= 1,015 mol di HCl

/19

,015 / .08403 = 12.08 M

1.015 mol / 0.063 kg = 16,111 m

f/mL T=

Soluz. 37% m/m di HCl $d = 1.19\ kg/L$ $mm_{HCl} = 36.46\ g/mol$

① $V = ?$ → 250 mL di HCl 0.1 M

$C = \frac{n}{V}$ $n = C \cdot V$ (no)

37% m/m → 12.08 M

→ $C_M \cdot V = n$

$0.250\ L \cdot 0.1\ M = n$

$n = 2.50 * 10^{-1} \cdot 10^{-1} = 2.5 \cdot 10^{-2}\ mol$

$n_i = n_f$

$12.08 \cdot x = 0.1 \cdot 0.250 = 2.5 \cdot 10^{-2}\ mol$

(n_i) (n_f)

$m_{HCl} = 2.5 \cdot 10^{-2} \cdot 36.46\ mm$

$= 0.9115\ g$

$x = \frac{2.5 \cdot 10^{-2}}{12.08} = 2.07 \cdot 10^{-3}\ L$

$2.07\ mL$

$C_M^i \cdot V^i = C_M^f \cdot V^f$

② 250 mL di HCl 0.1 m

1003 g + 3.6468 = 1003,6468 g

0.1 mol + 1 Kg H_2O

↳ $36.46 \cdot 0.1 = 3.6468$ g HCl

① 6/3/2020

$= 2.5 \cdot 10^{-2} \cdot 36.46$

$= 0.9115\ g$

$\cdot V^i = C_M^f \cdot V^f$

$1\ Kg\ H_2O$

$= 3.646\ g\ HCl$

② 5/3/2020

250 mL di HCl 0.1 m

$= \frac{0.1\ mol\ HCl}{1000\ g\ H_2O}$ ← $0.1 \cdot 36.46\ g/mol$ $= 3.646\ g$ di HCl

37 % m/m $\frac{37\ g\ HCl}{63\ g\ H_2O}$

1000 g di H_2O pura − 6.208 g di H_2O in HCl 37%

$= 993{,}792\ g$ di H_2O

+ 9.854 g di HCl 37%

3,7 : 10 = 3.646 : X

x = 9.854 g di HCl 37%

0.1 mol 3.646 g di HCl

6.208 g di H_2O

$d = \frac{m}{V}$ $V = \frac{m}{d} = 2.07\ mL$

$\frac{9.854\ g}{4}$ + $\frac{993{,}792\ g}{4}$ = 2.463 g + 248,448

HCl 37% H_2O pura HCl 37% H_2O pura

$=$

250.911 g

HCl 0.1 m

H_2O

$\frac{m}{V}$ $V = \frac{m}{d} = 2.07$ mL

3 g + 248,448 H_2O pura

37%

= 250.911 g

0.1 m

③ 6/3/2020 0.1 m

37%

37 g HCl + 63 g H_2O

37 g / 100 g tot

$\frac{0.1 \text{ mol HCl}}{1000 \text{ g } H_2O} = \frac{3.646 \text{ g HCl}}{1000 + 3.646 \text{ g totale}}$

$\frac{3,646}{1003,646} \times 100 = 0.363\%$

37 : 100 = 0.363 : X

$\frac{37}{0.363} = 101,93$ volte

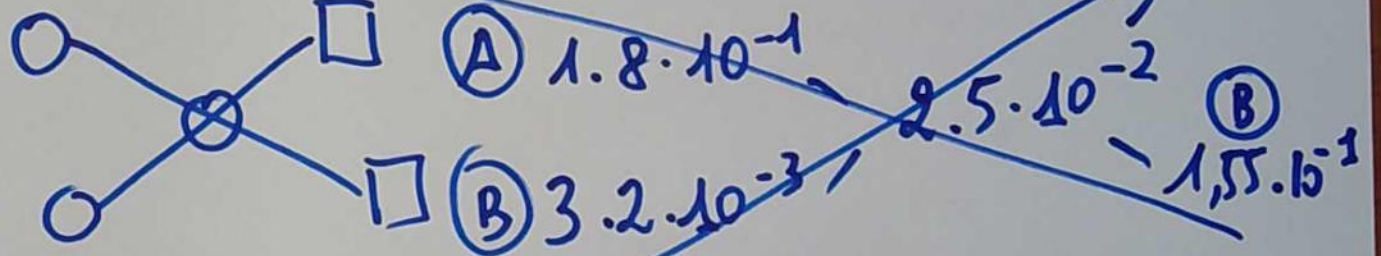
④ 6/3/2020

Soluzione A H_2SO_4 $C_M^A = 1.8 \cdot 10^{-1}$ M 250 mL

Soluzione B H_2SO_4 $C_M^B = 3.2 \cdot 10^{-3}$ M 250 mL

Soluzione X H_2SO_4 $C_M^X = 2.5 \cdot 10^{-2}$ M

V = 250 mL



A $2.18 \cdot 10^{-2} : 1.768 \cdot 10^{-1} = x : 250$

+ $1.768 \cdot 10^{-1}$

$$x = \frac{2.18 \cdot 10^{-2} \cdot 250}{1.768 \cdot 10^{-1}} = 30{,}826 \text{ mL di A}$$

$250 - 30{,}826 = 219.174$ mL B

(1) Tampon P_i a $pH = 6.8$ $C_M = 1\,M$ (1) 10/3/20

preparare P_i a $pH = 6.8$ $C_M = 2.5 \cdot 10^{-2} M$

$\frac{[AH]}{[A^-]}$ $K_a = [H^+]$

$-\log\frac{[AH]}{[A^-]} + pK_a = pH$

1 M → $2.5 \cdot 10^{-2}$ → $2.5 \cdot 10^{-2}$

$2.5 \cdot 10^{-2}$ → $9.75 \cdot 10^{-1}$

$9.95 \cdot 10^{-1}$ → V_{final} 250 mL

$2.5 \cdot 10^{-2} : X = 9.95 \cdot 10^{-1} : 250$

$X\,(mL) = \frac{250 \cdot 10^{-2} \cdot 2,5}{9.95 \cdot 10^{-1}} = 6.28\,mL$

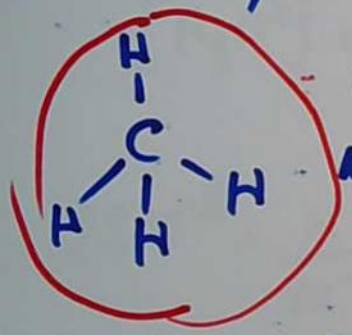
(2) 10/3/2020

(1) AH $HClO$

AH_2 H_2SO_4

AH_3 H_3PO_4

AH_4 H_4SiO_4



non acido non base

$HClO + H_2O \rightleftharpoons ClO^- + H_3O^+$

$K_a = \frac{[ClO^-]\cdot[H_3O^+]}{[HClO]}$

$C_M(H_2O) = \frac{n}{V} = \frac{55.5\ mol}{1\ L}$ ← $\frac{1000}{18}$

$= 55.5\ M$

$K_a > 1$ forte	$K_a < 1$ } debole
$K_a < 10^{-14}$ non acido	$K_a > 10^{-14}$ } debole

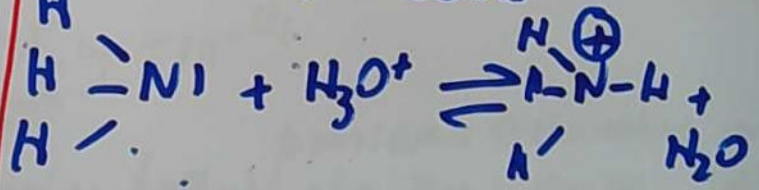
$AH_2 + H_2O \rightleftharpoons AH^- + H_3O^+$

$K_{a_1} = \frac{[H_3O^+][AH^-]}{[AH_2]} = 10^{-2}$

$AH^- + H_2O \rightleftharpoons A^= + H_3O^+$

$K_{a_2} = 10^{-7}$

NH_3 $K_a < 10^{-14}$ non acido



③ 10/3/2020

$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$ $K_W = y \cdot y$

$HClO + H_2O \rightleftharpoons ClO^- + H_3O^+$ $K_a = 2.9 \cdot 10^{-8}$

$K_a = \frac{[ClO^-] \cdot [H_3O^+]}{[HClO]}$

$[A]$ = all'equilibrio

$c_m(A)$ = transiente

$[H_3O^+] = K_a \frac{[HClO]}{[ClO^-]}$

$c_m(HClO) = 10^{-2} M$

$2.9 \cdot 10^{-8} = \frac{x^2}{10^{-2} - x}$ $x = 1.7 \cdot 10^{-5}$

$[H_3O^+]$

	$HClO + H_2O$	$\rightleftharpoons$	$ClO^- + H_3O^+$
i	10^{-2}	/	/ $10^{-7} M$
~~*~~	$10^{-2} - x$	/	x $x + y_{H_2O}$

$K_W = [H_3O^+][OH^-] = 1.7 \cdot 10^{-5} \cdot y = 10^{-14}$

~~y_{H_2O}~~ $\times$ y $y = 5.9 \cdot 10^{-10}$

possiamo ommettere in prima battuta che $y_{H_2O} << x$

11/03/2020

(1)

$AH + H_2O \rightleftharpoons A^- + H_3O^+$ ← $K_a = \frac{[A^-][H_3O^+]}{[AH]}$

$A^- + H_2O \rightleftharpoons AH + OH^-$

$10^{-1} < \frac{[AH]}{[A^-]} < 10$ in questo caso $[AH] = C_{AH}$, $[A^-] = C_{A^-}$

$[H_3O^+] = K_a \frac{[AH]}{[A^-]}$ $\quad -\log[H_3O^+] = -\left(\log K_a + \log \frac{[AH]}{[A^-]}\right)$

$pH = pK_a - \log \frac{[AH]}{[A^-]} \Big]_{10}^{0.1}$ $\quad -\log[H_3O^+] = -\log K_a - \log \frac{[AH]}{[A^-]}$

$pH \nearrow^{0.1}$

$pH = pK_a + 1$

$pH_{-10} = pK_a - 1$

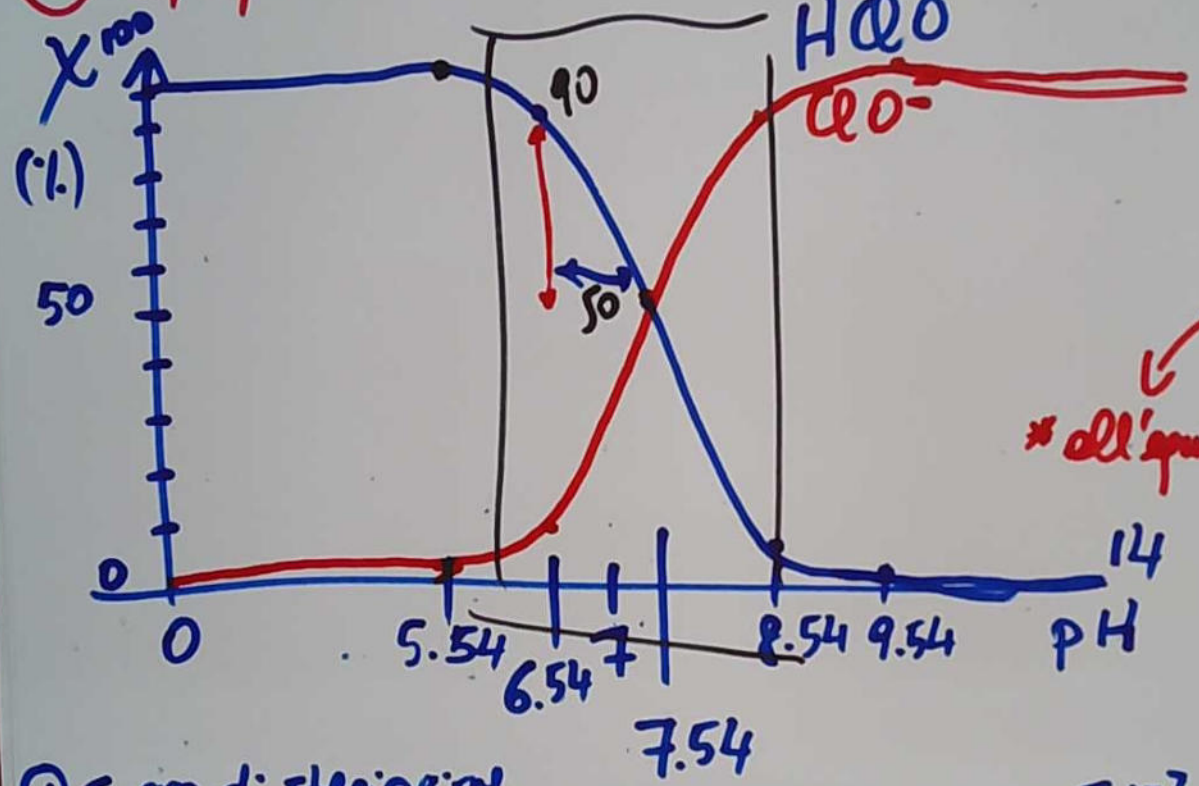
$pK_a - 1 < pH < pK_a + 1$

$HClO \rightarrow pK_a = 7.54$

$CH_3COOH \rightarrow pK_a = 4.42$

Tampone $HClO/ClO^-$ $pH \swarrow^{6.54}_{8.54}$

② 11/03/2020



distribuzione o composizione delle diverse specie* che si formano a partire dal soluto

