Lycée Galilée Gennevilliers

Esterification - Hydrolyse

chap.7

Jallu Laurent

Estérification - Hydrolyse

I. Hydrocarbures et fonctions oxygénées : Rappels

- ***3 Familles d'hydrocarbures***

Les Saturés ***(Planche 1)*** : Alcanes et Alcènes
Les insaturés ***(Planches 2 et 3)*** ; Alcynes

- ***L'hydratation d'Alcènes : Les Alcools***

(Planche 4)
Les trois classes d'Alcools.
La règle de Markovnikov.
Le degré 1 d'oxydation du Carbone.

- ***Oxydations ménagées d'alcools***

(Planche 5)
Aldéhydes et Cétones : degré 2 d'Oxydation du Carbone.
Acides carboxyliques : degré 3 d'oxydation du Carbone.
Oxydation selon la classe de l'alcool.
Tests communs et spécifiques des Aldéhydes et Cétones.

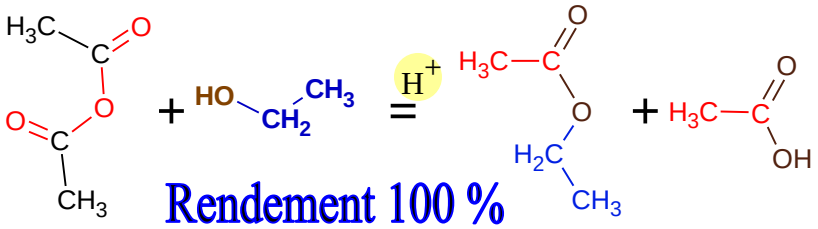
II. L'équilibre d'estérification - hydrolyse

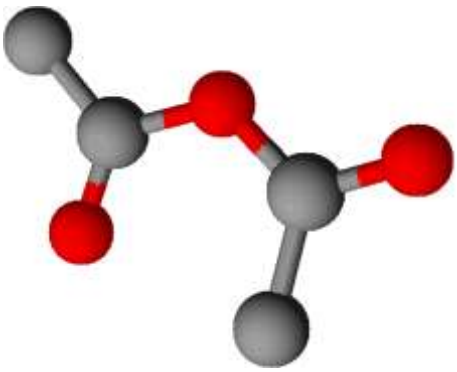
(Planche 6)

- ***Protocole : Le chauffage à reflux***
- ***Bilan réactionnel***
- ***Quotient réactionnel : Sens direct ou sens inverse, Estérification ou Hydrolyse***
- ***L'équilibre : Rendements avec les alcools primaires***

III. Contrôle de l'estérification : Les Anhydrides d'Acides

L'**Anhydride d'Acide** : Rendements et transformations, avantages, inconvénients.

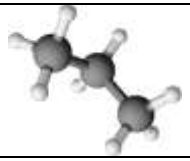
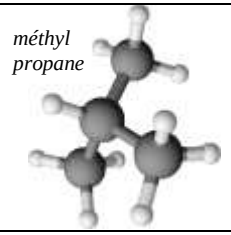
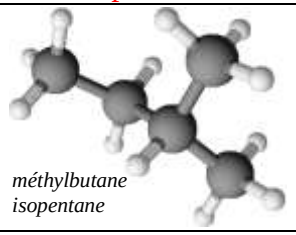
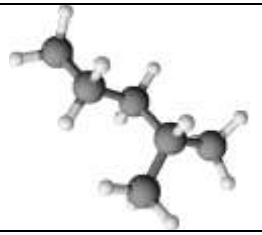
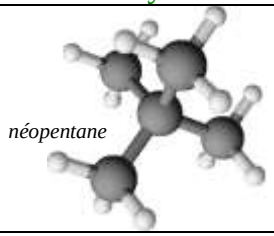
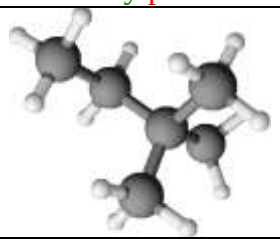
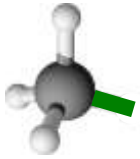
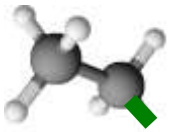
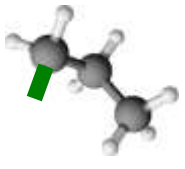
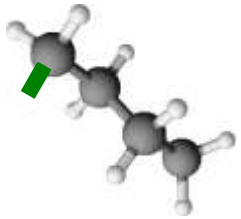
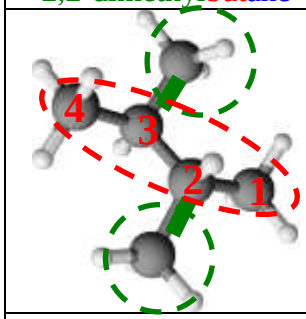


