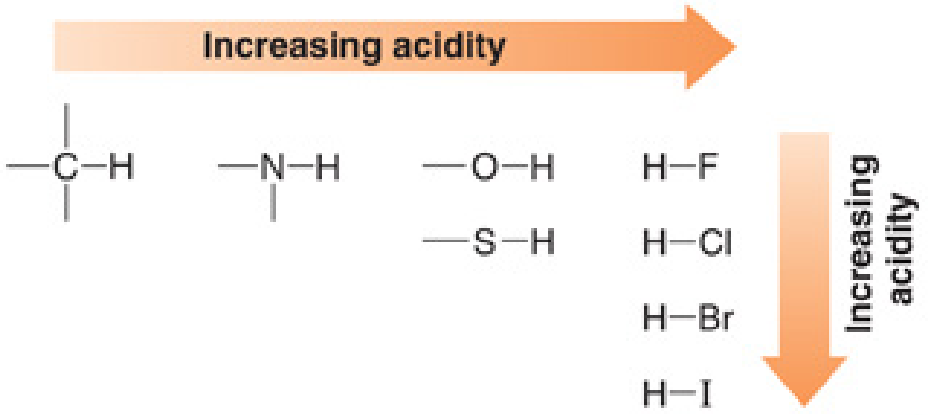
Fattori che determinano la forza acida

- **Qualsiasi parametro che stabilizzi una base coniugata $A:^-$ rende l'acido di partenza H-A più acido.**
- **Quattro fattori condizionano l'acidità di H-A. Essi sono:**
  - **Effetti dell'elemento A**
  - **Effetti induttivi**
  - **Effetti della risonanza**
  - **Effetti dell'ibridazione**
- **per confrontare l'acidità di due acidi confrontabili si segue sempre la stessa procedura:**
  - **Disegnare sempre le basi coniugate.**
  - **Determinare quale base coniugata sia più stabile.**
  - **Più è stabile la base coniugata, più forte è l'acido.**

Riassumendo:

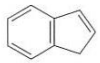
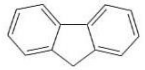
Factor	Example
1. **Element effect:** The acidity of H–A increases both left-to-right across a row and down a column of the periodic table.	
2. **Inductive effects:** The acidity of H–A increases with the presence of electron-withdrawing groups in A.	CH_3CH_2O-H CF_3CH_2O-H **more acidic**
3. **Resonance effects:** The acidity of H–A increases when the conjugate base $A:^-$ is resonance stabilized.	CH_3CH_2O-H CH_3COO-H **more acidic**
4. **Hybridization effects:** The acidity of H–A increases as the percent *s*-character of $A:^-$ increases.	CH_3CH_3 $CH_2=CH_2$ $H-C\equiv C-H$ **Increasing acidity**

Valori di pK_a di alcuni acidi

Acido	Base	pK_a
RNO_2H^+	RNO_2	– 12
$ArNO_2H^+$	$ArNO_2$	– 11
$HClO_4$	ClO_4^-	– 10
HI	I^-	– 10
$RC\overset{+}{N}H$	RCN	– 10
$R-\underset{\underset{{}^+OH}{\|\|}}{C}-H$	$R-\underset{\underset{O}{\|\|}}{C}-H$	– 10
HBr	Br^-	– 9
$Ar-\underset{\underset{{}^+OH}{\|\|}}{C}-OR$	$Ar-\underset{\underset{O}{\|\|}}{C}-OR$	– 7,4
HCl	Cl^-	– 7
$R\overset{+}{S}H_2$	RSH	– 7
$Ar-\underset{\underset{{}^+OH}{\|\|}}{C}-OH$	$Ar-\underset{\underset{O}{\|\|}}{C}-OH$	– 7
$Ar-\underset{\underset{{}^+OH}{\|\|}}{C}-H$	$Ar-\underset{\underset{O}{\|\|}}{C}-H$	– 7
$R-\underset{\underset{{}^+OH}{\|\|}}{C}-R$	$R-\underset{\underset{O}{\|\|}}{C}-R$	– 7
$ArSO_3H$	$ArSO_3^-$	– 6,5
$R-\underset{\underset{{}^+OH}{\|\|}}{C}-OR$	$R-\underset{\underset{O}{\|\|}}{C}-OR$	– 6,5
$Ar\overset{+}{O}H_2$	ArOH	– 6,4
$R-\underset{\underset{{}^+OH}{\|\|}}{C}-OH$	$R-\underset{\underset{O}{\|\|}}{C}-OH$	– 6