*all'equilibrio

SPECIAZIONE in funzione del pH

① Curva di speciazione CH_3COOH / CH_3COO^-

$$\alpha = \frac{[A^-]}{C_{AH}}$$

$K_a = 3{,}8 \cdot 10^{-5}$

② Calcolare il pH di CH_3COOH $C_M = 10^{-2}$ M

③ $V = 1$ L + 10 mL OH^- 10^{-1} M

$C_{AH} = [AH] + [A^-]$

13/03/2020

1

CH_3COOH

$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

	CH_3COOH		CH_3COO^-	H_3O^+
i	10^{-2}	/	/	10^{-7}
eq	$10^{-2}-x$		x	$x+y$

$C_M = 10^{-2}\,M \quad V = 1\,L$

$+ 10\,mL = 10^{-2}\,L \quad OH^- \; c_M = 10^{-1}\,M$

$K_a = 3.8 \cdot 10^5$

$$K_a = \frac{[CH_3COO^-]\cdot[H_3O^+]}{[CH_3COOH]}$$

$$K_a = \frac{x\cdot(x+y)}{10^{-2}-x}$$

$$x = \sqrt{K_a \cdot c_M}$$

$$K_w = [OH^-]\cdot[H_3O^+]$$

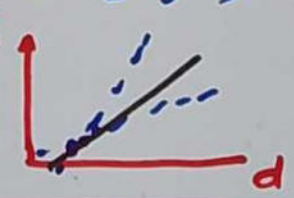
se $x \ll c_M$, $y \ll x$

$$K_{eq} = 10^{\frac{-\Delta G_R^\circ}{RT}}$$

$$\Delta G_R^\circ = \Delta H^\circ - T\cdot\Delta S^\circ$$

$x = 6.16 \cdot 10^{-4} = [CH_3COO^-] = [H_3O^+]$

$\left(\frac{x}{c_M} < 0.01\right) \; x = 0.06$



$CH_3COOH \quad C_M = 10^{-2}$

$K_a = 3.8 \cdot 10^{-5} \quad C_M = 10^{-3}$

$\alpha = [CH_3COO^-]/C_M$

23/3/2020

(2)

$$K_a = \frac{x^2}{C_M - x} \qquad x^2 + K_a x - C_M \cdot K_a = \emptyset$$

$$x = \frac{-K_a + \sqrt{K_a^2 + 4C_M \cdot K_a}}{2}$$

$$x = -3.8 \cdot 10^{-5} + \sqrt{1.444 \cdot 10^{-9} + 1{,}52 \cdot 10^{-6}}$$

$$= \frac{-3{,}8 \cdot 10^{-5} + 1.23 \cdot 10^{-3}}{2}$$

$1.52144 \cdot 10^{-6}$

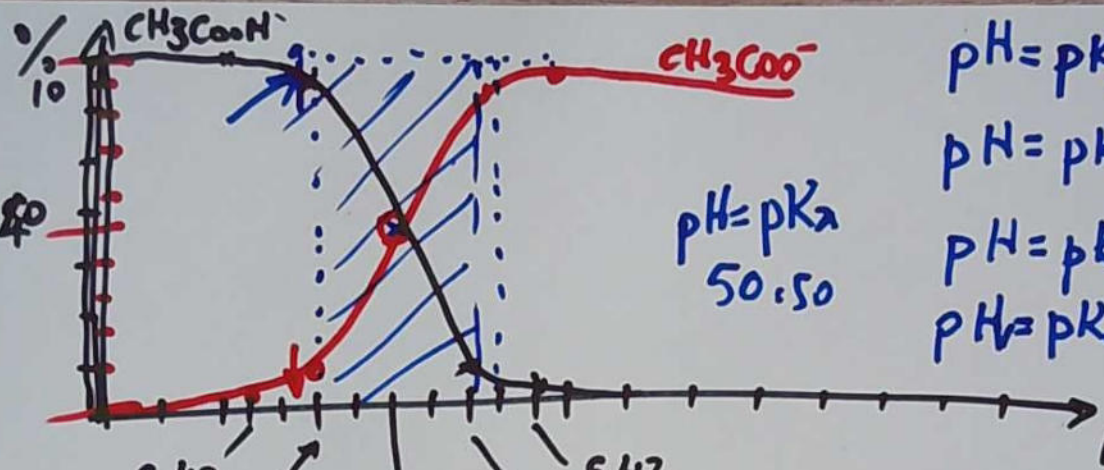
$$= \frac{1.195 \cdot 10^{-3}}{2} = 5.98 \cdot 10^{-4} = [CH_3COO^-] = [H_3O^+]$$

pH = 3,22

$$\alpha = \frac{5.98 \cdot 10^{-4}}{10^{-2}} = 0.0598 = 5.98\%$$

$$K_W = [OH^-] \cdot [H_3O^+] = y \cdot (x + y) = y \cdot (5.98 \cdot 10^{-4} + y)$$

$$y = \frac{10^{-14}}{5.98 \cdot 10^{-4}} = 1.67 \cdot 10^{-11} = [OH^-]$$



$pH = pK_a$
50 : 50

$pH = pK_a - 1 = \frac{10}{1} = 90.9$

$pH = pK_a - 2 = \frac{100}{1} = 99$

$pH = pK_a - 3 = \frac{1000}{1} = 99.9$

$pH = pK_a - 4 = \frac{10000}{1} = 99.99$

13/3/2020 (3)

$K_W = K_a \cdot K_b$

$(AH)\ (A^-)$

$K_a = 3.8 \cdot 10^{-5}$

$K_b = \frac{10^{-14}}{3.8 \cdot 10^{-5}} = 2.63 \cdot 10^{-10}$

$CH_3COOH + OH^- \rightleftharpoons CH_3COO^- + H_2O$

i 10^{-2} 10^{-3} / 10^{-3}

eq $10^{-2} - 10^{-3}$ ∅ / 10^{-3}

$9 \cdot 10^{-3}$

$pH = pK_a - \log \frac{[AH]}{[A^-]} = 4.42 - \log \frac{9 \cdot 10^{-3}}{10^{-3}}$

$pH = 3.47$

$4.42 - 0,95$

$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$

$K_{eq} = \frac{1}{K_b} = 3.8 \cdot 10^9$

17/03/2020

1

$H_2O + CH_3COOH + H_3O^+ \rightleftharpoons ?$

$\begin{cases} C_M(HCl) = 10^{-2}\ M \\ C_M(CH_3COOH) = 2 \cdot 10^{-2}\ M \end{cases}$

$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

$\longrightarrow K_a \gg 1$

① $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

② $H_3O^+ + H_2O \rightleftharpoons H_2O + H_3O^+ \quad K_{eq} = 1$

$i = e \quad 10^{-2} \qquad 10^{-2}$

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

i	$2 \cdot 10^{-2}$	/	10^{-2}
e	$2 \cdot 10^{-2} - x$	x	$10^{-2} + x$

$K_a = 3.8 \cdot 10^{-5} = \dfrac{x \cdot (10^{-2} + x)}{2 \cdot 10^{-2} - x}$

$x = \dfrac{3.8 \cdot 10^{-5} \cdot 2 \cdot 10^{-2}}{10^{-2}}$

$x = 7.6 \cdot 10^{-5}$

$K_a = \dfrac{[CH_3COO^-] \cdot [H_3O^+]}{[CH_3COOH]}$

$K_b = \dfrac{[CH_3COOH] \cdot [OH^-]}{[CH_3COO^-]}$

$K_a \cdot K_b = \dfrac{[CH_3COO^-] \cdot [H_3O^+]}{[CH_3COOH]} \cdot \dfrac{[CH_3COOH] \cdot [OH^-]}{[CH_3COO^-]} = K_w$

17/03/2020

(2) $H_2O + CH_3COO^- + OH^- \rightleftharpoons ?$

$C_M(NaOH) = 10^{-2}\,M$

$C_M(CH_3COO^-) = 2\cdot10^{-2}\,M$

$NaOH \rightleftharpoons OH^- + Na^+ \longrightarrow K_b >> 1$

(1) $OH^- + H_2O \rightleftharpoons H_2O + OH^- \quad K_3 = 1$

i 10^{-2} $\quad$ 10^{-2}

eq $10^{-2} - x$ $\quad$ $10^{-2} + x$

(2) $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$

i $2\cdot10^{-2}$ $\quad$ / $\quad$ 10^{-2}

eq $2\cdot10^{-2} - x$ $\quad$ x $\quad$ $10^{-2} + x$

$$K_b = \frac{10^{-14}}{K_a} = 2.63\cdot10^{-10} = \frac{x(10^{-2}+x)}{2\cdot10^{-2}-x} = \frac{2.63\cdot10^{-10}\cdot 2\cdot10^{-2}}{10^{-2}}$$

$x = [OH^-]_{CH_3COO^-} = 5.26\cdot10^{-10}$ $\quad$ $[OH^-] = 10^{-2} + 5.26\cdot10^{-10}\,M$

17/03/2020

③

① $H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+$ $K_{a1} = 10^{-2}$

② $H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$ $K_{a2} = 10^{-7}$

③ $HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+$ $K_{a3} = 10^{-12}$

$K_{a1} \cdot K_{b3} = 10^{-14}$ $K_{a2} \cdot K_{b2} = 10^{-14}$ $K_{a3} \cdot K_{b1} = 10^{-14}$

$C_M(H_3PO_4) = [H_3PO_4] + [H_2PO_4^-] + [HPO_4^{2-}] + [PO_4^{3-}]$

$10^{-2}M$ $K_W = [OH^-] \cdot [H_3O^+]$

$K_{a_1} = \frac{[H_2PO_4^-] \cdot [H_3O^+]}{[H_3PO_4]}$; $K_{a_2} = \frac{[HPO_4^{2-}] \cdot [H_3O^+]}{[H_2PO_4^-]}$; $K_{a_3} = \frac{[PO_4^{3-}] \cdot [H_3O^+]}{[HPO_4^{2-}]}$

$[\oplus] = [H_3O^+]$; $[\ominus] = [H_2PO_4^-] + 2[HPO_4^{2-}] + 3[PO_4^{3-}] + [OH^-]$

17/03/2020

4

① $H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+$

i 10^{-2} / / 10^{-7}

$K_a = 10^{-2}$ eq $10^{-2} - x$ x $x + y$

$$K_{a_1} = 10^{-2} = \frac{x(x+y)}{10^{-2}-x} \qquad x^2 + 10^{-2}x - 10^{-4} = 0$$

$$x = \frac{-10^{-2} + \sqrt{10^{-4} + 4 \cdot 10^{-4}}}{2} = \frac{-10^{-2} + 2.24 \cdot 10^{-2}}{2} = 6.18 \cdot 10^{-3} M$$

$[H_3O^+] \approx 6.18 \cdot 10^{-3} M$ $\quad pH = 2.21$

② $H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$

$6.18 \cdot 10^{-3} - z$ $\quad z$ $\quad 6.18 \cdot 10^{-3} + z$

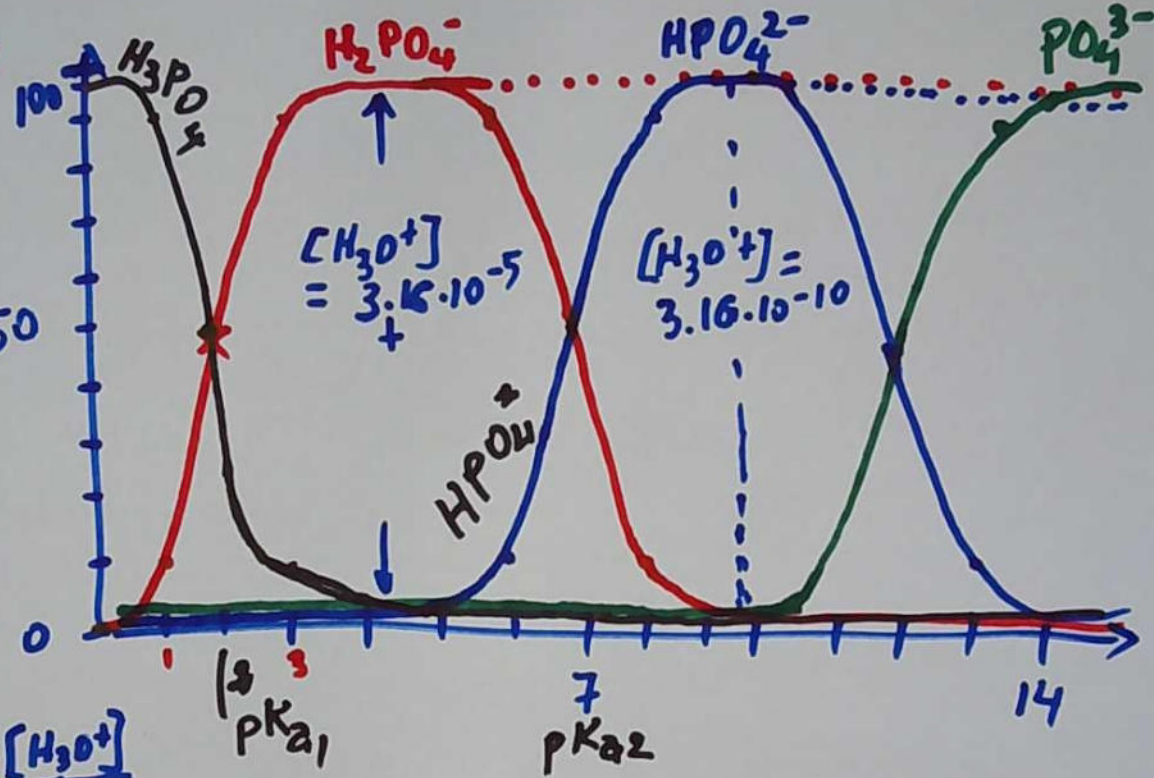
$$K_{a2} = \frac{[HPO_4^{=}][H_3O^+]}{[H_2PO_4^-]} = \frac{z \cdot 6.18 \cdot 10^{-3}}{6.18 \cdot 10^{-3} - z}$$

$$z = \frac{K_{a2} \cdot 6.18 \cdot 10^{-3}}{6.18 \cdot 10^{-3}}$$

$z = 10^{-7}$

18/03/2020

(1)



10^{-2}

$K_{a1} = \dfrac{[H_2PO_4^-] \cdot [H_3O^+]}{[H_3PO_4]}$

10^{-7}

$K_{a2} = \dfrac{[HPO_4^{2-}] \cdot [H_3O^+]}{[H_2PO_4^-]}$

10^{-12}

$K_{a3} = \dfrac{[PO_4^{3-}] \cdot [H_3O^+]}{[HPO_4^{2-}]}$

$pH = pK_{a_1} - 1 \Rightarrow \dfrac{[H_3PO_4]}{[H_2PO_4^-]} = 10$ $\dfrac{91\%}{9\%}$

$pK_a - pH = \log \dfrac{[AH]}{[A^-]}$ $\left| \dfrac{[AH]}{[A^-]} = 10^{(pK_a - pH)} \right.$

18/03/2020
(2)

$H_2PO_4^- + H_2O \rightleftharpoons H_3PO_4 + OH^-$ $\quad K_{b3} = 10^{-12}$

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$ $\quad K_{a2} = 10^{-7}$

$$pH = \frac{pK_{a1} + pK_{a2}}{2} = \frac{2+7}{2} = 4.5$$

$H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+$

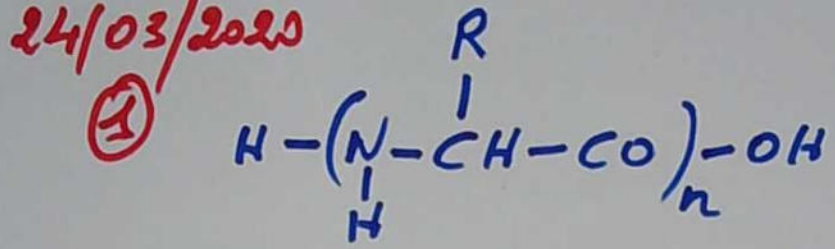
$K_{a1} = 10^{-2}$

$HPO_4^{2-} + H_2O \rightleftharpoons H_2PO_4^- + OH^- \quad K_{b2} = 10^{-7}$

$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+ \quad K_{a3} = 10^{-12}$

$$pH = \frac{pK_{a2} + pK_{a3}}{2} = \frac{7+12}{2} = 9.5$$

24/03/2020



campionamento
estrazione/attacco
solubilizzazione

selettività della risposta

campione: analita matrice

tal quale
derivato

rilevare quantificare

errore: un pH incompatibile con l'analita presente in soluzione

$$K_{ps} = [Fe^{(3+)}][OH^-]^3 = 10^{-36}$$

24/03/2020

(2)

Metodo di Kjeldahl

$$H-\left(NH-\underset{\underset{R}{|}}{CH}-CO\right)_n-OH$$

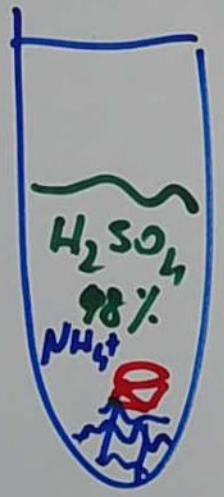
Attacco → (Δ Alta Temperatura)

