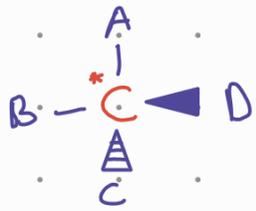


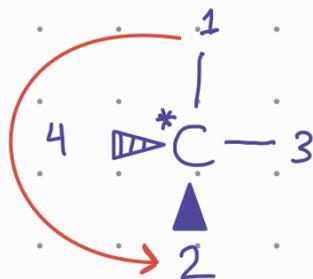
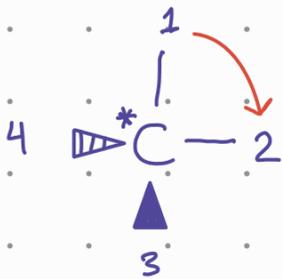
# Stereoisomers

# Chapter 5



- \*C → Chiral carbon
- \*C → Sterogenic carbon
- \*C → Sterocenter
- \*C → Asymmetric carbon

tetra. hedral  
 $sp^3$   
 different groups or atoms



Clockwise  
 give the chiral  
 carbon R configuration

Counter Clockwise  
 give the chiral  
 carbon S configuration

## "Cahn-Ingold-Prelog priority rule" CIP

$I > Br > Cl > S > F > O > N > C > H$

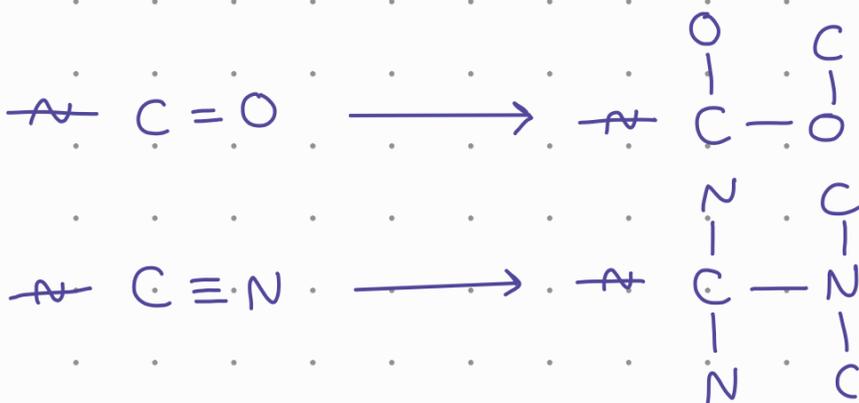
← Atomic number ↑ Priority ↑

النزول على  
 اولوية بالكاربون

Dash - wedge  
 رقم ع (اقل عدد ذري)

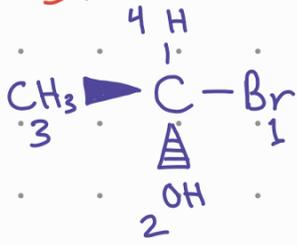
\* اذا صار في تشابه ننظر للذرة الأكثر اولوية المتصلة بها

