

KIMIKA TEORIA

- EQ QCO

- $2 C_3 H_8$ (cg)
 - ↑ zumbat molekula
 - ↓ zumbat atomo
- (EM) Enmektibo mugatzailea
 - AZKARREN DESAGERTU
 - KANTITA ESTEQUIOMETRIKOAN
 - Abiadura berdina.

• ERREAKZIOAK:

- - DESKONPOSIZIOA: $CaCO_3 \rightarrow CaO + CO_2$ (Zemento)
- KONBINAZIOA: Oc1ccc(O)cc1C(=O)O + $CH_3-O-COCH_3 \rightarrow$ CC(=O)Oc1ccc(O)cc1C(=O)O + (Farmazia)
- ISOMERIZAZIOA: $CH_3-CH_2-CH_2-CH_3 \rightarrow$ $CH_3-C(CH_3)_2-CH_3$ (Petrokimika)

▫ UR-DISOLUZIOAN:

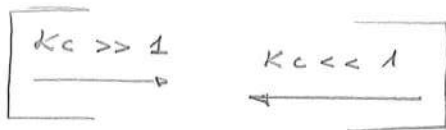
- AZ-B5 - Hauspeaketa - ERREDOX

▫ ITZULGARRIAK n ITZULEZINAK: \rightleftharpoons n \rightarrow

• OREKA KIMIKOA:

- ERREAKZIO \rightarrow eta \leftarrow -ren abiadurak \ominus eta $|C|$ guztiak kte.

- K_c n K_p kte-ak: - T mende - ESTEQUIOMETRIA/DOIETA -ren mende.



- SISTEMA HOMOGENEOAK: "Fase berdina"

- DALTON: $P_g = \sum y_i P_{tot}$

- SISTEMA HETEROGENEOAK: • SOLIDO • (L) puru • DBIZ $\Rightarrow [K_{te} = 1 K_c\text{-an}]$

• TERMOKIMIKA:

- TERMODINAMIKA: Inguuruarekin energia \leftrightarrow

- ALDAGAIAK: - INTENSIBOAK: P, T, d \leftrightarrow beti berdin

- ESTENSIBOAK: m, V \leftrightarrow materialaren arabera

- 1. PRINZIBIOA: $\Delta U = Q - W$
 - Q n W
 - espantsioa +
 - kompresioa -
 - endotermiko +
 - exotermiko -
- LANA: (W): $W = F \Delta x$
 $= P \Delta V$

- ENTALPIA: (ΔH) $P = k_{tean} \rightarrow \left[\begin{array}{l} \text{TRUKAZEN} \\ \text{DEN } Q \end{array} \right] \Delta H = Q_p$
 $\Delta H = H_{pu} - H_{ev}$

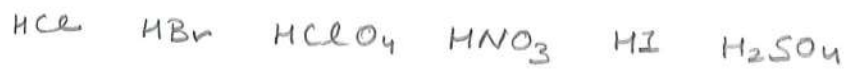
- ENTROPIA: (ΔS) $\left[\begin{array}{l} \text{E-nen} \\ \text{DISPERISIOA} \end{array} \right] \rightarrow \text{DESORDENA}$

- GIBBS: $\left[\Delta G = \Delta H - T \Delta S \right] \left[\Delta G = \Delta G^\circ + RT \ln Q_p \right]$

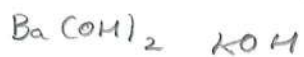
BEREZKOA	$\Delta G < 0$
EZ-BEREZKOA	$\Delta G > 0$
ORERA	$\Delta G = 0$

- A₂ - B₅

- AZIDO SENDOAK: guztiz disoziatu (INORGANIKOAK)



- BASE SENDOAK: guztiz disoziatu (METAL ALKALINOEN HIDROXI)



- DISOLBAGARRITASUNA

- ELEKTROLITO: elektrizitatea erosten duen disaluzioa (disaluzio-ionikoa)

- ASETASUNA:
 - Asegabe (dulurtua)
 - Asea (saturatua)
 - Gainasea (prezipitatuaketa)

- $T \uparrow S \uparrow$

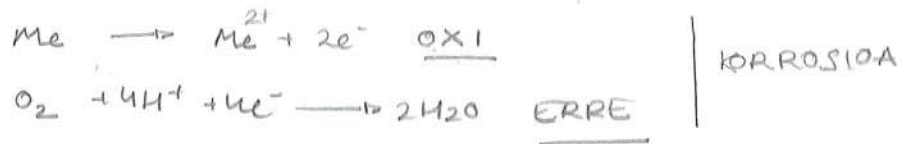
- ERREDOX

- OXIDAZIO ZENBAKIA: Atomo batuk izango lukeren karga.

- ZELDA GALBANIARRA: $\left| \begin{array}{l} RZ \text{ erreakzio ESPONTANEOA} \\ \longrightarrow \text{KORRONTA elektrikoak sortu.} \end{array} \right|$

- $E_{pila} < 0$ Ez-Buzko $E_{pila} > 0$ Buzko

- KORROSIOA: $\left[\text{Materiala oxidatu } E < 0,88 \text{ V denari BETI} \right]$



- KORROSIOTIK BABESTU:


- PINTURA


- GALVANIZAZIOA


- BABES KATODIKOA
Energiako oxidatzen beste metal batkian.


- BATERIAK:

- LECLANCHE PILA: $\text{Zn} // \text{NH}_4 / \text{MnO}_2$  1,5V

- MERKURIOZKO PILA: $\text{Zn} // \text{HgO}$  1,35V

- BERUN AZIDO BATERIA: $\text{Pb} / \text{SO}_4 // \text{PbSO}_4$  $6 \times 2 \text{V} = 12 \text{V}$

- IOI-LITHO PILA: $\text{Li} // \text{CoO}_2$  3,4V

- ERREGAI ZELDAK: $\text{H}_2\text{O} // \text{O}_2$  1,23V

- ELEKTROLISIA:

- BERRESKURAPENAK: $\text{Al}(\text{cs}) \quad \% 99,5$

$\text{Cu}(\text{cs}) \quad \% 99,95$

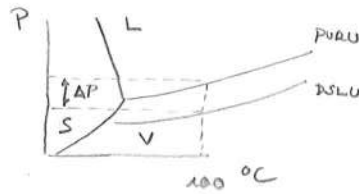
- FASEEN ARTEKO OREKA

- DISOLUZIOAK (HOMOGENEO) • KOLOIDEAK (HOMOGENEO MUGAN HAINBAT PARTIKULA IKUSI)
- SUSPENTSIOK (HETEROGENEOA)

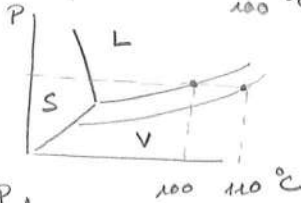
- DISOLBAGARRITASUNA [GASETAN] EXOTERMO $\rightarrow T \downarrow S \uparrow$

- PROPIETATE KOLIGATIBOAK :

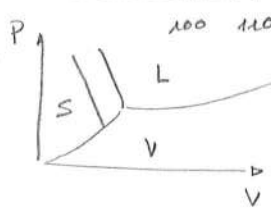
- P_v JAITSIERA



- T_c IGOERA



- T_c JAITSIERA



- OSMOSIA

HIPOTONIKO: $|C_{sto}| \downarrow \pi \downarrow$ HIPERTONIKO: $|C_{sto}| \uparrow \pi \uparrow$

- ERABILERAK:
- Izote kontutxoak
 - Uharu purifikazioa
 - Pisu molekularak

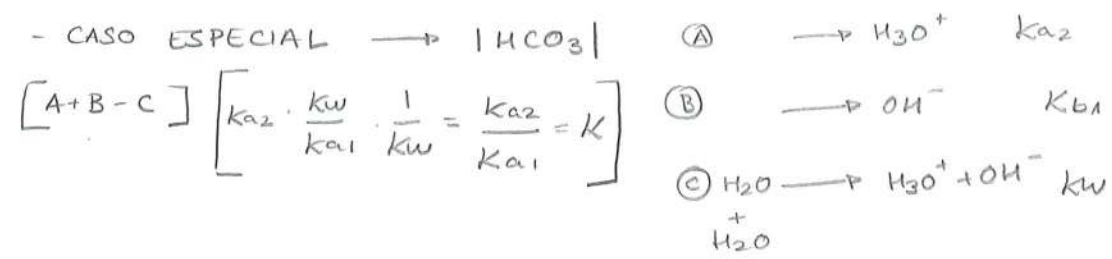
ARIKETAEN PROZEDURAK

- EQ. QCO :

- Δn (PARTE HARTZEN DUTEN ELEMENTUEN ARTEAN)
- $P_A = n P_B$ $n_A = N n_B$ - DALTON $P_g = \gamma_g \cdot P_{TOT}$
- $\% n = \% Vol$ - K (SOLIDO, DBTE $\rightarrow \perp$)
- $K_p \rightarrow P_i$

- Az - Bs :

- $H_2SO_4 \rightarrow$ GUTIZ DISOZIATU



- SLB

- GATZA EMAN (R) \rightarrow S; +X; DISOLBATU X
- IOI-AK EMAN (R) \leftarrow -X; HAUSPEATU X
- IOIAK \rightarrow OREKAN EGON JADA

- R2

- $Z \cdot I \dots = n \cdot \text{erreakzioetatuko molek}$
- zinkat? eta datunik EZ \rightarrow $K_{//}$
- OREKA: $E_{\text{pila}} = 0$ $E_{\text{kat}} = E_{\text{ano}}$
- SOLIDOAK $\rightarrow E^{\text{red}} = E^0$
- BERRESKURAZIOAK: B₁ metal, berreskurapen osoa, 2 metalen potentziale hasten dena.