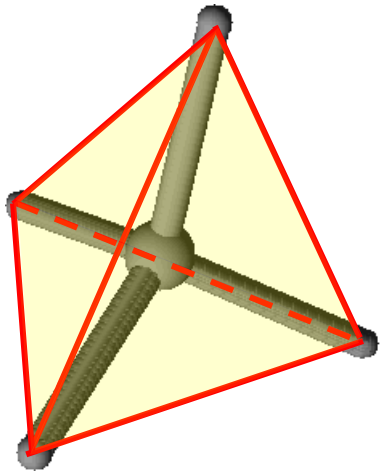


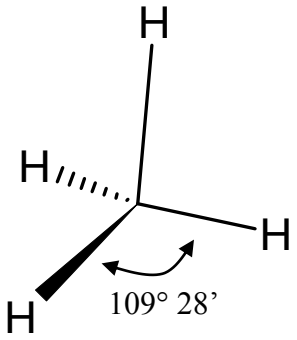
Hydrocarbures saturés

Planche 1

Alcanes
C_nH_{2n+2}

Méthane	Éthane	Propane	Butane	Pentane	Hexane
CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}
					
Méthane	Éthane	Propane	n-butane	n-pentane	n-hexane
			 *méthyl propane*	 *méthylbutane isopentane*	
			2-méthylpropane	2-méthylbutane	2-méthylpentane
				 *néopentane*	
				2,2-diméthylpropane	3-méthylpentane
					
					2,2-diméthylbutane
Radicaux Alkyles						
	méthyl	**éthyl**	**propyl**	**butyl**		2,3-diméthylbutane



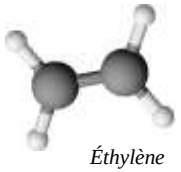
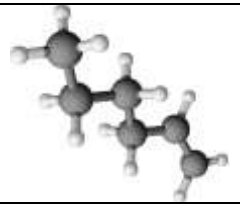
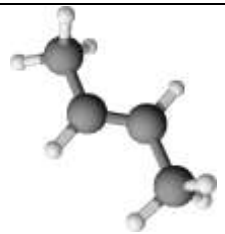
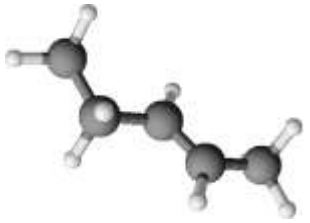
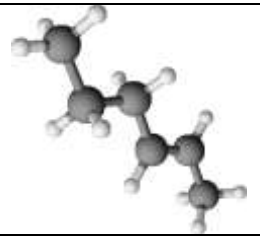
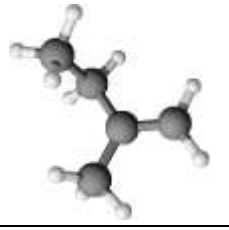
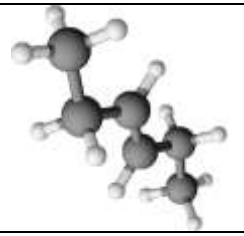
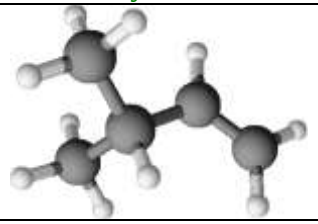
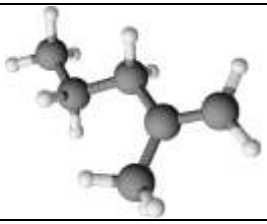
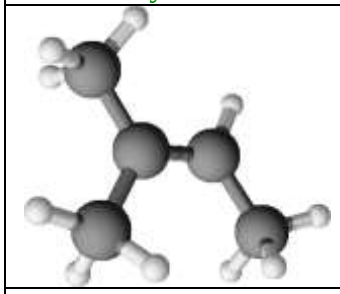
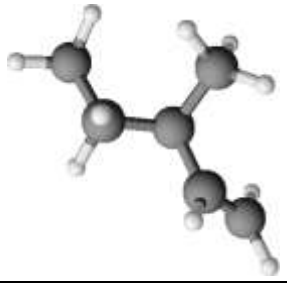


