REDUCING AGENTS AND THEIR ROLE

Group	Product	LAH in Ether	$NaBH_4$ in H_2O	B_2H_6 in THF	H_2 / Catalyst Δ
–CHO	$-CH_2OH$	+	+	+	+
>C = O	>CH – OH	+	+	+	+
$-CO_2H$	$-CH_2OH$	+	–	+	–
$-CO_2R$	$-CH_2OH$	+	–	+	+
–COCl	$-CH_2OH$	+	+	–	+
$-CONH_2$	$-CH_2NH_2$	+	–	+	+
$(RCO)_2O$	RCH_2OH	+	–	+	+
–CN	$-CH_2NH_2$	+	–	+	+
>C = NOH	$-CH_2NH_2$	+	–	–	+
>C = C<	>CH – CH<	–	–	+	+
–C ≡ C–	–CH = CH–	–	–	+	+
1° RX	RH	+	–	–	+

Note :

1. B_2H_6 in THF not able to reduce cyclic ester.

2. $NaBH_4$ can also reduce imine group ($\diagdown\!\!\diagup C = NH$).

3. Reactivity order towards Ni / H_2 , Δ ⇒ $-C \equiv N > -\underset{\underset{O}{\|}}{C} - O - R$

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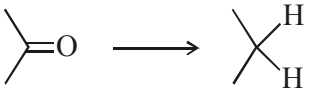
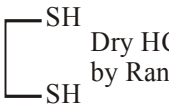
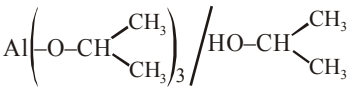
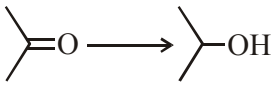
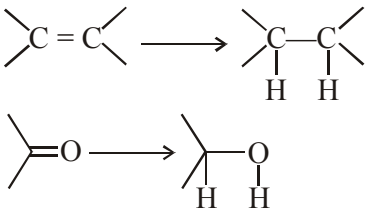
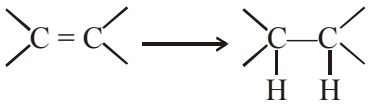
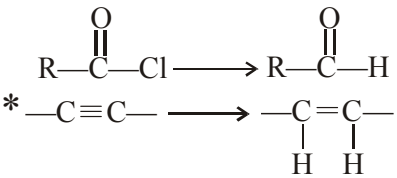
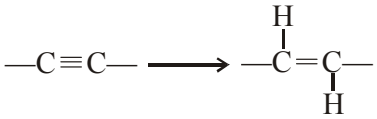
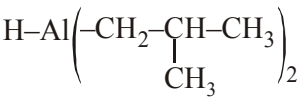
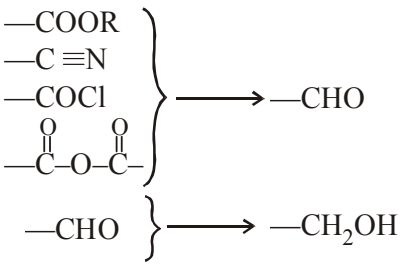
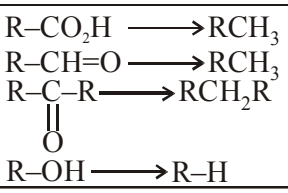
Name	Reagent	Function
Wolf Kishner Reduction	(i) N_2H_4 / (ii) KOH, Δ	
Clemenson Reduction	Zn–Hg / HCl	
Mozingo Reduction	 Dry HCl, followed by Raney Ni	
Stephen's Reduction	$SnCl_2$ / HCl followed by H_3O^+	$R–C\equiv N \longrightarrow R–CH=O$
MPV Reduction		
Hydroboration Reduction	B_2H_6 / AcOH, H_2O	
Bouvoult Blank Reduction	Na / EtOH	$R–COO–R \longrightarrow RCH_2OH + ROH$
Transfer Hydrogenation	N_2H_4 / H_2O_2	
Rosenmund Reduction	H_2, Pd–$BaSO_4$	
Birch Reduction	Na / Liq. NH_3	
DIBAL-H (–78°C)	 followed by $H_3O^{\oplus}$	
Red phosphorus in presence of HI	Red P + HI	

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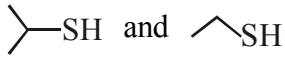
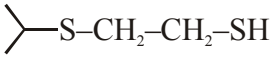
EXERCISE # O-I

1.

The end products of the reaction are :

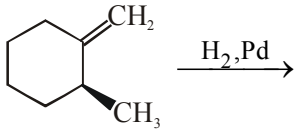
(A) 

(B) 

(C) and H_2O

(D)

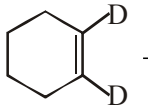
RD0001

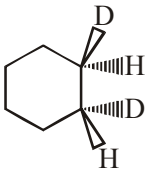
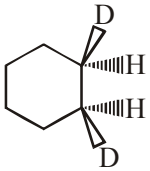
2. 

Products of the above reaction will be :

(A) Racemic mixture (B) Diastereomers (C) Meso (D) Structural isomer

RD0002

3.  Product :

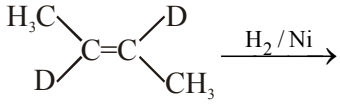
(A) (B)  (C)  (D) Both (B) and (C)

RD0003

4. On catalytic reduction with H_2/Pt how many alkenes will give n-butane ?

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

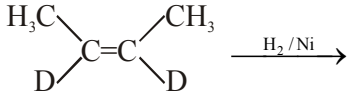
RD0004

5. 

Product of above reaction will be :

(A) Racemic mixture (B) Diastereomers (C) Meso (D) Constitutional isomers

RD0005

6. 

Product of above reaction will be :

(A) Racemic mixture (B) Diastereomers (C) Meso (D) Constitutional isomers

RD0006

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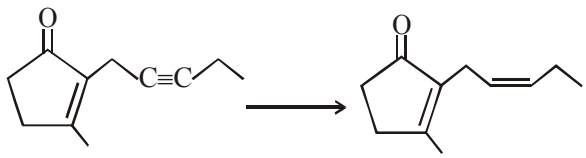
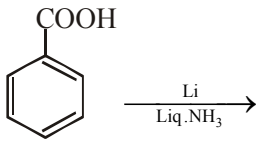
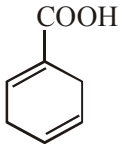
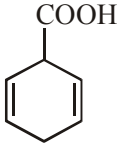
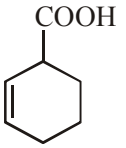
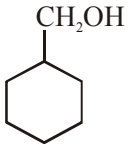
7. 

Which reagent will be used for the above conversion ?

