

## Term-I

# ALCOHOLS, PHENOLS AND ETHERS

### Syllabus

- **Alcohols:** Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration.
- **Phenols:** Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophillic substitution reactions, uses of phenols.
- **Ethers:** Nomenclature, methods of preparation, physical and chemical properties, uses



### STAND ALONE MCQs

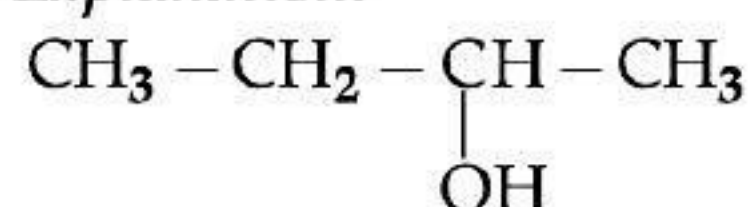
[1 Mark each]

Q. 1. How many alcohols with molecular formula  $C_4H_{10}O$  are chiral in nature?

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

Ans. Option (A) is correct.

**Explanation:**



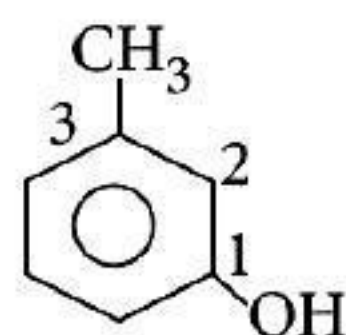
Butan-2-ol is chiral in nature as it possesses chiral center.

Q. 2. IUPAC name of m-cresol is \_\_\_\_\_.

- (A) 3-methylphenol (B) 3-chlorophenol  
(C) 3-methoxyphenol (D) benzene-1,3-diol

Ans. Option (A) is correct.

**Explanation:**



(i) -OH is functional group and  $-\text{CH}_3$  is substituent.

(ii) IUPAC name : 3-methylphenol.

Q. 3. Phenol is less acidic than \_\_\_\_\_.

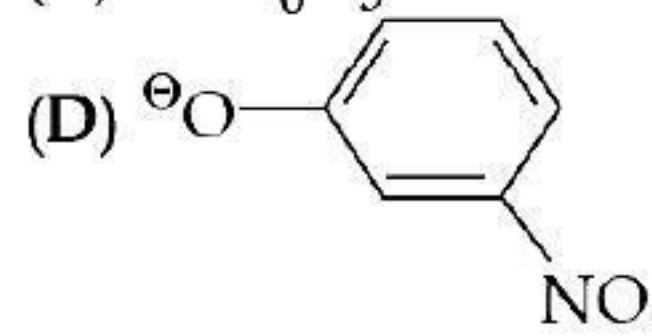
- (A) ethanol (B) o-nitrophenol  
(C) o-methylphenol (D) o-methoxyphenol

Ans. Option (B) is correct.

**Explanation:** In o-nitrophenol, nitro group is present at ortho position. Presence of electron withdrawing group at ortho position increases the acidic strength. On the other hand, in o-methylphenol and in o-methoxyphenol electron releasing group ( $-\text{CH}_3$  or  $-\text{OCH}_3$ ), at ortho or para positions of phenol decreases the acidic strength of phenols. So, phenol is less acidic than o-nitrophenol.

Q. 4. Which of the following species can act as the strongest base?

- (A)  $^{\ominus}\text{OH}$   
(B)  $^{\ominus}\text{OR}$   
(C)  $^{\ominus}\text{OC}_6\text{H}_5$



Ans. Option (B) is correct.

**Explanation:** Weakest acid has the strongest conjugate base. Since R-OH is the weakest acid, therefore,  $^{\ominus}\text{OR}$  is the strongest base.

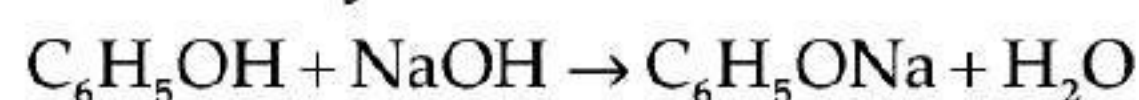
Q. 5. Which of the following compounds will react with sodium hydroxide solution in water?

- (A)  $\text{C}_6\text{H}_5\text{OH}$  (B)  $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$   
(C)  $(\text{CH}_3)_3\text{COH}$  (D)  $\text{C}_2\text{H}_5\text{OH}$

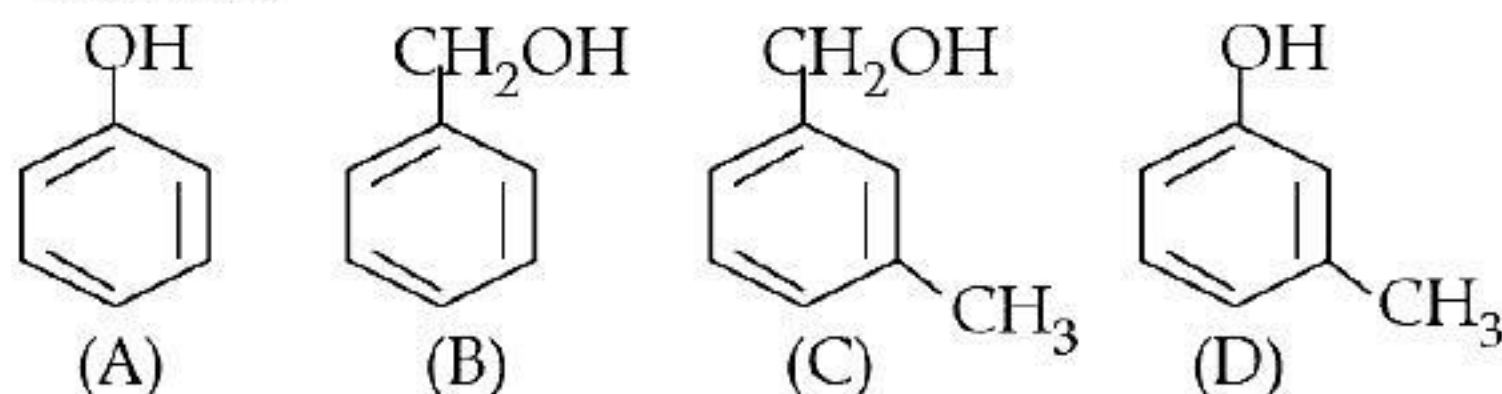


Ans. Option (C) is correct.