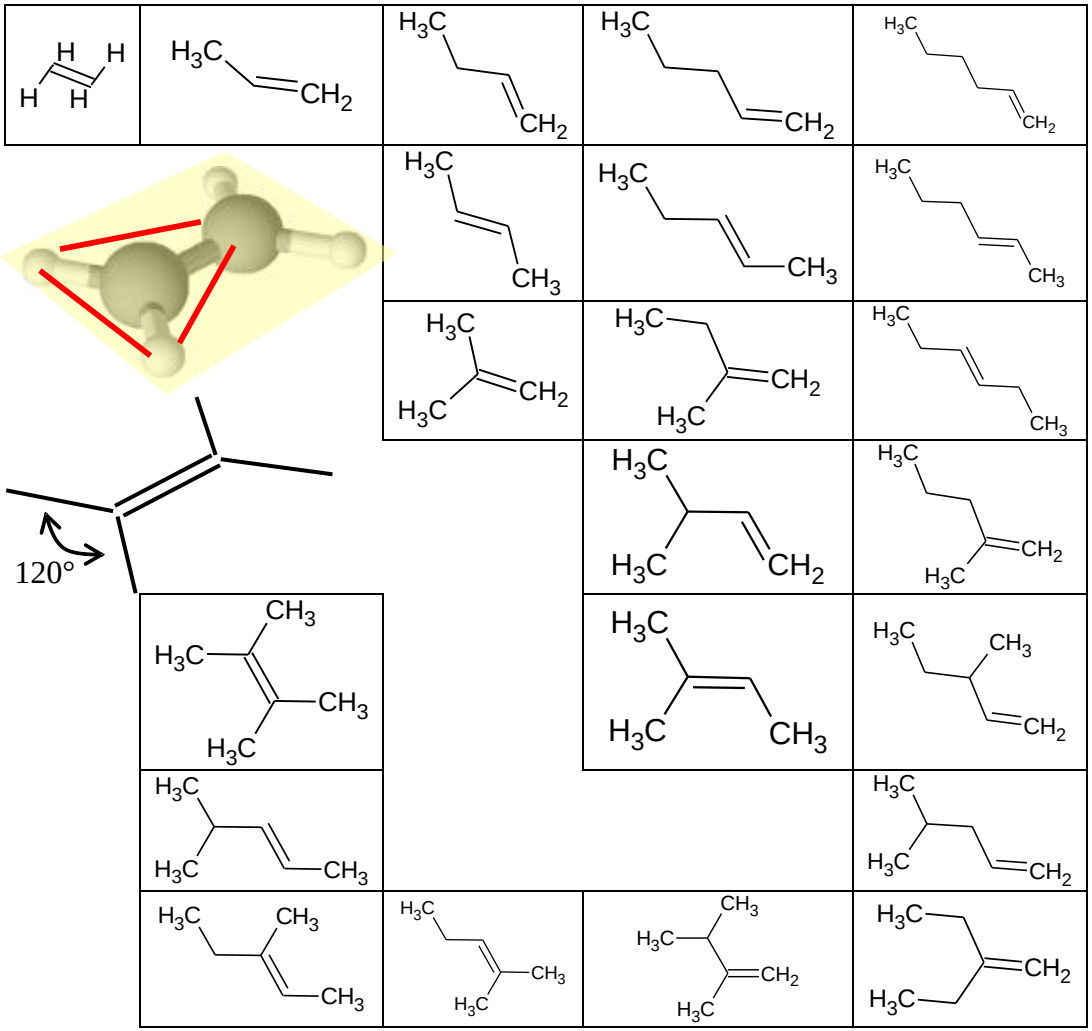
n°1,n°2-substituant | nom | saturation

Hydrocarbures insaturés

Planche 2

Alcènes
C_nH_{2n}

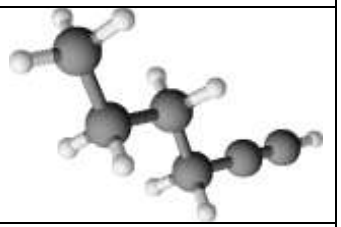
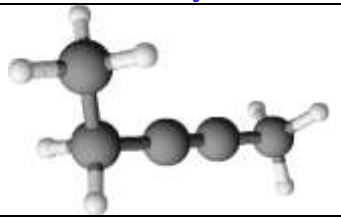
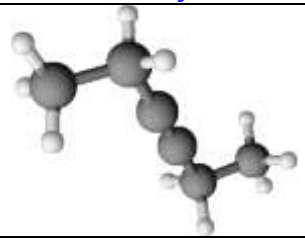
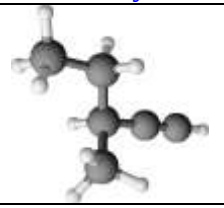
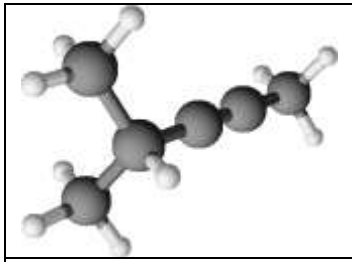
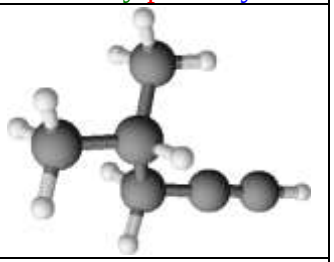
Éthène	Propène	Butène	Pentène	Hexène
C_2H_4	C_3H_6	C_4H_8	C_5H_{10}	C_6H_{12}
 *Éthylène*				
Éthène	Propène	But-1-ène	Pent-1-ène	Hex-1-ène
				