- ERREDUKZIOA KPS ERLAZIOA REKIN

- 1- $Mg^{2+} \xrightarrow[kps]{\text{ERLAZIOA}} OH^- \rightarrow$ [ERREDUZITU] \Rightarrow
- 2- E: $Mg^{2+}_{aq} \rightarrow OH^-_{aq}$ [kps bidez]
- 3- R: BERRESKURATU EZ den $\% \times \frac{2 \text{ mol}}{1 \text{ mol}}$
- 4- F: $\rightarrow T, I, Q, \dots$

$$I - R + F = E$$

\uparrow \uparrow \uparrow
 KPS R2 KPS

- OH⁻ GEHIGI → MEDIO BASIKO

- H⁺ GEHIGI → MEDIO AZIDO

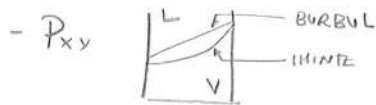
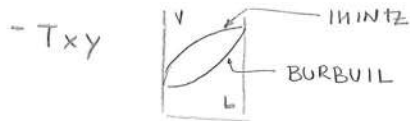
- KONTZENTRAZIO PILA → RED ICI ↑

$$E_{pila}^{\circ} = 0 = E_{kat} - E_{ano} = E - E = 0$$

→ zumbat (R) n → OREKA

- FASE OREKA

- BETI % X Y berdinaK



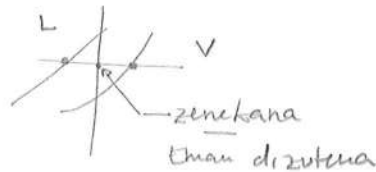
- FORMULA MOLEKULAR:

1- PFCION n → g → mal → ÷ txikuna → X mkt

2- PM $\frac{g}{mol}$ sto
 $\frac{mol}{sto}$

- PALANCA:

P_{tot}



$$\% L = \frac{LADO VAPOR}{TOTAL} \times 100$$

- \dot{i} → DISOCIA

- $\dot{i} \neq$ → NO DISOCIA

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$V = 0,2 \text{ L}$ $T = 27^\circ\text{C}$ \longrightarrow $P_{\text{Tot,eq}} = 27,8 \text{ atm}$

$w_r[\text{SO}_2] = 6,4 \text{ g}$ $n_{\text{SO}_2} = \frac{g}{PM} = 0,1 \text{ mol}$ $2\text{SO}_2(\text{cg}) + \text{O}_2(\text{cg}) \rightleftharpoons 2\text{SO}_3(\text{cg})$

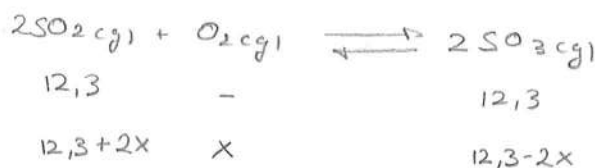
$w_r[\text{SO}_3] = 8 \text{ g}$ $n_{\text{SO}_3} = \frac{g}{PM} = 0,1 \text{ mol}$

a) K_p, K_c ?

$P_{\text{Tot}}^{\text{inici.}} = \frac{nRT}{V} = \frac{0,2 \cdot 0,082 \cdot (27+273)}{0,2} = 24,6 \text{ atm}$

$P_{\text{SO}_2} = \frac{0,1}{0,2} \cdot 24,6 = 12,3 \text{ atm}$

$P_{\text{SO}_3} = 12,3 \text{ atm}$



$P_{\text{Tot,eq}} = 27,8 = 12,3 + 2x + x + 12,3 - 2x$

$x = 3,2$

$K_p = \frac{P_{\text{SO}_3}^2}{P_{\text{SO}_2}^2 \cdot P_{\text{O}_2}} = \frac{(12,3 - 2 \cdot 3,2)^2}{(12,3 + 2 \cdot 3,2)^2 \cdot 3,2} = 0,031$

$K_p = 0,031$

$K_p = K_c \cdot (RT)^{\Delta n} \longrightarrow K_c = \frac{K_p}{(RT)^{\Delta n}}$

$\Delta n = 2 - (2+1) = -1$

$K_c = 0,031 \cdot (0,082 \cdot (27+273)) =$

$= 0,76 = K_c$

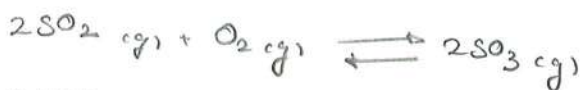
b) $n[\text{SO}_3]_{\text{eq}} = 0,01$ $\left\{ \longrightarrow P_{\text{SO}_2, \text{eq}} = 3,35 P_{\text{SO}_3, \text{eq}}$

$n_{\text{Tot,eq}} = \frac{PV}{RT} = \frac{27,8 \cdot 0,2}{0,082 \cdot (27+273)} = 0,22 \text{ mol}$

$\left. \begin{array}{l} \% \text{ SO}_2 = 70\% \\ \% \text{ O}_2 = 10\% \\ \% \text{ SO}_3 = 20\% \end{array} \right\}$

eq 1:

$P_{\text{SO}_2, \text{eq}} = Y_{\text{SO}_2, \text{eq}} \cdot P_{\text{Tot,eq}} \longrightarrow Y_{\text{SO}_2} = \frac{n_{\text{SO}_2}}{n_{\text{Tot}}} \longrightarrow \frac{P_{\text{SO}_2}}{P_{\text{Tot}}} \cdot n_{\text{Tot}} = n_{\text{SO}_2} = 0,148$



$\frac{P_{\text{SO}_3}}{P_{\text{Tot}}} \cdot n_{\text{Tot}} = n_{\text{SO}_3} = 0,047$

$\frac{P_{\text{O}_2}}{P_{\text{Tot}}} \cdot n_{\text{Tot}} = n_{\text{O}_2} = 0,025$

$K_c = 0,76 = \frac{[(0,037+x)/0,2]^2}{[(0,025-x)/0,2] \cdot [(0,148-2x)/0,2]^2}$

$x = 0,00342$

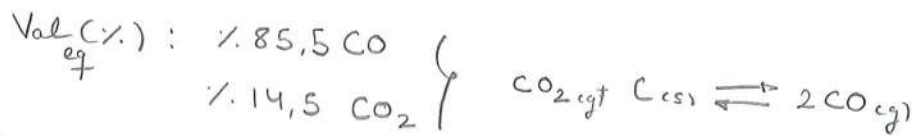
$n_{\text{Tot}} = 0,203$

EX. 16 3.1.

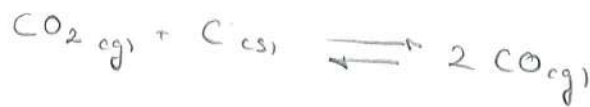
$T = 800^\circ\text{C}$



$P_{\text{tot eg}} = 2 \text{ atm}$



a) $K_p, K_c?$



100 mol

85,5 mol CO_{eg}

14,5 mol CO_2_{eg}

$\Rightarrow PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{100 \cdot 0,082 \cdot (800 + 273)}{2} = 4400 \text{ L}$

$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} = \frac{(85,5/4400)^2}{(14,5/4400)} = \boxed{0,115 = K_c}$

$K_p = K_c (RT)^{\Delta n} \quad \Delta n = (2+0) - (1+0) = 1$

$K_p = 0,115 \cdot (0,082 \cdot 800 + 273)^1 = \boxed{10,1 = K_p}$

b) $\left. \begin{array}{l} T_{\text{kte}} \\ \text{EQ} \end{array} \right\} V \rightarrow \frac{1}{2} V$
 $\left. \begin{array}{l} \% 85,5 \text{ CO} \\ \% 14,5 \text{ CO}_2 \end{array} \right\} ?$

Ez, balantzean eragina gertsiz $P = \frac{nRT}{V}$ presioa handitzen da. Beraz erreakzio Le chatelierren printzipioa jarraituz erreakzioa aldatutari aurre egungo da eta kasu konstante gas mol gutxiaren sartuko dituen noranzkoa hartuko du. Kasu konstante ezkerretara: $\text{CO}_2(\text{g}) \uparrow \quad \text{CO}(\text{g}) \downarrow$

c)

$Q_p = \frac{P_{\text{CO}}^2}{P_{\text{CO}_2}} = \frac{5^2}{2} = 12,5$

$K_p = 10,1$

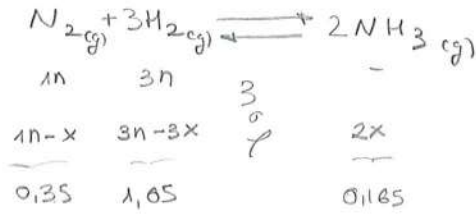
$Q_p > K_p$ Bai, sartuko da erreakzioa ezkerretara material delako.