**Explanation:** Phenol being more acidic reacts with sodium hydroxide solution in water to give sodium phenoxide which is resonance stabilized. Alcohols are very weak acids.



Q. 6. Which of the following compounds is aromatic alcohol?



(A) A, B, C, D

(C) B, C

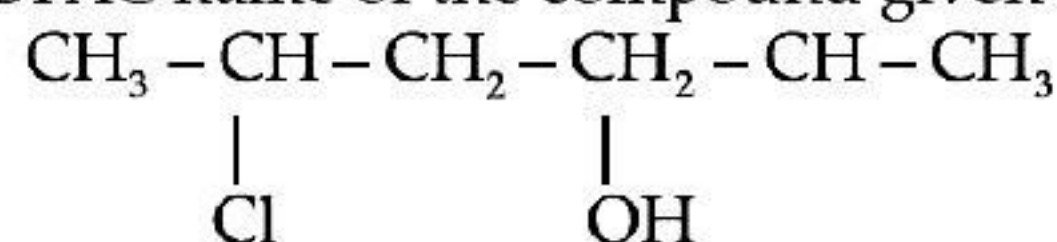
(B) A, D

(D) A

Ans. Option (C) is correct.

**Explanation:** Compound (A) i.e., phenol and compound (D), that is, a derivative of phenol cannot be considered as aromatic alcohol. As phenol is also known as carboxylic acid and cannot be considered as aromatic alcohol. Compound (B) and (C) -OH group is bonded to  $\text{Sp}^3$  hybridized carbon which in turn is bonded to benzene ring.

Q. 7. Give IUPAC name of the compound given below.



(A) 2-Chloro-5-hydroxyhexane

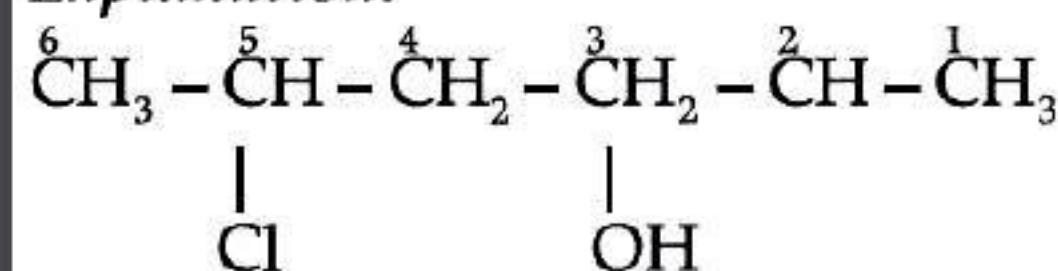
(B) 2-Hydroxy-5-chlorohexane

(C) 5-Chlorohexan-2-ol

(D) 2-Chlorohexan-5-ol

Ans. Option (C) is correct.

**Explanation:**



5-chlorohexan-2-ol

Q. 8. Arrange the following compounds in increasing order of boiling point. :

Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(A) Propan-1-ol, butan-2-ol, butan-1-ol, pentan-1-ol

(B) Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(C) Pentan-1-ol, butan-2-ol, butan-1-ol, propan-1-ol

(D) Pentan-1-ol, butan-1-ol, butan-2-ol, propan-1-ol

Ans. Option (A) is correct.

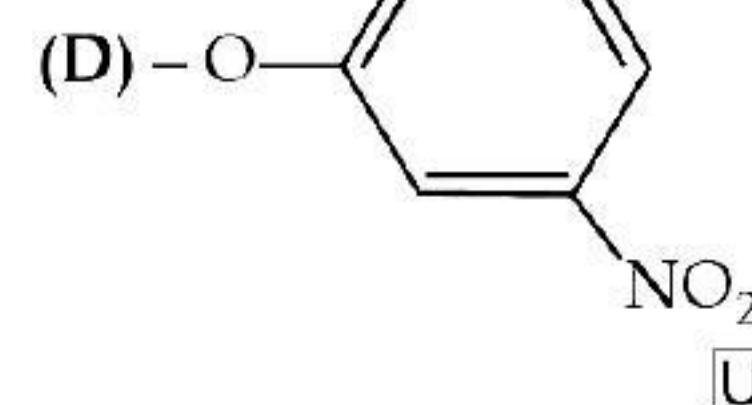
**Explanation:** Boiling point increases with increase in molecular mass of the alcohols. Among isomeric alcohols  $1^\circ$  alcohols have higher boiling point than  $2^\circ$  alcohols. Thus, correct order is :  
Propan-1-ol < Butan-2-ol < Butan-1-ol < pentan-1-ol

Q. 9. Which of the following species can act as the strongest base?

(A) -OH

(B) -OR

(C) -OC<sub>6</sub>H<sub>5</sub>



Ans. Option (B) is correct.

**Explanation:** Weakest acid has the strongest conjugate base. Since R-OH is the weakest acid, therefore, -OR is the strongest base.

Q. 10. The IUPAC name of anisole is

(A) 2-methyltoluene

(B) Methyl phenyl ether

(C) Methoxybenzene

(D) Ethoxybenzene

Ans. Option (C) is correct.

