** | acetophenone | butyrophenone | benzophenone |
| **derived name:** | methyl phenyl ketone | phenyl propyl ketone | diphenyl ketone |

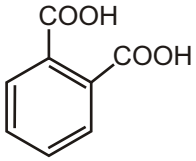
Carboxylic acids in which a carboxyl group is attached to a ring are named by adding "carboxylic acid" to the name of the cyclic compound.




cyclohexanecarboxylic acid



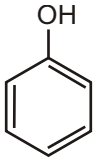

benzenecarboxylic acid
benzoic acid

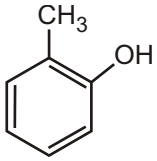


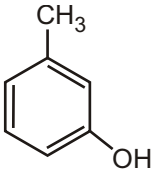

1,2-benzenedicarboxylic acid

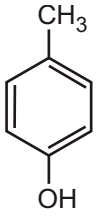
☞ **Phenols :** The simplest hydroxy derivative of benzene is phenol. It is its common name and also an accepted IUPAC name.

**Common name IUPAC Name :**



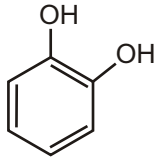



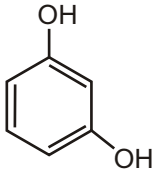




| | | | | |
|---|---|---|---|---|
| **Common names :** | Phenol | o-Cresol | m-Cresol | p-Cresol |
| **IUPAC names :** | Phenol | 2-Methylphenol | 3-Methylphenol | 4-Methylphenol |

Dihydroxy derivatives of benzene are known as 1,2-, 1, 3-and 1, 4-benzenediol.

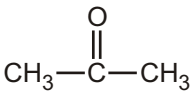
**Common name IUPAC Name :**



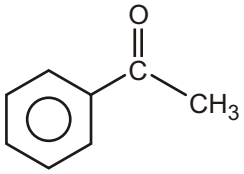





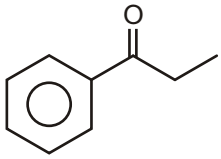
| | | | |
|---|---|---|---|
| **Common names :** | Catechol | Resorcinol | Hydroquinone or quinol |
| **IUPAC names :** | Benzene-1,2-diol | Benzene-1,3-diol | Benzene-1,4-diol |



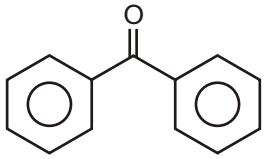

acetone



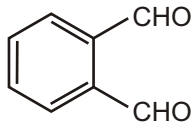
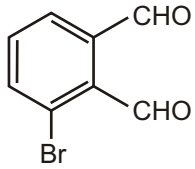

acetophenone




propiophenone

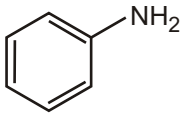



benzophenone

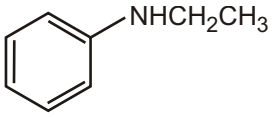
| Structure | Common name | IUPAC name |
|---|---|---|
|  | Phthaldehyde | Benzene-1,2-dicarbaldehyde |
|  | *m*-Bromophthaldehyde | 3-Bromobenzene-1,2-dicarbaldehyde |

☞ **Aromatic Amines :**

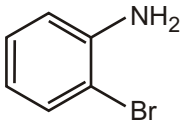
Aromatic amines are named as derivatives of aniline.