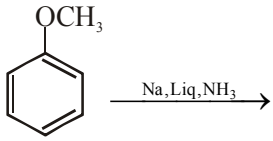
(A) Na/Liq. NH_3 (B) H_2, Pd–$CaCO_3$ (C) Li, Ph–NH_2 (D) H_2, Pt

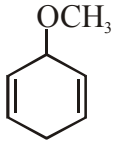
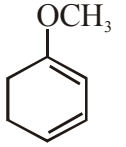
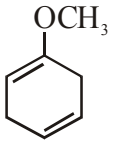
RD0007

8.  Major product :

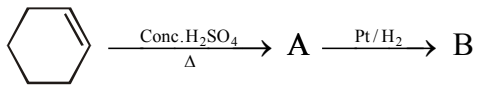
(A)  (B)  (C)  (D) 

RD0008

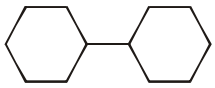
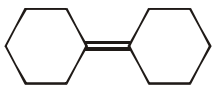
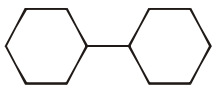
9.  Major product :

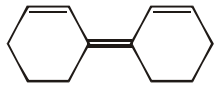
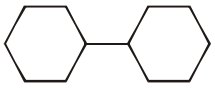
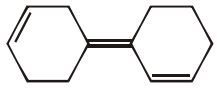
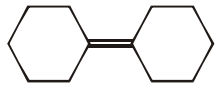
(A)  (B)  (C)  (D) None of these

RD0009

10. 

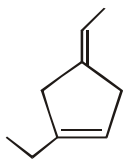
A and B respectively are :

(A) Both  (B)  , 

(C)  ,  (D)  , 

RD0010

11. If the following compound is treated with Pd in excess of H_2 gas, how many stereoisomers of the product will be obtained ?



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

RD0011

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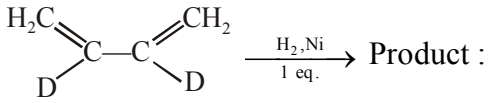
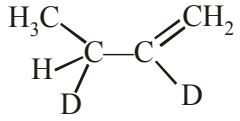
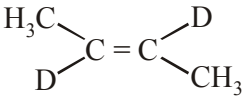
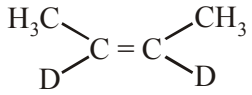
12.  Product :

(A) 

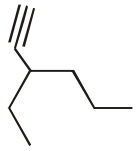
(B) 

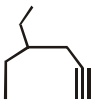
(C) 

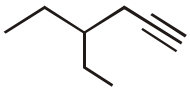
(D) All of these

RD0012

13. Which alkyne gives 3-ethylhexane on catalytic hydrogenation ?

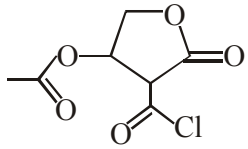
(A) 

(B) 

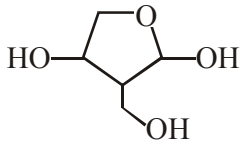
(C) 

(D) All of these

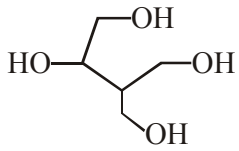
RD0013

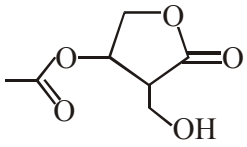
14.  Product

The product is :

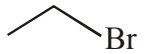
(A) 

(B) $CH_3–CH_2–OH$

(C) 

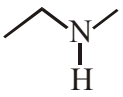
(D) 

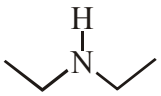
RD0014

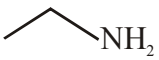
15.  $\xrightarrow{AgCN}$ A $\xrightarrow{H_2, Ni}$ B

The final product (B) is :

(A)

(B) 

(C) 

(D) 

RD0015

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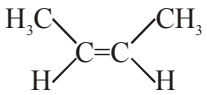
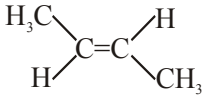
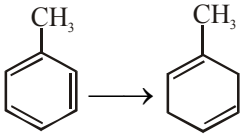
EXERCISE # O-II

1. **Column-I (Conversion)** | **Column-II (Required Reagent)**

(A) $H_3C–C\equiv C–CH_3 \longrightarrow$  (P) H_2 , Pd-$BaSO_4$

(B) $H_3C–C\equiv C–CH_3 \longrightarrow$  (Q) Li , Liq.NH_3

(C) $H_3C–CH=CH–CH_3 \longrightarrow H_3C–CH_2–CH_2–CH_3$ (R) N_2H_4 / H_2O_2 (1 eq.)

(D)  (S) B_2H_6 , CH_3COOH

RD0016

2. $R–\overset{\overset{O}{\|}}{C}–R \xrightarrow{?} R–CH_2–R$

Identify numbers of reagent that can be used for above conversion.

(a) Zn–Hg / HCl (b) $LiAlH_4$ (c) N_2H_4 / $\overset{\ominus}{O}H$ (d) $\begin{matrix}CH_2–SH\\|\\CH_2–SH\end{matrix}$, H_2 / Ni

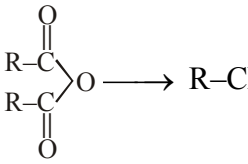
RD0017

3. **Column-I (Conversion)** | **Column-II (Required Reagent)**

(A) $–\overset{\overset{O}{\|}}{C}–OH \longrightarrow –CH_2OH$ (P) $LiAlH_4$

(B) $–\overset{\overset{O}{\|}}{C}–Cl \longrightarrow –CH_2OH$ (Q) $NaBH_4$

(C) $–\overset{\overset{O}{\|}}{C}–OR' \longrightarrow –CH_2OH$ (R) B_2H_6 / THF

(D)  $\longrightarrow R–CH_2OH$ (S) H_2 / Catalyst, Δ

RD0018

4. How many alkene on catalytic reduction gives following product.

(i) (A) $\xrightarrow{H_2/Pt}$ n-butane (ii) (B) $\xrightarrow{H_2/Pt}$ Iso-pentane

(iii) (C) $\xrightarrow{H_2/Pt}$ Neo-pentane (iv) (D) $\xrightarrow{H_2/Pt}$ Cyclopentane

(v) (E) $\xrightarrow[Pt]{H_2}$

RD0019

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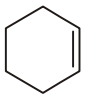
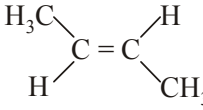
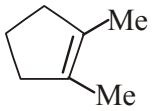
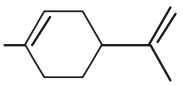
5. Give the expected major product for each reaction, including stereochemistry where applicable.