**Explanation:**  $\text{C}_6\text{H}_5\text{OCH}_3$

IUPAC name: Methoxybenzene

Q. 11. Williamson synthesis is used to obtain

(A) Primary alcohol

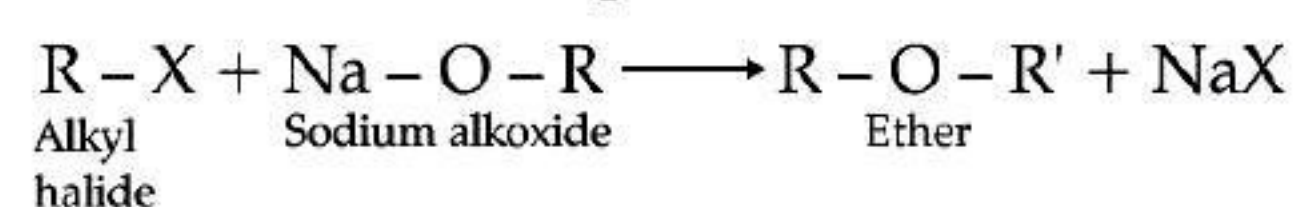
(B) Ether

(C) Aldehyde

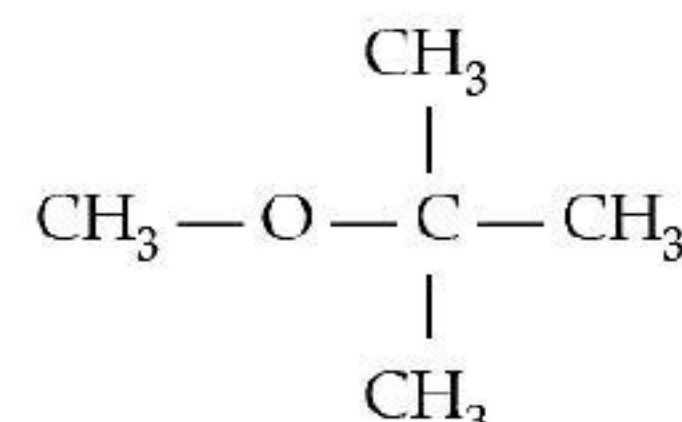
(D) Ketone

Ans. Option (B) is correct.

**Explanation:** Williamson synthesis is used to obtain ether. For example,



Q. 12. Write the IUPAC name of the following compounds



(A) 2-Methoxy-isopropane

(B) 2-Methyl-2-methoxypropane

(C) 2-Methoxy-2-methylpropane

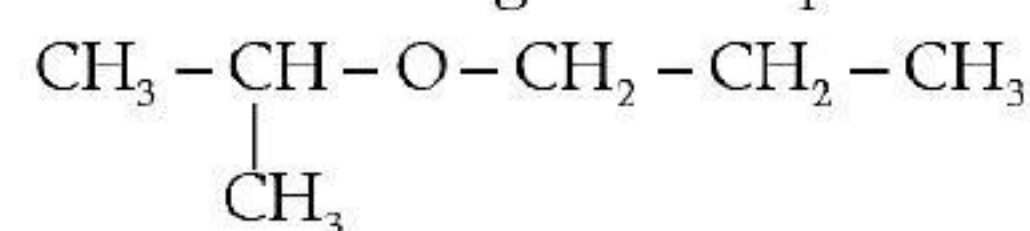
(D) 2-Methoxy-2,2 -dimethyl ethane

Ans. Option (C) is correct.

**Explanation:** 2-Methoxy-2-methylpropane.

Longest carbon chain is taken as the parent alkane in the IUPAC nomenclature.

Q. 13. IUPAC name for the given compound is



(A) 2-ethoxy-2-methylethane.

(B) 2-propoxypropane.

(C) 2-methyl-2-ethoxypropane

(D) None of the above

Ans. Option (B) is correct.



**Explanation:** IUPAC name of the compound is 2-propoxypropane.

Q. 14. Bond angle in ethers is slightly less than

- (A) Square planar angle
- (B) Trigonal bipyramidal angle
- (C) Tetrahedral angle
- (D) None of the above

Ans. Option (C) is correct.

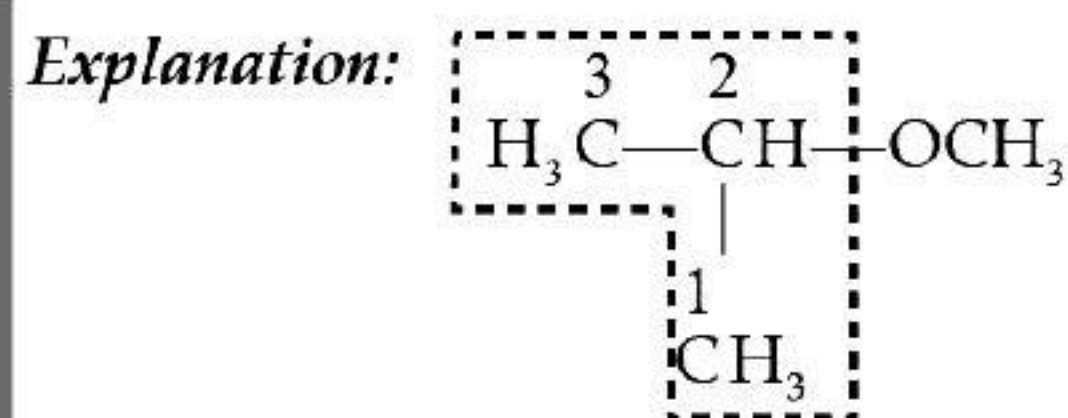
**Explanation:** Bond angle in ether is slightly more than the tetrahedral angle due to repulsion between the two bulky alkyl groups.