← acido ossido-riduttivo

$CO_2 + H_2O \rightleftharpoons HCO_3^- + H_3O^+$

$CO_2 + NH_3 + H_2O$

$+ (H_2S)$

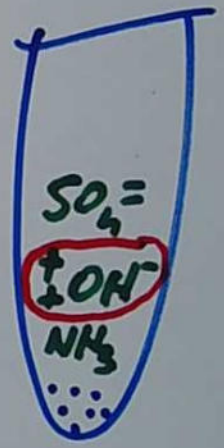


$NH_3 + H_3O^+ \rightleftharpoons NH_4^+ + OH_2$

$NH_4^+ + HO^- \rightleftharpoons NH_3 + H_2O$

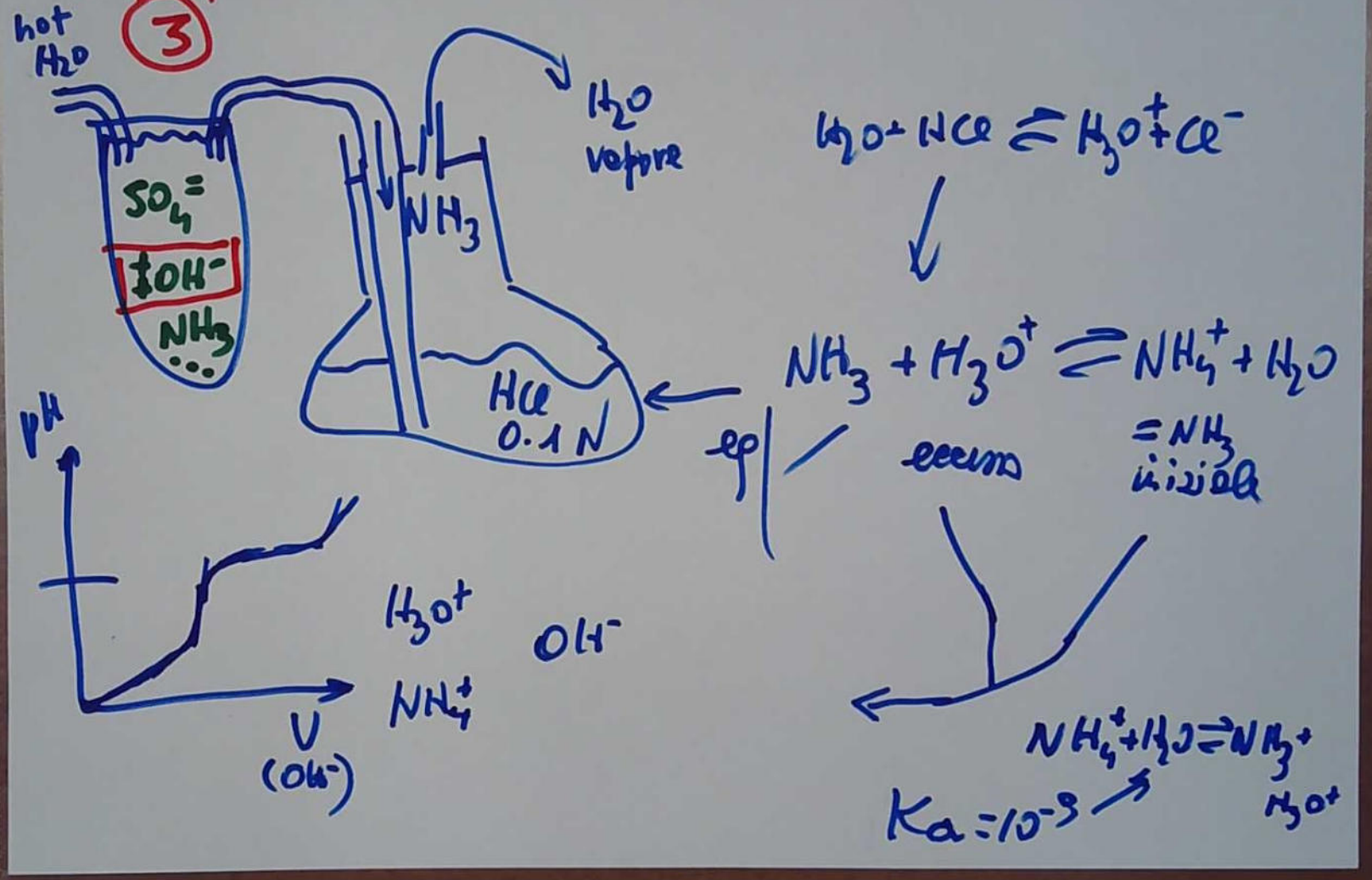
$H_2SO_4 + HO^- \rightleftharpoons HSO_4^- + H_2O$

$HSO_4^- + HO^- \rightleftharpoons SO_4^= + H_2O$



24/03/2020

3


hot H2O
H2O vapore
SO4=
OH-
NH3
NH3
HCl 0.1 N
pH
V (OH-)
H3O+
NH4+
OH-
H2O + HCl ⇌ H3O+ + Cl-
NH3 + H3O+ ⇌ NH4+ + H2O
eq
eccesso
= NH3 iniziale
NH4+ + H2O ⇌ NH3 + H3O+
Ka = 10-9

25/03/2020

(1)

$MM(\alpha\text{-caseina } S1) = 24442{,}85\ g\,mol^{-1}$

$n_N = 281 \qquad m_N = 281 \cdot 14 = 3934\ g\,mol^{-1}$ (N)

$\%\ N/p = 16.095\% \qquad I_N = 6.213$

75% di Caseina-α S1 + 25% di altro no N

mone 10 g di pulsto comprine è sottoposta a Kjeldahl. Quanto NH$_3$ si sviluppa?

↓

7.5 g di caseina in 10 g di integratore proteico

$7.5\ g / 24442{,}85\ g\,mol^{-1} = 3.068 \cdot 10^{-4}$ mol di P

$3.068 \cdot 10^{-4} \cdot 281 = 8.62 \cdot 10^{-2}$ mol di N

$= 8.62 \cdot 10^{-2}$ mol di NH_3

25/03/202

②

10^{-1} mol di HCl ⟶ 100 mL 1M HCl

$0.1\ L \cdot 1\ M = 0.1$ mol

10^{-1} mol H_3O^+ + ~~7.06E-05~~ $8.62 \cdot 10^{-2}$ mol di NH_3

⟶ $8.62 \cdot 10^{-2}$ mol di NH_4^+ ~~oltre 1.38·10⁻³M~~

$+ (10^{-1} - 8.62 \cdot 10^{-2}) = 1.38 \cdot 10^{-2}$ M di HCl in eccesso

$H_3O^+ + OH^- \rightarrow 2H_2O$

$NH_4^+ + OH^- \not\rightarrow NH_3 + H_2O$

10^{-1} M di NaOH

$n = C \cdot V \rightarrow 10^{-1} \cdot V_x$

$V_x = 0.138\ L$

25/03/2020 (3)

OH^- $C_M = 10^{-2} N$ $V_x = 18{,}1\ mL$

HCl $C_M = 10^{-1} M$ $V_{HCl} = 0.100\ L$

$M = 10.3\ g$ di integratore contenente α-caseina come unica fonte di N

% mm di α caseina nel campione

$n_{OH} = V_x \cdot C_M(HO^-) = 0.0181\ L \cdot 10^{-1} M = 1.81 \cdot 10^{-3}$ mol di OH^-

eccesso di HCl

$n^{\bullet}_{HCl} = V_{HCl} \cdot C_M(HCl) = 0.100\ L \cdot 10^{-1} M = 10^{-1}$ mol di HCl

1M

$n_T = n_{ecc} + n_{NH_3}$ $n_{ecc} = n_T - n_{NH_3}$

$n_{NH_3} = n_T - n_{ecc} = (10^{-2} - 1.81 \cdot 10^{-4})\ mol = 9.82 \cdot 10^{-3}$ mol di NH_3

$10^{-2} = 1.81 \cdot 10^{-3}$ ottengo $9.82 \cdot 10^{-3}$

25/03/2020

(4)

$9.82 \cdot 10^{-3}$ mol di NH_3 = mol di N

$9.82 \cdot 10^{-3} \cdot 14 = 1.375 \cdot 10^{-1}$ g di N

$1,375 \cdot 10^{-1} \cdot I_N = 1.375 \cdot 10^{-1} \cdot 6,213 = 0.854$ g di α-caseina

27/03/2020

①

α_{S1}-Cn = 38 % 16.1

α_{S2}-Cn = 11 % 16.9

β-Cn = 36 % 45.5

K-Cn = 13 % 19.5

γ-Cn = 2 % 2

α_{S1}-CN ⇦ MM = 24494.86 N = 279 3906 AA = 214

α_{S2}-CN ⇨ MM = 26018.69 N = 303 4242 AA = 222

β-CN ⇒ MM = 25147.35 N = 286 4004 AA = 224

K-CN → MM = 21237.39 N = 245 3430 AA = 190

γ-CN (mus) → MM = 21100.61 N = 243 3402 AA = 184

I_N 8 α_{S1} = 6.27 α_{S2} = 6.13

β = 6.28 K = 6.19 γ = 6.20

I_N^{mod} = 6.24

I_N^{Tot} = 6.2464 = 6.2339

27/03/2020

(2)

$V_{OH^-} = 14.8\ mL \quad C_M(OH^-) = 10^{-1}\ M$

$V_i(HCl) = 100\ mL \quad C_i(HCl) = 1\ M$

$m_{camp} = 9.32\ g$

$n_{OH^-} = V \cdot C = 0.0148 \cdot 10^{-1} = 1.48 \cdot 10^{-3}\ mol =$

$= n_{HCl}\ (eccesso)$

$n^i_{HCl} = V_i \cdot C_i = 10^{-1}\ mol$

$n^R_{HCl} = n^i_{HCl} - n^e_{HCl} = 9.852 \cdot 10^{-2}\ mol =$

$= n_{NH_3} = n_N \qquad m_N = 9.852 \cdot 10^{-2} \cdot 14 = 1.379\ g\ N$

27/03/2020

③ $m_p = m_N \cdot I_N = 1.379 \cdot 6.24 = 8.60$ g di proteine

$m_p / m_s = 8.60 / 9.32 = 92.3\%$

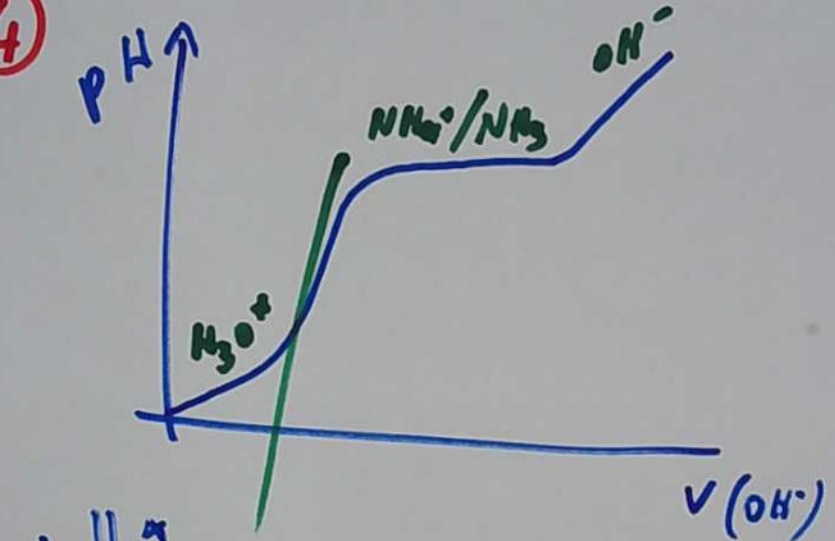
Cosa devo fare se la quantità di proteine fosse dimezzata?

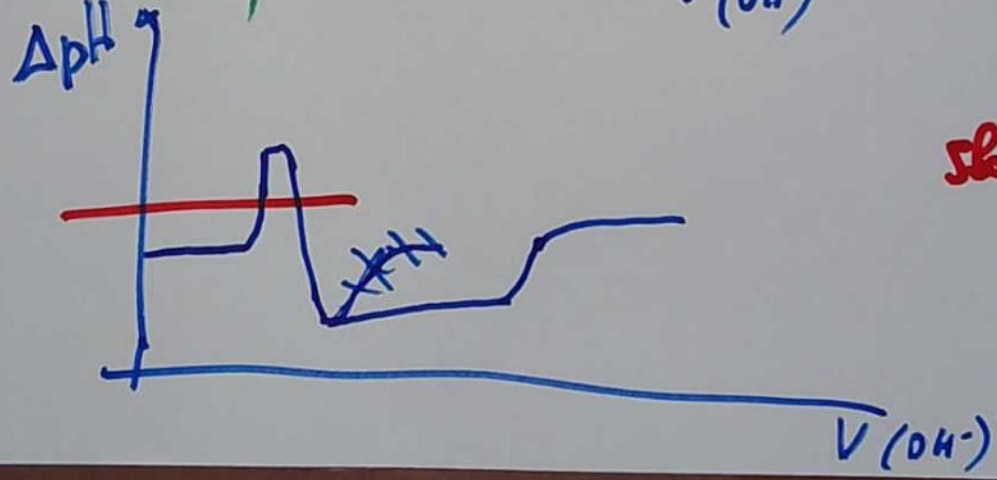
Cosa fare se invece è raddoppiata?

