

# ESEMPIO 1

①

200 cc  $d = 1,2 \text{ g/cc}$  0,1 M He

200 cc  $\Rightarrow$  200 g di soluzione

200 cc  $\Rightarrow$  0,2 l  $\Rightarrow 0,2 \times 0,1 = 0,02 \text{ moli He in ①}$

$0,02 \times 36,46 = 0,73 \text{ g di He}$

$193,27 \text{ g di H}_2\text{O in ①}$

OPPURE  
 $M_1 = 0,1$

$$M_1 = \frac{0,02}{0,19327} = 0,1$$

↓

②

100 cc  $d = 1,13 \text{ g/cc}$

$100 \times 1,13 = 113 \text{ g di soluzione}$

$113 \times 0,38 = 45,22 \text{ g di He}$

$\frac{45,22}{36,46} = 1,24 \text{ moli di He in ②}$

$113 - 45,22 = 73,78 \text{ g di H}_2\text{O in ②}$

$$M_2 = \frac{1,24}{0,1} = 12,4$$

$$M_2 = \frac{12,4}{0,07378} = 16,8$$

DOPPO MESCOLAMENTO

$1,24 + 0,02 = 1,26 \text{ moli totali di He}$

$200 + 100 = 300 \text{ cc volume totale} = 0,3 \text{ l}$

$193,27 + 73,78 = 273,05 \text{ g di H}_2\text{O totale}$

$m = \frac{1,26}{0,27305} = 4,61 ; M = \frac{1,26}{0,3} = 4,2$

DOPPO MESCOLAMENTO

↓

$$M_3 = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}$$

$$M_3 = \frac{0,1 \times 0,2 + 12,4 \times 0,1}{0,3} = 4,2$$

$$M_3 = \frac{m_1 K_{g1} + m_2 K_{g2}}{K_{g1} + K_{g2}}$$

$$M_3 = \frac{0,1 \times 0,19327 + 16,8 \times 0,07378}{0,27305}$$

## ESEMPIO 02



$$\frac{\text{Kw}}{[\text{OH}^-]} + 2C_b = [\text{OH}^-]$$

$$[\text{OH}^-]^2 - 2C_b[\text{OH}^-] - \text{Kw} = 0$$

$$x = \frac{2 \cdot 10^{-4} \pm \sqrt{4 \cdot 10^{-8} + 4 \cdot 10^{-14}}}{2}$$

troviamo la tensione  $10^{-14}$  rispetto a  $10^{-8}$   $\Rightarrow x = 2 \cdot 10^{-4} = [\text{OH}^-]$

$$\text{pOH} = 3,63 \quad (\text{pH} = 10,31)$$



$$[\text{H}_3\text{O}^+] = \frac{\text{Kw}}{[\text{H}_3\text{O}^+]} + \frac{C_a K_a}{K_a + [\text{H}_3\text{O}^+]}$$

troviamo  $[\text{OH}^-]$  rispetto ad  $[\text{H}_3\text{O}^+]$   $\Rightarrow K_e [\text{H}_3\text{O}^+] + [\text{H}_3\text{O}^+]^2 = C_a K_a$

$$x^2 + K_e x - C_a K_a = 0$$

$$x = \frac{-1,8 \cdot 10^{-5} \pm \sqrt{3,24 \cdot 10^{-10} + 2,88 \cdot 10^{-8}}}{2} \Rightarrow x = 7,63 \cdot 10^{-5}$$

$$\text{pH} = 4,11$$



$$[\text{CH}_3\text{COO}^-] = \frac{C_b}{2} \cdot 2 + ([\text{H}_3\text{O}^+] - [\text{OH}^-])$$

$$[\text{CH}_3\text{COOH}] = \frac{C_a}{2} - C_b - ([\text{H}_3\text{O}^+] - [\text{OH}^-]);$$

posso trovarmi  $[\text{OH}^-]$  rispetto  $[\text{H}_3\text{O}^+]$  ma non posso trovarmi  $([\text{H}_3\text{O}^+] - [\text{OH}^-])$  rispetto alle concentrazioni  $\Rightarrow [\text{H}_3\text{O}^+] = k_a \frac{(\frac{C_a}{2} - C_b - [\text{H}_3\text{O}^+])}{(C_b + [\text{H}_3\text{O}^+])} \Rightarrow K_e \frac{1 \cdot 10^{-4} - [\text{H}_3\text{O}^+]}{1 \cdot 10^{-4} + [\text{H}_3\text{O}^+]} = [\text{H}_3\text{O}^+]$