7

a) $T = 500^\circ\text{C}$

$P_{\text{eq}} = 100 \text{ atm}$

$V[\text{NH}_3] = 10,5\%$



ESTOIC: $\begin{cases} \text{N}_2 : 1 \\ \text{H}_2 : 3 \end{cases}$

$P_{\text{eq}} V = n R T \rightarrow n_{\text{tot}} = \frac{P_{\text{eq}} \cdot V}{R T} = \frac{100 \cdot 1}{0,082 \cdot (500 + 273)} = 1,57 \text{ mol}$

$n[\text{NH}_3] = 1,57 \cdot 0,105 = 0,165 \text{ mol NH}_3 \quad 0,165 = 2x \quad x = 0,0824$

$n_{\text{tot}} = 1,57 = 1n - 0,0824 + 3n - 3 \cdot 0,0824 + 2 \cdot 0,0824$

$n = 0,433$

$K_c = \frac{[\text{NH}_3]^2}{[\text{H}_2]^3 \cdot [\text{N}_2]} = \frac{\left(\frac{0,165}{1}\right)^2}{\left(\frac{1,05}{1}\right)^3 \cdot \left(\frac{0,35}{1}\right)} = 0,067$

$0,067 = K_c$

b) EXOTERMICA

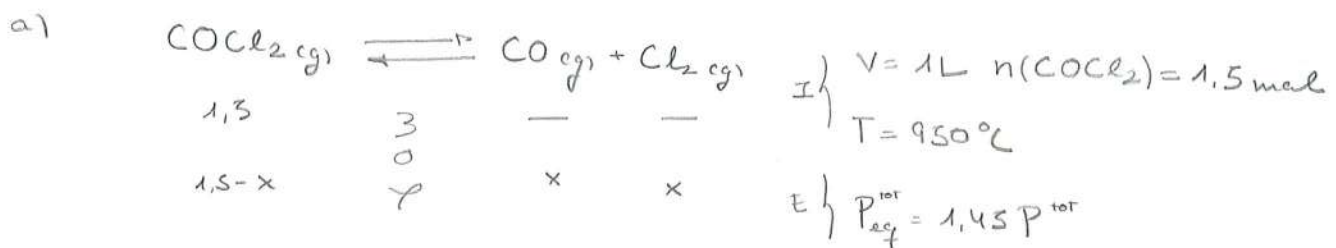
$T \uparrow \rightarrow K_p \downarrow \leftarrow \text{MENOS AMONIACO}$

$T \downarrow \rightarrow K_p \uparrow \Rightarrow \text{MÁS AMONIACO}$

$P \uparrow \rightarrow \ominus n_{\text{gas}} \Rightarrow \text{MÁS AMONIACO}$

$P \downarrow \rightarrow \oplus n_{\text{gas}} \leftarrow \text{MENOS AMONIACO}$

EX. 26 1.



$2,175 = 1,5 - x + x + x$

$2,175 = 1,5 + x$

$x = 0,675$

$\hookrightarrow \frac{0,825}{2} \quad n_{\text{tot,eq}} = 1,45 n_0$

$n_{\text{tot,eq}} = 2,175$

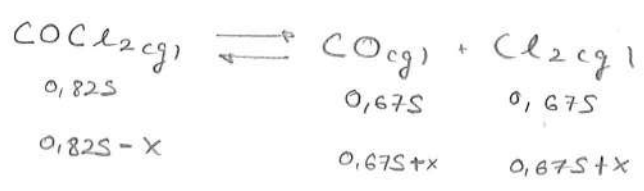
$\bar{X} = \frac{0,675}{1,5} = \boxed{45\% = \bar{X}}$

$K_c = \frac{0,675 \cdot 0,675}{0,825} = \boxed{0,55 = K_c}$

b) $V = 2\text{L}$ $T = 950^\circ\text{C}$

Ⓜ \rightarrow DECH.

$P \downarrow$



$K_c = 0,55 = \frac{(0,675+x) \cdot (0,675+x)}{\left(\frac{0,825-x}{2}\right)}$

$x = 0,17$

ag 2: $n_{\text{tot}} = 2,34$

$P_{\text{tot}} = 117,7\text{ atm}$

$P_{\text{tot}} = \frac{n RT}{V} = \frac{2,34 \cdot 0,082 (950 + 273)}{2} =$

o) 1) $[\text{Cl}_2] \downarrow$ Ⓜ $\xrightarrow{\text{ESK.}}$ $\bar{X} \uparrow$

2) $V \downarrow$ $P \uparrow$ $[\text{COCl}_2] \uparrow$ Ⓜ $\xrightarrow{\text{ESK.}}$ $\bar{X} \downarrow$

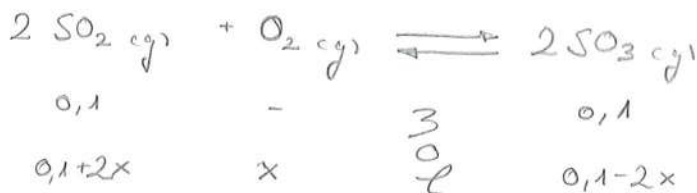
- OREKA KIMIKOA

9

$V = 0,2 \text{ L} \quad T = 27^\circ\text{C} = 300 \text{ K}$



$P_{\text{tot}} = 27,8 \text{ atm}$



a) K_p ? K_c ?

$n_{\text{tot}} = (0,1 + \cancel{0,1} + x + 0,1 - \cancel{0,1}) = 0,2 + x$

$n = \frac{g}{PM} = \frac{6,4}{64} = 0,1$

$n = \frac{g}{PM} = \frac{8}{80} = 0,1$

$PV = nRT \rightarrow$

$\rightarrow 27,8 \cdot 0,2 = (0,2 + x) \cdot 0,082 \cdot 300$

$K_c = \frac{[\text{SO}_3]^2}{[\text{O}_2] \cdot [\text{SO}_2]^2} = \frac{\left(\frac{0,1 - 2 \cdot 0,026}{0,2}\right)^2}{\frac{0,026}{0,2} \cdot \left(\frac{0,1 + 2 \cdot 0,026}{0,2}\right)^2} = 0,767 \quad \boxed{K_c = 0,767}$

$K_p = K_c \cdot (CRT)^{\Delta n}$

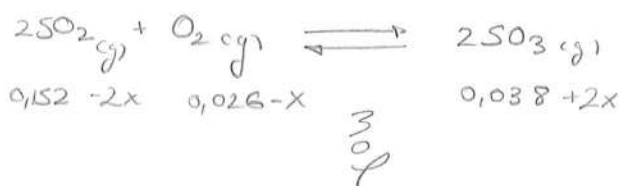
$\Delta n = (2) - (2+1) = -1$

$K_p = 0,767 \cdot (0,082 \cdot 300)^{-1}$

$K_p = 0,0312$

b)

eg: $P_{\text{SO}_2} = 3,35 P_{\text{SO}_3}$



eg. 900 $P_{\text{SO}_2} = 3,35 P_{\text{SO}_3}$

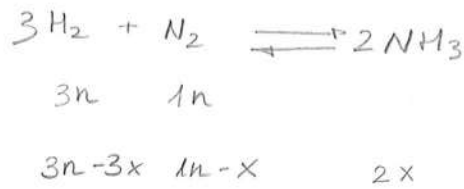
$n_{\text{SO}_2} = 3,35 n_{\text{SO}_3}$

$0,152 - 2x = 3,35 \cdot (0,038 + 2x) \rightarrow 0,152 - 0,127 = 6,7x + 2x \quad x = \frac{0,152 - 0,127}{8,7}$

$x = 0,00287$

7

$$T = 773 \text{ K}$$



$\text{H}_2 : \text{N}_2$
$3 : 1$

a)

$$P_{\text{tot}} = 100 \text{ atm}$$

$$\text{Vol}(\text{NH}_3) = 10,5\% \Leftrightarrow n(\text{NH}_3) = 10,5\% \Rightarrow Y_{\text{NH}_3} = 0,105$$

$$P_{\text{NH}_3} = P_{\text{tot}} \cdot Y_{\text{NH}_3} \rightarrow P_{\text{tot}} = P_{\text{H}_2} + P_{\text{N}_2} + P_{\text{NH}_3} \rightarrow P_{\text{tot}} = 3P_{\text{N}_2} + P_{\text{N}_2} + 10,5$$

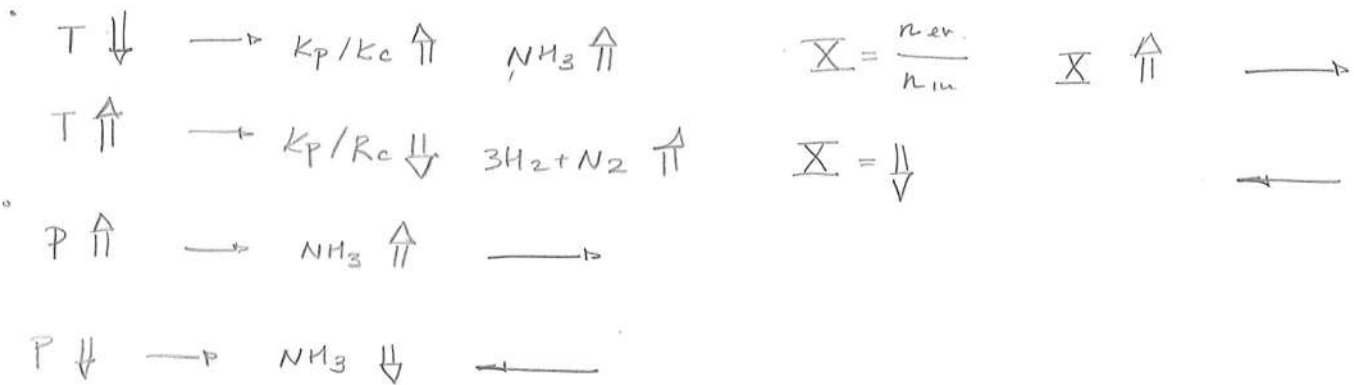
$$P_{\text{NH}_3} = 100 \cdot 0,105 \Rightarrow 100 = 4P_{\text{N}_2} + 10,5 \quad P_{\text{N}_2} = \frac{89,5}{4} = 22,38 \text{ atm}$$

$$K_p = \frac{P_{\text{NH}_3}^2}{P_{\text{N}_2} \cdot P_{\text{H}_2}^3} = \frac{10,5^2}{22,38 \cdot (3 \cdot 22,38)^3} = \boxed{1,63 \cdot 10^{-5} = K_p}$$

$$K_p = K_c \cdot (RT)^{\Delta n} \quad \Delta n = 2 - (3+1) = -2$$

$$K_c = 1,63 \cdot 10^{-5} (0,082 \cdot 773)^2 = \boxed{0,0655 = K_c}$$

b) EXOTERMIKOA

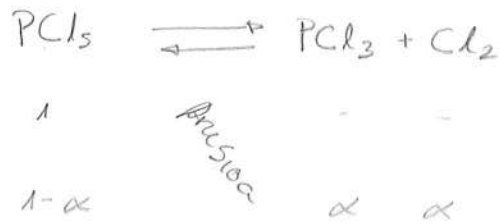


1

$$T = 250^\circ\text{C} = 523\text{K}$$

$$P_{\text{PCL}_5, \text{inc.}} = 1 \text{ atm}$$

$$\alpha = 0,8$$



a) K_p ?