Q. 15. IUPAC name of the compound,  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{OCH}_3$

is \_\_\_\_\_.

- (A) 1-methoxy-1-methylethane
- (B) 2-methoxy-2-methylethane
- (C) 2-methoxypropane
- (D) isopropylmethyl ether

Ans. Option (C) is correct.



## ASSERTION AND REASON BASED MCQs

[1 Mark each]

**Directions :** In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

- (A) Both A and R are true and R is the correct explanation of A
- (B) Both A and R are true but R is NOT the correct explanation of A
- (C) A is true but R is false
- (D) A is false and R is True

Q. 1. Assertion (A): Ortho and para-nitrophenol can be separated by steam distillation.

Reason (R): Ortho isomer associates through intermolecular hydrogen bonding while para isomer associates through intermolecular hydrogen bonding. [U] [CBSE Delhi Set-II 2020]

Ans. Option (C) is correct.

**Explanation:** Ortho isomer has intermolecular H-bonding while para isomer has intermolecular hydrogen bonding.

Q. 2. Assertion (A):  $(\text{CH}_3)_3\text{C}-\text{O}-\text{CH}_3$  gives  $(\text{CH}_3)_3\text{C}-\text{I}$  and  $\text{CH}_3\text{OH}$  on treatment with HI.

Reason (R): The reaction occurs by  $\text{S}_{\text{N}}1$  mechanism. [U] [CBSE O.D. Set-I 2020]

Ans. Option (A) is correct.

**Explanation:**  $(\text{CH}_3)_3\text{C}-\text{O}-\text{CH}_3$  gives  $(\text{CH}_3)_3\text{C}-\text{I}$  and  $\text{CH}_3\text{OH}$  on treatment with HI. The reaction occurs by  $\text{S}_{\text{N}}1$  mechanism.

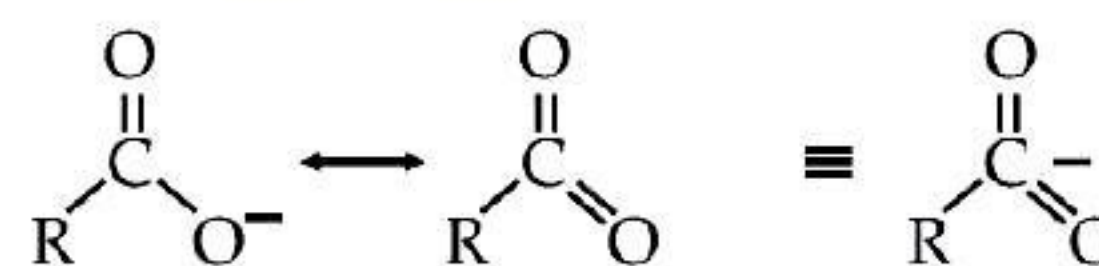
Q. 3. Assertion (A): Carboxylic acids are more acidic than phenols.

Reason (R): Phenols are ortho and para directing.

[A&E] [CBSE SQP 2021]

Ans. Option (B) is correct.

**Explanation:** Carboxylic acids are more acidic than phenols as the carboxylate ion, the conjugate base of carboxylic acid is stabilized by two equivalent resonance structures. Thus, the negative charge is delocalized effectively. However, in phenols, negative charge is less effectively delocalized over oxygen atom and carbon atoms in phenoxide ion.

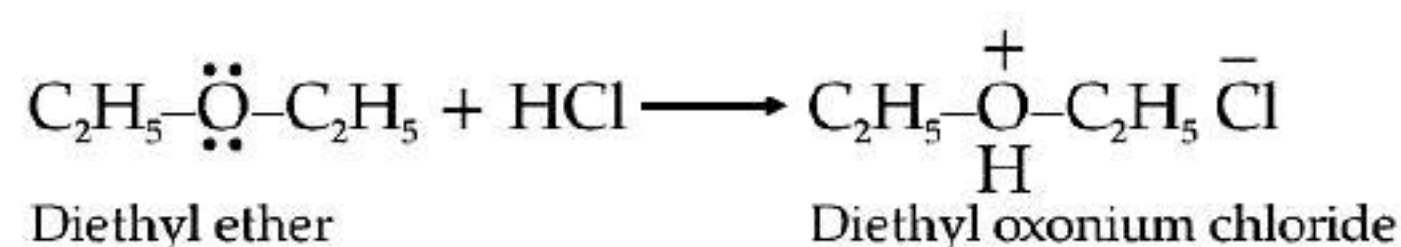


Q. 4. Assertion (A): Ethers behave as bases in the presence of mineral acids.

Reason (R) : In ethers, oxygen consists of lone pair of electrons. [U]

Ans. Option (A) is correct.

**Explanation:** Ethers behave as bases in the presence of mineral acids like HCl due to presence of lone pair of electrons on oxygen atom and form stable oxonium salts with mineral acids.



Q. 5. Assertion (A) : The C-O-C bond angle in ethers is slightly less than tetrahedral angle.

Reason (R): Due to the repulsive interaction between the two alkyl groups in ethers.

[R] [CBSE Delhi Set-I 2020]

Ans. Option (D) is correct.

**Explanation:** The C-O-C bond angle in ether is slightly greater than tetrahedral angle. It is due to the repulsive interaction between the two alkyl groups in ethers.

Q. 6. Assertion (A): Methoxy ethane reacts with HI to give ethanol and iodomethane.

Reason (R): Reaction of ether with HI follows  $\text{S}_{\text{N}}2$  mechanism. [A&E] [CBSE SQP 2021]

Ans. Option (A) is correct.

**Explanation:** Methoxy ethane reacts with HI to give ethanol and iodomethane. Reaction of ether with HI follows  $\text{S}_{\text{N}}2$  mechanism.