Acido	Base	pK_a
$Ar-\underset{\underset{{}^+OH}{\|\|}}{C}-R$	$Ar-\underset{\underset{O}{\|\|}}{C}-R$	– 6
$Ar-\overset{+}{\underset{\underset{H}{\|}}{O}}-R$	Ar–O–R	– 6
$CH(CN)_3$	$^-C(CN)_3$	– 5
$Ar_3\overset{+}{N}H$	Ar_3N	– 5
$H-\underset{\underset{{}^+OH}{\|\|}}{C}-H$	$H-\underset{\underset{O}{\|\|}}{C}-H$	– 4
$R-\overset{+}{\underset{\underset{H}{\|}}{O}}-R$	R–O–R	– 3,5
$R_3C\overset{+}{O}H_2$	R_3COH	– 2
$R_2CH\overset{+}{O}H_2$	R_2CHOH	– 2
$RCH_2\overset{+}{O}H_2$	RCH_2OH	– 2
H_3O^+	H_2O	– 1,74
$Ar-\underset{\underset{{}^+OH}{\|\|}}{C}-NH_2$	$Ar-\underset{\underset{O}{\|\|}}{C}-NH_2$	– 1,5
HNO_3	NO_3^-	– 1,4
$R-\underset{\underset{{}^+OH}{\|\|}}{C}-NH_2$	$R-\underset{\underset{O}{\|\|}}{C}-NH_2$	– 0,5
$Ar_2\overset{+}{N}H_2$	Ar_2NH	1
HSO_4^-	SO_4^{2-}	1,99
HF	F^-	3,17
HONO	NO_2^-	3,29
$Ar\overset{+}{N}H_3$	$ArNH_2$	3-5

Acido	Base	pK_a
$ArNR_2H$	$ArNR_2$	3-5
RCOOH	$RCOO^-$	4-5
$HCOCH_2CHO$	$HCOC^-HCHO$	5
H_2CO_3	HCO_3^-	6,35
H_2S	HS^-	7,00
ArSH	ArS^-	6-8
$CH_3COCH_2COCH_3$	$CH_3COC^-HCOCH_3$	9
HCN	CN^-	9,2
$^+NH_4$	NH_3	9,24
ArOH	ArO^-	8-11
RCH_2NO_2	RC^-HNO_2	10
R_3NH	R_3N	10-11
RNH_3	RNH_2	10-11
HCO_3^-	CO_3^{2-}	10,33
RSH	RS^-	10-11
R_2NH_2	R_2NH	11
$NCCH_2CN$	NCC^-HCN	11
CH_3COCH_2COOR	CH_3COC^-HCOOR	11
$CH_3SO_2CH_2SO_2CH_3$	$CH_3SO_2C^-HSO_2CH_3$	12,5
$EtOOCCH_2COOEt$	$EtOOCC^-HCOOEt$	13
CH_3OH	CH_3O^-	15,2
H_2O	OH^-	15,74
		16
RCH_2OH	RCH_2O^-	16

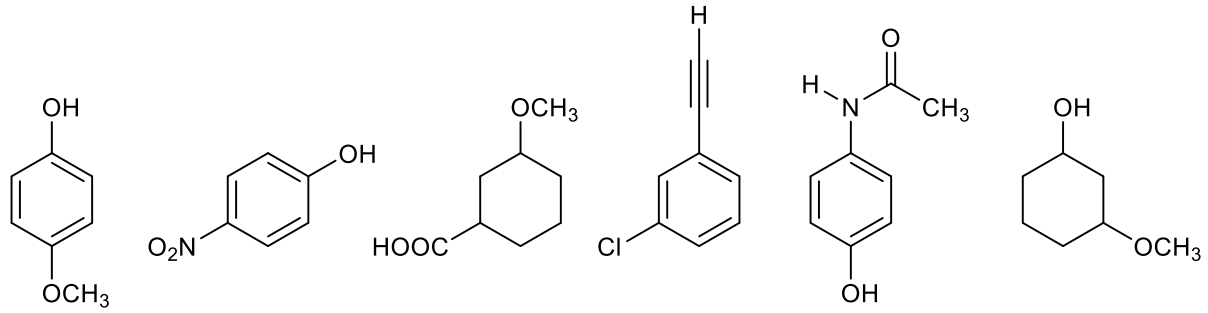
Acido	Base	pK_a
RCH_2CHO	RC^-HCHO	16
R_2CHOH	R_2CHO^-	16,5
R_3COH	R_3CO^-	17
$RCONH_2$	$RCONH^-$	17
$RCOCH_2R$	$RCOC^-HR$	19-20
		20
		23
$ROOCCH_2R$	$ROOCC^-HR$	24,5
RCH_2CN	RC^-HCN	25
$HC\equiv CH$	$HC\equiv C^-$	25
Ar_3CH	Ar_3C^-	31,5
Ar_2CH_2	Ar_2CH^-	33,5
H_2	H^-	35
NH_3	NH_2^-	38
$PhCH_3$	$PhCH_2^-$	40
$CH_2=CHCH_3$	$[CH_2 \cdots CH \cdots CH_2]^-$	43
PhH	Ph^-	43
$CH_2=CH_2$	$CH_2=CH^-$	44
ciclo-C_3H_6	ciclo-$C_3H_5^-$	46
CH_4	CH_3^-	48
C_2H_6	$C_2H_5^-$	50
$(CH_3)_2CH_2$	$(CH_3)_2CH^-$	51