(a) $CH_3–CH_2–CH=CH_2 \xrightarrow[Pt]{H_2} P_1$ **RD0020**

(b)  $\xrightarrow[Pt]{D_2} P_2$ **RD0021**

(c)  $\xrightarrow[Ni]{D_2} P_3$ **RD0022**

(d)  $\xrightarrow{Ni/H_2} P_4$ **RD0023**

(e)  $\xrightarrow[\text{excess}]{H_2/Pt} P_5$; $\xrightarrow[\text{1 eq.}]{H_2/Pt} P_6$ **RD0024**

6. **(i)** $CH_2=CH–CH_2–CH=O \xrightarrow[\text{excess}]{H_2/Pt} P_1$ **RD0025**

(ii) $CH_2=CH–CH_2–C\equiv N \xrightarrow[\text{excess}]{H_2/Pt} P_2$ **RD0026**

7. **(a) Identify the product ?**

(i) $\xleftarrow{NaBH_4}$ Me–CHO $\xrightarrow[-78°C]{LiAlH_4 \text{ / } DIBAL\text{-}H}$ **RD0027**

(ii) $\xleftarrow{NaBH_4}$ Me_2CO $\xrightarrow{LiAlH_4 \text{ / } DIBAL\text{-}H}$ **RD0028**

(iii) $\xleftarrow{NaBH_4}$ Me–COCl $\xrightarrow{LiAlH_4 \text{ / } DIBAL\text{-}H}$ **RD0029**

(iv) $\xleftarrow{NaBH_4}$ Me–COOEt $\xrightarrow{LiAlH_4 \text{ / } DIBAL\text{-}H}$ **RD0030**

(b) Identify the product ?

(v) $\xleftarrow{NaBH_4}$ Me–COOH $\xrightarrow{LiAlH_4}$ **RD0031**

(vi) $\xleftarrow{NaBH_4}$ Me–COOMe $\xrightarrow{LiAlH_4}$ **RD0031**

(vii) $\xleftarrow{NaBH_4}$ $Me–CONH_2$ $\xrightarrow{LiAlH_4}$ **RD0031**

(viii) $\xleftarrow{NaBH_4}$ Me–CONH–Me $\xrightarrow{LiAlH_4}$ **RD0032**

(ix) $\xleftarrow{NaBH_4}$ $Me–CONMe_2$ $\xrightarrow{LiAlH_4}$ **RD0032**

(x) $\xleftarrow{NaBH_4}$ $CH_3–CH=CH_2$ $\xrightarrow{LiAlH_4}$ **RD0032**

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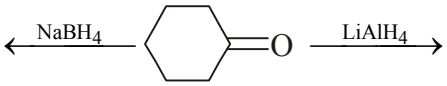
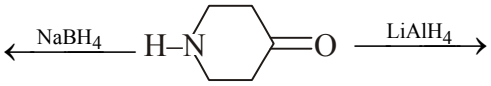
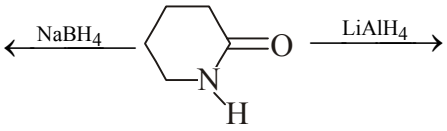
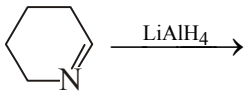
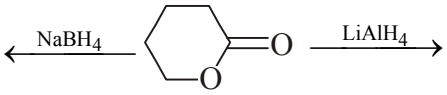
8. Give product in following reactions.

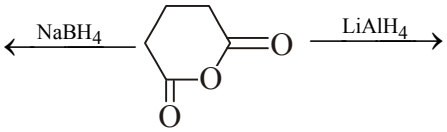
(i)  **RD0033**

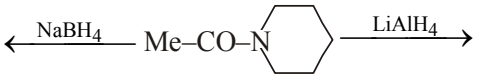
(ii)  **RD0034**

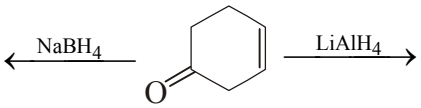
(iii)  **RD0033**

(iv)  **RD0034**

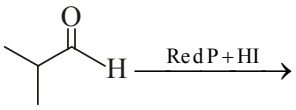
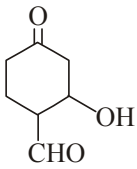
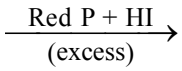
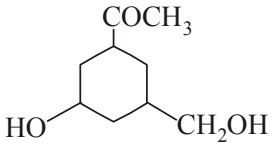
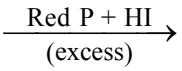
(v)  **RD0033**

(vi)  **RD0034**

(vii)  **RD0033**

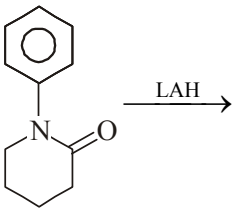
(viii)  **RD0034**

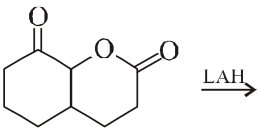
9. Give product in following reactions.

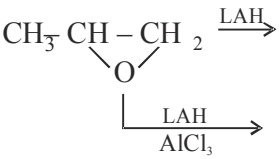
(a)  (b)   (c)  

RD0035

10. Give product in following reactions.

(i)  **RD0036**

(ii)  **RD0037**

(iii)  **RD0038**

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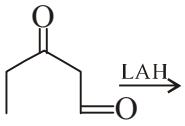
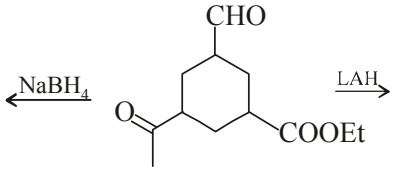
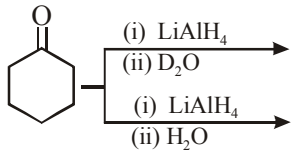
(iv) 

RD0039

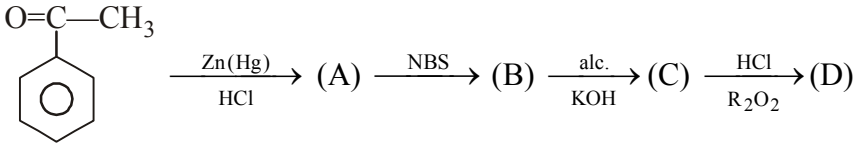
11. Give product in following reactions.