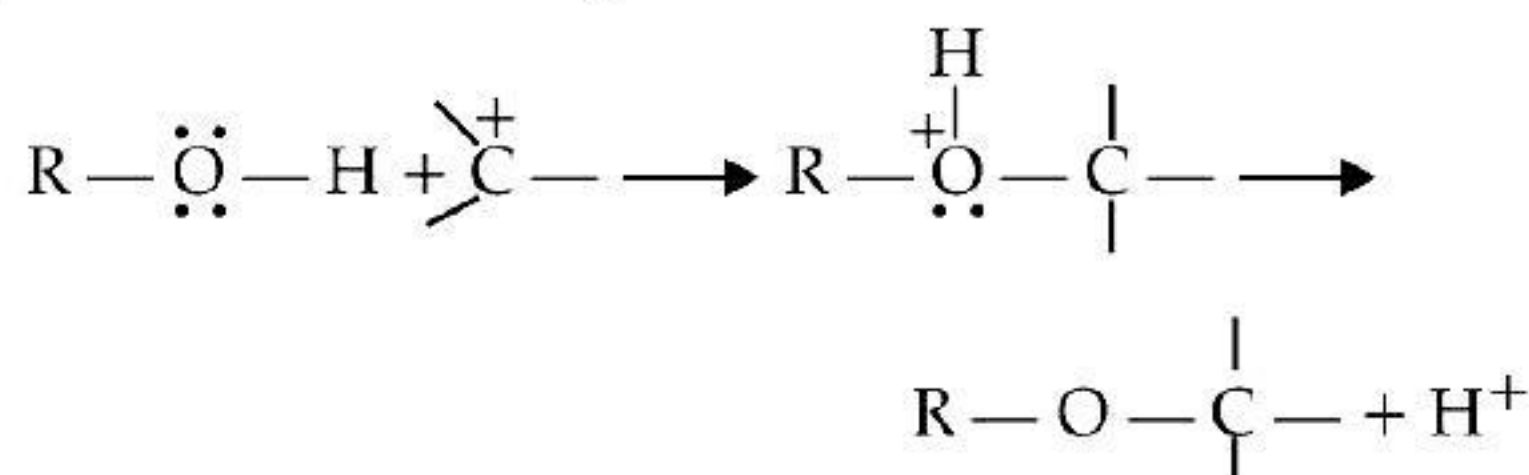


## CASE-BASED MCQs

I. Read the passage given below and answer the following questions :

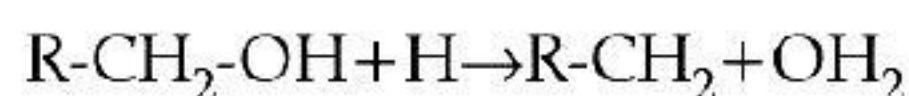
Alcohols are versatile compounds. They act both as nucleophiles and electrophiles. The bond between O-H is broken when alcohols act as nucleophiles.

(i) Alcohols as nucleophiles



(ii) The bond between C-O is broken when they act as, electrophiles. Protonated alcohols react in this manner.

Protonated alcohols as electrophiles



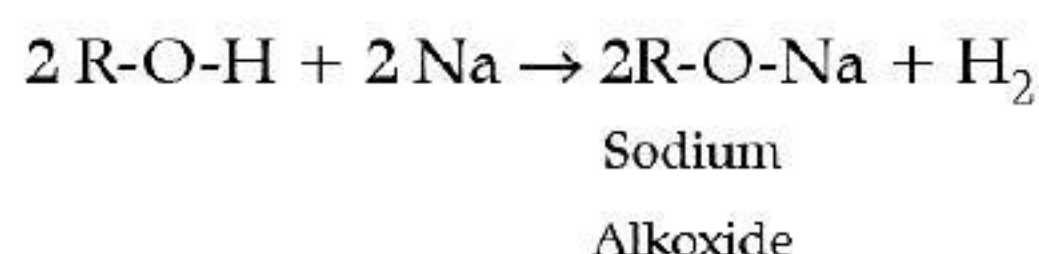
Based on the cleavage of O-H and C-O bonds, the reaction of alcohols and phenols may be divided into two groups :

(a) Reactions involving cleavage of O-H bond

(b) Reactions involving cleavage of C-O bond

Acidity of alcohols and phenols

(i) Reaction with metals : Alcohols and phenols react with active metals such as sodium, potassium and aluminium to yield corresponding alkoxide/phenoxides and hydrogen.



Q. 1. Write down the decreasing order of reactivity of sodium metal towards primary, secondary and tertiary alcohols.

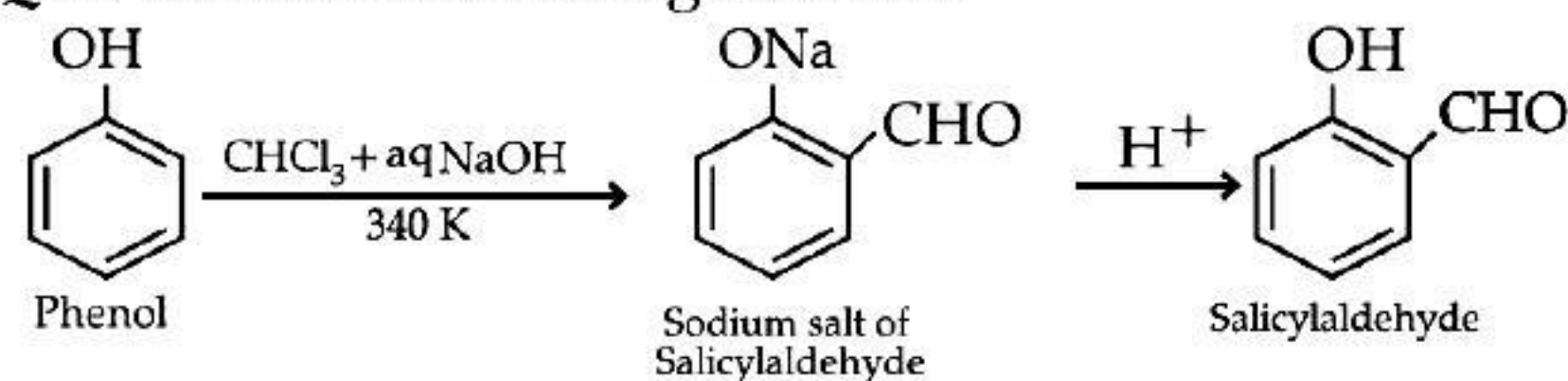
- (A)  $1^\circ\text{alc} < 2^\circ\text{alc} < 3^\circ\text{alc}$       (B)  $1^\circ\text{alc} > 2^\circ\text{alc} > 3^\circ\text{alc}$   
(C)  $3^\circ\text{alc} < 1^\circ\text{alc} < 2^\circ\text{alc}$       (D)  $3^\circ\text{alc} > 1^\circ\text{alc} < 2^\circ\text{alc}^\circ$