		But-2-ène	Pent-2-ène	Hex-2-ène
				
		2-méthylprop-1-ène	2-méthylbut-1-ène	Hex-3-ène
				
			3-méthylbut-1-ène	2-méthylpent-1-ène
				
			2-méthylbut-2-ène	3-méthylpent-1-ène

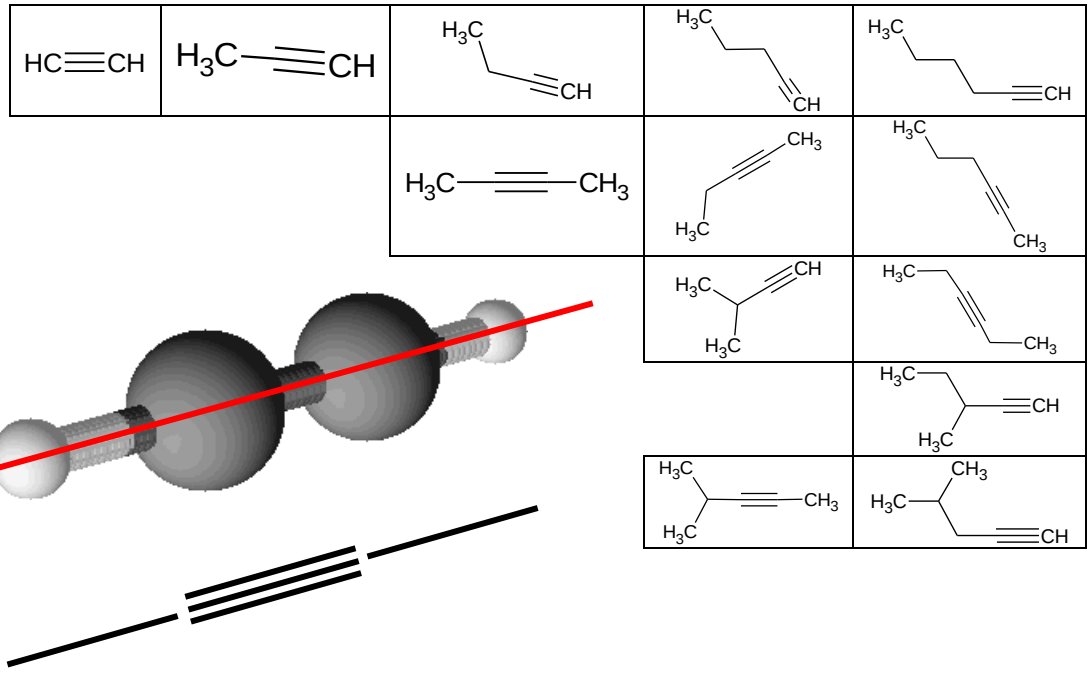


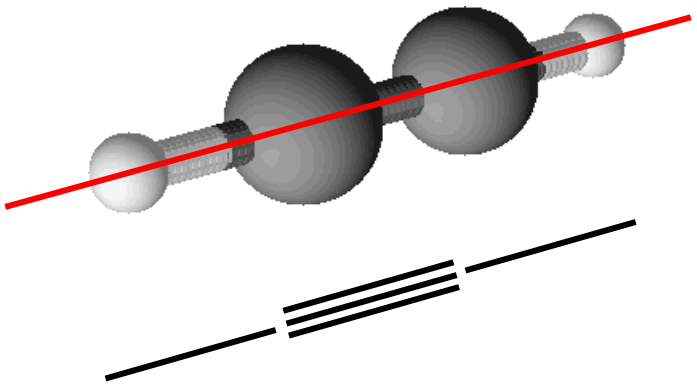
Hydrocarbures insaturés

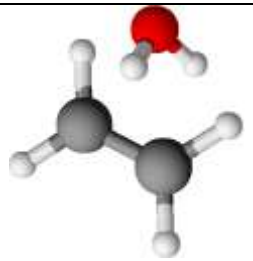