1. INTERVENIRE SU QUANTITÀ DI CAMPIONE
2. CAMBIARE CONCENTRAZIONE DI HCl
3. CAMBIARE CONCENTRAZIONE DI OH^-

27/03/2020

④





$$\text{Slope} = \frac{\Delta pH}{\Delta V}$$

31/03/2020

(1)

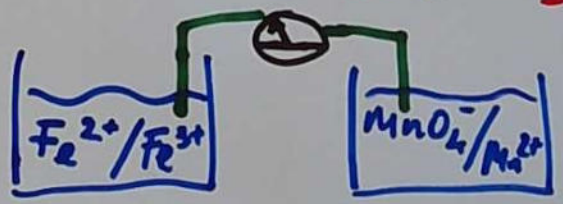
$$Fe^{3+}_{(III)} + MnO_4^-_{(VII)} \not\rightleftharpoons$$

A) $Fe^{2+}_{(II)} + MnO_4^-_{(VII)} \rightleftharpoons Fe^{3+} + Mn^{2+}$

B) $Fe^{3+}_{(III)} + MnO_2_{(IV)} \rightleftharpoons Fe^{2+} + MnO_4^-$

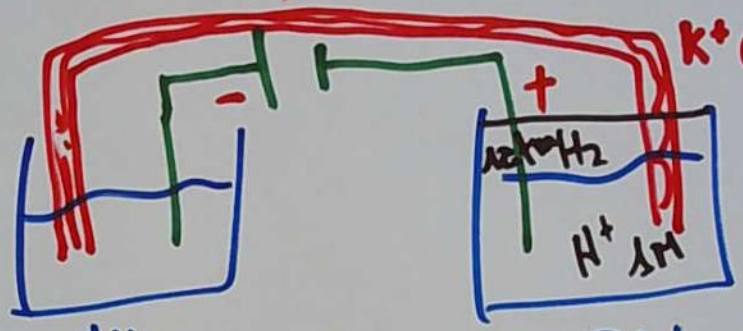
A_R) $MnO_4^- + 5e^- + 8H^+ \rightleftharpoons Mn^{2+} + 4H_2O$

A_O) $5Fe^{2+} \rightleftharpoons 5Fe^{3+} + 5e^-$



31/03/2020

② $8H^+ + MnO_4^- + \cancel{5e^-} + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 4H_2O + 5Fe^{3+} \; \cancel{+5e^-}$



$E^\circ = +1.51V$ $_{MnO_4^-/Mn^{2+}}$

MnO_4^-/Mn^{2+}

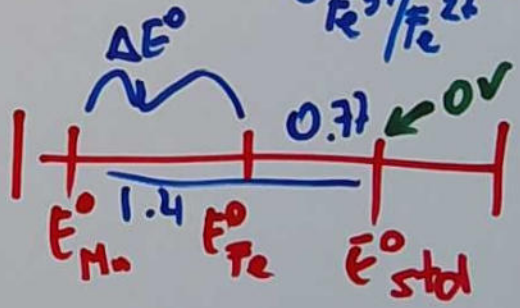
Fe^{3+}/Fe^{2+}

O_2/H_2O

H^+/H_2

$2H^+ + 2e^- \rightleftharpoons H_2$

$E^\circ_{Fe^{3+}/Fe^{2+}} = +0.77V$



$4H^+ + O_2 + 4e^- \rightleftharpoons 2H_2O$

31/03/2020

③

$2H^+ + 2e^- \rightleftharpoons H_2$ $\quad E^\circ_{H^+/H_2} = 0\,V$

$Zn^{2+} + 2e^- \rightleftharpoons Zn$ $\quad E^\circ_{Zn^{2+}/Zn} = -0.76\,V$

$2H^+ + \cancel{2e^-} + Zn \rightleftharpoons H_2 + Zn^{2+} + \cancel{2e^-}$

$K_{eq} > 1$

1/4/2020

77 Studenti (1)

$$\overset{+7}{Mn}O_4^- + \overset{-2}{H_2O} \rightleftharpoons \overset{+2}{Mn^{2+}} + \overset{0}{O_2}$$

Rid

Ox

MnO_4^-/Mn^{2+} $E^\circ_{Mn} = +1.51$

O_2/H_2O $E^\circ_{O_2} = +1.23$

$8H^+ + \overset{+7}{Mn}O_4^- + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$ ×4

$2\overset{-2}{H_2O} \rightleftharpoons \overset{0}{O_2} + 4e^- + 4H^+$ ×5

1) Atomi redox
2) Elettroni
3) Cariche (ambiente)
4) Masse
5) Bilanciamento tra 2 semireazioni
6) Semplificazione

$32H^+ + 4MnO_4^- + 20e^- + 10H_2O \rightleftharpoons 4Mn^{2+} + 16H_2O + 5O_2 + 20e^- + 20H^+$

$12H^+ + 4MnO_4^- \rightleftharpoons 4Mn^{2+} + 6H_2O + 5O_2$

$12H_3O^+ + 4MnO_4^- \rightleftharpoons 4Mn^{2+} + 18H_2O + 5O_2$

1/4/2020 ②

$$12\,H_3O^+ + 4\,MnO_4^- \rightleftharpoons 4\,Mn^{2+} + 18\,H_2O + 5\,O_2$$

$$K_{eq} = \frac{[Mn^{2+}]^4 \cdot [O_2]^5}{[MnO_4^-]^4 \cdot [H_3O^+]^{12}}$$

Nerst

$$E_{\frac{MnO_4^-}{Mn^{2+}}} = E^0_{\frac{MnO_4^-}{Mn^{2+}}} - \frac{RT}{nF} \cdot \ln \frac{\pi C_P}{\pi C_R} = 1.51 - \frac{RT}{nF} \cdot \ln \frac{C_{Mn^{2+}}}{C_{MnO_4^-} \cdot C_{H^+}^8}$$

0.0592 / log

$$= 1.51 - \frac{0.0592}{n} \cdot \log \frac{C_{Mn^{2+}}}{C_{MnO_4^-} \cdot C_{H^+}^8}$$

$C_{MnO_4^-} = 10\,C_{Mn^{2+}} \rightarrow E = 1.522\,V$

$C_{MnO_4^-} = \frac{1}{10}\,C_{Mn^{2+}} \rightarrow E = 1.498\,V$

$C_{MnO_4^-} = C_{Mn^{2+}} \rightarrow E = E^0$

1/4/2020

③

$$O_2 + 4e^- + 4H^+ \rightleftharpoons 2H_2O$$

$$E = E^\circ - \frac{0.0592}{n} \cdot \log \frac{1}{P_{O_2} \cdot C_{H^+}^4}$$

$P_{O_2} = 10$ atm $pH = 0$

P_{O_2}

$$E = E^\circ - \frac{0.0592}{4} \cdot \log \frac{1}{10} = 1{,}245\ V$$

1.23 ✓

$+0.015$

$P_{O_2} = 0.1$ atm

$E = 1.23$

-0.015

$= 1.215\ V$

1/4/2020 (4)

$$\Delta E = \phi = E^{\circ}_{MnO_4^-/Mn^{2+}} - E_{O_2/H_2O}$$

$$E_{MnO_4^-/Mn^{2+}} = E^{\circ}_{Mn} - \frac{0.0592}{20} \cdot \log \frac{C^4_{Mn^{2+}} \cdot}{C^4_{MnO_4^-} \cdot C^{32}_{H^+}}$$

~~$$E_{O_2/H_2O} = E^{\circ}_{O_2} - \frac{0.0592}{20} \cdot \log \left(\frac{P^5_{O_2} \cdot C^{20}_{H^+}}{1} \right)^{-1}$$~~

$$E_{O_2/H_2} = E^{\circ}_{O_2} - \frac{0.0592}{20} \cdot \log \frac{1}{P^5_{O_2} \cdot C^{20}_{H^+}}$$

1/4/2020

(5)

$$\Delta E = E^{\circ}_{Mn} - \frac{0.0592}{20} \cdot \log \frac{C^4_{Mn^{2+}}}{C^4_{MnO_4^-} \cdot C^{32}_{H^+}} -$$

$$- \left(E^{\circ}_{O_2} - \frac{0.0592}{20} \cdot \log \frac{1}{P^5_{O_2} \cdot C^{20}_{H^+}} \right)$$

$$= \left(E^{\circ}_{Mn} - E^{\circ}_{O_2} \right) - \left(\frac{0.0592}{20} \cdot \left[\log \frac{C^4_{Mn}}{C^4_{MnO_4^-} \cdot C^{32}_{H^+}} - \log \frac{1}{P^5_{O_2} \cdot C^{20}_{H^+}} \right] \right)$$

$$\Delta E^{\circ} - \frac{0.0592}{20} \cdot \log \frac{C^4_{Mn^{2+}}}{C^4_{MnO_4^-} \cdot C^{32}_{H^+}} \cdot \frac{P^5_{O_2} \cdot C^{20}_{H^+}}{1}$$

$$\Delta E = \Delta E^\circ - \frac{0.0592}{20} \log \frac{C^4_{Mn^{2+}} \cdot P^5_{O_2}}{C^4_{MnO_4^-} \cdot C^{12}_{H^+}}$$ fuori dell'equilibrio

1/4/2020 (6)

All'equilibrio

$$\phi = \Delta E^\circ - \frac{0.0592}{20} \cdot \log \frac{[Mn^{2+}]^4 \cdot P^5_{O_2}}{[MnO_4^-]^4 \cdot [H^+]^{12}}$$

$$\phi = \Delta E^\circ - \frac{0.0592}{n} \cdot \log K_{eq}$$

$$\Delta E^\circ = \frac{0.0592}{n} \log K_{eq} \qquad K_{eq} = 10^{\frac{\Delta E^\circ \cdot n}{0.0592}}$$

3/4/2020

①

O_2/H_2O Fe^{3+}/Fe^{2+} Cu^{2+}/Cu^{+}

H_2O $pH=0$

$$E = E^\circ - \frac{0.0592}{n} \log \frac{[Red]}{[Ox]}$$

$E^\circ_{O_2/H_2O} = 1.23\ V$

$E_{H^+/H_2} = 0\ V$

$$4H^+ + O_2 + 4e^- \rightleftharpoons 2H_2O$$

$$E = 1.23 - \frac{0.0592}{4} \log \frac{1}{[O_2]\cdot[H^+]^4}$$

MAX

$S_{O_2}(25°C) = 8.23\ mg/L$

$E^{O_2M} = 1.23 - \frac{0.0592}{4} \log \frac{1}{2.57\cdot10^{-4}\cdot10^{-28}} = 0.76$

$= 2.57\cdot10^{-4}\ M$

MIN

$E^{O_2m} = 1.23 - \frac{0.0592}{4} \log \frac{1}{3.12\cdot10^{-5}\cdot10^{-28}} = 0.749$

$S_{O_2}(25°C) = 1\ mg/L$

$= 3.12\cdot10^{-5}\ M$

②

3/4/2020

$2H^+ + 2e^- \rightleftharpoons H_2$ $\quad E^\circ_{H^+/H_2} = 0\,V$ $\quad S_{H_2} = 10^{-3}\,M$

$$E = E^\circ - \frac{0.0592}{2} \log \frac{[H_2]}{[H^+]^2}$$

$$E = 0 - \frac{0.0592}{2} \log \frac{1}{10^{-14}} = -0.41$$

$E = 0.4\,V$

$$0.4 = 0 - \frac{0.0592}{2} \log \frac{[H_2]}{10^{-14}}$$

$$13.513 = -\log \frac{[H_2]}{10^{-14}}$$

$$-\log [H_2] = 27.51$$

pH = 0 $\quad E = E^\circ$

pH = 7 $\quad E =$

$E^{0\prime} = E^\circ$ @ pH = 7

$-0.32 \quad [H_2] = 10^{-3}\,M$

$-0.24 \quad [H_2] = 10^{-6}\,M$

$+0.4 \quad [H_2] = 10^{-27.51}\,M$

$$\frac{0.4}{0.0592} \cdot 2 = -\log \frac{[H_2]}{10^{-14}}$$

$$13.513 = -(\log [H_2] - \log 10^{-14})$$

$$13.513 = -\log [H_2] - 14$$

3/4/2020

③

$O_2 + 4e^- + 4H^+ \rightleftharpoons 2H_2O$

$E = 1.23 - \frac{0.0592}{4} \log \frac{1}{[O_2] \cdot [H^+]^4}$

$E = 0.4\ V$

$[O_2] = ?$

$pH = 7$

$0.4 = 1.23 - \frac{0.0592}{4} \cdot \log \frac{1}{X \cdot 10^{-28}}$

$1{,}23 - 0.4 = \frac{0.0592}{4} \log \frac{1}{X \cdot 10^{-28}}$

$56.08 = \log \frac{1}{X \cdot 10^{-28}}$

$56.08 = \log 1 - \log X \cdot 10^{-28} = 8.31 \cdot 10^{-29}$

$56.08 = -\log X + 28 \rightarrow X = 10^{-28.08}\ M = [illegible]\ M$

ESERCIZI

3/4/2020

(4)

1) $Fe^{3+} + 1e^- \rightleftharpoons Fe^{2+}$

$[Fe^{3+}] = ?$

$[Fe^{2+}] = ?$

$E = E^\circ - \frac{0.0592}{1} \log \frac{[Fe^{2+}]}{[Fe^{3+}]}$

$C_{Fe} = 10^{-5} M$

$E = 0.72\ V$

$E^\circ = 0.77\ V$

---

2) $C_{Fe} = 10^{-5} M$ $\quad [Fe^{3+}] = 10^{-6}\ M$ $\quad E = ?$

ESERCIZI

3/4/2020 (4)

1) $Fe^{3+} + 1e^- \rightleftharpoons Fe^{2+}$

$[Fe^{3+}] = ?$

$[Fe^{2+}] = ?$

$C_{Fe} = 10^{-5} M$

$E = E^\circ - \frac{0.0592}{1} \log \frac{[Fe^{2+}]}{[Fe^{3+}]}$

$E = 0.72\ V$

$\frac{0.72 - 0.77}{0.0592} = -\log \frac{[Fe^{2+}]}{[Fe^{3+}]}$

$E^\circ = 0.77\ V$

$\frac{[Fe^{2+}]}{[Fe^{3+}]} = 6.992 \qquad [Fe^{2+}] + [Fe^{3+}] = 10^{-5} M$

---

2) $C_{Fe} = 10^{-5} M \qquad [Fe^{3+}] = 10^{-6} M \qquad E = ?$

$E = 0.077 - \frac{0.0592}{1} \log \frac{C_{Fe} - [Fe^{3+}]}{[Fe^{3+}]}$

7/4/2020 (2)

7/4/2020 (1)

$32H^+ + MnO_4^- + 5Cl_2 \rightleftharpoons 4Mn^{2+} + 10ClO_4^- + 16H_2O$

$14 \times \quad 8H^+ + MnO_4^- + 5e^- \longrightarrow Mn^{2+} + 4H_2O \qquad E^\circ_{Mn} = 1.49V$

$5 \times \quad 8H_2O + Cl_2 \longrightarrow 2ClO_4^- + 14e^- + 16H^+ \qquad E^\circ_{Cl} = 1.28V$

$32H^+ + 4MnO_4^- + 70e^- + 40H_2O + 5Cl_2 \rightleftharpoons 14Mn^{2+} + 5(16)H_2O + 10ClO_4^- + 70e^- + 80H^+$

$\Delta E^\circ = 0.21V$

$K_{eq} = 10^{\frac{\Delta E^\circ \cdot n}{0.0592}} = 10^{\frac{0.21 \cdot (n \to 70)}{0.0592}} = 10^{248.3}$

$32H^+ + 4MnO_4^- + 5Cl_2 \rightleftharpoons 14Mn^{2+} + 16H_2O + 10ClO_4^-$

ACIDO-BASE

$K_{eq} = \frac{K_a \cdot K_b}{K_w}$

REDOX

$K_{eq} = 10^{\frac{\Delta E^\circ \cdot n}{0.0592}}$

$HClO_2 \rightarrow Cl_2 \quad E^\circ = 1.66 \quad 3e^-$

$ClO_2 \rightarrow HClO_2 \quad E^\circ = 1.19 \quad 1e^-$

$ClO_2 \rightarrow HClO_2 \rightarrow Cl_2$

$\frac{3 \cdot 1,66 + 1 \cdot 1.19}{4} = 1.542$

3/4/2 (2)

7/4/2020 (2)

7/4/2020

(2)

ESERCIZI

$MnO_4^- + O_2 \rightleftharpoons$ (H^+)

$H_2\overset{-1}{O}_2 \rightarrow O_2 +$ ~~~ (H^+)

$\overset{0}{Cl}_2 + \cancel{OH^-} \rightarrow$ (OH^-)

$MnO_2 \rightarrow$ (H^+)