(i) 

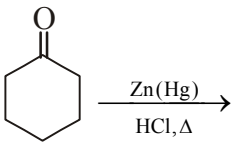
RD0040

(ii) 

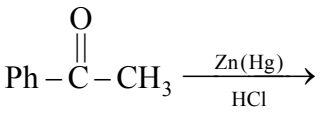
RD0041

12. (a) 

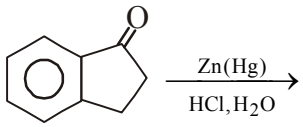
RD0042

13. (a) 

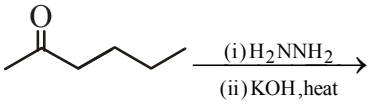
RD0043

(b) 

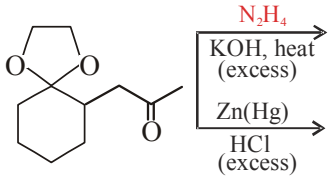
RD0043

(c) 

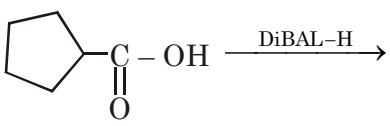
RD0043

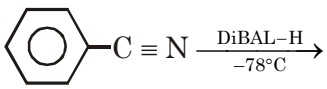
(d) 

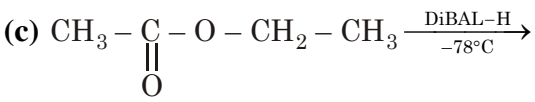
RD0044

(e) 

RD0045

14. (a) 

(b) 

(c) 

RD0046

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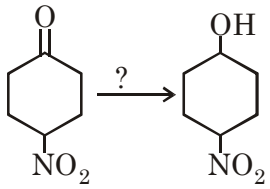
15. 

above conversion can be achieved by

(A) $LiAlH_4$ (B) H_2 / Ni, Δ (C) $NaBH_4$ (D) All

RD0047

node06\B080-BA\Kota\JEE(Advanced)\Leader\Che\SheetReduction\Eng.p65

EXERCISE # (MAIN & ADVANCE)

1. Hydrogenation of benzoyl chloride in the presence of Pd and $BaSO_4$ gives : **[IIT 1992]**

(A) Benzyl alcohol (B) Benzaldehyde (C) Benzoic acid (D) Phenol

RD0048

2. Draw the stereochemical structure of the product in the following reactions. **[IIT 1994]**

$$R–C\equiv C–R \xrightarrow[\text{Lindlar catalyst}]{H_2}$$

RD0049

3. Under Wolff Kishner reduction conditions, the conversions which may be brought about is?

(A) Benzaldehyde into Benzyl alcohol

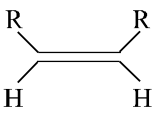
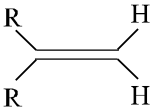
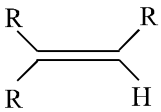
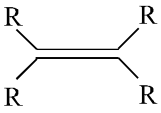
(B) Cyclohexanol into Cyclohexane

(C) Cyclohexanone into Cyclohexanol

(D) Benzophenone into Diphenylmethane **[IIT 1995]**

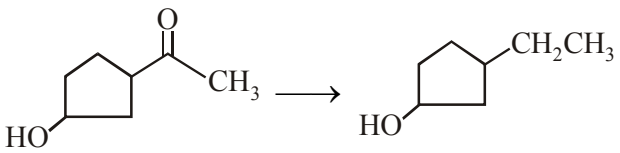
RD0050

4. Which one of the following alkenes will react fastest with H_2 under catalytic hydrogenation condition **[IIT 2000]**

(A)  (B)  (C)  (D) 

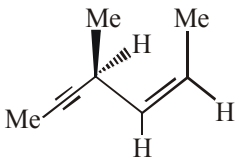
RD0051

5. The appropriate reagent for the following transformation: **[IIT-2000]**



(A) Zn(Hg), HCl (B) NH_2NH_2, OH^- (C) H_2/Ni (D) $NaBH_4$

RD0052

6. 

Hydrogenation of the above compound in the presence of poisoned paladium catalyst gives-

(A) An optically active compound (B) An optically inactive compound **[IIT-2001]**

(C) A racemic mixture (D) A diastereomeric mixture

RD0053

7. When $CH_2=CH–COOH$ is reduced with $LiAlH_4$, the compound obtained will be -**[AIEEE-2003]**

(A) $CH_3–CH_2–CH_2OH$ (B) $CH_3–CH_2–CHO$

(C) $CH_3–CH_2–COOH$ (D) $CH_2=CH–CH_2OH$

RD0054

8. 2–hexyne can be converted into trans–2–hexene by the action of : **[IIT-2004]**

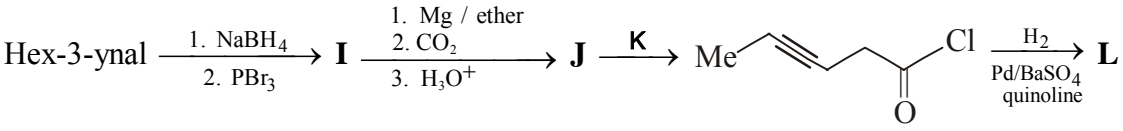
(A) H_2–Pd-$BaSO_4$ (B) Li in liq. NH_3 (C) H_2–PtO_2 (D) $NaBH_4$

RD0055

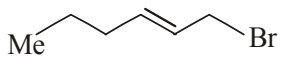
node06\B080-BA\Kota\JEE(Advanced)\Leader\Che\Sheet\Reduction\Eng.p65

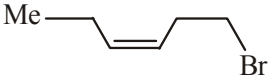
Paragraph for Question No. 09 to 11

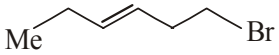
In the following reaction sequence, products **I**, **J** and **L** are formed. **K** represents a reagent.

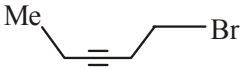


9. The structure of the product **I** is **[JEE-2008]**

(A) 

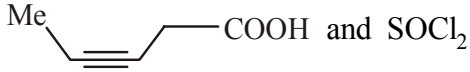
(B) 

(C) 

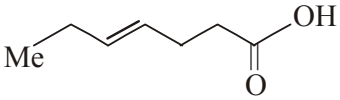
(D) 

RD0056

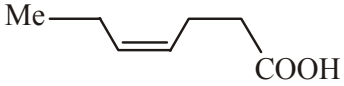
10. The structures of compounds **J** and **K**, respectively, are **[JEE-2008]**

(A) 

and $SOCl_2$

(B) 

and SO_2Cl_2

(C) 

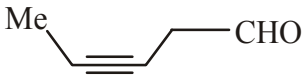
and $SOCl_2$

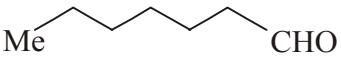
(D)

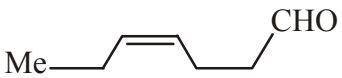
and CH_3SO_2Cl

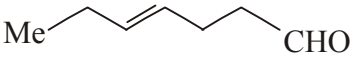
RD0056

11. The structure of product **L** is : **[JEE-2008]**

(A) 

(B) 

(C) 

(D) 

RD0056

12. Consider all possible isomeric ketones including stereoisomers of MW = 100, All these isomers are independently reacted with $NaBH_4$ (**NOTE :** stereoisomers are also reacted separately). The total number of ketones that give a racemic product(s) is/are. **[JEE-2014]**

RD0057

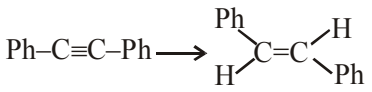
13. In the reaction, **[JEE-2014]**

$CH_3COOH \xrightarrow{LiAlH_4} A \xrightarrow{PCl_5} B \xrightarrow{AlC.\ KOH} C$, Final product C is.