$$K_p = \frac{\alpha^2}{1-\alpha} = \frac{0,8^2}{1-0,8} = \boxed{3,2 = K_p}$$

b)

$$P_{\text{PCL}_5, \text{inc.}} = 1,5 \text{ atm} \quad 1,80 \quad \alpha = 12 \text{ atm}$$

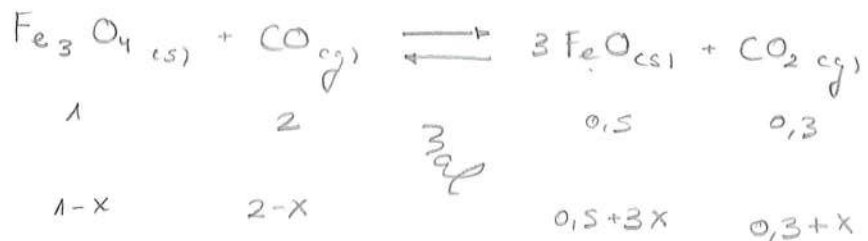
c) ENDOTERMIKOA



2

$$K_p(873\text{K}) = 1,15$$

$$P_{\text{tot}} = 5 \text{ atm}$$



$$n_{\text{tot}} = 2,3$$

$$Y_{\text{CO}} = \frac{2}{2,3} = 0,87 \quad P_{\text{CO}} = 5 \cdot 0,87 = 4,35 \text{ atm}$$

$$Q_p = \frac{P_{\text{CO}_2}}{P_{\text{CO}}} = \frac{0,15}{4,35} = 0,15$$

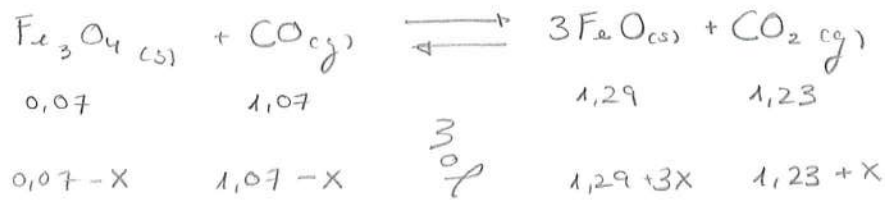
$$Y_{\text{CO}_2} = \frac{0,3}{2,3} = 0,13 \quad P_{\text{CO}_2} = 5 \cdot 0,13 = 0,65 \text{ atm}$$

$$K_p > Q_p \rightarrow$$

$$K_p = 1,15 = \frac{(0,3+x) \cdot RT}{(2-x) \cdot RT} = \frac{(0,3+x) \cdot RT \cdot V}{(2-x) \cdot RT \cdot V} \Rightarrow 0,93 = x$$

$n(\text{Fe}_3\text{O}_4) = 0,07 \text{ mol}$	$n(\text{FeO}) = 3,29 \text{ mol}$
$n(\text{CO}) = 1,07 \text{ mol}$	$n(\text{CO}_2) = 1,23 \text{ mol}$

b)



$$K_p(600^\circ\text{C}) = 1,15 = \frac{\frac{(1,23+X)RT}{X}}{\frac{(1,07-X)RT}{X}} = \frac{1,23+X}{1,07-X} \quad X = 2,33 \cdot 10^{-4}$$

$$PV = nRT \quad V = \frac{nRT}{P} = \frac{2,3 \cdot 0,082 \cdot 873}{5} = 32,93 \text{ l}$$

$$n_T = (1,23 + 2,33 \cdot 10^{-4}) + (1,07 - 2,33 \cdot 10^{-4}) = 2,3$$

$$\begin{array}{ll}
 |\text{Fe}_3\text{O}_4| = & |\text{FeO}| = \\
 |\text{CO}| = 0,032 \text{ mol/l} & |\text{CO}_2| = 0,037 \text{ mol/l}
 \end{array}$$

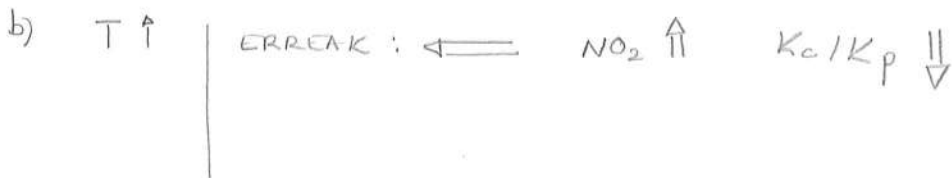
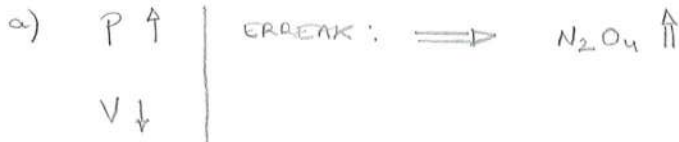
EJ1



$$\left[\begin{array}{l} \Delta H = -58 \text{ kJ} \\ \text{EXOTERMISKO} \end{array} \right]$$

$T = 298 \text{ K}$

$Y_{\text{N}_2\text{O}_4} = 0,92$



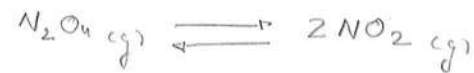
EJ2

$V = 1 \text{ L}$

$T = 35^\circ\text{C} = 308 \text{ K}$

$46 \text{ g} \cdot \text{N}_2\text{O}_4$

$K_c = 0,0125$



a) $X ?$

0,5

-

$n_{\text{mole}} = \frac{g}{PM} = \frac{46}{92} = 0,5 \text{ mol}$

0,5 - x

3
0
l

2x

$K_c = 0,0125 = \frac{\left(\frac{2x}{1}\right)^2}{\frac{0,5-x}{1}} = \frac{4x^2}{0,5-x}$ $X = 0,038$

$X = \frac{0,038}{0,5} = \boxed{0,076 = X}$

b)

$P_{\text{tot}} = \frac{nRT}{V}$

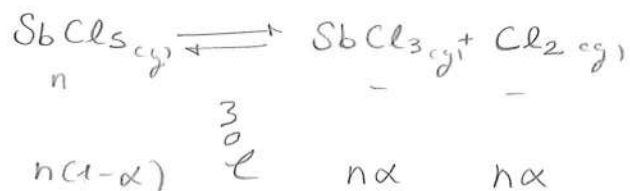
$n_T = 0,5 - 0,038 + 2 \cdot 0,038 = 0,538$

$P_{\text{tot}} = \frac{0,538 \cdot 0,082 \cdot 308}{1} = \boxed{13,58 \text{ atm} = P}$

EJ 3

$$T = 185^\circ\text{C} = 458\text{K} \quad P = 1\text{atm} \quad \bar{X} = 0,3 = \alpha \quad V = 1\text{L}$$

a)



$$n_T = \frac{PV}{RT} = \frac{1}{0,082 \cdot 458} = 0,0266$$

$$n_T = 0,0266 = n(1-0,3) + n0,3 + 0,3n$$

$$n_T = 0,0266 = 1,3n$$

$$n = 0,02$$

$$K_c = \frac{(0,02 \cdot 0,3)^2}{0,02 \cdot (0,7)} = \boxed{0,00257 = K_c}$$

$$K_p = K_c \cdot (RT)^{\Delta n} \quad \Delta n = (1+1) - 1 = 1$$

$$K_p = 0,00257 \cdot (0,082 \cdot 458) = \boxed{0,0966 = K_p}$$

b)

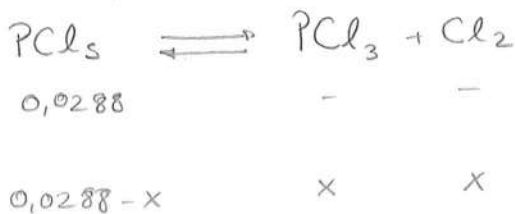
$$K_c = 0,00257 = \frac{\frac{n0,6}{V} \cdot \frac{n0,6}{V}}{\frac{n(1-0,6)}{V}} \Rightarrow n = 2,856 \cdot 10^{-3}$$

$$n_T = 2,856 \cdot 10^{-3} \cdot (0,4) + 2,856 \cdot 10^{-3} \cdot (0,4) + 2,856 \cdot 10^{-3} \cdot 0,6 = 0,00457$$

$$P = \frac{n_T RT}{V} = \frac{0,00457 \cdot 0,082 \cdot 485}{1} = \boxed{0,182\text{atm} = P}$$