Gruppo	Struttura	+I	-I
alchilico	-R	*	
Alogeni	-X		*
idrossile	-OH		*
etereo (alcossi)	-OR		*
alcolato (alcossido)	$-O^-$	*	
carbossile	-COOH		*
ammidico	$-CONH_2$		*
aldeidico	-COH		*
chetonico	-COR		*
amminico	$-NH_2$		*
estereo	-COOR		*
nitro	$-NO_2$		*
tiolato	$-S^-$	*	
tioetereo	-SR		*
ciano	-CN		*
solfidrilico (tiolico)	-SH		*
tioetereo	-SR		*

	Forza	Gruppo	Orientazione
Attivanti Elettron-donatori *(EDG)*	**Forti**	$-O^-$ -OH $-NH_2$ -NHR $-NR_2$	**orto-para**
	Medi	$-OCH_3$ -OR $-NHCOCH_3$ -NHCOR	**orto-para**
	Deboli	$-CH_3$ $-C_2H_5$ -R $-C_6H_5$ $-CH=CR_2$	**orto-para**
Riferimento	**Neutro**	**-H**	
Disattivanti Elettron-attrattori *(EWG)*	**deboli**	-F -Cl -Br -I	**orto-para**
	Medi	-COH, -COR -COOH, COOR $-COX$, $-CONH_2$ $-SO_3H$ -CN	**meta**
	Forti	$-CF_3$, CCl_3,.. $-NH_3^+$ $-NR_3^+$ $-NO_2$	**meta**

ESERCITAZIONI: Scale acidità e basicità_1

1. Indicare il corretto ordine di acidità crescente

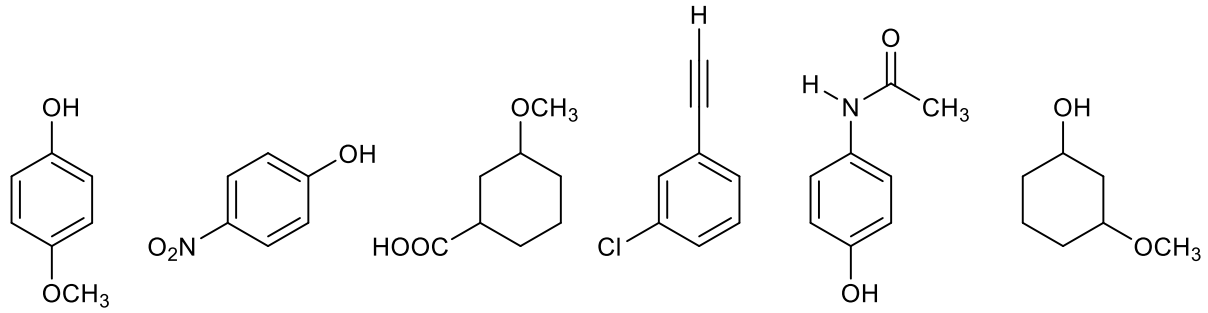


1 **2** **3** **4** **5** **6**

A 4<6<3<1<5<2
B 6<5<2<1<4<3
C 4<1<5<2<6<3
D 2<5<1<4<3<6
E 4<6<1<5<2<3

ESERCITAZIONI: Scale acidità e basicità_1

1. Indicare il corretto ordine di acidità crescente

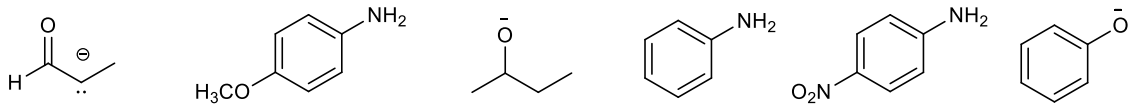


1 **2** **3** **4** **5** **6**

A 4<6<3<1<5<2
B 6<5<2<1<4<3
C 4<1<5<2<6<3
D 2<5<1<4<3<6
E 4<6<1<5<2<3

ESERCITAZIONI: Scale acidità e basicità_2

1.