8/4/2020

①

$ClO^- + Ag$

$E^\circ_N = \begin{cases} 0.96\ V\ (H^+) \\ 0.16\ V\ (OH^-) \end{cases}$

$E^\circ_{Ag} = 0.80\ V$

$NO_3^- + Ag \rightleftharpoons NO + Ag^+$

$+3e^-$ $\quad$ $-1e^-$

$C_M = \frac{n}{V}$

$C_N = \frac{eq}{V}$

$NO_3^- \xrightarrow[0.94V]{2e^-} HNO_2 \xrightarrow[0.996V]{1e^-} NO$

$(2 \cdot 0.94 + 1 \cdot 0.996)/3$

$0.96V$

① $3e^- + NO_3^- + 4H^+ \longrightarrow NO + 2H_2O$

② $Ag \longleftrightarrow Ag^+ + 1e^-$

$3Ag \longrightarrow 3Ag^+ + 3e^-$

$NO_3^- + 4H^+ + 3Ag \rightleftharpoons NO + 3Ag^+ + 2H_2O$

$Kep = 10^{8.1}$

Nelle redox: 1 equivalente è la quantità di sostanza che scambia 1 mole di e^-

$1\ eq\ NO_3^- = 1/3\ mol\ di\ NO_3^-$

8/4/2020 (2)

$C_M = \frac{n}{V}$ $\quad C_N = \frac{eq}{V}$

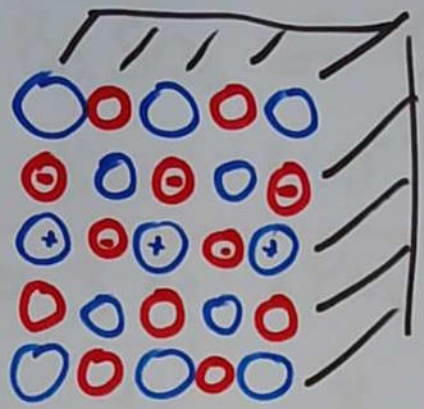
mol di sostanza → $n = ?^{\leftarrow 3}\ eq$ $\quad eq = ?^{\leftarrow 1/3}\ n$ $\quad eq = \frac{n}{ne^-}$

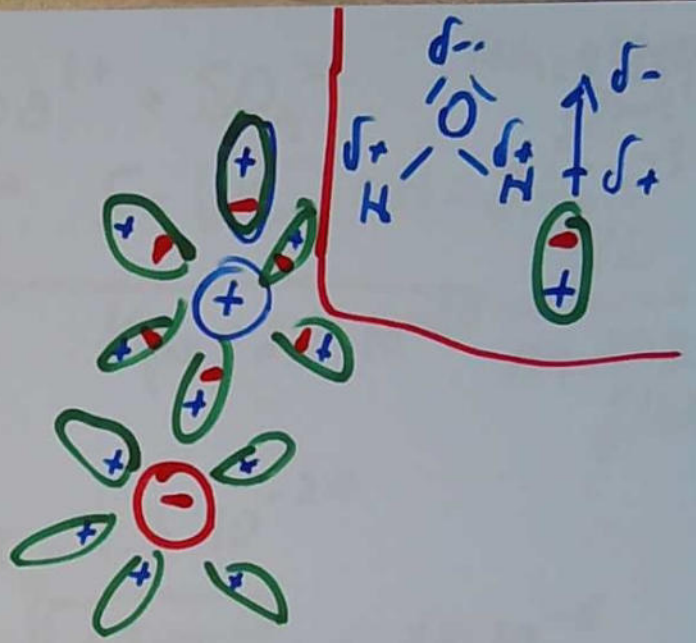
redox con 3 e^- scambiati

1 eq scambia 1 mol di e^-

15/04/2020

1





$$NaCl_{(s)} \overset{H_2O}{\rightleftharpoons} Na^+_{(aq)} + Cl^-_{(aq)}$$

$K_{eq} = K_{ps}$ $\quad K_{ps} = \dfrac{[Na^+] \cdot [Cl^-]}{1}$

$$CaCO_{3\,(s)} \overset{H_2O}{\rightleftharpoons} Ca^{2+} + CO_3^{2-}$$

$K_{ps} = [Ca^{2+}] \cdot [CO_3^{2-}] = X^2 = 3.8 \cdot 10^{-9}$

$X = 6.16 \cdot 10^{-5}\ M$

$S = \sqrt{K_{ps}} \cdot \frac{MM}{MM/V} = 6.16 \cdot 10^{-3}\ g/L$

15/04/2020 (2)

$BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{=}$ $MM = 233.39\ g/mol$

$K_{ps} = 1.1 \cdot 10^{-10}$ $S = \sqrt{K_{ps}} \cdot MM = 2.45 \cdot 10^{-3}\ g/L$

$Ag_3PO_4 \rightleftharpoons 3Ag^+ + PO_4^{3-}$ $K_{ps} = 1.3 \cdot 10^{-20}$ $MM = 391.58\ g/mol$

$3x \quad x$

$[Ag^+]^3 \cdot [PO_4^{3-}] = K_{ps}$ $(3x)^3 \cdot x = 1.3 \cdot 10^{-20}$

$27x^4 = 1.3 \cdot 10^{-20}$ $x = \sqrt[4]{\frac{1.3 \cdot 10^{-20}}{27}} = 4.68 \cdot 10^{-6}$

$S = x \cdot MM = 1.83 \cdot 10^{-3}\ g/L$

$Fe(OH)_2 \rightleftharpoons Fe^{2+} + 2OH^-$ $K_{ps} = 7.9 \cdot 10^{-15}$ $MM = 89.84\ g/mol$

$x \quad 2x$

$x(2x)^2 = 7.9 \cdot 10^{-15}$ $x = \sqrt[3]{\frac{7.9 \cdot 10^{-15}}{4}} = 1.25 \cdot 10^{-5}\ mol/L$ $S = 1.13 \cdot 10^{-3}\ g/L$

$[OH^-] = 2x = 2.5 \cdot 10^{-5}\ M$ $pH = 9.40$

15/4/2020 (3)

$Fe(OH)_3 \rightleftharpoons Fe^{3+} + 3OH^-$ $K_{ps} = 6.3 \cdot 10^{-38}$ MM = 106.84 g/mol

$x \quad 3x$

$x \cdot (3x)^3 = 6.3 \cdot 10^{-38}$ $\quad x = \sqrt[4]{\frac{6.3 \cdot 10^{-38}}{27}} = 2.20 \cdot 10^{-10}$ mol/L $\quad S = 2.35 \cdot 10^{-8}$ g/L

$[OH^-] = 3x = 6.6 \cdot 10^{-10}$ M $\quad K_W = [H_3O^+] \cdot [OH^-]$

$y \quad y + 6.6 \cdot 10^{-10}$

$\longrightarrow y = 10^{-7}$

per Fe^{2+} $\longrightarrow$ $K_W = [H_3O^+] \cdot [OH^-]$

$y \quad y + 2.5 \cdot 10^{-5}$

$\longrightarrow y = 4 \cdot 10^{-10}$

Fe 1.2 mg / 100 g di carne

$g \; \frac{1.2 \cdot 10^{-3}}{111,68 \text{ g/mol}} \cdot \frac{1}{0.1 L} = 2.15 \cdot 10^{-4} M$

$\downarrow$ compatibile con

$pH = 2.82 \leftarrow [OH^-] = 6.64 \cdot 10^{-12}$

$pH = 7$

$[OH^-] = 10^{-7}$

$[Fe^{3+}] \cdot [OH^-]^3 = K_{ps}$

$[Fe^{3+}] = \frac{K_{ps}}{10^{-21}} = 6.3 \cdot 10^{-17}$

17/4/2020

(1)

$[Fe^{2+}] \cdot [OH^-]^2 = K_{ps} = 7.9 \cdot 10^{-15}$

$[Fe^{2+}] = 2.15 \cdot 10^{-4} M$

$[OH^-]^2 = \frac{7.9 \cdot 10^{-15}}{2.15 \cdot 10^{-4}}$

$[OH^-] = 6.06 \cdot 10^{-6}$

$[OH^-]^2 = 3.67 \cdot 10^{-11}$

$pH = 8.78$

$[Fe^{2+}] \cdot [OH^-]^2 = K_{ps}$ $\quad pH = 7$ $\quad [OH^-] = 10^{-7} M$

$[Fe^{2+}] = \frac{7.9 \cdot 10^{-15}}{10^{-14}} = 7.9 \cdot 10^{-1} M$

$n = C \cdot V = 7.9 \cdot 10^{-1} M \cdot 0.1 L = 7.9 \cdot 10^{-2} mol$

$m = n \cdot mm = 7.9 \cdot 10^{-2} \cdot 55.68 g/mol = 4.40 g$

17/4/2020

(2)

$Ag_3PO_4 \rightleftharpoons 3Ag^+ + PO_4^{3-}$

$x = 4.68 \cdot 10^{-6}$ $\quad 3x$

Calcolare $E^*_{Ag^+/Ag}$ in una soluzione satura di Ag_3PO_4

$E^\circ_{in\ H^+} = 0.80\,V$

$E^\circ_{in\ OH^-} = -0.37\,V$

$E = E^\circ - \frac{0.0592}{1} \lg \frac{1}{[Ag^+]}$

$K_{ps} = [Ag^+]^3 \cdot [PO_4^{3-}] = 1.3 \cdot 10^{-20}$

$[PO_4^{3-}] = ?$

$PO_4^{3-} + H_2O \rightleftharpoons HPO_4^{2-} + OH^-$

i $\quad 4.68 \cdot 10^{-6}$

eq $\quad 4.68 \cdot 10^{-6} - y \qquad y \qquad y + w$

$K_{b1} = \frac{y(y+w)}{x-y} = 10^{-2} \quad w$

$K_{ps} = 3x \cdot (x-y)$

$K_w = w(w+y)$

17/4/2020

(3)

$K_{b_1} = 10^{-2}$ $K_{ps} = 1.3 \cdot 10^{-20}$

$$10^{-2} = \frac{y^2}{x-y} \qquad 1.3 \cdot 10^{-20} = (3x)^3 (x-y)$$

$$y^2 = 10^{-2}(x-y); \qquad \boxed{1.3 \cdot 10^{-20} = 27x^4 - 27x^3 y}$$

$$y^2 = 10^{-2}x - 10^{-2}y \qquad 10^{-2}x = y^2 + 10^{-2}y$$

$$x = \frac{y^2 + 10^{-2}y}{10^{-2}}$$

$$1.3 \cdot 10^{-20} = 27\left(\frac{y^2 + 10^{-2}y}{10^{-2}}\right)^4 - 27\left(\frac{y^2 + 10^{-2}y}{10^{-2}}\right)^3 y$$

$x = 1M$

$y = 9.51 \cdot 10^{-2}$

$$y^2 + 10^{-2}y - 10^{-2} = 0$$

$$y = \frac{-10^{-2} + \sqrt{10^{-4} + 4 \cdot 10^{-2}}}{2}$$

17/4/2020 (4)

$Ag_3PO_4 \rightleftharpoons 3Ag^+ + PO_4^{3-}$ $\quad [Ag^+]^3 \cdot [PO_4^{3-}] = 10^{-20}$

$\quad\quad\quad\quad 3x \quad\quad x-y$

$PO_4^{3-} + H_2O \rightleftharpoons HPO_4^{2-} + OH^-$ $\quad pH = 14$

$x-y \quad\quad\quad y \quad\quad y$ $\quad K_{a_3} = 10^{-12} = \frac{[PO_4^{3-}][H^+]}{[HPO_4^{2-}]}$

Ipotesi solubilità $> 1\,M$

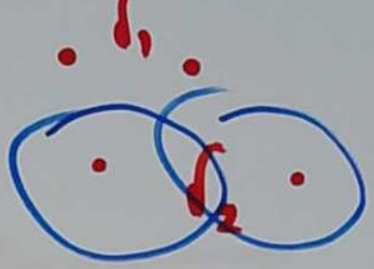
$C_{Ag_3PO_4} = 1\,M \longrightarrow [PO_4^{3-}] = 1\,M \,;\, [Ag^+] = 3\,M$

$1-y \longrightarrow y^2 \quad K_3 = \frac{y^2}{1-y} \quad [PO_4^{3-}] = \frac{10^{-20}}{27} = 3.7 \cdot 10^{-22}$

$10^{-5}-y \quad\quad y = 9.5 \cdot 10^{-2}$

21/04/2020

(1)



$CH_3-C_6H_4-C(=O_1)-O-H$

orbitali di legame

" " anti-legame

" " non-legame

Lowest unoccupied MO

LUMO

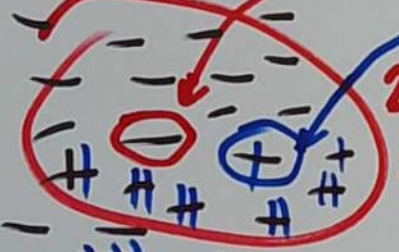
$E = h\nu$

HOMO

Highest occupied MO

$C_8H_8O_2$

18 nuclei



24 orbitali di anti-legame

96 e^-

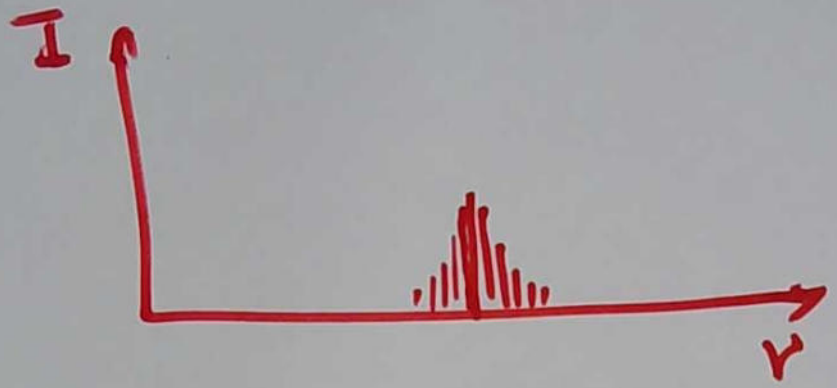
48 orb. mol.