EJ 4

$V = 1L$ $6g = PCl_5$ $T = 250^\circ C = 523K$ $P = 2,08 \text{ atm}$



$n_{mole} = \frac{g}{PM} = \frac{6}{208} = 0,0288$

$PV = nRT$ $n_{tot} = \frac{PV}{RT} = \frac{2,08 \cdot 1}{0,082 \cdot 523} = 0,0485$

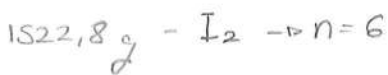
$n_{tot} = 0,0485 = 0,0288 - x + 2x$ $x = 0,0197$

a) $\bar{X} = \frac{0,0197}{0,0288} = 0,68$ $68\% = \bar{X}$

b) $K_c = \frac{0,0197^2}{0,0288 - 0,0197} = 0,04265$ $K_p = K_c (RT)^{\Delta n}$ $\Delta n = (1+1) - 1 = 1$

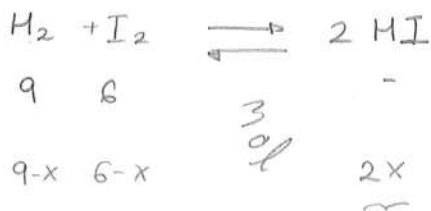
$K_p = 0,04265 \cdot (0,082 \cdot 523) = 1,829 = K_p$ $1,829 = K_p$

EJ 5

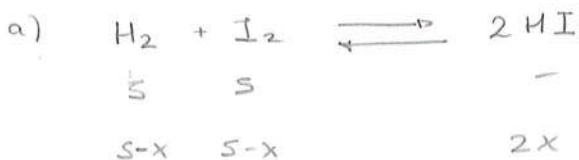


$T = 550^\circ C = 823K$

EXOTERMICO



$K_c = \frac{\left(\frac{10}{V}\right)^2}{\frac{4}{V} \cdot \frac{6}{V}} = \frac{\frac{10^2}{V^2}}{\frac{24}{V^2}} = \frac{100}{24} = 4,166$



$K_c = 4,166 = \frac{\left(\frac{2x}{V}\right)^2}{\frac{(5-x)^2}{V^2}} = \frac{4x^2}{(5-x)^2}$ $x = 5,1$

NO HAY SUFICIENTE REACTIVO

b)

$T \uparrow$ / EXOTERMO : Erreak. : \leftarrow $K_p, K_c \downarrow$

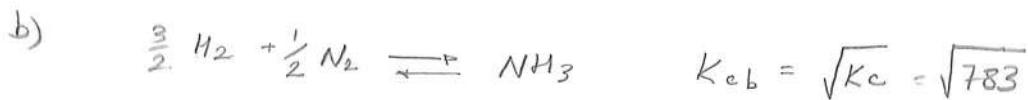
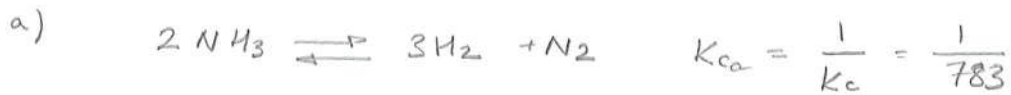
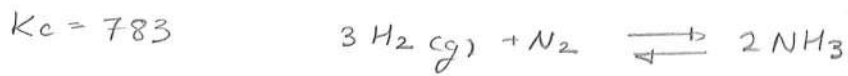
$T \downarrow$ / EXOTERMO : Erreak. : \rightarrow $K_p, K_c \uparrow$

$P \uparrow$: mol gas gutxi

$P \downarrow$: mol gas gehien

KATALIZATZAILEA abiadura \uparrow berruntik

6



5

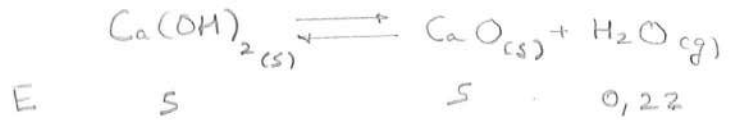
$T = 475^\circ\text{C} = 748\text{K}$

$V = 10\text{L}$

$370\text{g} - \text{Ca(OH)}_2 \quad n = 5$

$280\text{g} - \text{CaO} \quad n = 5$

$4\text{g} - \text{H}_2\text{O} \quad n = 0,22$



$K_c = 0,022 \quad K_p = 1,35$

$P_{\text{H}_2\text{O}} = \frac{nRT}{V} = \frac{0,22 \cdot 0,082 \cdot 748}{10} = 1,35$

1- $20\text{g} \text{Ca(OH)}_2 \quad n = 0,27$



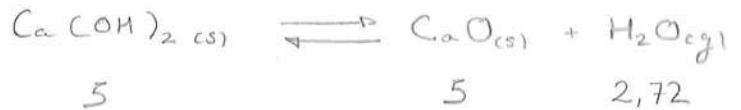
$K_c = \frac{0,22+x}{10} = 0,022 \quad [x=0]$



NO AFECTA AL EQUILIBRIO \rightarrow SOLIDO

2-

$45\text{g} \text{H}_2\text{O} \quad n = 2,5$



$K_c = \frac{2,72-x}{10} = 0,022$



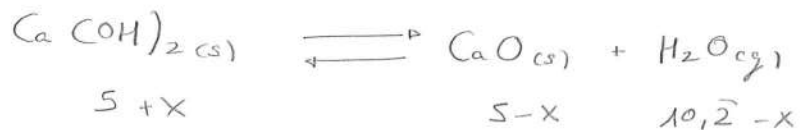
$x = 2,5$

$n_{\text{H}_2\text{O}} = 0,2 \text{ mol}$

$n_{\text{CaO}} = 2,5 \text{ mol}$

$n_{\text{Ca(OH)}_2} = 7,5 \text{ mol}$

3- $180\text{g} \text{H}_2\text{O} \rightarrow n = 10$



$K_c = \frac{10,2-x}{10} = 0,022$

$x = 10,00$

EZIN DA EMAN EZ DABO
HAINBESTE CaO

5

$pH_{NH_3} = 11$ $[NH_3] = ?$ $K_{b_{NH_3}} = 1,8 \cdot 10^{-5}$



$[H_3O^+] = 10^{-11} \rightarrow K_w = [H_3O^+] \cdot [OH^-] \rightarrow [OH^-] = \frac{K_w}{[H_3O^+]} = \frac{10^{-14}}{10^{-11}} = 10^{-3}$

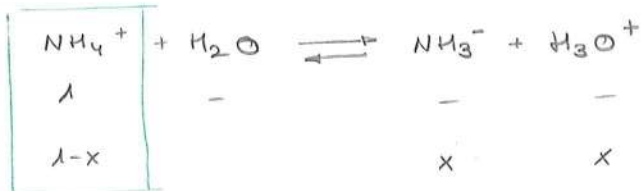
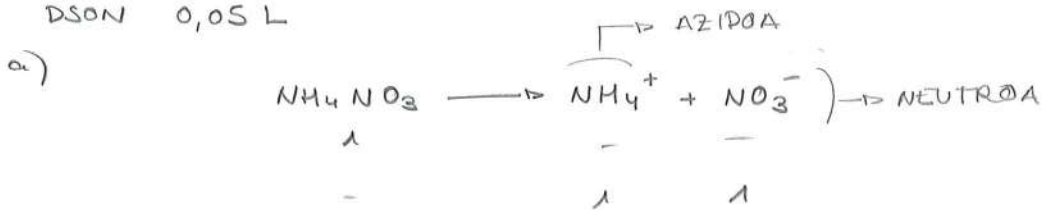
$x = [OH^-] = 10^{-3} M$

$K_b = 1,8 \cdot 10^{-5} = \frac{[OH^-] \cdot [NH_4^+]}{[NH_3]} = \frac{10^{-3} \cdot 10^{-3}}{C - 10^{-3}} \Rightarrow \boxed{C = 0,056 \text{ mol/l}}$

7

4g $NH_4NO_3 \rightarrow n = \frac{g}{PM} = 0,05 \text{ mol}$ $[NH_4NO_3] = \frac{n}{V} = 1 \text{ mol/l}$

DSON 0,05 L



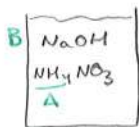
$K_{a_{NH_4}} = \frac{K_w}{K_{b_{NH_3}}} = \frac{10^{-14}}{1,8 \cdot 10^{-5}} = 5,55 \cdot 10^{-10} = \frac{x^2}{1-x} \Rightarrow$