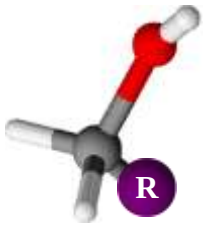
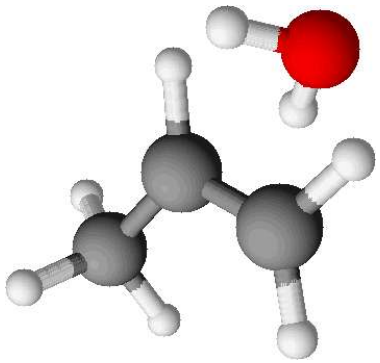
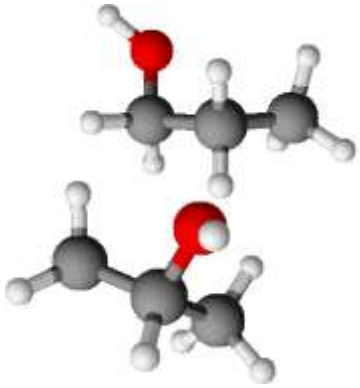
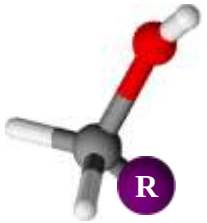
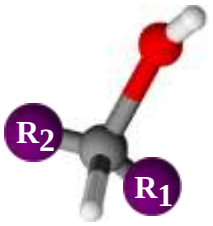
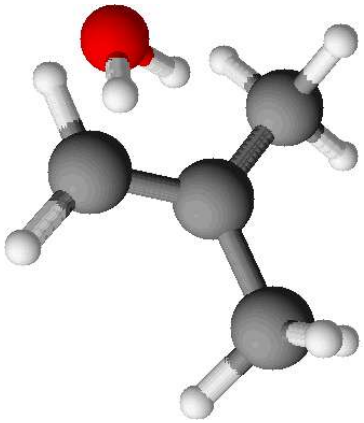
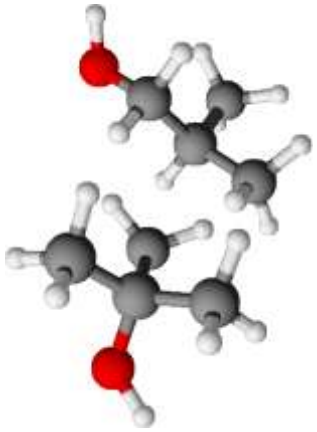
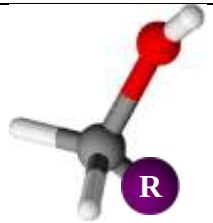
Planche 3