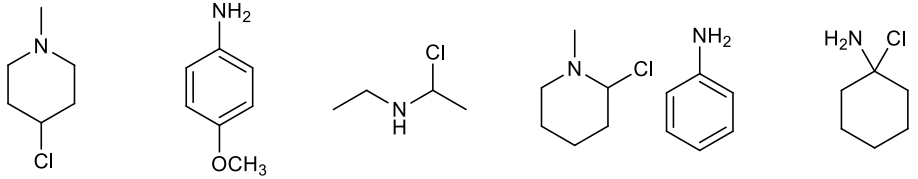


1 2 3 4 5 6

□ < □ < □ < □ < □ < □

basicità crescente

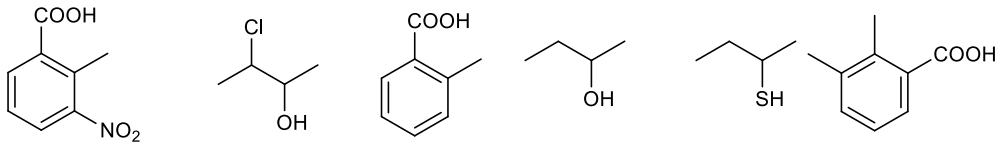
2. Indicare il corretto ordine di basicità



1 2 3 4 5 6

A 5>2>3>6>4>1
B 4>1>3>6>2>5
C 4>1>6>3>5>2
D 1>4>3>6>2>5
E 1>4>6>2>5>3

3. Indicare il corretto ordine di acidità crescente

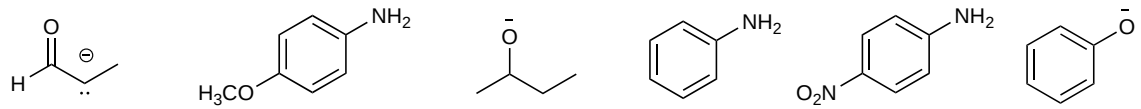


1 2 3 4 5 6

A 1>6>3>5>2>4
B 3>1>6>5>2>4
C 1>3>6>5>2>4
D 1>3>6>2>4>5
E 1>3>6>5>4>2

ESERCITAZIONI: Scale acidità e basicità_Soluzioni_2

1.

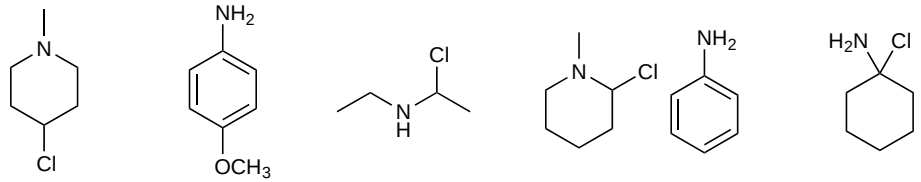


1 2 3 4 5 6

5 < **4** < **2** < **6** < **1** < **3**

basicità crescente

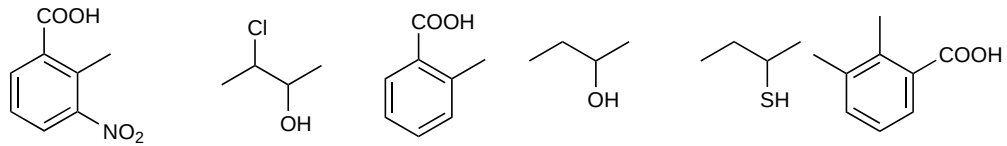
2. Indicare il corretto ordine di basicità



1 2 3 4 5 6

A 5>2>3>6>4>1
B 4>1>3>6>2>5
C 4>1>6>3>5>2
D 1>4>3>6>2>5
E 1>4>6>2>5>3

3. Indicare il corretto ordine di acidità crescente



1 2 3 4 5 6

A 1>6>3>5>2>4
B 3>1>6>5>2>4
C 1>3>6>5>2>4
D 1>3>6>2>4>5
E 1>3>6>5>4>2