\* يمكن العبور من فوق الرقم ٤ ولا يمكن من فوق الرقم ٣

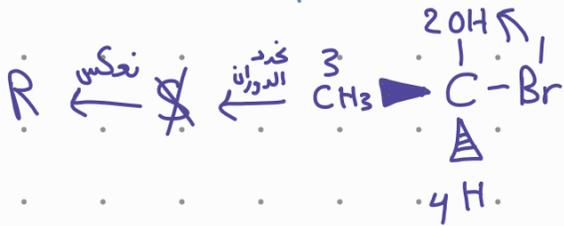


Tertbutyl > vinyl > isopropyl  
 + >   
 ← Priority ↑

\* إذا كانت المجموعة ع — plane

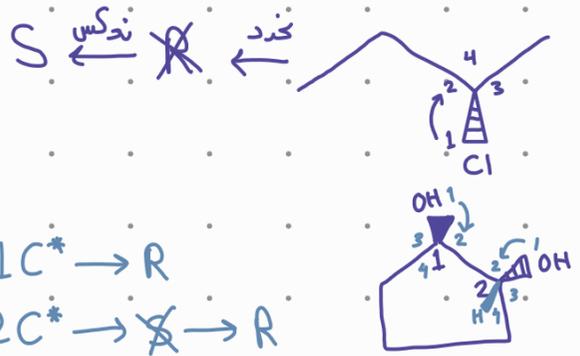


① بدل مجموعة ع مع ال Dash  
 ② حدد الدوران ثم انعكسه



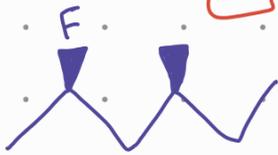
\* إذا كانت المجموعة رقم ع ◀ solid

← حدد الدوران و انعكس الجواب الأخير

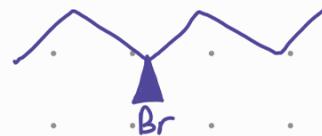


1C\* → R  
 2C\* → ~~S~~ → R

\* يدخل الدوران في تسمية المركبات



(2R,4S)-2-fluoro-4-methyl hexane



S-3-bromohexane.

### Chirality of compounds

#### Chiral compound

1. One chiral carbon
2. two or more chiral carbon

with no plane of symmetry



#### Achiral compound

1. No chiral carbon
2. two or more chiral carbon

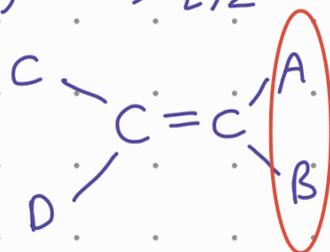
with plane of symmetry



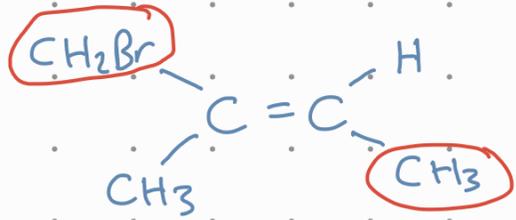
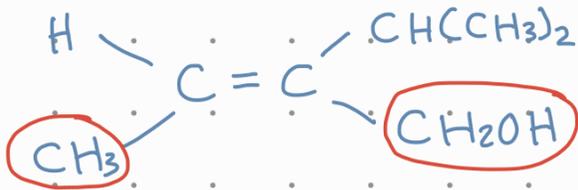
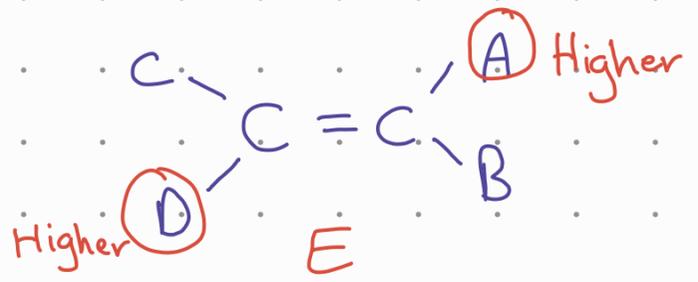
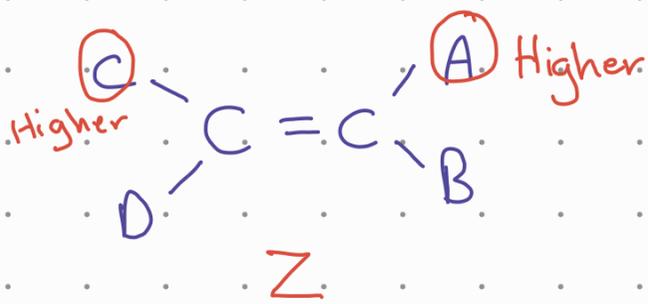
\* Ambiguous Alkenes (no clear cis/trans) → E/Z

\* شرط المجموعات على نفس الكربونة مختلفة

نكرر العملية  
 للطرف الآخر



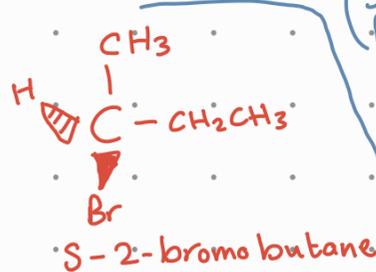
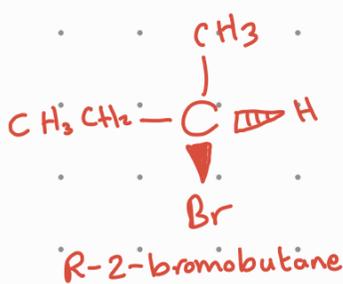
نقارن بينهم اعتماداً على (CIP) ونحدد ال Higher من هنا الطرف