$$x^2 + 1,18 \cdot 10^{-4} x - 1,8 \cdot 10^{-9} = 0$$

$$\begin{aligned} & \text{CONDIZIONI ANALITICHE} \\ & [\text{Mg}^{+2}] = \frac{C_b}{2} \quad \text{Dopo mescolamento} \\ & [\text{CH}_3\text{COO}^-] + [\text{CH}_3\text{COOH}] = \frac{C_a}{2} \end{aligned}$$

$$[\text{H}_3\text{O}^+] = K_a \frac{[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COO}^-]}$$

$$\text{se troviamo } ([\text{H}_3\text{O}^+] - [\text{OH}^-]); [\text{H}_3\text{O}^+] = \frac{2 \cdot 10^{-4} - 1 \cdot 10^{-4}}{1 \cdot 10^{-4}} K_a$$

$$[\text{H}_3\text{O}^+] = 1,8 \cdot 10^{-5} \Rightarrow \text{la soluzione è acida}$$

posso trovarmi  $[\text{OH}^-]$  rispetto  $[\text{H}_3\text{O}^+]$  ma non posso trovarmi  $([\text{H}_3\text{O}^+] - [\text{OH}^-])$  rispetto alle concentrazioni  $\Rightarrow [\text{H}_3\text{O}^+] = k_a \frac{(\frac{C_a}{2} - C_b - [\text{H}_3\text{O}^+])}{(C_b + [\text{H}_3\text{O}^+])} \Rightarrow K_e \frac{1 \cdot 10^{-4} - [\text{H}_3\text{O}^+]}{1 \cdot 10^{-4} + [\text{H}_3\text{O}^+]} = [\text{H}_3\text{O}^+]$

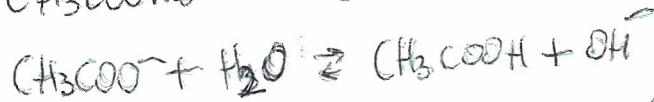
$$x = 1,36 \cdot 10^{-5} \quad (\text{pH} = 4,86)$$

### ESEMPIO 3



$$\frac{1}{(23+32+24+3)} = \frac{1}{82} = 0,0121$$

(mole di  
 $\text{CH}_3\text{COONa}$ )



$$c_s = [\text{CH}_3\text{COONa}] = \frac{0,0121}{0,1} = 0,121 \text{ M}$$

$$c_a = [\text{CH}_3\text{COOH}] = 0,121 \text{ dal Testo}$$

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]} = 1,8 \cdot 10^{-5}$$

$$[\text{H}_3\text{O}^+] = K_a \cdot \frac{[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COO}^-]}$$

$$\begin{aligned} &\text{CONDIZIONE ANALITICA} \\ &[\text{CH}_3\text{COO}^-] + [\text{CH}_3\text{COOH}] = c_s + c_a \\ &= 0,121 + 0,1 \\ &= 0,221 \end{aligned}$$

$$\text{c.e.m. } [\text{H}_3\text{O}^+] + [\text{Na}^+] = [\text{CH}_3\text{COO}^-] + [\text{OH}^-]$$

$$[\text{CH}_3\text{COO}^-] = 0,121 + ([\text{H}_3\text{O}^+] - [\text{OH}^-])$$

$$[\text{Na}^+] = 0,121 \text{ M}$$

$$[\text{CH}_3\text{COOH}] = 0,221 - 0,121 - ([\text{H}_3\text{O}^+] - [\text{OH}^-])$$

$$[\text{H}_3\text{O}^+] = K_a \cdot \frac{0,1 - ([\text{H}_3\text{O}^+] - [\text{OH}^-])}{0,121 + ([\text{H}_3\text{O}^+] - [\text{OH}^-])}$$

$$\text{pH} = \text{p}K_a + 0,082 = 4,82$$

IN QUESTO CASO

le concentrazioni di  
 $[\text{H}_3\text{O}^+]$  e  $[\text{OH}^-]$  sono  
tali da poter essere  
in prima approssimazione  
trascurate