A&E

Ans. Option (B) is correct.

**Explanation:** Na metal is basic and alcohols are acidic in nature. Hence, reactivity of Na metal towards alcohols decreases as the acidic strength of alcohols decreases due to steric hinderance of alkyl groups in tertiary alcohol and increase in electron density on an oxygen atom in the hydroxyl bond.

Q. 2. Name the following reaction:



- (A) Williamson's synthesis  
(B) Kolbe's reaction  
(C) Reimer-Tiemann reaction  
(D) Sandmeyer's reaction

Ans. Option (C) is correct.

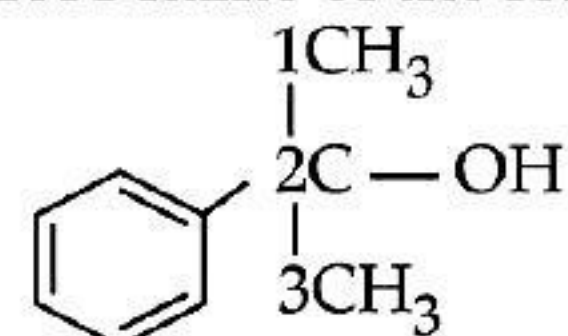
Q. 3. Given the descending order of acid strength of alcohols.

- (A)  $\text{RCH}_2\text{OH} > \text{RR}'\text{CHOH} > \text{RR}'\text{R}''\text{COH}$   
(B)  $\text{RCH}_2\text{OH} > \text{RR}'\text{R}''\text{COH} > \text{RR}'\text{CHOH}$   
(C)  $\text{RCH}_2\text{OH} < \text{RR}'\text{CHOH} < \text{RR}'\text{R}''\text{COH}$   
(D)  $\text{RCH}_2\text{OH} < \text{RR}'\text{R}''\text{COH} < \text{RR}'\text{CHOH}$  A&E

Ans. Option (A) is correct.

**Explanation:** The more stable the alkoxide ion, the more acidic is the alcohol. Electron releasing effect (+I effect) of alkyl group in secondary and tertiary alcohols makes the alkoxide ion less stable.

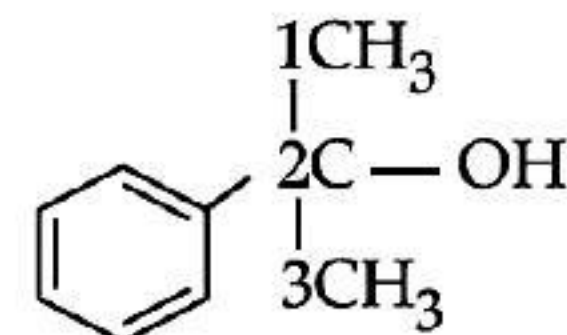
Q. 4. Write the IUPAC name of the following compound:



- (A) 2-methyl, 2-phenyl ethanol  
(B) 2-phenyl butanol  
(C) 2-Phenylpropan-2-ol  
(D) 1-methyl, 1-phenyl ethanol A

Ans. Option (C) is correct.

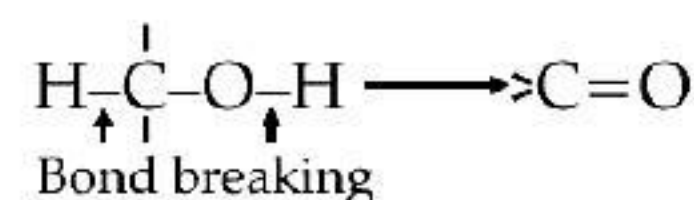
**Explanation:**



IUPAC name = 2-Phenylpropan-2-ol

II. Read the passage given below and answer the following questions:

Oxidation of alcohols involves the formation of a carbon-oxygen double bond with cleavage of an O-H and C-H bonds.



Such a cleavage and formation of bonds occur in oxidation reactions. These are also known as dehydrogenation reactions as these involve loss of dihydrogen from an alcohol molecule. Depending on the oxidising agent used, a primary alcohol is



oxidised to an aldehyde which in turn is oxidised to a carboxylic acid.

Strong oxidising agents such as acidified potassium permanganate are used for getting carboxylic acids from alcohols directly.  $\text{CrO}_3$  in anhydrous medium is used as the oxidising agent for the isolation of aldehydes.