\* يمكن تسمية الـ Cis بـ (Z) والـ Trans بـ (E) ولا يمكن العكس  
 يعني Z بـ Cis و E بـ Trans

\* تدخل E/Z التسمية ونضيف احكام قبل التسم

\* Enantiomers  $\rightarrow$  a pair of molecule that are related to each other as non superimposable mirror images  
 غير متطابق



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

two chiral compound differ in rotation have same physical properties [enantiomers]

\* Chiral compound  $\rightarrow$  optically active can rotate plane polarizer light (PPL)  
 rotation for right  $\Rightarrow$  Dextratory (D)  $\xrightarrow{\text{its symbol}}$  (+)  
 rotation for left  $\Rightarrow$  Levodextratory (L)  $\xrightarrow{\text{its symbol}}$  (-)  
 called

\* Achiral compound  $\rightarrow$  optically inactive

\* لا توجد علاقة بين اتجاه دوران الـ chiral carbon واتجاه انحراف الضوء D, L

$[\alpha]_D^T = \frac{\text{observed rotation } \alpha}{\text{Concentration} * \text{Tube length}}$   
 specific rotation  $\rightarrow$  physical property  
 g/ml  $\leftarrow$  dm  
 dm = 10 cm = 100 mm

T = 20°C  
 $\lambda = 589.3 \text{ nm}$   
 lamp: sodium vapor

في الحساب ننسبه بنقط موجب والسالب

if we have two compounds their rotation are  $\begin{pmatrix} S & R \\ R & S \end{pmatrix}$  without plane of symmetry they are enantiomers but if they have plane of symmetry they will be identical compound

Enantiomers differ from each other by  $\begin{cases} \text{direction of rotation in polarimeter (not magnitude)} \\ \text{Interaction with other chiral molecules} \end{cases}$

Resolution  $\rightarrow$  Racemic mixture enantiomers  $\rightarrow$   $\begin{matrix} 50\% & 50\% \\ (R:S) & / & (L:D) \end{matrix}$

(Enantiomers تقوم هذه العملية على استخراج مركب كيرال لعزل ال)

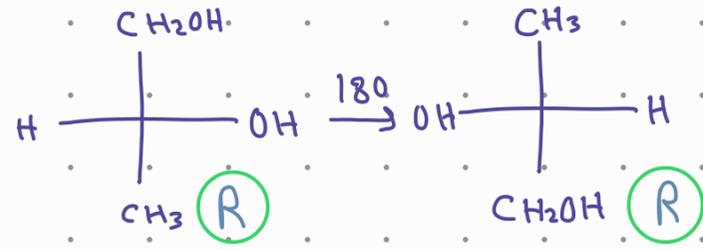
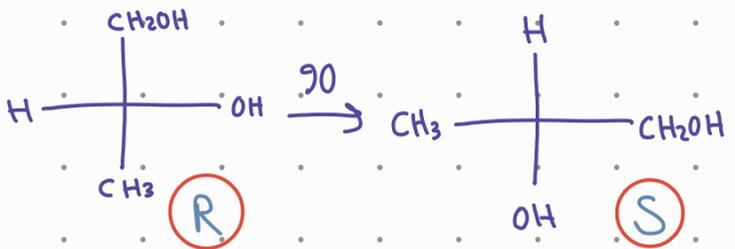
Racemic mixture  $\rightarrow$  pair of enantiomers with equal amount (R:S) / (L:D) it has **NO** optical activity

\* Fisher Projection Formula (cross formula)

- best way to represent multiple chiral centers at the intersection of horizontal and vertical lines (solid  $\blacktriangleright$ ) (dash  $\blacktriangleleft$ )

\* اذا كانت المجموعة 4 على الخط الأفقي  $\leftarrow$  نكس الدوران  $\leftarrow$

Rotation of Fisher projection



\* Diastereomers  $\rightarrow$  a relationship between two compounds that have more than one chiral carbon and have opposite configuration at some chirality centers but the same at others. Enantiomers have opposite configuration at all chiral centers

Diastereomers  $\rightarrow$  **NOT mirror images**  
 have different physical properties (B.P, m.p) and magnitude and direction of rotation (PPL) because of that we can easily separate them  
 a mixture of them (50% : 50%) is optically active