(A) Ethylene (B) Acetyl chloride (C) Acetaldehyde (D) Acetylene

RD0058

14. The reagent needed for converting is : **[JEE-2014]**



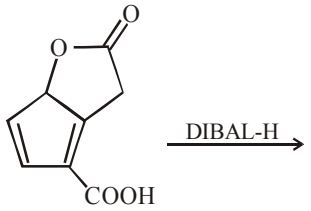
(A) H_2 / Lindlar Cat. (B) Cat. hydrogenation

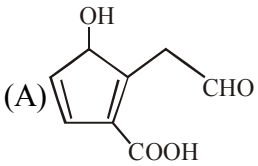
(C) $LiAlH_4$ (D) Li / NH_3

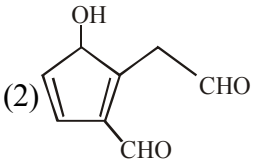
RD0059

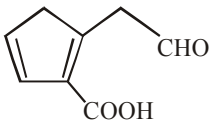
node06\B080-BA\Kota\JEE(Advanced)\Leader\Che\Sheet\Reduction\Eng.p65

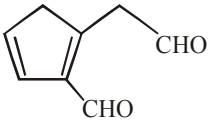
15. The major product obtained in the following reaction is : **[JEE MAIN-2017]**



(A) 

(2) 

(3) 

(4) 

RD0060

16. Glucose on prolonged heating with HI gives : **[Jee Main - 2018]**

(1) 1–Hexene (2) Hexanoic acid (3) 6-iodohexanal (4) n-Hexane

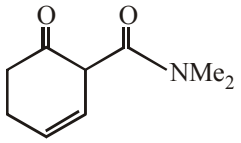
RD0061

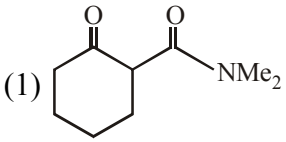
17. The *trans*-alkenes are formed by the reduction of alkynes with : **[Jee Main - 2018]**

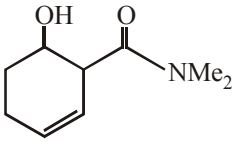
(1) $NaBH_4$ (2) $Na/liq.NH_3$ (3) Sn–HCl (4) H_2–Pd/C, $BaSO_4$

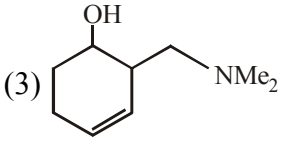
RD0062

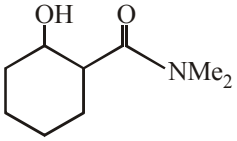
18. The main reduction product of the following compound with $NaBH_4$ in methanol is :- **[Jee Main - Onl_line Morning 2018]**



(1) 

(2) 

(3) 

(4) 

RD0063

19. The major product of following reaction is : **[JEE-MAIN-On-line-(Jan)-2019]**

$R-C\equiv N \xrightarrow[(2)H_2O]{(1)AlH(i\text{-}Bu_2)} ?$

(1) RCHO (2) RCOOH (3) RCH_2NH_2 (4) $RCONH_2$

RD0064

20. Wilkinson catalyst is : **[JEE-MAIN-On-line-(Jan)-2019]**

(1) $[(Ph_3P)_3RhCl]$ (Et = C_2H_5) (2) $[Et_3P)_3IrCl]$

(3) $[Et_3P)_3RhCl]$ (4) $[Ph_3P)_3IrCl]$

RD0065

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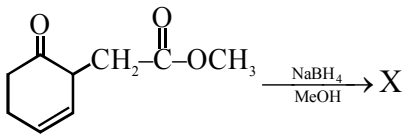
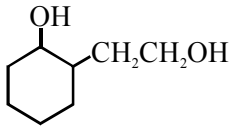
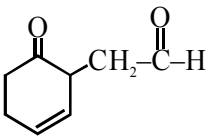
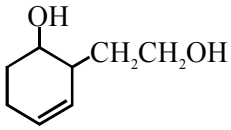
21. The major product 'X' formed in the following reaction is :

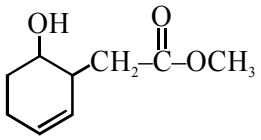
[JEE-MAIN-On-line-(Jan)-2019]



(1) 

(2) 

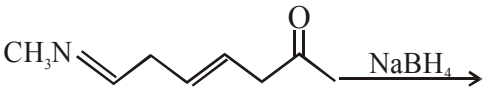
(3) 

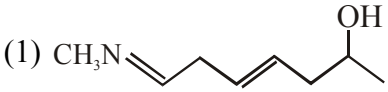
(4) 

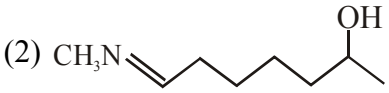
RD0066

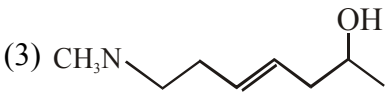
22. The major product of the following recation is:

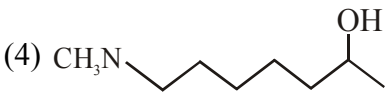
[JEE-MAIN-On-line-(Jan)-2019]



(1) 

(2) 

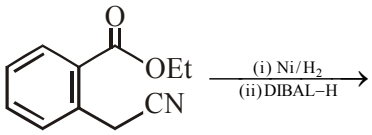
(3) 

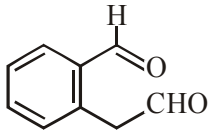
(4) 

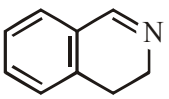
RD0067

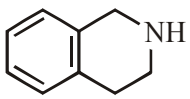
23. The major product of the following reaction is:

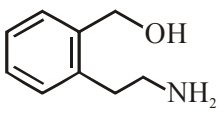
[JEE-MAIN-On-line-(Jan)-2019]



(1) 

(2) 

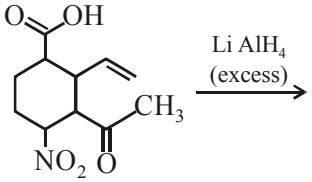
(3) 