24 orbitali di legame

at. orb.	32	8 C	$\nearrow 2$ $\searrow 4$	32
"	8	8 H	$\rightarrow 1$	8
	8	20	$\rightarrow 2$ $\searrow 6$	12
at. orb.	48			52_e^-

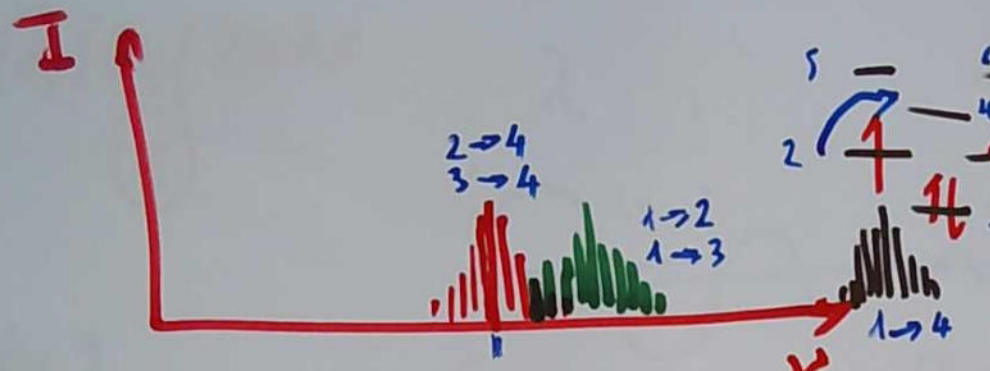
21/04/2020

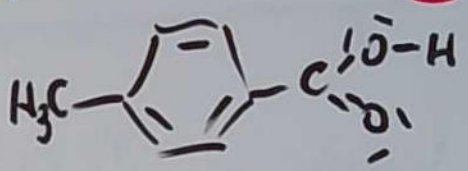
(2)



21/04/2020

2





$C_8H_8O_2$

18 nuclei

orbitali esterni = 48

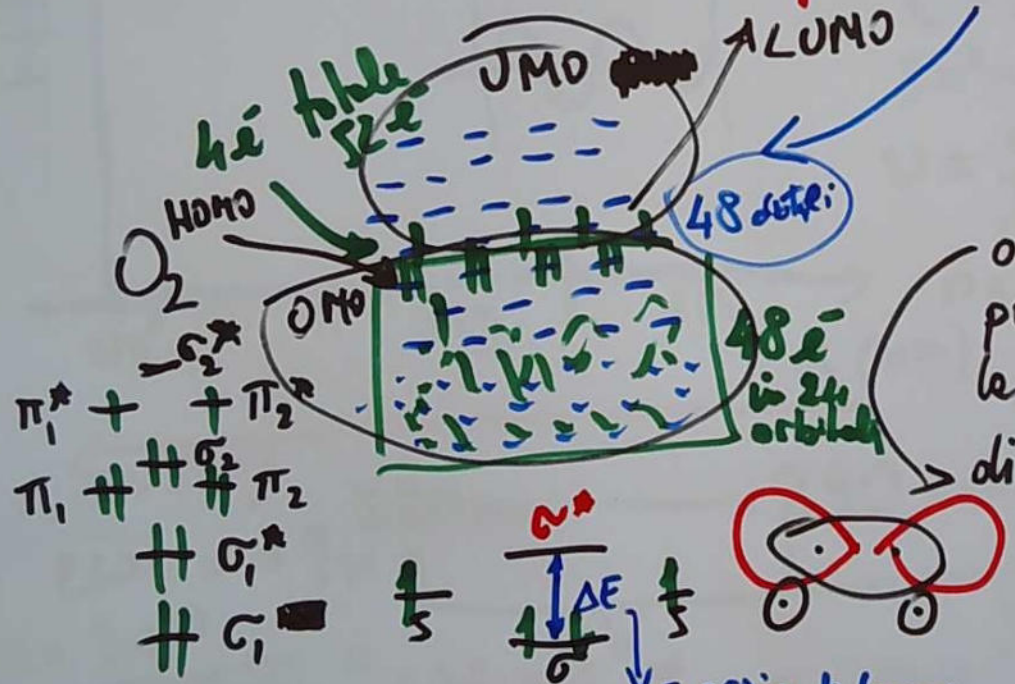
possono accogliere = 96 e^-

le molecole ne = 52 e^- esterni

diventano 48 orbitali molecolari

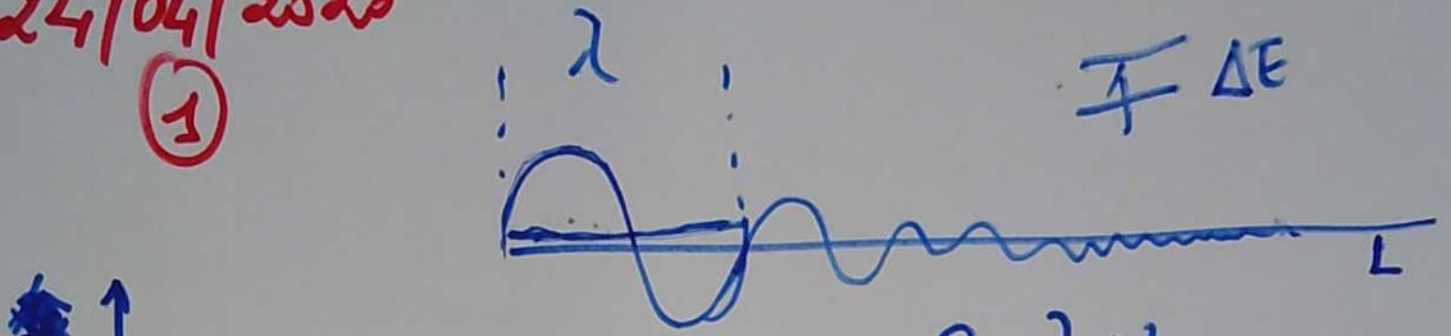
24 legame

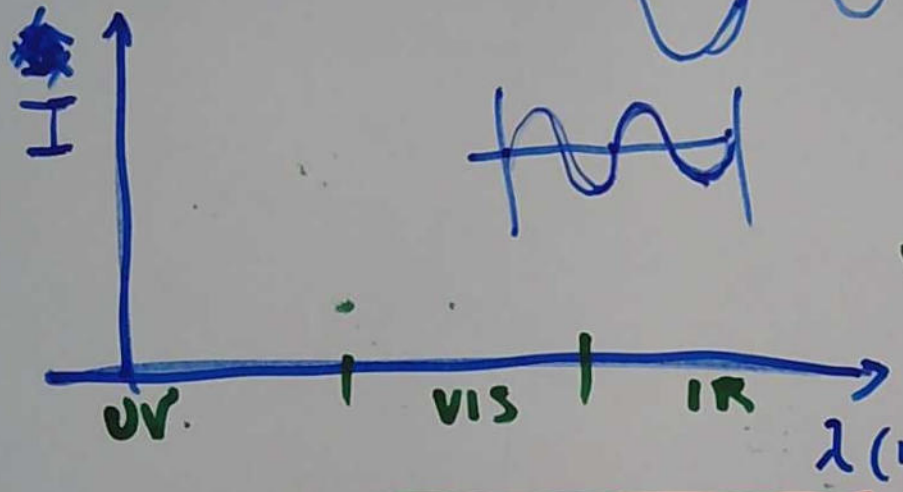
24 antilegame



24/04/2020

(1)





$C = \lambda \cdot \nu$

$3 \cdot 10^8 \, m s^{-1} = m \cdot s^{-1}$

$E = h\nu$

W

$\nu = \frac{c}{\lambda}$

$\bar{n} = \frac{1}{\lambda}$

$\leftarrow \nu (s^{-1})$

220 nm ⟷ 390 nm ⟷ 800 nm

UV VISIBILE IR

220 nm = ? ν

$\nu = \frac{3 \cdot 10^8}{220 \cdot 10^{-9} \, m} = 1.36 \cdot 10^{15} \, s^{-1}$

$\rightarrow 6.62 \cdot 10^{-34} \, J \cdot s^{-1} \cdot 1.36 \cdot 10^{15} \, s^{-1} = 9 \cdot 10^{-19} \, J$

24/04/2022 (2)

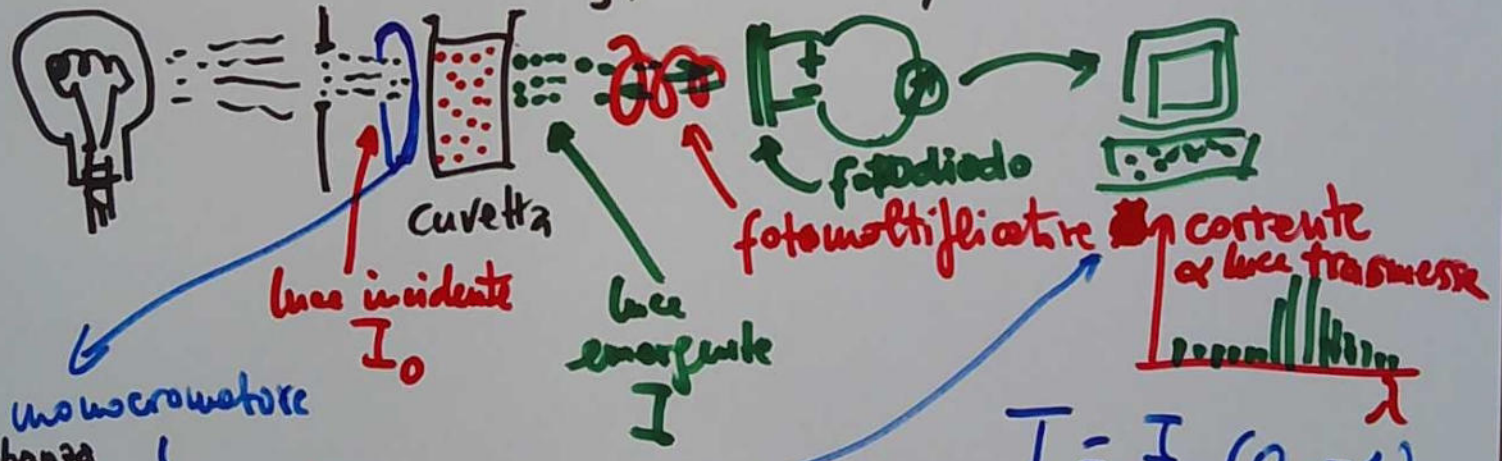
1 mL 10^{-3} M mm = 1000 g/mol

$n = C \cdot V = 10^{-3} \cdot 10^{-3} = 10^{-6}$ mol

$m = n \cdot mm = 10^{-6} \cdot 10^{3} = 10^{-3}$ g = 1,0 mg

$10^{-6} \cdot 6 \cdot 10^{23} = 6 \cdot 10^{17}$ molecole

$\nu = 1.36 \cdot 10^{15}$ s^{-1} → $9 \cdot 10^{-19}$ J/molecola → $9 \cdot 10^{-2}$ J

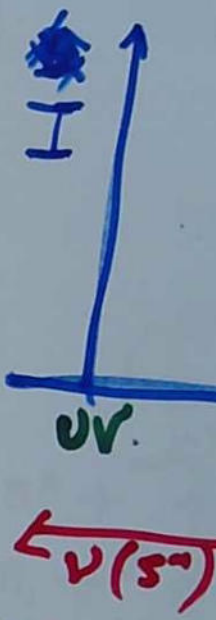


Assorbanza

$A = \varepsilon \cdot l \cdot C = \log \frac{1}{T}$

$T = \frac{I}{I_0}$ (0 → 1)

$T\% = \frac{I}{I_0} \cdot 100$ (0 → 100)



220 nm =

$\nu = \frac{3 \cdot 10^8}{220 \cdot 10^{-9}}$ m

24/04/2020

③

LEGGE di LAMBERT - BEER

$$\underbrace{C \cdot \varepsilon}_{K} \cdot l = A$$

M ↑ 1 cm

$M^{-1} \cdot cm^{-1}$

$$A = \log \frac{1}{T}$$

$$T = \frac{I}{I_0}$$

$$\varepsilon^{\lambda} = A^{\lambda}_{1M}$$

Assorbanza

$A_{\varepsilon \cdot l \cdot C} =$

24/04/2020

③

LEGGE di LAMBERT - BEER

$$\underbrace{C \cdot \varepsilon}_{K} \cdot l = A$$

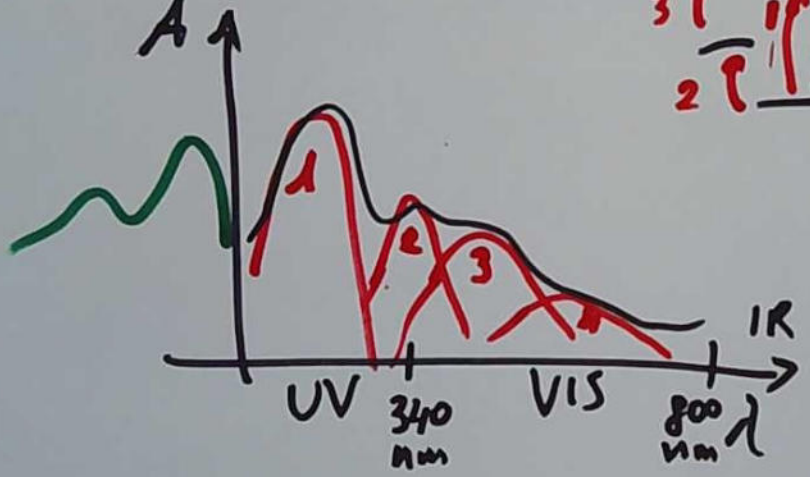
M ↑ 1 cm

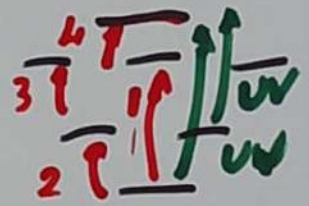
$M^{-1} \cdot cm^{-1}$

$$A = \log \frac{1}{T}$$

$$T = \frac{I}{I_0}$$

$$\varepsilon^{\lambda} = A^{\lambda}_{1M}$$





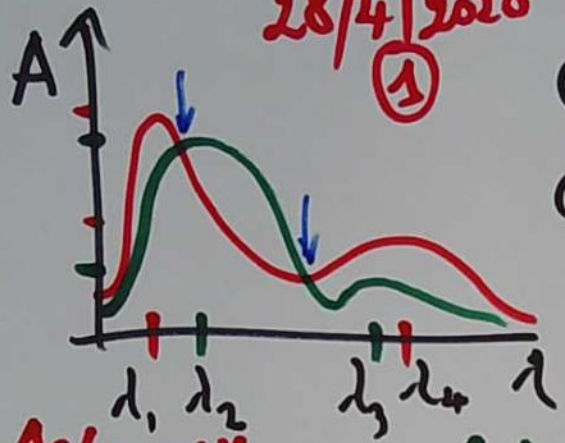
$$\frac{\varepsilon^{\lambda_1}}{\varepsilon^{\lambda_2}} = K$$

Indice di Purezza

$$\lambda = \frac{c}{\nu} \qquad h\nu = E$$

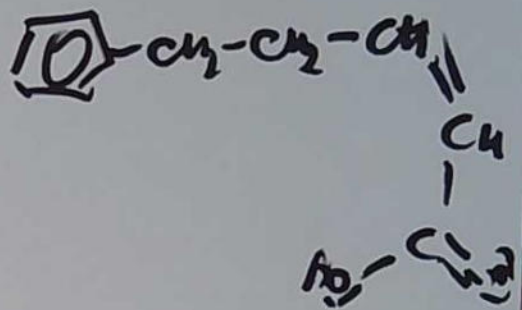
28/4/2020

(1)

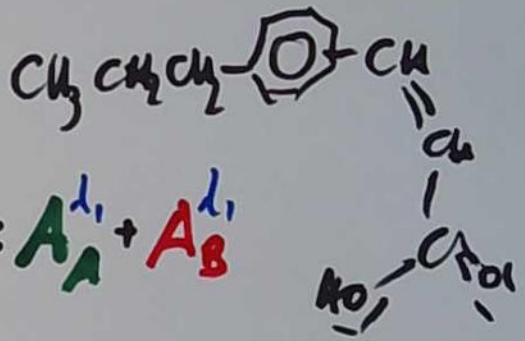


$C_A = 10^{-3}$ M (A)

$C_B = 10^{-3}$ M



(B)