\* Mesocompound  $\rightarrow$  compound  $\begin{matrix} \text{1} \\ \text{2} \end{matrix}$  contain 2 chiral carbon and a  $\begin{matrix} \text{1} \\ \text{2} \end{matrix}$  plane of symmetry. meso compounds are Achiral compounds so they are optically inactive.  
 \* كل مركب meso له achiral والعكس غير صحيح



# Number of stereoisomers

Rotation

E/Z

without plane of symmetry

$$= 2^n$$

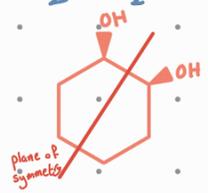
n → number of chiral carbon



$$2^1 = 2$$

with plane of symmetry

$$= 2^n - 1$$



SS, SR, RS, RR

identical

$$2^2 - 1 = 3$$

double bond with different groups on each carbon

$$= 2^d$$

d → number of double bond which can make E/Z



$$2^1 = 2$$

trans/cis داخل الحلقة لا تكون لئلا لا يحسبها بالقانون \*

مع الانتباه لوجود 6 plane ال

TOTAL number of stereoisomers =  $2^n * 2^d$

optically active stereoisomers → RR/SS

optically inactive stereoisomers → RS/SR [Meso]

## \* Alkene stereochemical reaction \*

Addition to Alkene with no Chiral carbon

→ Enantiomers 50:50  
Racemic mixture

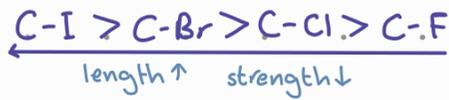
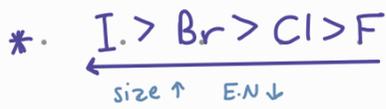
optically inactive

Addition to Alkene with chiral carbon

→ Diastereomers  
unequal amount

optically active

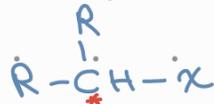
# Organic Halogen compounds



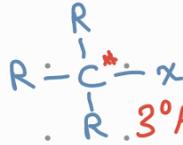
## \* Classification of alkyl halides



1° Alkyl halide



2° Alkyl halide



3° Alkyl halide



methyl Alkyl halide



1. vinyl halide when X binds to  $sp^2$  carbon



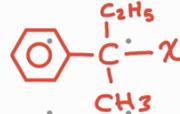
2° vinyl halide

2. Aryl halide when X binds directly to benzene



Aryl halide

3. Benzylic halide when X binds to carbon binds to benzene



3° Benzylic halide

4. Allylic halide when X binds to  $sp^3$  carbon and this carbon binds to  $sp^2$  carbon



2° Allylic halide

## \* Nucleophile: electron rich compound

having (P, O, N, S, C)

one of these atoms

neutral weak

negative strong



higher nucleophilicity

Oxygen nucleophiles  
 $\bar{O}H$  Hydroxide ion  
 $ROH$  Alcohol  
 $RO^-$  Alkoxide ion  
 $R-C(=O)O^-$  Carboxylate

Nitrogen nucleophiles  
 $NH_3$  Ammonia  
 $NH_2^-$  Amide  
 $RNH_2$  Amine  
 $N_3^-$  Azide

Carbon nucleophiles  
 $\bar{C}\equiv N$  Cyanide  
 Sulfur nucleophiles  
 $SH^-$  Sulfhydryl ion  
 $H_2S$  Hydrogen sulfide  
 $RS^-$  Thiolate ion  
 $RSH$  Thiol

\* we use polar solvent to make Alkyl halide reaction faster

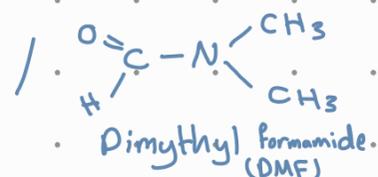
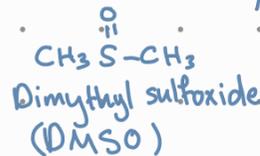
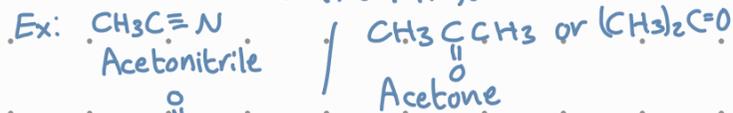
### ① Polar Protic Solvent