Alcynes
C_nH_{2n-2}

Éthyne	Propyne	Butyne	Pentyne	Hexyne
C_2H_2	C_3H_4	C_4H_6	C_5H_8	C_6H_{10}
 *Acéthylène*				
Éthyne	Propyne	But-1-yne	Pent-1-yne	Hex-1-yne
				
		But-2-yne	Pent-2-yne	Hex-2-yne
				
			3-méthylbut-1-yne	Hex-3-yne
				
				3-méthylpent-1-yne
				
			4-méthylpent-2-yne	4-méthylpent-1-yne

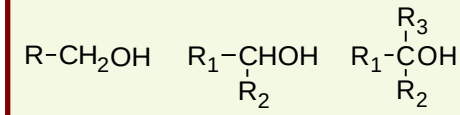




C_2H_4	 $H_2C{=}CH_2 + H_2O$ =	 C_2H_5OH		**alcool *classe* I**
C_3H_6	 $H_3C{-}CH{=}CH_2 + H_2O$ =	 C_3H_7OH		**alcool *classe* I**
				**alcool *classe* II**
C_4H_8	 $H_2C{=}CCH_3{-}CH_3 + H_2O$ =	 C_4H_9OH		**alcool *classe* III**

Degré 1 d'oxydation du Carbone

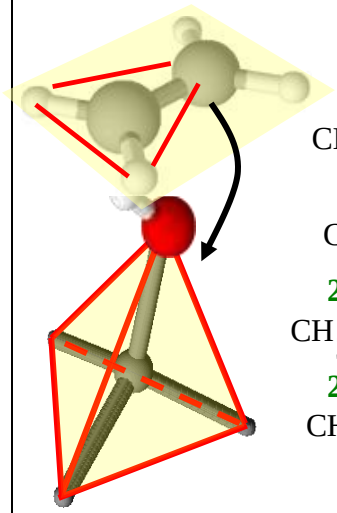
Alcools ROH



Un **alcool** (de l'arabe al-khwl الكحول, ou al-ghawl الغول, « l'esprit » (lit.), « toute substance pulvérisée », « liquide distillé ») est un composé organique dont l'un des carbones est lié à un **groupement hydroxyle « —OH »**.

substituant | nom | saturation | fonction

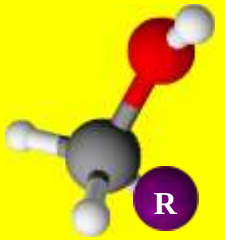
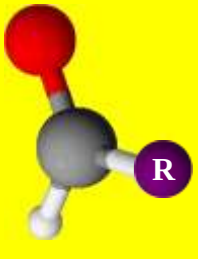
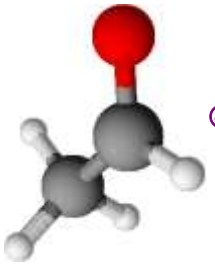
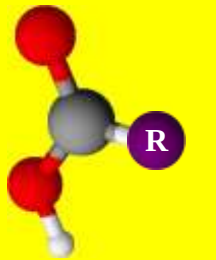
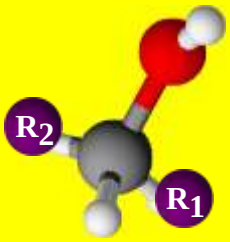
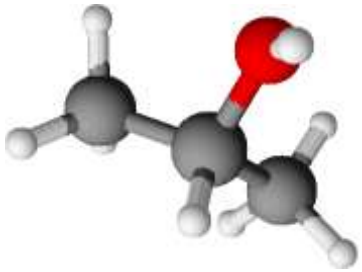
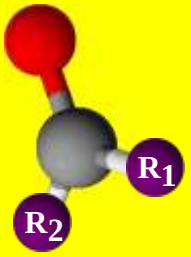
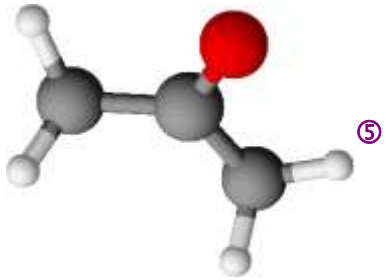
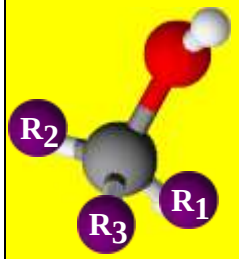
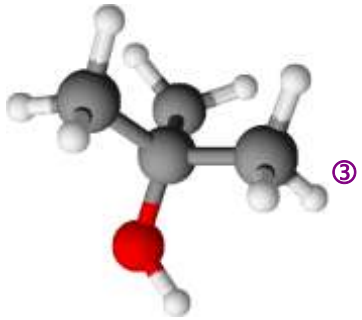
- **Fonction** : *suffixe* « **ol** »
- **Substituant** : *préfixe* « **hydroxy** »