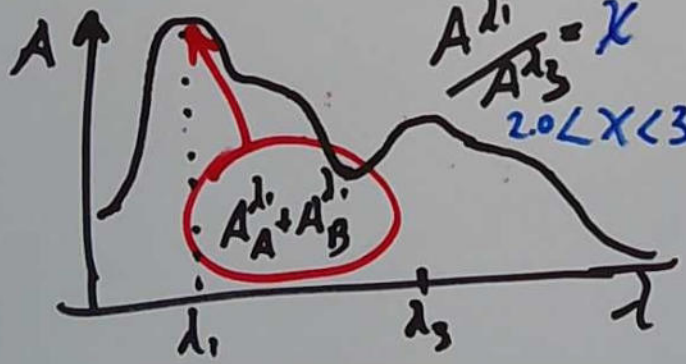
$A_2/A_3 = K'_B$

$\frac{A_2}{A_3} = K'_A$

$A_1/A_4 = K^2_A$

$\frac{A_1}{A_4} = K^2_B$

$A_T^{\lambda_1} = A_A^{\lambda_1} + A_B^{\lambda_1}$



$\frac{A^{\lambda_1}}{A^{\lambda_3}} = X$

$2.0 < X < 3.2$

$C_M(A) = 10^{-4}$ M

A^{λ_1}	A^{λ_2}	A^{λ_3}	A^{λ_4}
0.8	0.5	0.25	0.3

$C_M(B) = 10^{-6}$ M

A^{λ_1}	A^{λ_2}	A^{λ_3}	A^{λ_4}
0.04	0.05	2.02	2.015

$A^{\lambda_1} = \varepsilon^{\lambda_1} \cdot C$ $\quad \varepsilon^{\lambda_1} = \frac{A^{\lambda_1}}{C}$

$C = \frac{A^{\lambda_1}}{\varepsilon^{\lambda_1}}$

	280	340 nm	420	480 nm
	ε^{λ_1}	ε^{λ_2}	ε^{λ_3}	ε^{λ_4}
A	8000	5000	2500	3000
B	40000	50.000	20.000	15.000

$A_T^{340} = 1.3$ A.U. $\quad \lambda_2 = 340$ nm

$A_T^{480} = 0.78$ A.U. $\quad \lambda_4 = 480$ nm

$\frac{A^{340}}{A^{480}} = 1.667$

$C = \frac{A^{340}}{\varepsilon^{340}} = \frac{1.3}{5000} = 2.6 \cdot 10^{-4}$ M

$C = A^{480} / \varepsilon^{480} = \frac{0.78}{3000} = 2.6 \cdot 10^{-4}$ M

$\begin{cases} IP_A = \varepsilon_A^{\lambda_1} / \varepsilon_A^{\lambda_3} = 3.2 \\ IP_B = \varepsilon_B^{\lambda_1} / \varepsilon_B^{\lambda_3} = 2.0 \end{cases}$

$\begin{cases} IP_A = \varepsilon^{\lambda_2} / \varepsilon^{\lambda_4} = 1.667 \\ IP_B = \varepsilon^{\lambda_2} / \varepsilon^{\lambda_4} = 3.333 \end{cases}$

28/4/2020 (2)

28/4/2020

③

$A_T^{340} = 1.48$

$A_T^{480} = 0.82$

A = integratore

B = contaminante

$\frac{A^{340}}{A^{480}} = 1.805$

$1.667 < 1.805 < 3.333$

0.138

1.666

$\frac{0.138}{1.666} = 0.083$

8.3% (B)

$C = \frac{A_T^{340}}{\varepsilon^{340}}$?

$A_T^{340} = A_A^{340} + A_B^{340}$

$A_T^{480} = A_A^{480} + A_B^{480}$

$A_T^{340} = \varepsilon_A^{340} \cdot C_A + \varepsilon_B^{340} \cdot C_B$

$A^{480} = \varepsilon_A^{480} \cdot C_A + \varepsilon_B^{480} \cdot C_B$

$$\begin{cases} A_T^{340} = \varepsilon_A^{340} \cdot C_A + \varepsilon_B^{340} \cdot C_B \\ A^{480} = \varepsilon_A^{480} \cdot C_A + \varepsilon_B^{480} \cdot C_B \end{cases}$$

29/4/2020

①

$$\begin{cases} A_T^{340} = \varepsilon_A^{340} \cdot C_A + \varepsilon_B^{340} \cdot C_B \\ A_T^{480} = \varepsilon_A^{480} \cdot C_A + \varepsilon_B^{480} \cdot C_B \end{cases}$$

$$\begin{cases} 1.48 = 5000 \cdot C_A + 50.000 \cdot C_B \\ 0.82 = 3000 \cdot C_A + 15.000 \cdot C_B \end{cases} \qquad \begin{cases} C_A = \dfrac{1.48 - 50.000\, C_B}{5000} \\ 0.82 = 3000 \cdot \left(\dfrac{1.48 - 50.000 C_B}{5000} \right) + 15.000 C_B \end{cases}$$

$$0.82 = \frac{3000}{5000} \cdot 1.48 - \frac{3000}{5000} \cdot 50.000 C_B + 15.000 C_B$$

$$C_B = 1{,}78\%$$

$$0.82 - 0.888 = -30.000 C_B + 15.000 C_B$$

$$0.068 = 15.000 C_B \qquad C_B = 4.533 \cdot 10^{-6} M \qquad C_A = 2.507 \cdot 10^{-4} M$$

5/5/2020

1

$H_2 + Br_2 \rightleftharpoons 2HBr$

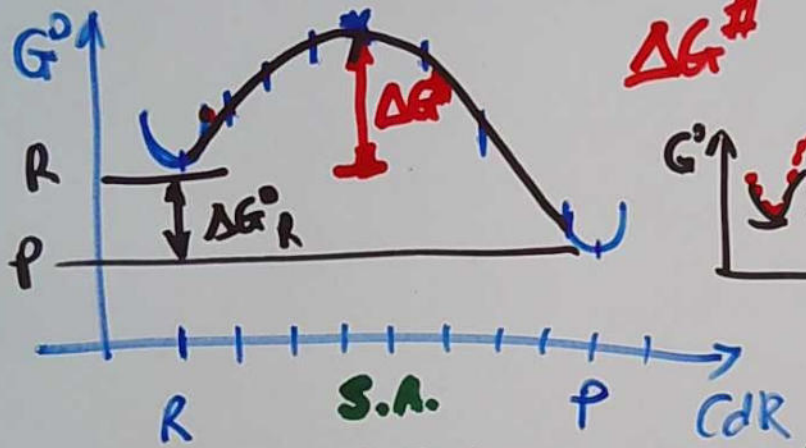
$K_{eq} = \dfrac{[HBr]^2}{[H_2][Br_2]}$

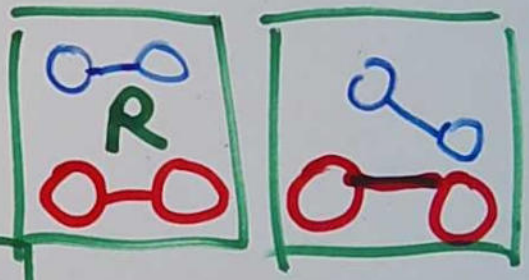
$K_{eq} = 10^{\frac{-\Delta G^\circ_R}{RT}}$

$\Delta G^\circ_R > 0 \quad K_{eq} < 1$

$\Delta G^\circ_R < 0 \quad K_{eq} > 1$

$\Delta G^\circ_R = 0 \quad K_{eq} = 1$

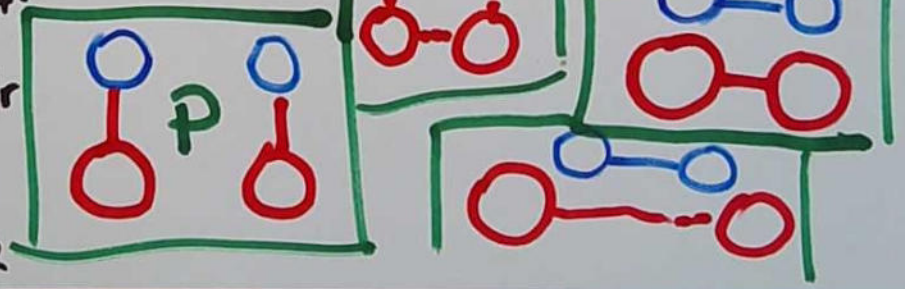




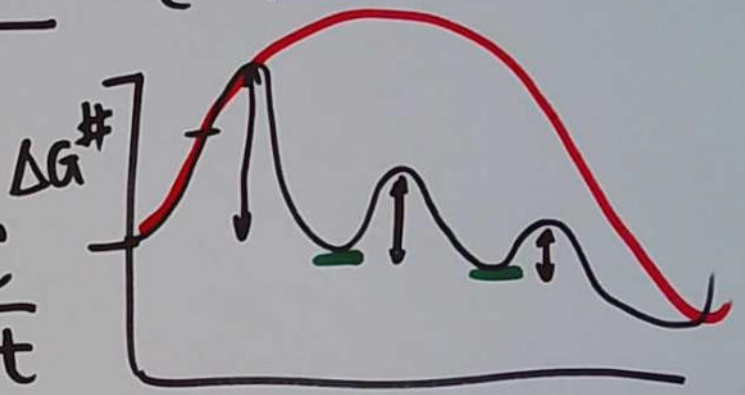
$H_2 + Br_2 \rightleftharpoons H_2 + 2\,Br^\cdot$

$H_2 + 2Br^\cdot \rightleftharpoons HBr + Br^\cdot + H^\cdot$

$HBr + Br^\cdot + H^\cdot \rightleftharpoons HBr + HBr$



$E_c = 3/2\,RT$



$$\bar{J} = \frac{\Delta C}{\Delta t} \qquad v_t = \frac{\delta C}{\delta t}$$

[ ]

5/5/2020

(2)

$v_0 = k \cdot C_A^m \cdot C_B^n$ $\quad aA + bB \rightleftharpoons cC + dD$ 6/5/2022 (1)

$m+n$ = ordine della reazione

$C_0(A)$	$C_0(B)$	$v_0\ (M \cdot s^{-1})$	q
$1.3 \cdot 10^{-2}$	$1.3 \cdot 10^{-2}$	$3 \cdot 10^{-4}$	
$2.6 \cdot 10^{-2}$	$1.3 \cdot 10^{-2}$	$1.2 \cdot 10^{-3}$	
$3.9 \cdot 10^{-2}$	$1.3 \cdot 10^{-2}$	$2.7 \cdot 10^{-3}$	
$1,3 \cdot 10^{-2}$	$2.6 \cdot 10^{-2}$	$3 \cdot 10^{-4}$	$n=0$
$1,3 \cdot 10^{-2}$	$3.9 \cdot 10^{-2}$	$3 \cdot 10^{-4}$	

$$\frac{v_0}{C_A^m} = q = k \cdot C_B^n$$

$$v = -\frac{\delta C_A}{\delta t} \cdot \frac{1}{a} = -\frac{\delta C_B}{\delta t} \cdot \frac{1}{b} = \frac{\delta C_C}{\delta t} \cdot \frac{1}{c} = \frac{\delta C_D}{\delta t} \cdot \frac{1}{d}$$

$\frac{v_0}{C_A^m}$, $m=1$: $2.308 \cdot 10^{-2}$; $4.615 \cdot 10^{-2}$; $6.923 \cdot 10^{-2}$

$m=2$: 1.775; 1.775; 1.775

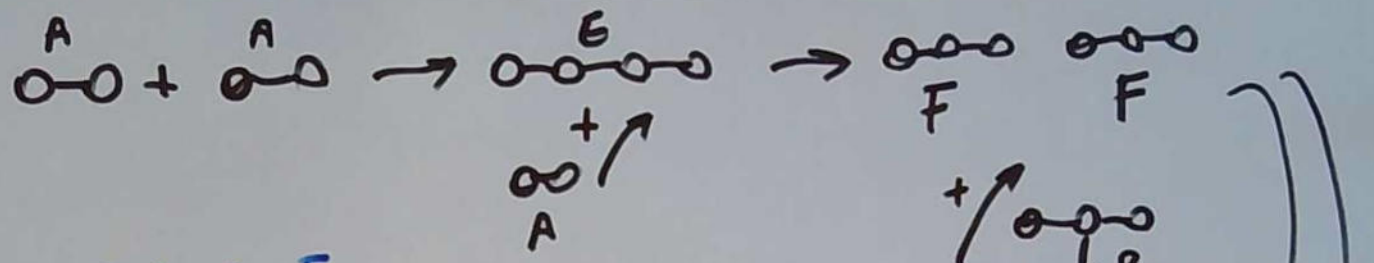
1 $2A \rightleftharpoons E$

$E + A \rightleftharpoons 2F$

$+ B \rightleftharpoons C$

$+ A \rightleftharpoons D$

→ ○○○○ + ○○○ → ○○○○○○○

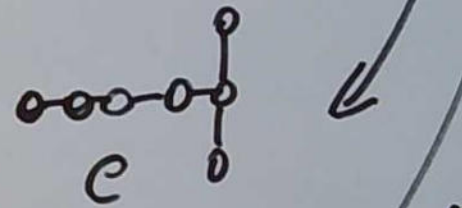


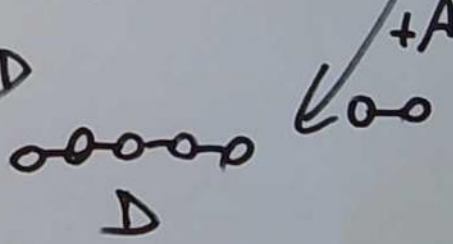
1 $2A \rightleftharpoons E$

2 $E + A \rightleftharpoons 2F$

3 $F + B \rightleftharpoons C$

4 $F + A \rightleftharpoons D$

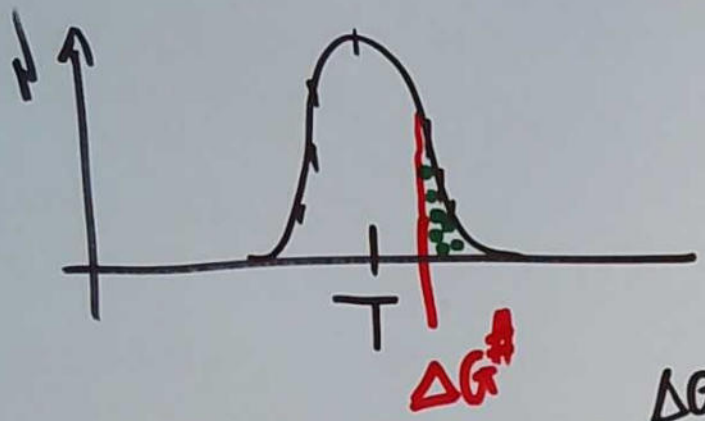




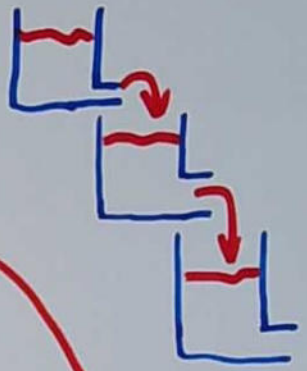
$4A + \cancel{E} + \cancel{2F} + B \rightleftharpoons \cancel{E} + \cancel{2F} + C + D$