have H binding to O or N



### ② Polar Aprotic solvent

doesn't have H-O / H-N



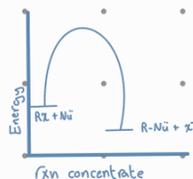
## \* Nucleophile substitution reaction



### → Nucleophile substitution 2



- one step reaction
- no intermediate
- one transition state



second order

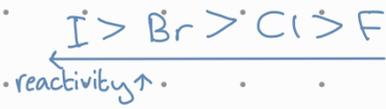
Rate =  $k [RX] [Nu^-]$

$SN_2 \rightarrow$  رقم 2 دلالة على انه يعتمد على تركيز الاثنين



\* أهم خطوة هي تكوين carbon cation لذلك كلما كان R أكثر ازدحاماً كان carbon cation المتكون أكثر استقراراً وبالتالي تزداد سرعة الـ SN1

② Nature of the leaving group → يتناسب مع SN2



③ Nature of the Nu → كلما كان الـ Nu أضعف تزداد سرعة التفاعل

④ Nature of solvent → تحتاج إلى Polar Protic solvent في SN2 مثل H2O, Ethanol, Methanol, NH3

→ الكحول والماء ممكن يكونو Nu أو Protic solvent وانا مش عايزم يعني التفاعل SN1

\* stereochemistry of SN1 reaction

[mixture inversion and retention] 50% / 50% R → R and R → S or S → S and S → R

- 1. chiral → enantiomers, racemic mixture
- 2. chiral → diastereomers

→ Primary Alkyl halides react via SN2 mechanism

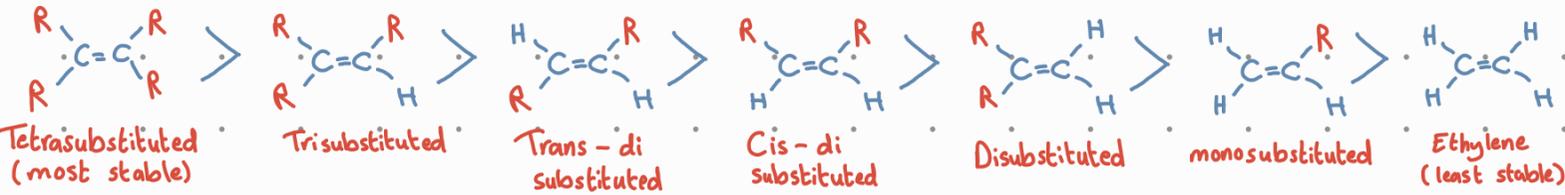
→ Tertiary Alkyl halides react via SN1 mechanism

→ Aryl, vinyl halides don't react via SN2, SN1.

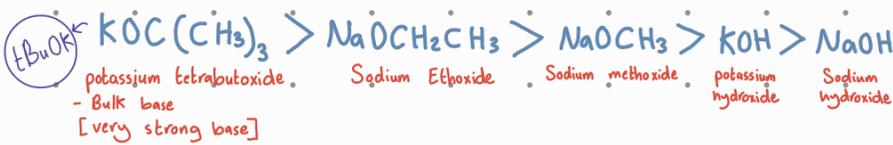
\* Elimination reaction → [dehydrohalogenation reaction] → CC(C)X + Base -> CC=C + BH + X-

product of ER is Alkene

→ stability of Alkenes



→ strength of Bases    Bases → take H from βC



\* Negative bases are strong

\* Neutral bases are weak

\* Na/K لما شويهم يقارن بغيرهم

## Elimination Reaction

① حدد الـ α Carbon

② حدد الـ β Carbons وهي الكربونات التي سنقوم بحذف H منها

③ حدد جميع التفرعات المتصلة بـ α Carbon وقارن بينها فيما اذا كانت متشابهة أو مختلفة لمعرفة عدد الاكين الذي سينتج

④ قم بحذف الهالوجين من α carbon والهيدروجين من β Carbon رقم بتكوين (=) double bond بين α C و β C

\* ينتج أكثر من الأكين واحد بنسب مختلفة عند الحذف من β Cs لذلك يوجد major و minor