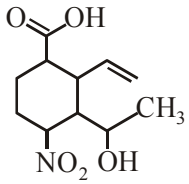
(4) 

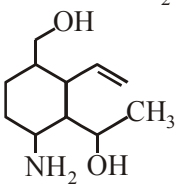
RD0068

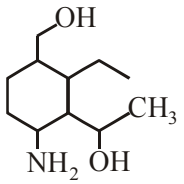
24. The major product obtained in the following reaction is :-

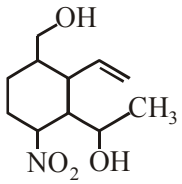
[JEE-MAIN-On-line-(Jan)-2019]



(1) 

(2) 

(3) 

(4) 

RD0069

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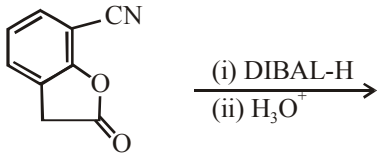
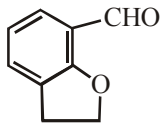
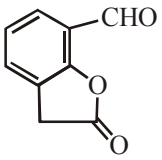
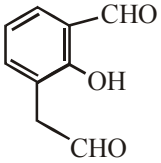
25. The major product of the following reaction is:

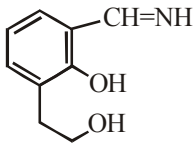
[JEE-MAIN-On-line-(Jan)-2019]



(1) 

(2) 

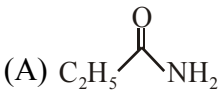
(3) 

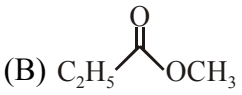
(4) 

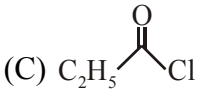
RD0070

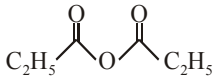
26. The increasing order of the reactivity of the following with $LiAlH_4$ is :

[JEE-MAIN-On-line-(Jan)-2019]

(A) 

(B) 

(C) 

(D) 

(1) (A) < (B) < (D) < (C)

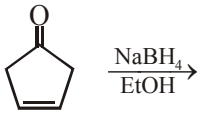
(2) (A) < (B) < (C) < (D)

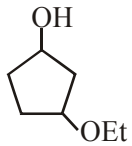
(3) (B) < (A) < (D) < (C)

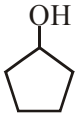
(4) (B) < (A) < (C) < (D)

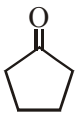
RD0071

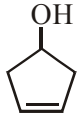
27. The major product of the following reaction is: **[JEE-MAIN-On-line-(Jan)-2019]**



(1) 

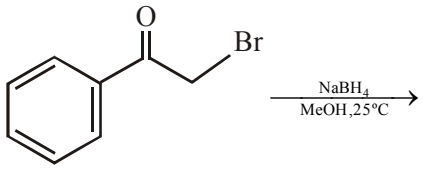
(2) 

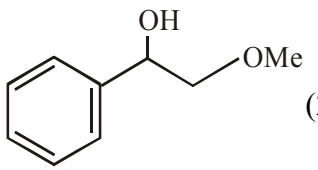
(3) 

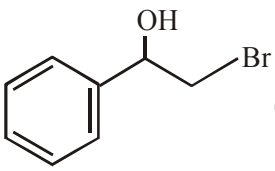
(4) 

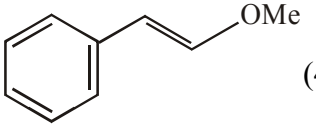
RD0072

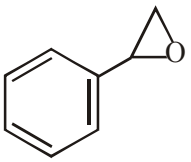
28. The major product of the following reaction is: **[JEE-MAIN-On-line-(April)-2019]**



(1) 

(2) 

(3) 

(4) 

RD0073

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29. The major product of the following reaction is : **[JEE-MAIN-On-line-(April)-2019]**

$CH_3CH = CHCO_2CH_3 \xrightarrow{LiAlH_4}$

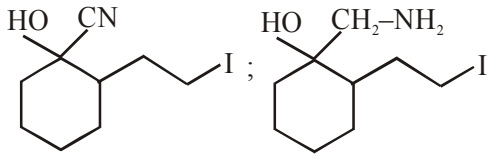
(1) $CH_3CH_2CH_2CHO$ (2) $CH_3CH = CHCH_2OH$

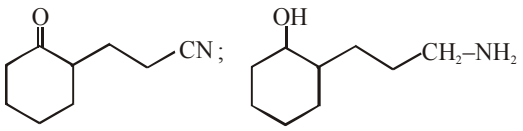
(3) $CH_3CH_2CH_2CO_2CH_3$ (4) $CH_3CH_2CH_2CH_2OH$

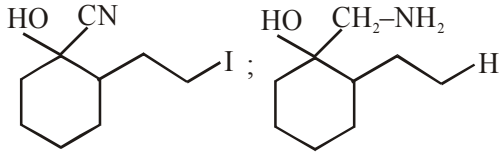
RD0074

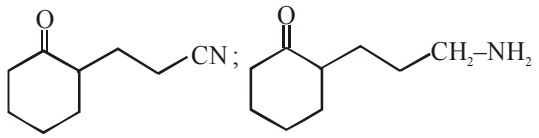
30. The major products A and B for the following reactions are, respectively:

[JEE-MAIN-On-line-(April)-2019]

(1) 

(2) 

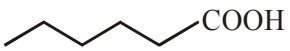
(3) 

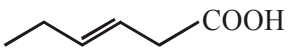
(4) 

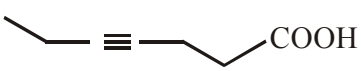
RD0075

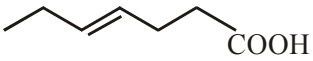
31. What is the product of following reaction ? **[JEE-MAIN-On-line-(Jan)-2020]**

Hex-3-ynal $\xrightarrow[\text{(ii) } PBr_3 \\ \text{(iii) Mg/ether} \\ \text{(iv) } CO_2/H_3O^+]{\text{(i) } NaBH_4}$?