aniline



N-ethylaniline



o-Bromoaniline

# EXERCISE

## SINGLE CHOICE QUESTIONS

**1.** Which of the following represent incorrectly named IUPAC compound?

(A) $CH_3COC_6H_5$ 1-Phenylethanone

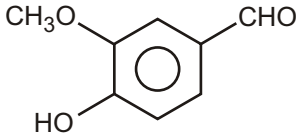
(B) $CH_3CH_2COCH(CH_3)_2$ 3-Hexanone

(C) $(CH_3)_2CHCOCH(CH_3)_2$ 2, 4-Dimethyl 3-Pentanone

(D) $C_6H_5COC_6H_5$ Diphenyl methanone

**2.** Which of the following represent incorrect number of carbons in parent chain?

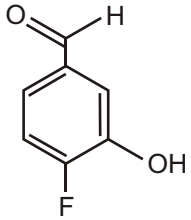
(A) $CH_3(CH_2)_3CO(CH_2)_3CH_3$ 9

(B)  1

(C) $C_6H_5CHCH_2CHO$ 3

(D) $CH_3(CH_2)_2CO(CH_2)_2CH_3$ 3

**3.** IUPAC name of the given compound is :



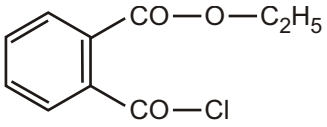
(A) 2-Fluoro-5-formylbenzenol

(B) 4-Fluoro-3-hydroxybenzenecarbaldehyde

(C) 1-Fluoro-4-formyl-2-hydroxybenzene

(D) 4-Fluoro-5-hydroxybenzenecarbaldehyde

**4.** Write the IUPAC name of the following compound :



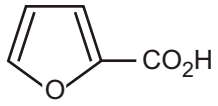
(A) ethyl-2-(chlorocarbonyl) benzoate

(B) ethyl-2-(chlorocarbonyl) hexanoate

(C) 2-(ethoxycarbonyl) benzoyl chloride

(D) None of these

**5.** The correct IUPAC name for the molecule is :



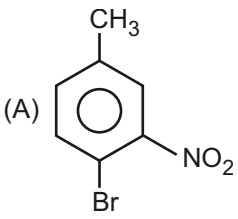
(A) 1-furoic acid

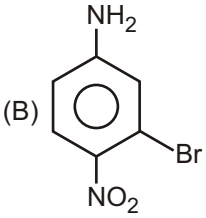
(B) furanyl carboxylic acid

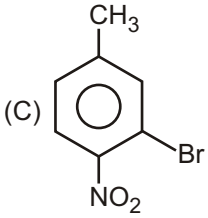
(C) 2-furoic acid

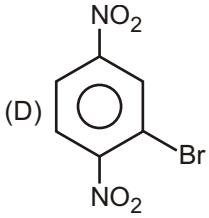
(D) 3-furoic acid

**6.** Which of the following is 3-bromo-4-nitro toluene?

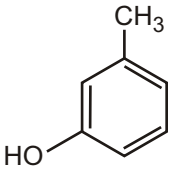
(A) 

(B) 

(C) 

(D) 

**7.** What would be the best name for the following compound?



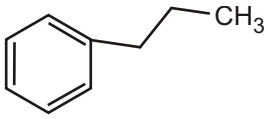
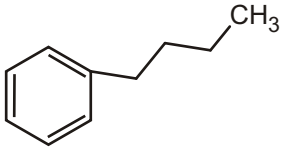
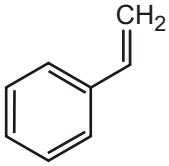
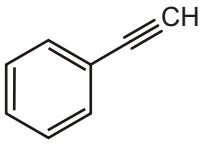
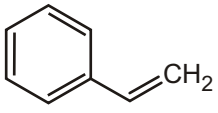
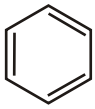
(A) 3-methylhydroxybenzene

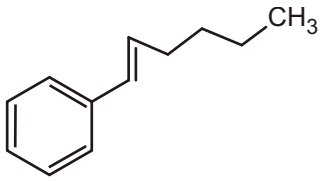
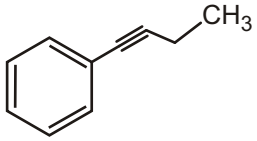
(B) 3-methylcyclohexa-13,5-trien-1-ol

(C) 3-methylphenol

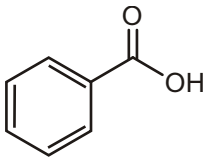
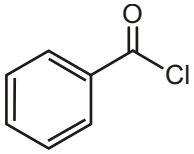
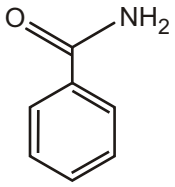
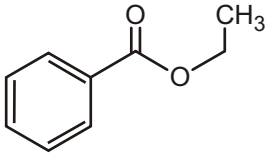
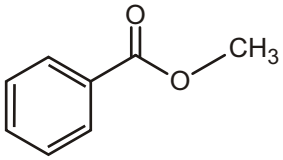
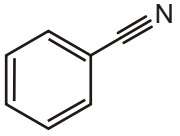
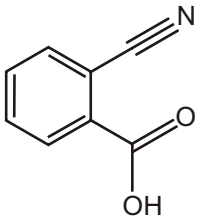
(D) 2-hydroxytoluene