$\Rightarrow x = 2,35 \cdot 10^{-5}$

$pH = -\log [2,35 \cdot 10^{-5} \text{ mol/l}] =$

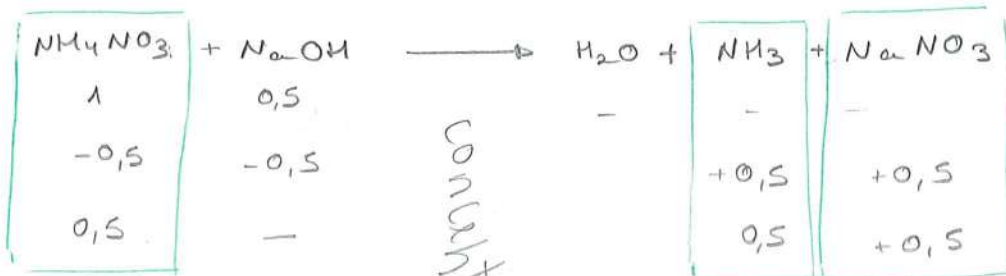
$\boxed{4,63 = pH}$ AZIDO

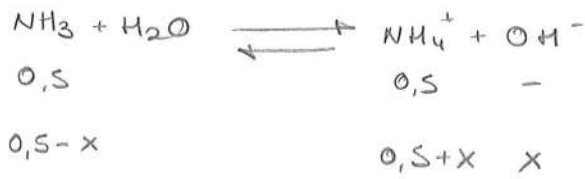
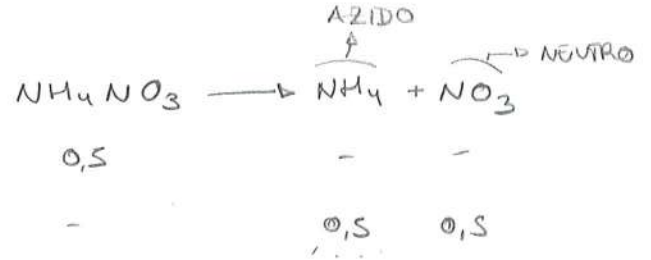
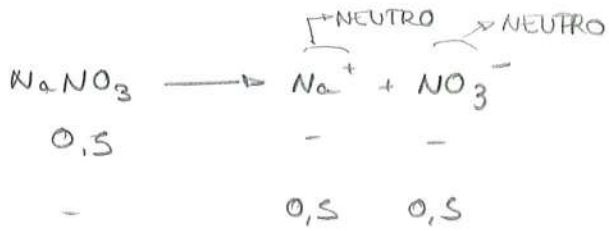
b)



$NaOH \ 1g \rightarrow n = \frac{g}{PM} = \frac{1}{40} = 0,025$

$[NaOH] = \frac{n}{V} = \frac{0,025}{0,05} = \frac{1}{2} = 0,5 \text{ mol/l}$





$$K_{b, \text{NH}_3} = 1,8 \cdot 10^{-5} = \frac{[\text{OH}^-][\text{NH}_4^+]}{[\text{NH}_3]} =$$

$$= \frac{x \cdot (x+0,5)}{(0,5-x)} = 1,8 \cdot 10^{-5}$$

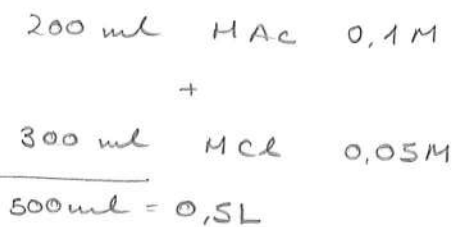
$$x = 1,8 \cdot 10^{-5}$$

$$[\text{OH}^-] = 1,8 \cdot 10^{-5} = \frac{K_w}{[\text{H}^+]}$$

$$[\text{H}^+] = \frac{10^{-14}}{1,8 \cdot 10^{-5}} = 5,55 \cdot 10^{-10}$$

$$\rightarrow \boxed{\text{pH} = 9,25} \text{ BASIKO}$$

15



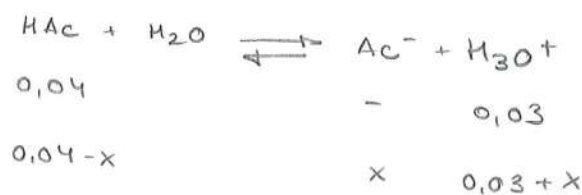
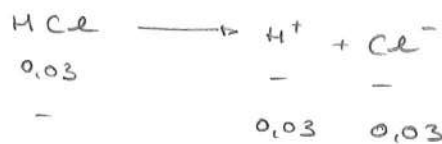
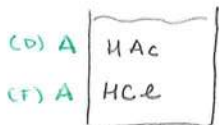
M beumiak

$$\rightarrow n = M \cdot V \quad n = 0,1 \cdot 0,2 = 0,02 \text{ mol}$$

$$[\text{HAc}] = \frac{n}{V} = \frac{0,02}{0,5} = \boxed{0,04 \text{ M} = [\text{HAc}]}$$

$$\rightarrow n = M \cdot V \quad n = 0,05 \cdot 0,3 = 0,015 \text{ mol}$$

$$\frac{n}{V} = \frac{0,015}{0,5} = \boxed{0,03 \text{ M} = [\text{HCl}]}$$



$$K_{a, \text{HAc}} = 1,8 \cdot 10^{-5} = \frac{[\text{H}_3\text{O}^+][\text{Ac}^-]}{[\text{HAc}]}$$

$$= \frac{(0,03+x) \cdot x}{0,04-x} = 1,8 \cdot 10^{-5}$$

$$[\text{H}_3\text{O}^+] = 3,002 \cdot 10^{-2}$$

$$x = 2,4 \cdot 10^{-5}$$

$$\boxed{\text{pH} = 1,52} \quad \alpha = \frac{2,4 \cdot 10^{-5}}{0,04} \cdot 100 = \boxed{0,06 \% = \alpha}$$

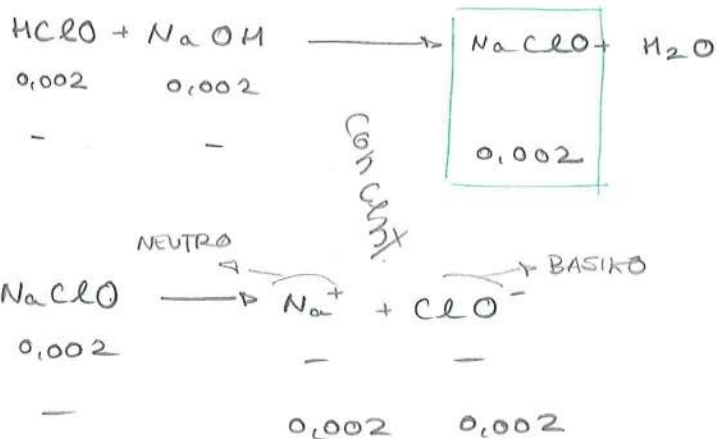
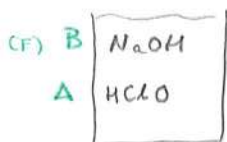
19

A: 0,25 g NaOH 500 ml $\rightarrow n = \frac{g}{PM} = \frac{0,25}{40} = 0,00625 \text{ mol}$
 +
 B: 10^{-2} M HClO 300 ml $\rightarrow [NaOH] = \frac{0,00625}{0,5} = 0,0125 \text{ mol/l}$

A: 0,04 L $[NaOH] = 0,0125 \text{ mol/l}$ $n = M \cdot V = 0,0125 \cdot 0,04 = 0,0005 \text{ mol}$

B: 0,05 L $[HClO] = 10^{-2} \text{ mol/l}$ $n = M \cdot V = 0,05 \cdot 10^{-2} = 0,0005 \text{ mol}$

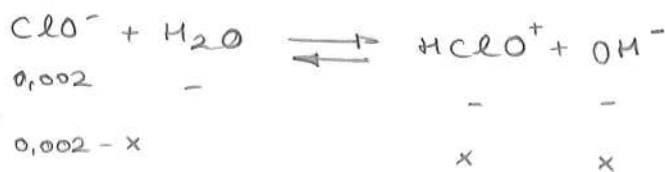
$[NaOH] = \frac{0,0005}{0,25} = 0,002 \text{ mol/l} = [HClO]$



$pK_a = 7,53$

$K_a = 10^{-7,53}$

$K_b = \frac{K_w}{K_a} = \frac{10^{-14}}{10^{-7,53}} =$



$= 3,39 \cdot 10^{-7} = \frac{[HClO][OH^-]}{[ClO^-]} = \frac{x^2}{(0,002-x)}$ $x = 2,58 \cdot 10^{-5}$

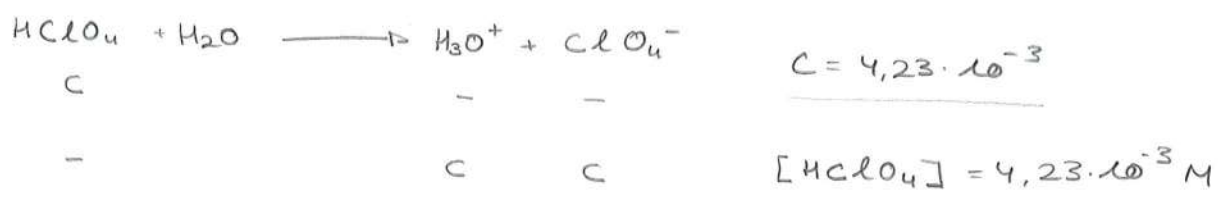
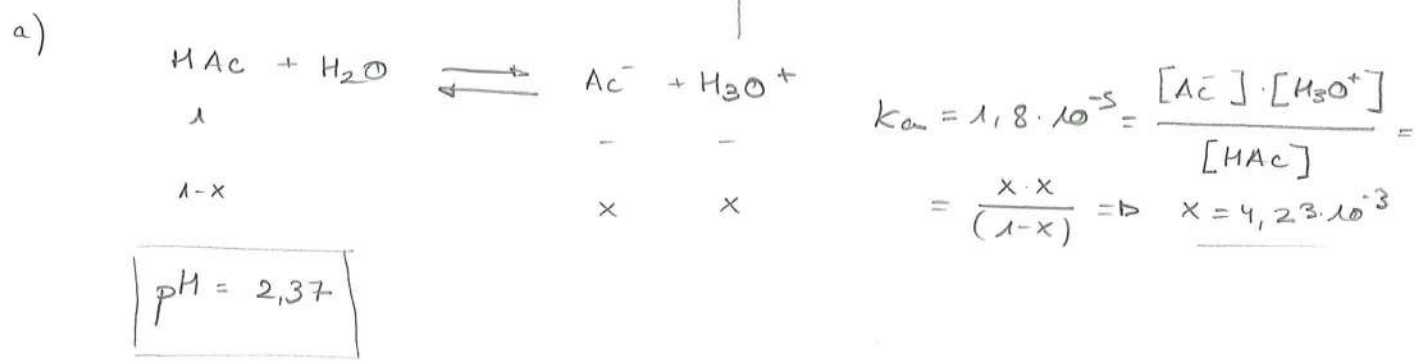
$[OH^-] = 2,58 \cdot 10^{-5} \rightarrow [H_3O^+] = \frac{10^{-14}}{2,58 \cdot 10^{-5}} = 3,87 \cdot 10^{-10}$