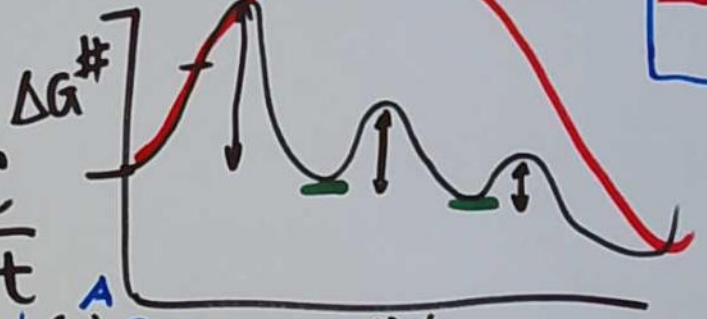
$4A + B \rightleftharpoons C + D$

6/5/2020

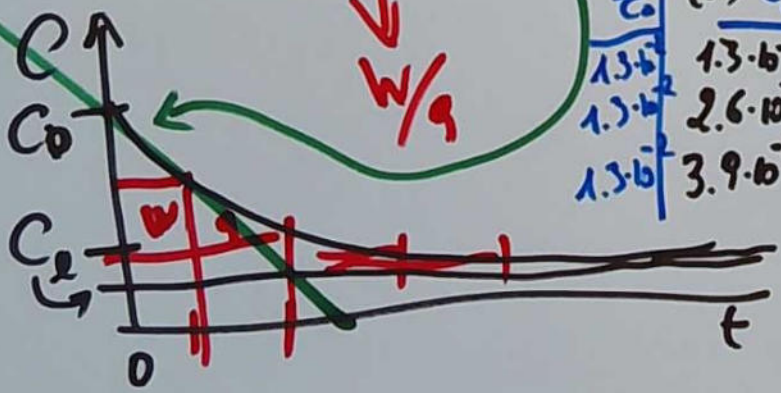


$E_c = 3/2\ RT$





$\bar{v} = \frac{\Delta C}{\Delta t}$ $\quad v_t = \frac{\delta C}{\delta t}$



W/S

B_{C_0}	(n) C_0	v_0 ($M\ sec^{-1}$)
1.3·10	$1.3 \cdot 10^{-2}$	$3 \cdot 10^{-4}$
1.3·10	$2.6 \cdot 10^{-2}$	$1.2 \cdot 10^{-3}$
1.3·10	$3.9 \cdot 10^{-2}$	$2.4 \cdot 10^{-3}$

[ ]

DATO EMPIRICO

$v_0 = k \cdot C_A^m \cdot C_B^n$

$A + B \rightleftarrows C + D$

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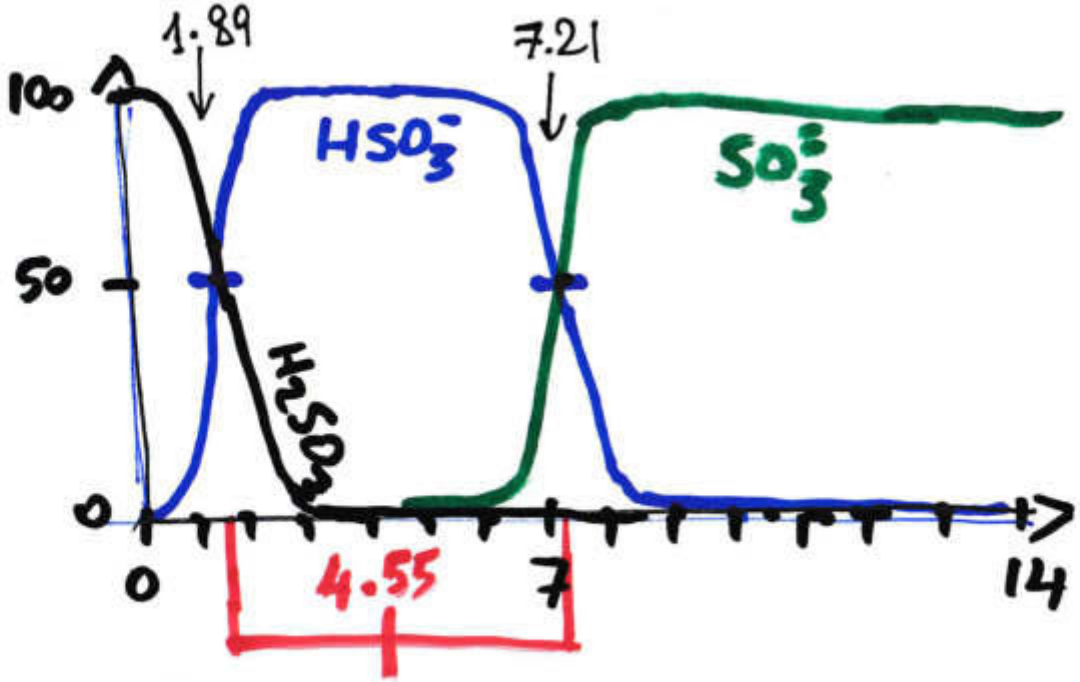
①

ESERCIZIO N. 4



$$H_2SO_3 + H_2O \rightleftharpoons HSO_3^- + H_3O^+$$

$$K_{a_1} = \frac{[HSO_3^-] \cdot [H_3O^+]}{[H_2SO_3]} = 1.3 \cdot 10^{-2} \quad pK_{a_1} = 1.886$$

$$HSO_3^- + H_2O \rightleftharpoons SO_3^{=} + H_3O^+$$

$$K_{a_2} = \frac{[SO_3^{=}] \cdot [H_3O^+]}{[HSO_3^-]} = 6.2 \cdot 10^{-8} \quad pK_{a_2} = 7.208$$

% H_2SO_3	pH	=
99.01	-0.11	$pK_{a_1}-2$
91	0.886	$pK_{a_1}-1$
50	1.866	pK_{a_1}
9.1	2.866	$pK_{a_1}+1$
0.99	3.866	$pK_{a_1}+2$
0.2	4.55	$\frac{pK_{a_1}+pK_{a_2}}{2}$
/	5.21	$pK_{a_2}-2$
/	6.21	$pK_{a_2}-1$
/	7.21	pK_{a_2}
/	8.21	$pK_{a_2}+1$
/	9.21	$pK_{a_2}+2$

ESERCIZIO N.4

19.05.20

pH	-0.11	0.886	1.866	2.866	3.866	4.55	5.21	6.21	7.21	8.21
$K_{a_1}/[H_3O^+]$	0.01	0.1	1	10	100	461	2108	21083	21083	$2{,}10 \cdot 10^5$
$[HSO_3^-]/[H_2SO_3]$	0.01	0.1	1	10	100	461	2108	$2.108 \cdot 10^4$	$2.108 \cdot 10^5$	$2{,}10 \cdot 10^5$
$[H_3O^+]$	1.288	$1.3 \cdot 10^{-1}$	$1.3 \cdot 10^{-2}$	$1.3 \cdot 10^{-3}$	$1.3 \cdot 10^{-4}$	$2.818 \cdot 10^{-5}$	$6.166 \cdot 10^{-6}$	$6.166 \cdot 10^{-7}$	$6.2 \cdot 10^{-8}$	$6.2 \cdot 10^{-9}$
% H_2SO_3	99.01	91.0	50	9.0	0.99	0.217	/	/	/	/
% HSO_3^-	0.99	9.0	50	91.0	99.01	99.57	99.01	91.0	50	9.0
% $SO_3^=$	/	/	/	/	/	0.217	0.99	9.0	50	91.0

pH = 7.0

$K_{a_2}/[H_3O^+] = 0.62 = \frac{[SO_3^=]}{[HSO_3^-]} = \frac{x}{100-x}$ $\quad x = 38.3\% = [SO_3^=]$ $\quad [HSO_3^-] = 61.7\%$

ESERCIZIO N.5

19.5.2020

(3)

$\overset{+7}{Mn}O_4^- + H_2\overset{-2}{O} \rightleftharpoons \overset{+4}{Mn}O_2 + H_2\overset{-1}{O_2}$

rid ox

pH=0

$[H_3O^+]=1\,M$

$4H^+ + MnO_4^- + 3e^- \rightarrow MnO_2 + 2H_2O$ ×2

$2H_2O \rightarrow H_2O_2 + 2e^- + 2H^+$ ×3

$6e^-$

$8H^+ + 2MnO_4^- + 6H_2O \rightleftharpoons 2MnO_2 + 4H_2O + 3H_2O_2 + 6H^+$

$2MnO_4^- + 2H_2O + 2H^+ \rightleftharpoons 2MnO_2 + 3H_2O_2$

$K_{eq} = \dfrac{[MnO_2]^2 \cdot [H_2O_2]^3}{[MnO_4^-]^2 \cdot [H^+]^2} = 8.3 \cdot 10^{-7}$

Calcolato mediante ΔE°

ESERCIZIO N.5

$\Delta E = 0 \qquad \Delta E = \Delta E^\circ - \frac{0.0592}{n} \cdot \log \frac{C_C^c \cdot C_D^d}{C_A^a \cdot C_B^b}$

19.5.2020 (4)

$\hookrightarrow 0 = \Delta E - \frac{0.0592}{6} \cdot \log K_{eq}$ All'equilibrio

$\log K_{eq} = \frac{\Delta E^\circ \cdot 6}{0.0592}$; $K_{eq} = 10^{\frac{\Delta E^\circ \cdot 6}{0.0592}}$

$C_A = [A] \cdot \sim$
$C_B = [B] \cdot \sim$
$\Delta E = 0$

$\Delta E^\circ = E^\circ_{rid} - E^\circ_{ox} = 1.70 - 1.76 = -0.06\ V$

MnO_4^- H_2O

$K_{eq} = 10^{\frac{-0.06 \cdot 6}{0.0592}} = 10^{-6.1} = 8.3 \cdot 10^{-7}$

$K_{eq} = \frac{[MnO_2]^2 \cdot [H_2O_2]^3}{[MnO_4^-]^2 \cdot [H^+]^2} = \frac{(C_{MnO_2} + 2x)^2 \cdot (C_{H_2O_2} + 3x)^3}{(C_{MnO_4^-} - 2x)^2 \cdot (10^{-pH} - 2x)^2}$

C = concentrazioni iniziali

ESERCIZIO N. 6

19.5/20 (5)

Elettrodo $HClO_2/Cl_2$ a pH = ∅

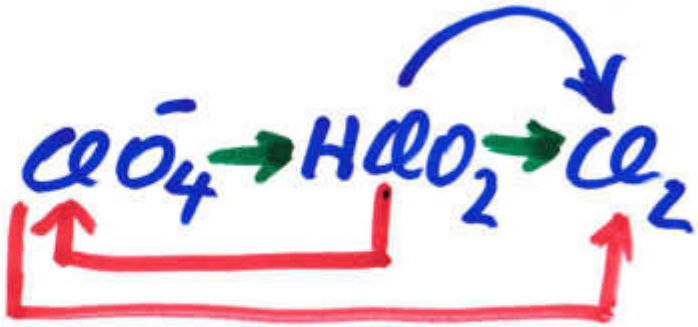
$C_{HClO_2} = 6.2 \cdot 10^{-3} M$ $C_{Cl_2} = 3.2 \cdot 10^{-3} M$

$E^\circ_{ClO_4^-/HClO_2} = 1.19 V$ $E^\circ_{ClO_4^-/Cl_2} = 1.28 V$

$E^\circ_{HClO_2/Cl_2} = ?$

$$2\,H\overset{+3}{Cl}O_2 + 6H^+ + 6e^- \rightarrow \overset{0}{Cl}_2 + 4H_2O$$

$$E = E^\circ - \frac{0.0592}{6} \cdot \log \frac{C_{Cl_2}}{C^2_{HClO_2} \cdot C^6_{H^+}}$$



LEGGE DI HESS:

L'ENERGIA IN GIOCO IN UNA REAZIONE NON DIPENDE DAL CAMMINO DELLA REAZIONE MA SOLAMENTE DALLO STATO INIZIALE E DA QUELLO FINALE

ESERCIZIO N.6

19.5.2020

(6)

$$\overset{+7}{Cl}O_4^- + 4e^- \rightarrow H\overset{+3}{Cl}O_2 \qquad E_1^\circ = 1.19\ V$$

$$2\overset{+7}{Cl}O_4^- + 14e^- \rightarrow \overset{0}{Cl}_2 \qquad E_2^\circ = 1.28\ V$$

$$H\overset{+3}{Cl}O_2 + 6e^- \rightarrow \overset{0}{Cl}_2 \qquad E_3^\circ = ?$$

$$2\,HClO_2 + 6H^+ + 6e^- \rightleftharpoons Cl_2 + 4H_2O$$

$$HClO_2 \xrightarrow{E_1^\circ,\ -1.19\times 4} ClO_4^- \xrightarrow{E_2^\circ,\ +1.28\times 7} Cl_2$$

rid $4e^-$ | rid $7e^-$

contiene e^- per ogni atomo

$$E_3^\circ = \frac{(-E_1^\circ \times 4) + (E_2^\circ \times 7)}{11} = \frac{-4.76 + 8.96}{11} = 0.38\ V$$

$$E = E^\circ - \frac{0.0592}{6}\log\frac{C_{Cl_2}}{C_{HClO_2}^2 \cdot C_{H^+}^6} = 0.38 - 9.87\cdot10^{-3}\cdot\log\frac{3.2\cdot10^{-3}}{3.84\cdot10^{-5}}$$

$C_{H^+} \leftarrow 1\ M$

$$E = 0.38 - 9.87\cdot10^{-3}\cdot 1{,}92 = 0.38 - 0.019 = 0.361\ V$$

CONSEGUENZA LEGGE DI HESS

19.5.2020

7

POSSIBILE SCOMPORRE QUALUNQUE REAZIONE TRA UN ACIDO E UNA BASE GENERICA IN DUE REAZIONE IN SEQUENZA CHE COINVOLGONO L'ACQUA

$$HClO_2 + NH_3 \rightleftharpoons ClO_2^- + NH_4^+$$

$$HClO_2 + H_2O \rightleftharpoons ClO_2^- + H_3O^+ \qquad K_{eq_1} = K_a(HClO_2)$$

$$H_3O^+ + NH_3 \rightleftharpoons H_2O + NH_4^+ \qquad K_{eq_2} = 1/K_a(NH_4^+)$$

$$HClO_2 + \cancel{H_2O} + \cancel{H_3O^+} + NH_3 \rightleftharpoons ClO_2^- + \cancel{H_3O^+} + \cancel{H_2O} + NH_4^+$$

$K_a(NH_4^+) \rightarrow K_b(NH_3)/K_w$

$$K_{eq} = \frac{[ClO_2^-]\cdot[NH_4^+]}{[HClO]\cdot[NH_3]} = \left(K_{a_{HClO_2}} \cdot K_{b(NH_3)}\right)/K_w$$

CONSEGUENZA LEGGE DI HESS

19.5.2020

REAZIONE SCOMPOSTA IN PASSI SUCCESSIVI (8)

1	$aA + bB \rightleftharpoons cC + dD$	K_{eq1}
2	$xX + yY \rightleftharpoons wW + jJ$	K_{eq2}
3	...	K_{eq3}
⋮	...	K_{eq4}
n	...	$K_{eq\,n}$
	REAZIONE TOTALE DATA DALLA SOMMA DELLE REAZIONI INTERMEDIE SUCCESSIVE	$K_{eq\,(TOT)}$

$$K_{eq(tot)} = K_{eq1} \cdot K_{eq2} \cdot K_{eq3} \cdots K_{eqn}$$

LA COSTANTE DI EQUILIBRIO DELLA REAZIONE COMPLESSIVA È PARI AL PRODOTTO DELLE COSTANTI DELLE REAZIONI INTERMEDIE