(1) 

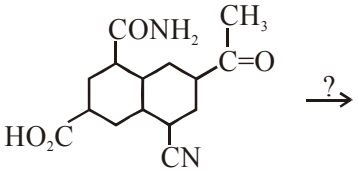
(2) 

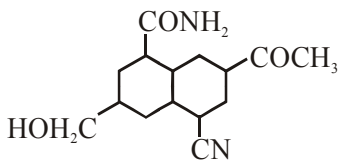
(3) 

(4) 

RD0076

32. The most suitable reagent for the given conversion is : **[JEE-MAIN-On-line-(Jan)-2020]**





(1) $LiAlH_4$ (2) $NaBH_4$ (3) H_2/Pd (4) B_2H_6

RD0077

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ANSWER KEY

EXERCISE # O-I

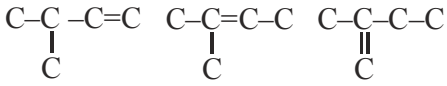
1.	**Ans. (D)**	**2.**	**Ans. (B)**	**3.**	**Ans. (C)**	**4.**	**Ans. (C)**	**5.**	**Ans. (A)**
6.	**Ans. (C)**	**7.**	**Ans. (B)**	**8.**	**Ans. (B)**	**9.**	**Ans. (C)**	**10.**	**Ans. (B)**
11.	**Ans. (C)**	**12.**	**Ans. (C)**	**13.**	**Ans. (D)**	**14.**	**Ans. (D)**	**15.**	**Ans. (B)**

EXERCISE # O-II

1. **Ans. (A)→P, R, S; (B)→Q; (C)→R, S; (D)→Q** **2.** **Ans. (3)**

3. **Ans. (A)→P, R, S; (B)→P, Q, S; (C)→P, R, S; (D)→P, R, S**

4. **Ans.**

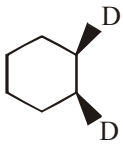
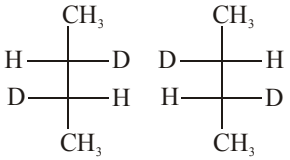
(i) Cis & trans 2-butene & 1-butene ; (ii) 

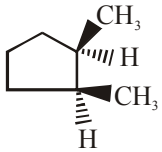
(iii) Zero (Neo-pentane can not be prepared by catalytic hydrogenation of alkene) ; (iv) One

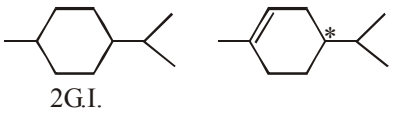
(v) Including optical = 4 , Excluding optical = 3.

5. **Ans.**

(a)

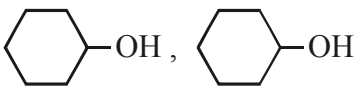
(b)  (c) 

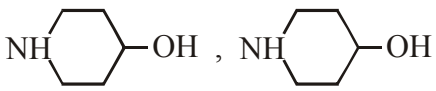
(d) 

(e) 
2G.I.

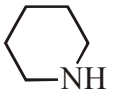
6. **Ans.** (i) $P_1 = CH_3–CH_2–CH_2–CH_2–OH$ (ii) $P_2 = CH_3–CH_2–CH_2–CH_2–NH_2$

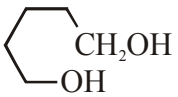
8. **Ans.**

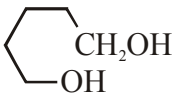
(i) 

(ii) 

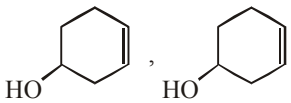
(iii) No reaction,

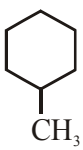
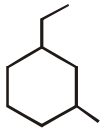
(iv) 

(v) No reaction, 

(vi) No reaction, 

(vii) No reaction,

(viii) 

9. **Ans.** (a) (b)  (c) 

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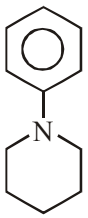
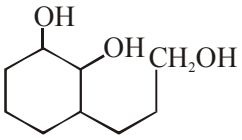
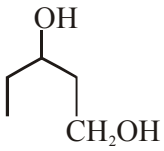
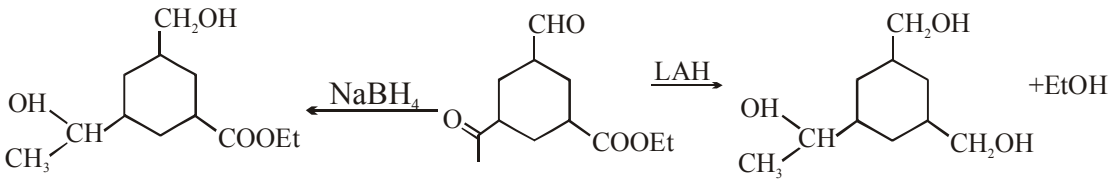
10. Ans.

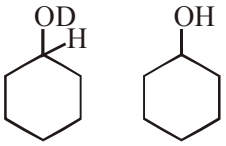
(i) 

(ii) 

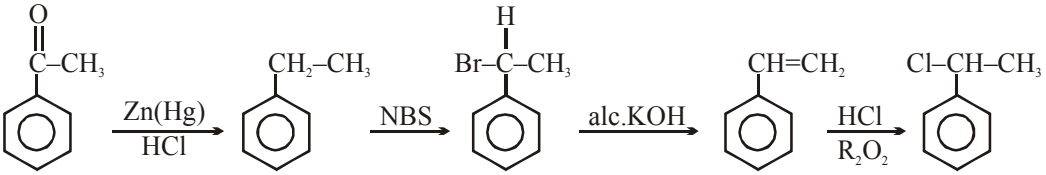
(iii) $CH_3–\underset{\underset{OH}{|}}{CH}–CH_3$, $CH_3–CH_2–CH_2OH$

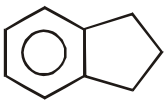
(iv) 

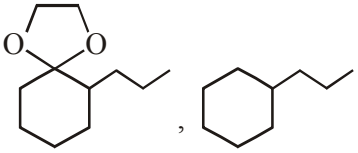
11. Ans. (i) 

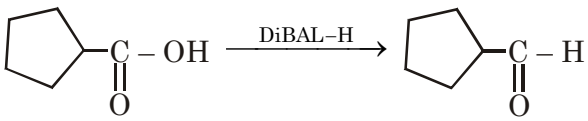
(ii) 

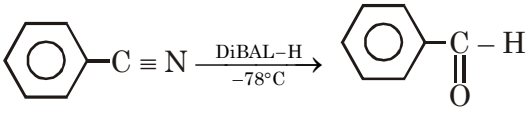
12. Ans.