$pH = 9,41$

9

⊖ pH
 $[HAc] = 60g/l \rightarrow n = \frac{60g}{PM} = 1 \text{ mol} \quad [HAc] = 1 \text{ mol/l}$

$HClO_4 \rightarrow V_{DSON} = 1L \quad V_{DSON} ?$
 rigueza 1/15
 $d = 1,215 g/ml$



$4,23 \cdot 10^{-3} \text{ mol/l} \xrightarrow{1L DSON_{FINAL}} n_{HClO_4} = 4,23 \cdot 10^{-3} \text{ mol}$

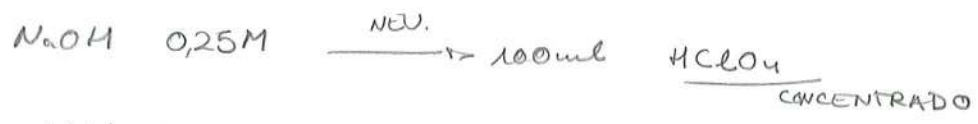
$g = n \cdot PM \rightarrow g = 4,23 \cdot 10^{-3} \cdot 100 = 0,423 g$

$g_{DSON} \cdot 0,15 = 0,423 \rightarrow g_{DSON} = \frac{0,423}{0,15} = 2,82 g$

$1,215 g \rightarrow 1 ml$
 $2,82 g \rightarrow x = 2,32 ml$

$V_{DSON HClO_4} = 2,32 ml$

b)



$M \cdot V = n$

$[HClO_4] = \frac{4,23 \cdot 10^{-3}}{0,0232} = 1,82 \text{ mol/l}$

$0,25 \cdot V = 0,182$

$n = M \cdot V = 1,82 \cdot 0,1 = 0,182 \text{ mol}$

$V = 0,728 L$



$\begin{matrix} 0,182 & n & & - \\ 0,182 - n & n - n & & n & n \\ 0 & 0 & & n = 0,182 \text{ mol} \end{matrix}$

pH?

200ml HCOOH = 0,2M

pKa = 3,65



0,2

0,2 - x

Ka = 10^{-3,65} = $\frac{x^2}{0,2-x}$ x = 6,69 · 10⁻³

pH = -log [H₃O⁺] = -log [6,69 · 10⁻³]

pH = 2,17

HCOOH

pH?

200 ml HCOOH 0,2M

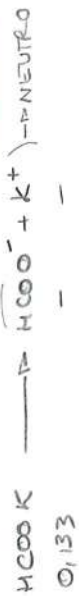
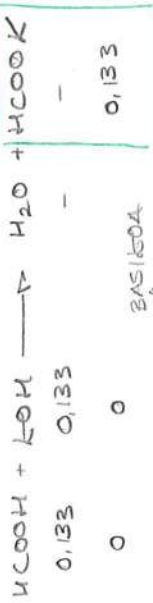
100 ml KOH 0,4M

0,3L

n = M · V = 0,2 · 0,2 = 0,04 mol HCOOH

n = M · V = 0,4 · 0,1 = 0,04 mol KOH

[HCOOH] = [KOH] = $\frac{0,04}{0,3} = 0,133$ M



0,133 0,133



0,133

0,133 - x

K_b = $\frac{K_w}{K_a} = \frac{10^{-14}}{10^{-3,65}} = 4,47 \cdot 10^{-11} = \frac{x^2}{0,133-x}$

x = 2,44 · 10⁻⁶ = [OH⁻] = $\frac{K_w}{[H^+]}$

[H⁺] = $\frac{K_w}{[OH^-]} = \frac{10^{-14}}{2,44 \cdot 10^{-6}} = 4,1 \cdot 10^{-9}$

pH = 8,39

pH?

200 ml HCOOH 0,2M

100 ml KOH 0,2M

0,3L

n = M · V = 0,2 · 0,2 = 0,04 mol HCOOH

n = M · V = 0,2 · 0,1 = 0,02 mol KOH

[HCOOH] = 0,133 M

[KOH] = 0,066 M



0,066 0,066



0,0663

0,0663 - x

0,066 + x

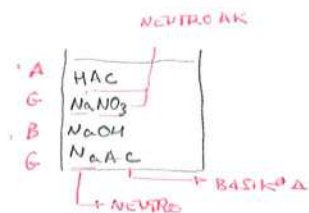
K_a = 10^{-3,65} = $\frac{x \cdot (0,066 + x)}{(0,0663 - x)}$ ⇒ x = 2,24 · 10⁻⁴

pH = 3,64

PL

$$K_a_{HAc} = 1,8 \cdot 10^{-5}$$

}	300 ml HAc 1M	$n = M \cdot V$	$n_{HAc} = 0,3 \text{ mol}$
	100 ml NaNO ₃ 1,5M		$n_{NaNO_3} = 0,15 \text{ mol}$
	150 ml NaOH 1M		$n_{NaOH} = 0,15 \text{ mol}$
	200 ml NaAc 1M		$n_{NaAc} = 0,2 \text{ mol}$
	250 ml H ₂ O		
1L			

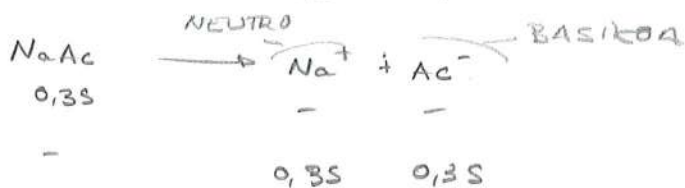
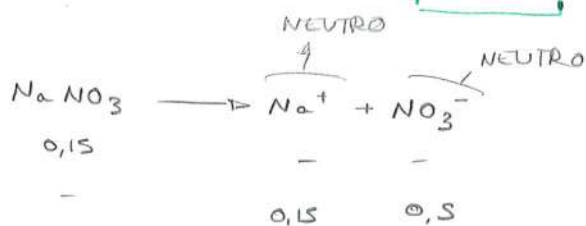
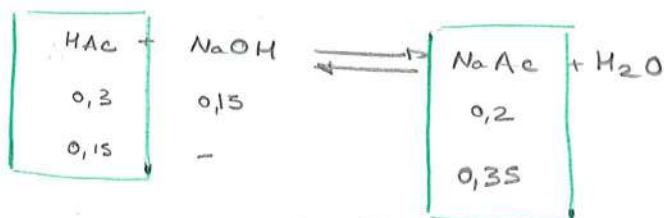


$$[HAc] = 0,3 \text{ mol/l}$$

$$[NaNO_3] = 0,15 \text{ mol/l}$$

$$[NaOH] = 0,15 \text{ mol/l}$$

$$[NaAc] = 0,2 \text{ mol/l}$$



$$K_a = 1,8 \cdot 10^{-5} = \frac{(0,35+x) \cdot x}{(0,15-x)}$$

$$x = 7,71 \cdot 10^{-6}$$



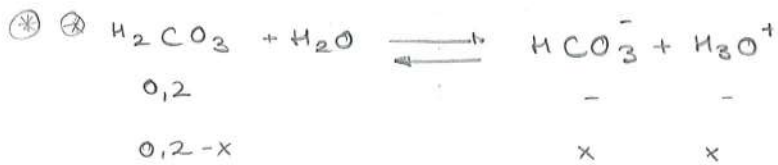
$$pH = -\log[H_3O^+] = -\log[7,71 \cdot 10^{-6}]$$

$$pH = 5,11$$

21

1) $[H_2CO_3] = 0,2 \text{ mol}$ $K_{a1} = 10^{-6,3} = 5,01 \cdot 10^{-7}$ ⊗⊗
 $K_{a2} = 10^{-10,3} = 5,01 \cdot 10^{-11}$

a)



$$K_{a1} = 5,01 \cdot 10^{-7} = \frac{x^2}{(0,2-x)} \quad x = 3,16 \cdot 10^{-4}$$

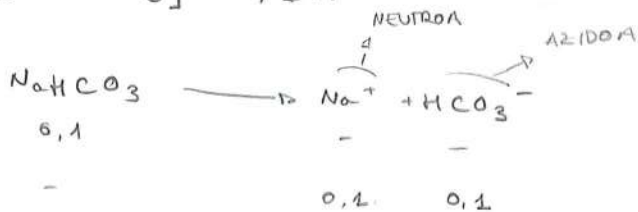
pH = 3,5

b) $|CO_3^{2-}| = ?$

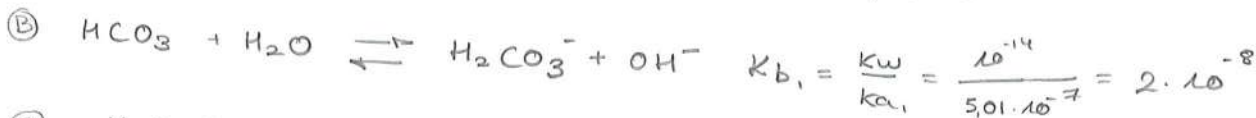
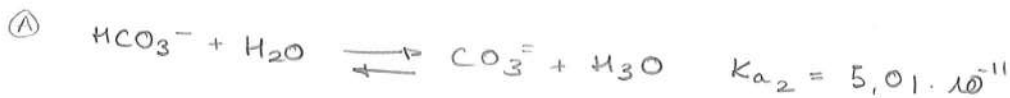
$$K_{a2} = 5,01 \cdot 10^{-11} = \frac{|CO_3^{2-}| \cdot 3,16 \cdot 10^{-4}}{3,16 \cdot 10^{-4}}$$