3,8g

ESERCIZIO 4

$$\frac{3,8}{128,9} = 0,0294 \text{ moli di acido}$$

$$P.F.(\text{Acido}) = 128,9$$

$$P.F.(\text{Base}) = 40$$

$$K_e = 3,32 \cdot 10^{-2}$$

$$\frac{0,0294}{12} = 2,456 \cdot 10^{-3} \text{ M mololitro acido} C_a$$

$$\frac{0,59}{40} = 0,0147 \text{ moli di base}$$

$$\frac{0,0147}{12} = 1,229 \cdot 10^{-3} \text{ M mololitro base} C_b \Rightarrow C_a \approx 2C_b$$

$$K_e = \frac{[\text{CH}_3\text{Cl}_2\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{Cl}_2\text{COOH}]}$$

CONDIZIONE ANALITICA

$$C_a = [\text{CH}_3\text{Cl}_2\text{COO}^-] + [\text{CH}_3\text{Cl}_2\text{COOH}]$$

$$C_b = [\text{Na}^+]$$

$$\text{C.E.M. } [\text{Na}^+] + [\text{H}_3\text{O}^+] = [\text{CH}_3\text{Cl}_2\text{COO}^-] + [\text{OH}^-]$$

$$[\text{H}_3\text{O}^+] = K_e \cdot \frac{[\text{CH}_3\text{Cl}_2\text{COOH}]}{[\text{CH}_3\text{Cl}_2\text{COO}^-]}$$

$$C_b + [\text{H}_3\text{O}^+] = [\text{OH}^-] = [\text{CH}_3\text{Cl}_2\text{COO}^-]$$

$$C_a - C_b - [\text{H}_3\text{O}^+] + [\text{OH}^-] = [\text{CH}_3\text{Cl}_2\text{COOH}]$$

NON POSSO

$$\text{trascurare } ([\text{H}_3\text{O}^+] - [\text{OH}^-]) \text{ MA}$$

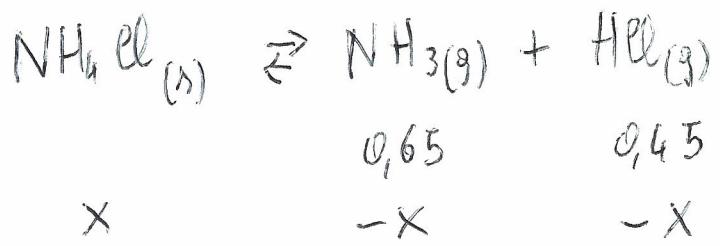
TRASCURSO  $[\text{OH}^-]$  RISPETTO A  $[\text{H}_3\text{O}^+]$ 

$$[\text{H}_3\text{O}^+] = K_e \cdot \frac{C_a - C_b - ([\text{H}_3\text{O}^+] - [\text{OH}^-])}{C_b + ([\text{H}_3\text{O}^+] - [\text{OH}^-])}$$

$$[\text{H}_3\text{O}^+] = 3,32 \cdot 10^{-2} \frac{1,229 \cdot 10^{-3} - [\text{H}_3\text{O}^+]}{1,229 \cdot 10^{-3} + [\text{H}_3\text{O}^+]}$$

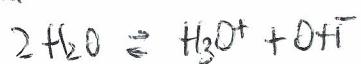
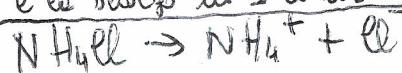
$$[\text{H}_3\text{O}^+]^2 + (1,229 \cdot 10^{-3} + 3,32 \cdot 10^{-2})[\text{H}_3\text{O}^+] - 1,229 \cdot 10^{-3} \cdot 3,32 \cdot 10^{-2} = 0 \Rightarrow \text{pH} = 2,9$$

## ESERCIZIO 5)



$$V = 1 \text{ l}$$

Preleva la fase solida nella quantità pari a  $x$



$$\text{c.e.m. } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{OH}^-] + [\text{Cl}^-] \quad [\text{Cl}^-] = \frac{x}{1} = x$$

$$\frac{x[\text{H}_3\text{O}^+]}{K_\text{w} + [\text{H}_3\text{O}^+]} + [\text{H}_3\text{O}^+] = x \quad \text{da cui } x = 1,97 \cdot 10^{-5} \text{ M}$$

$$\text{qui } [\text{H}_3\text{O}^+] \text{ è nota} = 1,047 \cdot 10^{-5} \text{ M}$$