In these questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (A) Assertion and reason both are correct statements and reason is correct explanation for assertion.  
 (B) Assertion and reason both are correct statements but reason is not correct explanation for assertion.  
 (C) Assertion is correct statement but reason is wrong statement.  
 (D) Assertion is wrong statement but reason is correct statement

**Q. 1. Assertion (A):** Dehydrogenation reaction of alcohols is an oxidising reaction.

**Reason (R):** It involves loss of dihydrogen from alcohol. [R]

**Ans. Option (A) is correct.**

**Explanation:** Dehydrogenation means loss of dihydrogen from a molecule.

**Q. 2. Assertion (A):**  $\text{CH}_3\text{CH}_2\text{OH}$  can be converted into  $\text{CH}_3\text{CHO}$  by treatment with pyridinium chlorochromate.

**Reason (R):** PCC is a better reagent for oxidation of primary alcohols to aldehydes. [R]

**Ans. Option (A) is correct.**

**Explanation:** PCC (Pyridinium chlorochromate) is a better reagent for converting ethyl alcohol into acetaldehyde.

**Q. 3. Assertion (A):** Tertiary alcohols do not undergo oxidation reactions.

**Reason (R):** They do not have the required C-H bond. [R]

**Ans. Option (A) is correct.**

**Explanation:** Tertiary alcohols do not undergo oxidation reactions because the carbon atom that carries the -OH group does not have a hydrogen atom.

**Q. 4. Assertion (A):** Vapours of primary and secondary alcohols are passed through heated copper an aldehyde and ketone are formed.

**Reason (R):** It's a dehydration reaction. [R]

**Ans. Option (C) is correct.**

**Explanation:** Vapours of primary and secondary alcohols are passed through heated copper an aldehyde and ketone are formed. It's a dehydrogenation reaction.

**III. Read the passage given below and answer the following questions:**

The reaction of phenol with aqueous sodium hydroxide indicates that phenols are stronger acids than alcohols and water. Due to the higher electronegativity of  $\text{sp}^2$  hybridised carbon of phenol to which -OH is attached, electron density decreases on oxygen. This increases the polarity of O-H bond and results in an increase in ionisation of phenols than that of alcohols. Now let us examine the stabilities of alkoxide and phenoxide ions. In alkoxide ion, the negative charge is localised on oxygen while in phenoxide ion, the charge is delocalised. The delocalisation of negative charge makes phenoxide ion more stable and favours the ionisation of phenol.

**Q. 1.** Phenol is less acidic than \_\_\_\_\_.

- (A) ethanol (B) o-nitrophenol  
 (C) o-methylphenol (D) o-methoxyphenol [U]

**Ans. Option (B) is correct.**

**Explanation:** Phenol is less acidic than o-nitrophenol as electron withdrawing ( $-\text{NO}_2$ ) group increases the acidity of phenols.

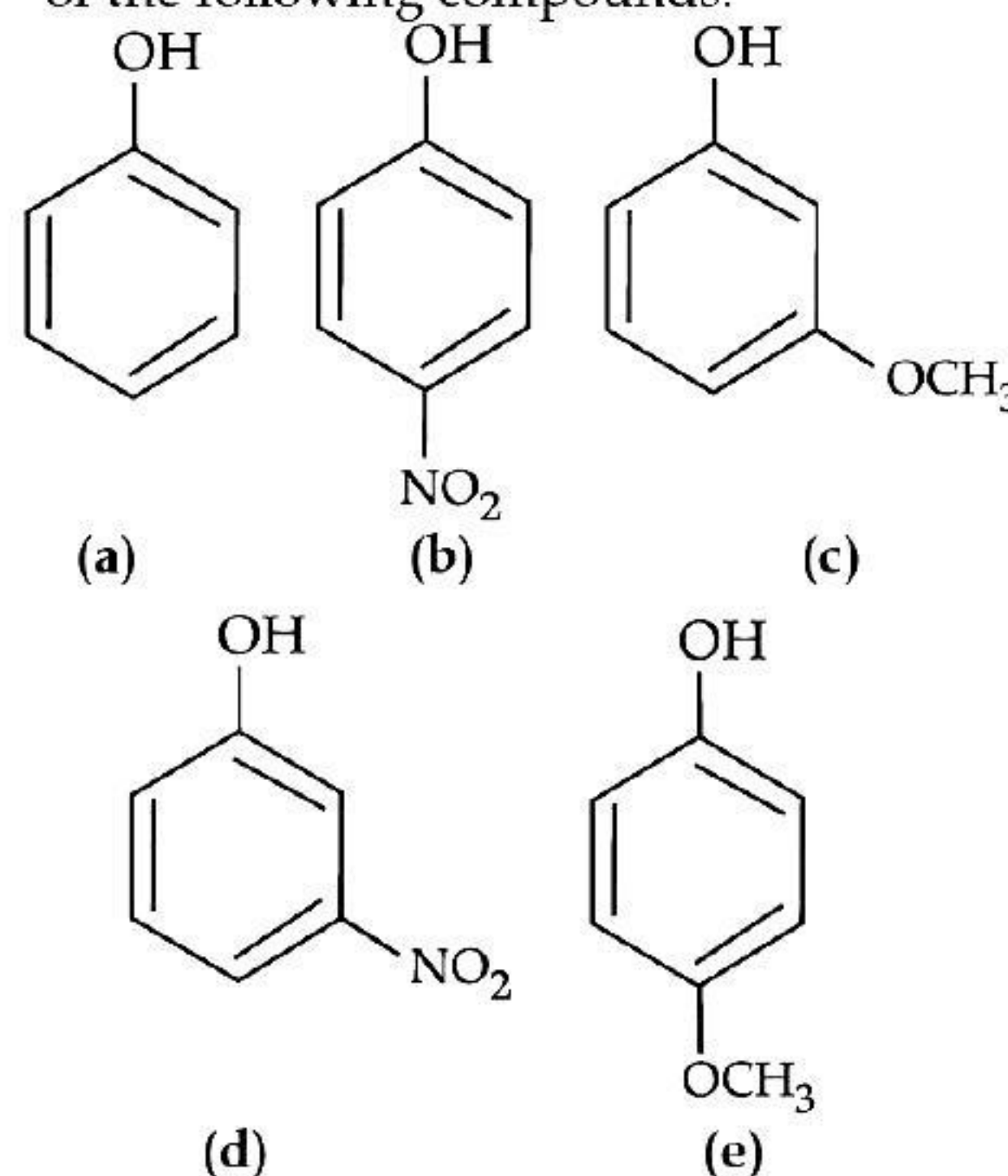
**Q. 2.** Which of the following is most acidic?