Éthan-1-ol
$CH_3{-}CH_2OH$
Propan-1-ol
$CH_3{-}CH_2{-}CH_2OH$
Propan-2-ol
$CH_3{-}CHOH{-}CH_3$
2-Méthylpropan-1-ol
$CH_3{-}CHCH_3{-}CH_2OH$
2-Méthylpropan-2-ol
$CH_3{-}COHCH_3{-}CH_3$

Planche 4

Hydratation d'alcènes

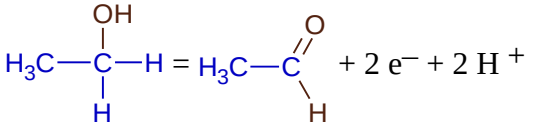
Première oxydation (*degré* 1)		Deuxième oxydation (*degré* 2)		Troisième oxydation (*degré* 3)	
	 ①		 ④		 ⑥
Alcool *classe I*	CH_3-CH_2OH	**Aldéhyde**	CH_3-CHO $R-CHO$	**Acide carboxylique**	CH_3-CO_2H $R-CO_2H$
	 ②		 ⑤		
Alcool *classe II*	$CH_3-CHOH-CH_3$	**Cétone**	$CH_3-CO-CH_3$ R_1-CO-R_2		
	 ③				
Alcool *classe III*	$CH_3-C(CH_3)OH-CH_3$				

substituant | nom | saturation | fonction

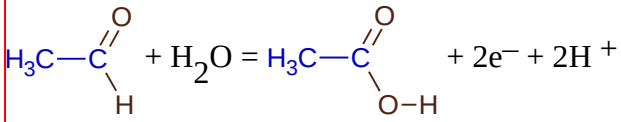
Fonction : *suffixe* « **al** » pour **aldéhyde**,
« **one** » pour **cétone**,
« **oïque** » pour **acide carboxylique**.

Test commun aux Aldéhydes et Cétones :
2,4 DNPH (2,4-dinitrophénylhydrazine)
Tests spécifiques aux Aldéhydes :
liqueur de Fehling, **solution de Tollens**,
Réaction de Schiff.

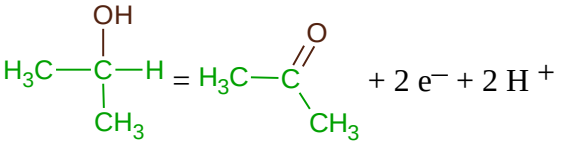
- CH_3-CHO / CH_3-CH_2OH



- CH_3-CO_2H / CH_3-CHO



- $CH_3-CO-CH_3$ / $CH_3-CHOH-CH_3$



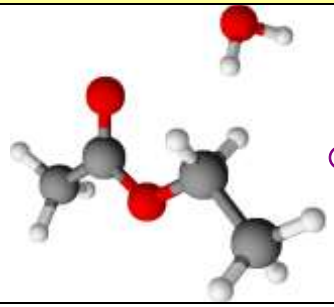
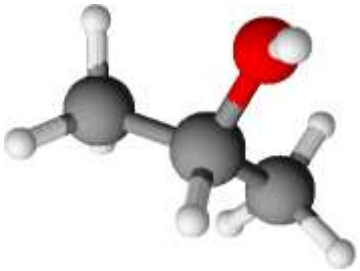
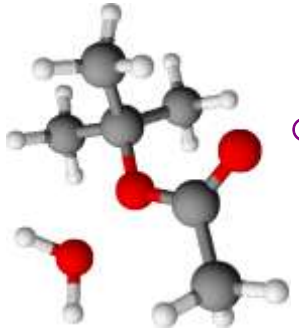
Avec des Oxydants puissants, par exemple :