لليجاد الـ major بطريقة سريعة تكون الـ double bond مع β C التي تملك أقل عدد Hs

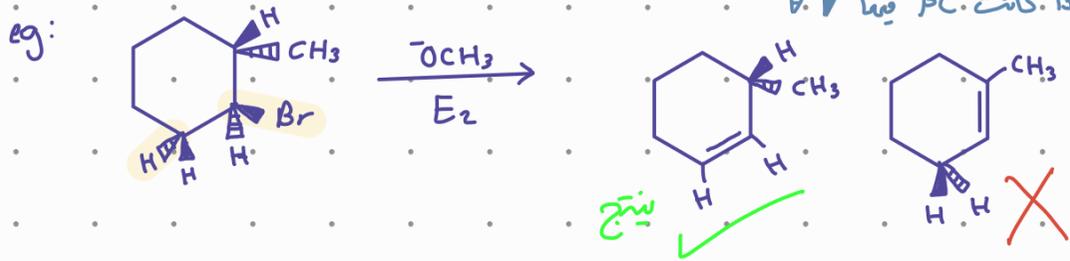
General information

	$E_2$	$E_1$
Depend on	strong base (-ve, contain oxygen) eg: $\text{OH}^-$ , $\text{OR}^-$	weak base (neutral, contain oxygen) eg: $\text{H}_2\text{O}$ , $\text{CH}_3\text{OH}$ , $\text{CH}_3\text{CH}_2\text{OH}$
1 The base	Polar Aprotic solution eg: $\text{DMSO}$ , $\text{DMF}$	Polar protic solution eg: $\text{H}_2\text{O}$ , $\text{NH}_3$ , $\text{CH}_3\text{OH}$
2 The solvent	<p>مستأن يكون كسرهما سهل <math>\rightarrow</math> أكبر LG</p> <p><math>\text{I} &gt; \text{Br} &gt; \text{Cl} &gt; \text{F}</math></p> <p><math>\leftarrow</math> reactivity</p>	
3 The leaving group	<p>نفس ترتيب ال <math>\text{SN}_1</math> [ كلما كان الألكيل أكثر تفرع يكون أكثر استقرار ]</p> <p>* متشابهين <math>E_1 / \text{SN}_1</math></p> <p> <math>3^\circ \text{Allylic} &gt; 3^\circ &gt; 2^\circ \text{Allylic} &gt; 2^\circ &gt; 1^\circ \text{Allylic} &gt; 1^\circ</math>  <math>3^\circ \text{Benzylic} &gt; 2^\circ \text{Benzylic} &gt; 1^\circ \text{Benzylic}</math> </p> <p> <math>\left[ 1^\circ \right] &gt; \text{CH}_3\text{-X methyl halide} &gt; \text{Aryl halide vinyl halide}</math> </p> <p> <math>\text{No } E_2</math> <math>\leftarrow</math> <math>\text{No } E_1</math> </p>	
4 The nature of Alkyl halide	<p> <chem>CC(C)(Br)c1ccccc1</chem> + <math>\text{KOH} \rightarrow \text{NO RXN}</math> </p> <p><math>\leftarrow</math> انتباه هذه الحالة</p>	

\* stereochemistry of  $E_2$  Reaction

halogen (X) and proton (H) must be anti-coplanar ( $\theta = 180$ ) to each other

متى نتبعها؟ - اذا كانت C-X فيها  $\nabla$   
 - اذا كانت C-H فيها  $\blacktriangledown$



\* Alkyl halide could have E and  $\text{SN}$  reactions at the same time  
 type of (RX) and (Nu or base) will determine the type of reaction

- \* strong Nu  $\rightarrow$  without oxygen, negative charge [ $\text{NH}_2$ ,  $\text{SH}$ ]
- \* strong base  $\rightarrow$  with oxygen, negative charge [ $\text{OH}^-$ ,  $\text{OR}^-$ ]
- \* weak Nu  $\rightarrow$  without oxygen, neutral [ $\text{HCN}$ ,  $\text{CH}_3\text{SH}$ ]
- \* weak base  $\rightarrow$  with oxygen, neutral [ $\text{H}_2\text{O}$ ,  $\text{CH}_3\text{OH}$ ,  $\text{CH}_3\text{CH}_2\text{OH}$ ]

← تشيخ على mechanism بترقية

وفقنا الله وإياكم