QVINDI	$\text{NH}_3$	$\text{HCl}$
initio	0,65	0,45
	$-0,197$	$-0,197$
eq	0,452	0,253



$$\text{c.e.m. } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{Cl}^-] + [\text{OH}^-]$$

$$[\text{OH}^-] = K_\text{b} \frac{[\text{NH}_3]}{[\text{NH}_4^+]} =$$

$$[\text{OH}^-] = 1,8 \cdot 10^{-5} \frac{0,452 - 0,253 - ([\text{OH}^-] - [\text{H}_3\text{O}^+])}{0,253 + ([\text{OH}^-] - [\text{H}_3\text{O}^+])} = 1,415 \cdot 10^{-5} \text{ M}$$

$$\text{pH} = 4,98, [\text{H}_3\text{O}^+] = 10^{-4,98}$$

$$[\text{H}_3\text{O}^+] = 1,047 \cdot 10^{-5}$$

$$K_\text{b} = \frac{K_\text{w}}{K_\text{a}} \quad K_\text{a} = 10^{-4,74} \text{ (DAL TESTO)}$$

$$K_\text{b} = 1,8 \cdot 10^{-5}$$

$$\text{CONDIZIONE ANALITICA} \quad ① K_\text{c} = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]}, ③ [\text{NH}_4^+] + [\text{NH}_3] = \frac{x}{1} = x$$

$$② K_\text{w} = [\text{H}_3\text{O}^+][\text{OH}^-]; ④ [\text{NH}_4^+] = \frac{x[\text{H}_3\text{O}^+]}{K_\text{c} + [\text{H}_3\text{O}^+]}$$

↑

DALLA ① e ②  
③ RICAVO ④

PREVEDE LA FASE GASSOSA E LA SCOLLO IN 1 L

anche qui il  $V = 1 \text{ l}$

$$[\text{NH}_3] = 0,452 \text{ M} = C_b \quad \text{DEBOLI}$$

$$[\text{HCl}] = 0,253 \text{ M} = C_a \quad \text{FORTE}$$

$C_{\text{DEBOLI}} > C_{\text{FORTE}}$

↓

EQUAZIONE DI HENDERSON - HASSELBALCH

$$K_\text{b} = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$$

CONDIZIONE ANALITICA

$$[\text{NH}_3] + [\text{NH}_4^+] = 0,452 \quad \text{H}$$

$$[\text{Cl}^-] = 0,253 \text{ M}$$

$$[\text{NH}_4^+] = [\text{Cl}^-] + ([\text{OH}^-] - [\text{H}_3\text{O}^+])$$

$$[\text{NH}_3] = 0,452 - [\text{Cl}^-] - ([\text{OH}^-] - [\text{H}_3\text{O}^+])$$

$$\text{pH} = 9,15$$

SI PUÒ POI VERIFICARE CHE L'IPOTESI SEMPLIFICATIVA È VERA

QUI L'AMBIENTE È ACIDO

### ESERCIZIO 6]



$$[\text{H}^+] = 0,1 \text{ M}$$

$$[\text{MnO}_4^-] = 0,01 \text{ M}$$

$$E_s = E^\circ + \frac{0,0591}{3} \log \frac{[\text{MnO}_4^-] \cdot [\text{H}^+]^4}{[\text{MnO}_4^{+4}] = 1} \rightarrow \text{è solido}$$

le plus

$$E_d = E^\circ + \frac{0,0591}{3} \log \frac{[\text{MnO}_4^-] \cdot [\text{H}^+]^4}{[\text{MnO}_4^{+4}] = 1} \quad \begin{array}{l} [\text{H}^+] = 1 \cdot 10^{-7} \text{ M} \\ [\text{MnO}_4^-] = 0,01 \text{ M} \end{array} \quad \text{acqua neutra}$$

$$\varphi_{\text{el.m}} = E_s - E_d = \frac{0,0591}{3} \log \frac{\overbrace{[\text{H}^+]_s^4}^{0,1}}{\overbrace{[\text{H}^+]_d^4}^{1 \cdot 10^{-7}}} = \frac{4}{3} 0,0591 \log 10^6 =$$

$$\text{QUANDO AGGIUNGO NaOH ad HCl ottengo NaCl} \quad 1 \cdot 10^{-7} = 8 \times 0,0591 = 0,473 \text{ V}$$
$$\varphi_{\text{el.m}_2} \downarrow = 0 \text{ V} \quad \Leftarrow \text{anche a sinistra}$$