MnO_4^- / Mn^{2+} *ou* $Cr_2O_7^{2-}$ / Cr^{3+}

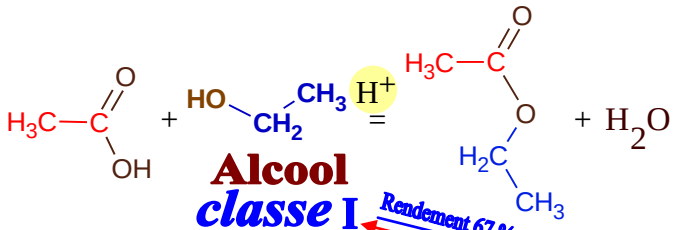
Oxydations ménagées d'alcools

①*Éthanol*, ②*Propan-2-ol*, ③*2-Méthylpropan-2-ol*, ④*Éthanal*, ⑤*Propanone*, ⑥*Acide Éthanoïque* ...

Planche 5

Acide carboxylique	+	Alcool	=	Ester + Eau
				 ①
CH_3-CO_2H	+	CH_3-CH_2OH	=	$CH_3-CO_2-CH_2-CH_3 + H_2O$
				 ②
CH_3-CO_2H	+	$CH_3-CHOH-CH_3$	=	$CH_3-CO_2-CH(CH_3)-CH_3 + H_2O$
				 ③
CH_3-CO_2H	+	$CH_3-C(CH_3)OH-CH_3$	=	$CH_3-CO_2-C(CH_3)_2-CH_3 + H_2O$

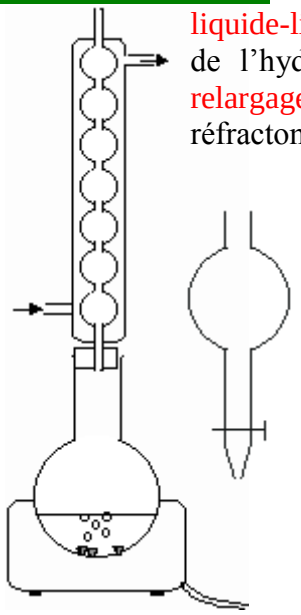
substituant | nom | saturation | fonction — **Fonction** : *suffixe* « **oate de** »

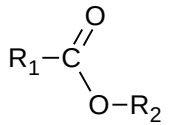


$$Q_{r,eq} = \frac{[CH_3CO_2C_2H_5] \times [H_2O]}{[CH_3CO_2H] \times [CH_3CH_2OH]} = \frac{\frac{2n}{3} \times \frac{2n}{3}}{\frac{n}{3} \times \frac{n}{3}} = 4$$

	x	$C_2H_4O_2 + C_2H_6O = C_4H_8O_2 + H_2O$				Q_r
EI	0	n	n	0	0	$Q_{r,i} = 0$
EF	x_f	$\frac{n}{3}$	$\frac{n}{3}$	$\frac{2n}{3}$	$\frac{2n}{3}$	$K = 4$
EI	0	0	0	n	n	$Q_{r,i} = \infty$

Protocole opératoire : Chauffage à reflux, extraction liquide-liquide (lavage à l'eau salée, action de l'hydrogénocarbonate de sodium,) ou relargage puis caractérisation (CCM, réfractomètre, point de fusion, densité …)





L'estérification est lente limitée et athermique. Le chauffage l'accélère, le réfrigérant condense et reflue les espèces chimiques dans le milieu réactionnel. Un acide minéral (H^+) catalyse la réaction.

$R_1—CO_2—R_2$

①Éthanoate d'éthyle, ②Éthanoate de propyle, ③Éthanoate de butyle ... Propanoate d'éthyle …

ÉQUILIBRE D'ESTÉRIFICATION - HYDROLYSE