(a) 

13. (a) (b) $Ph–CH_2–CH_3$ (c)  (d)

(e) 

14. (a) 

(b)  **(c)** $CH_3 - CHO$

15. Ans.(C)

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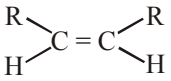
EXERCISE # (MAIN & ADVANCE)

1. **Ans. (B)** **2.** **Ans.**  **3.** **Ans. (D)** **4.** **Ans. (A)**

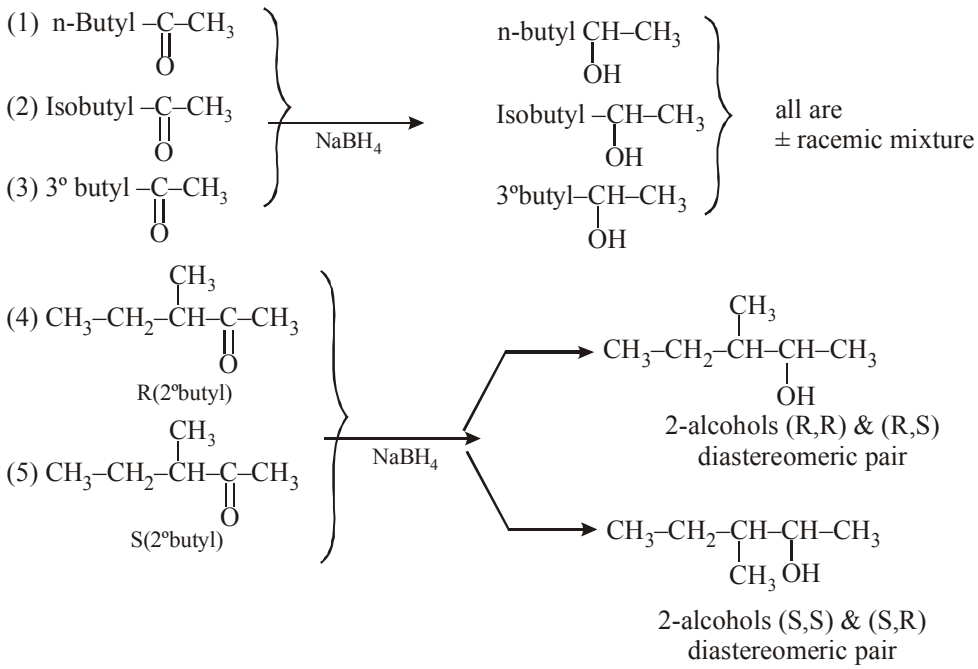
5. **Ans. (B)** **6.** **Ans. (B)** **7.** **Ans. (D)** **8.** **Ans. (B)**

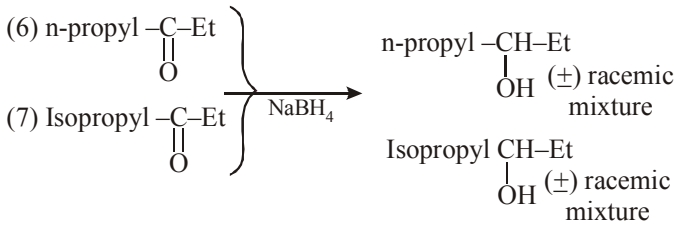
9. **Ans. (D)** **10.** **Ans. (A)** **11.** **Ans. (C)**

12. **Ans. (5)**

M. wt 100 of ketone

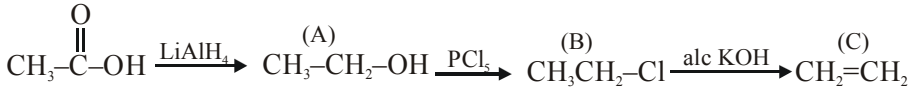
So m. formula = $C_6H_{12}O$





(1 ; 2 ; 3 ; 6 ; 7)

13. **Ans.** (A)



Reduction of CH_3COOH will produce $CH_3–CH_2–OH$(A)

Now reaction of $CH_3–CH_2–OH$(A) with PCl_5 will produce $CH_3–CH_2–Cl$(B).

Now alcoholic KOH with Et–Cl will produce $CH_2=CH_2$(C) Ethylene by E_2 elemination.

Thus Ans. is (1) Ethylene.

14. **Ans. (D)**

15. **Ans. (1)**

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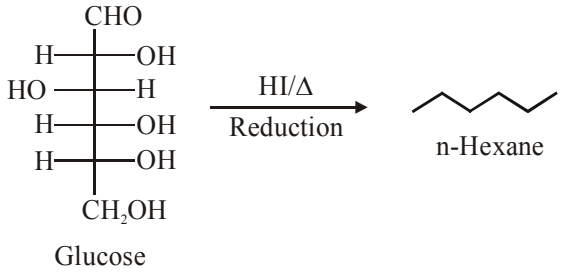
16. Ans. (4)

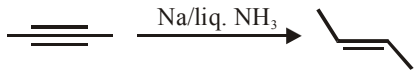
Sol.



Glucose

17. Ans. (2)

Sol.



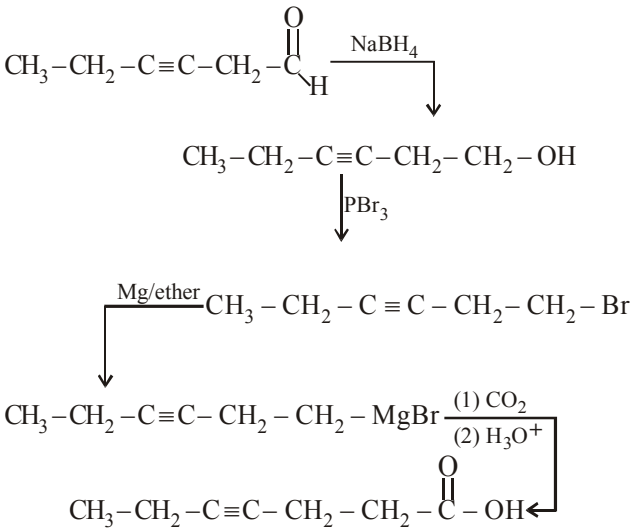
Birch reduction is anti addition. So trans alkene will be produced.

18.	**Ans. (4)**	**19.**	**Ans. (1)**	**20.**	**Ans. (1)**	**21.**	**Ans. (4)**
22.	**Ans.(3)**	**23.**	**Ans. (2)**	**24.**	**Ans. (2)**	**25.**	**Ans. (3)**
26.	**Ans. (1)**	**27.**	**Ans. (4)**	**28.**	**Ans. (4)**	**29.**	**Ans. (2)**

30. Ans. (2)

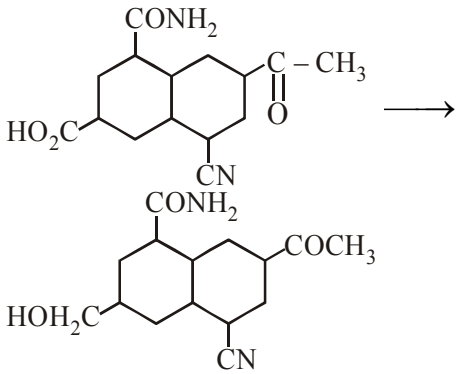
31. Ans. (3)

Sol.



32. Ans. (4)

Sol.



Most suitable reagent for given conversion is B_2H_6 (electrophilic reducing agent)

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