## WORK SHEET - 1

| S.No. | Compounds | Write IUPAC - Name |
|---|---|---|
| 1. |  | |
| 2. |  | |
| 3. |  | |
| 4. |  | |
| 5. |  | |
| 6. |  | |

| | | |
|---|---|---|
| 7. |  | |
| 8. |  | |

## WORK SHEET - 2

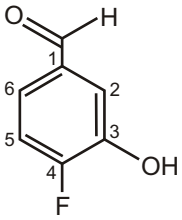
| S.No. | Compounds | Write IUPAC - Name |
|---|---|---|
| 1. |  | |
| 2. |  | |
| 3. |  | |
| 4. |  | |
| 5. |  | |
| 6. |  | |
| 7. |  | |

## Answers

### Single Choice Questions

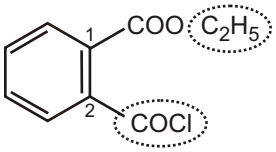
**1.** (B) **2.** (D) **3.** (B) **4.** (A) **5.** (B) **6.** (C) **7.** (C) **8.** (B)

**3.**




Additional suffix carbaldehyde is used for –CHO group.

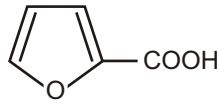
**4.**




ethyl-2-(chlorocarbonyl) benzoate

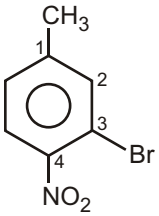
chlorocarbonyl

**5.**




= furanyl carboxylic acid.

**6.**




3-bromo-4-nitro toluene

### Work Sheet - 1

**1.** propylbenzene **2.** butyl benzene **3.** 1-phenyl ethene **4.** phenyl ethyne

**5.** 1-phenyl ethene **6.** benzene **7.** 1-phenyl hex-1-ene **8.** 1-phenyl but-1-yne

### Work sheet - 2

**1.** benzenecarboxylic acid or benzoic acid

**2.** benzenecarbonyl chloride or benzoyl chloride

**3.** benzenecarboamide or benzamide

**4.** ethyl benzene carboxylate or ethyl benzoate

**5.** methyl benzene carboxylate or methyl benzoate

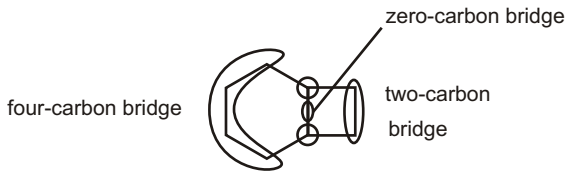
**6.** benzenecarbonitrile

**7.** 2-cyano benzenecarboxylic acid or 2-cyanobenzoic acid

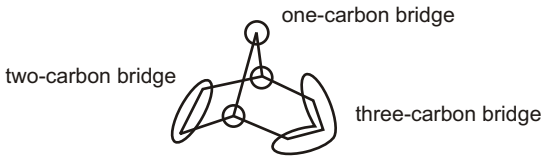
## ☑ SPECIAL TOPIC

### BICYCLO COMPOUNDS

All fused and bridged bicyclic systems have three bridges connecting the two bridgehead atoms where the rings connect. The numbers in the brackets give the number of carbon atoms in each of the three bridges connecting the bridgehead carbons, in order of decreasing size.




bicyclo[4,2,0]octane

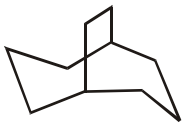



bicyclo[3,2,1]octane

# EXERCISE

## SINGLE CHOICE QUESTIONS

**1.** Which of the following best describes the compound given below?



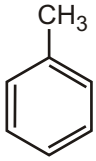
(A) bridged bicyclic
(B) fused bicyclic
(C) spiro bicyclic
(D) bridged tricyclic

## SUBJECTIVE TYPE QUESTIONS

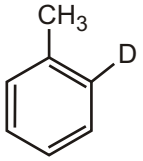
**1.** Which isomer of xylene can give three different monochloroderivatives ?

(a) *o*-xylene
(b) *m*-xylene
(c) *p*-xylene
(d) xylene cannot give a monochloro derivative

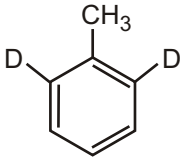
**2.**




(I)




(II)




(III)

The rate of o-nitration of the above compounds, (I) toluene, (II) 2-D-toluene and (III) 2, 6-$D_2$-toluene is in the following order

(a) I > II > III
(b) II > I > III
(c) III > I > II
(d) The rate is the same for all the three compounds

## Answers

### Single Choice Questions

**1.** (A)

### Subjective Type Questions

**1.** (b)

**2.** (d) I = II = III

In the rds step C — D bond cleavage is not involved.

❑❑❑