- (A) Benzyl alcohol (B) Cyclohexanol  
 (C) Phenol (D) m-Chlorophenol [A&E]

**Ans. Option (D) is correct.**

**Explanation:** m-chlorophenol is most acidic as electron withdrawing ( $-\text{Cl}$ ) group increases the acidity of phenols.

**Q. 3.** Mark the correct order of decreasing acid strength of the following compounds.



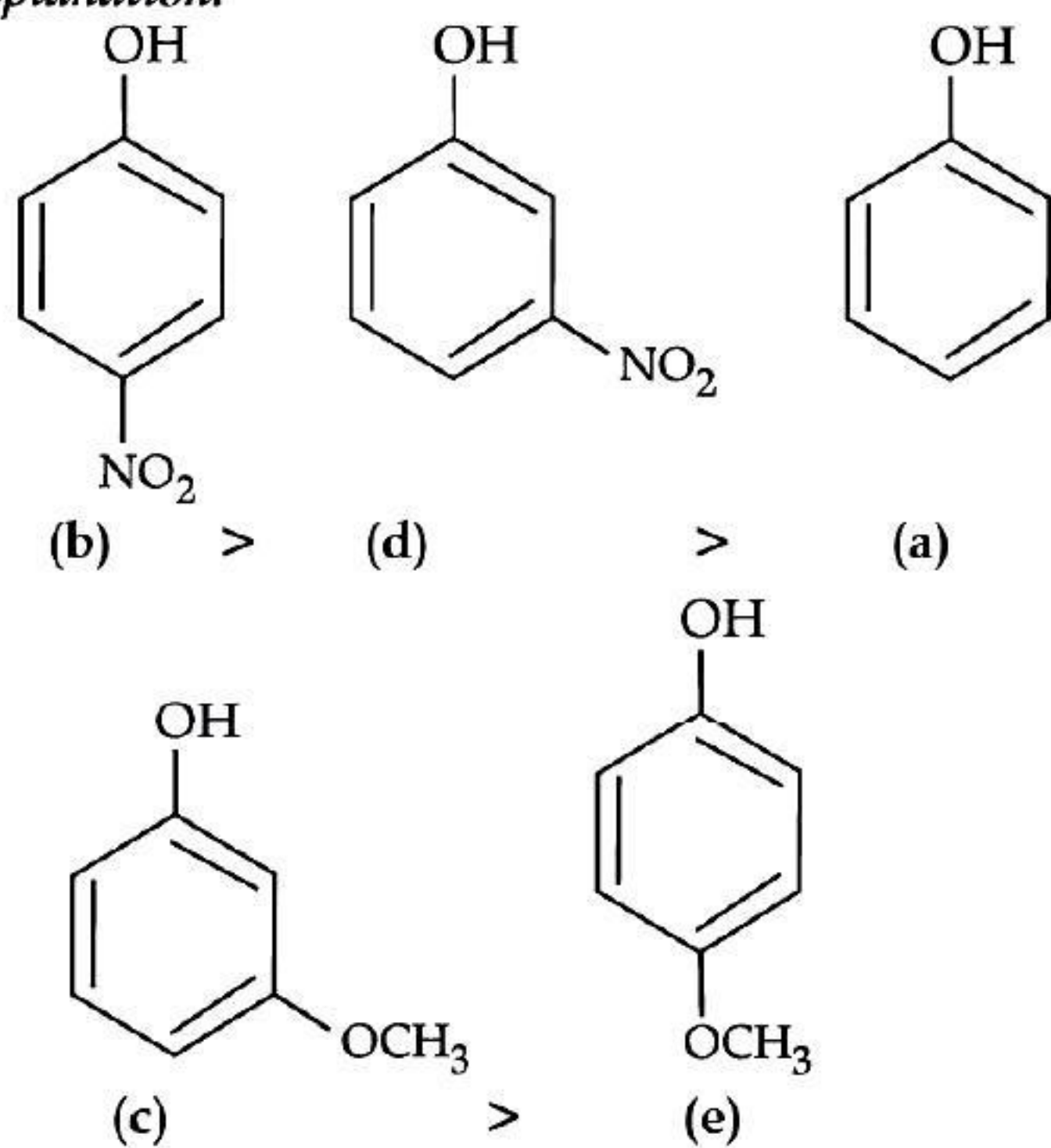
- (A)  $e > d > b > a > c$   
 (B)  $b > d > a > c > e$   
 (C)  $d > e > c > b > a$   
 (D)  $e > d > c > b > a$

A&E

**Ans. Option (B) is correct.**



**Explanation:**



The presence of electron withdrawing group viz.  $-\text{NO}_2$  group increases the acidity of phenol due to  $-I$  effect and electron releasing group viz.  $-\text{OCH}_3$  group decreases the acidity of phenol due to  $+I$  effect. Moreover, p-nitrophenol is more acidic than m-nitrophenol. While, p-methoxyphenol is less acidic than m-methoxyphenol.

**Q. 4.** Phenol can be distinguished from ethanol by the reaction with \_\_\_\_\_

- (A)  $\text{Br}_2/\text{water}$  (B) Na  
(C) Glycerol (D) All of the above R

**Ans.** Option (A) is correct.

**Explanation:** Phenol decolourises bromine water to form white precipitate of 2,4,6-tribromophenol whereas ethanol does not precipitate.