$|CO_3^{2-}| = 5,01 \cdot 10^{-11}$

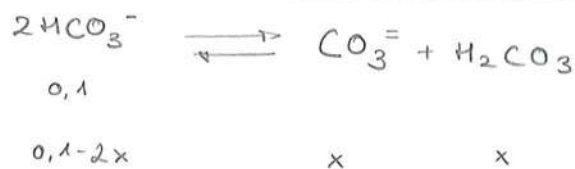
2) $[NaHCO_3] = 0,1 \text{ M}$



[CASO ESPECIAL]



[A+B-C]



$$K_{a2} \cdot \frac{K_w}{K_{a1}} \cdot \frac{1}{K_w} = \left[\frac{K_{a2}}{K_{a1}} = K \right]$$

$K = 10^{-4}$

$$K = 10^{-4} = \frac{x^2}{(0,1-2x)^2} \rightarrow x = 9,8 \cdot 10^{-4}$$

$$K_{a2} = 5,01 \cdot 10^{-11} = \frac{[H^+] \cdot 9,8 \cdot 10^{-4}}{0,1} \quad [H^+] = 5,11 \cdot 10^{-9}$$

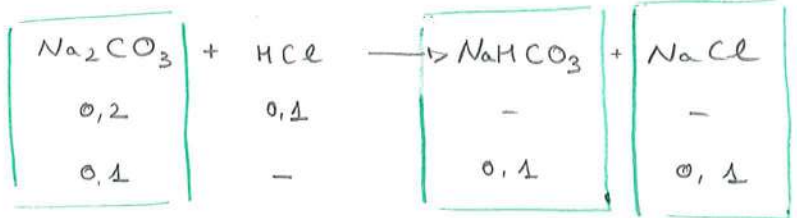
pH = 8,29

23

$pK_{a1} = 6,3$ $K_{a1} = 5,01 \cdot 10^{-7}$ $pK_{a2} = 10,3$ $K_{a2} = 5,01 \cdot 10^{-11}$

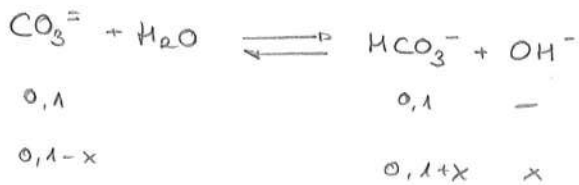
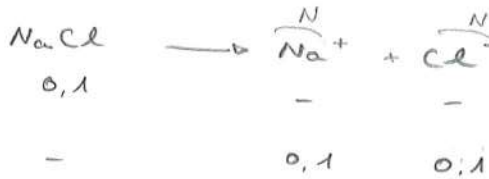
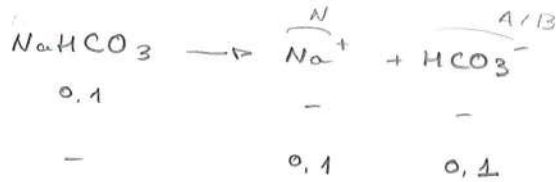
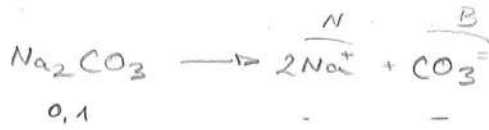
b) 500 ml HCl 0,2 M $n = M \cdot V = 0,2 \cdot 0,5 = 0,1 \text{ mol}$
 500 ml Na_2CO_3 0,4 M $n = M \cdot V = 0,4 \cdot 0,5 = 0,2 \text{ mol}$
 1 L

$|HCl| = 0,1 \text{ M}$
 $|Na_2CO_3| = 0,2 \text{ M}$



$K_{b1} = \frac{K_w}{K_{a1}} = \frac{10^{-14}}{5,01 \cdot 10^{-7}} = 2 \cdot 10^{-8}$

$K_{b2} = \frac{K_w}{K_{a2}} = \frac{10^{-14}}{5,01 \cdot 10^{-11}} = 2 \cdot 10^{-4}$



$K_{b2} = 2 \cdot 10^{-4} = \frac{x \cdot (0,1+x)}{(0,1-x)}$ $x = 2 \cdot 10^{-4}$

$\frac{K_w}{[OH^-]} = [H^+] = \frac{10^{-14}}{2 \cdot 10^{-4}} = 5,02 \cdot 10^{-11}$

$pH = 10,3$

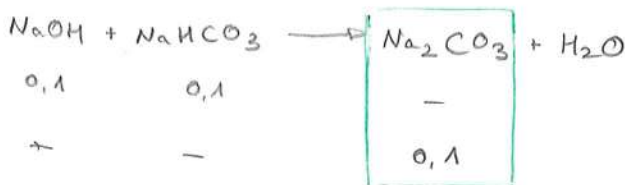
c) 500 ml NaOH 0,2 M $n = M \cdot V = 0,2 \cdot 0,5 = 0,1 \text{ mol}$ $|NaOH| = 0,1 \text{ M}$
 500 ml $NaHCO_3$ 0,2 M $n = M \cdot V = 0,2 \cdot 0,5 = 0,1 \text{ mol}$ $|NaHCO_3| = 0,1 \text{ M}$
 1 L

$K_{b1} = 2 \cdot 10^{-8}$

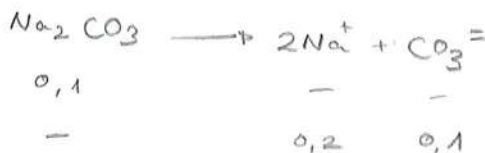
$K_{b2} = 2 \cdot 10^{-4}$

$K_{b2} = 2 \cdot 10^{-4} = \frac{x^2}{(0,1-x)}$

$x = 4,57 \cdot 10^{-3}$



B NaOH
 C $NaHCO_3$



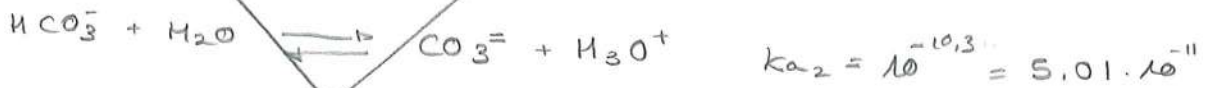
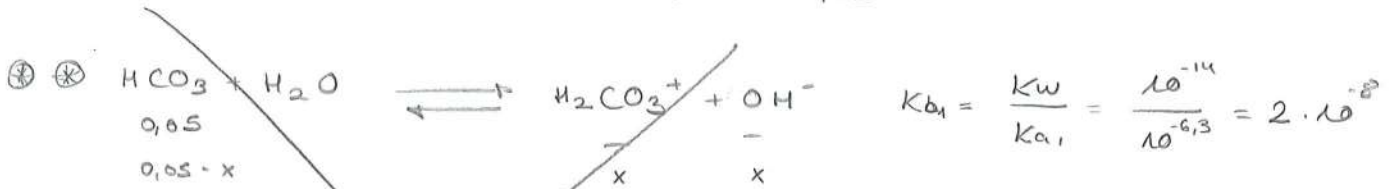
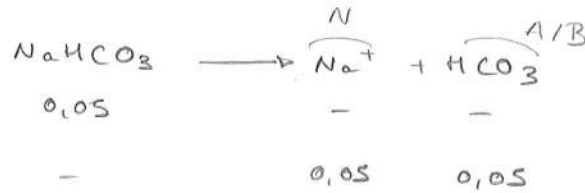
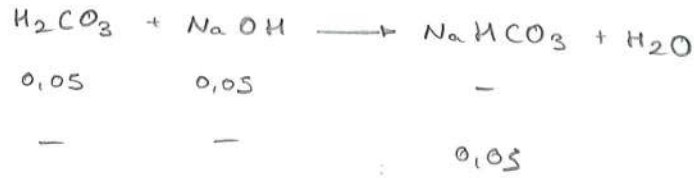
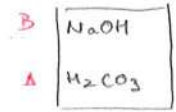
$pH = 11,65$

d)

500 ml NaOH 0,1 M $n = M \cdot V = 0,1 \cdot 0,5 = 0,05 \text{ mol}$ $[NaOH] = 0,05 \text{ M}$

500 ml H_2CO_3 0,1 M $n = M \cdot V = 0,1 \cdot 0,5 = 0,05 \text{ mol}$ $[H_2CO_3] = 0,05 \text{ M}$

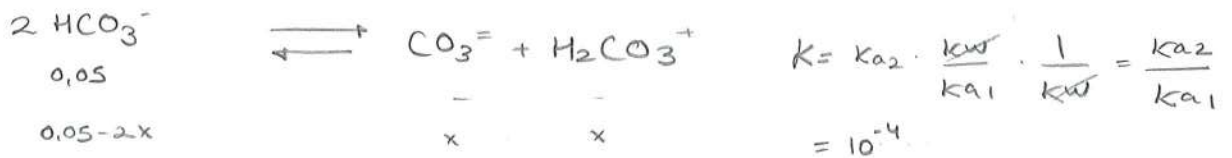
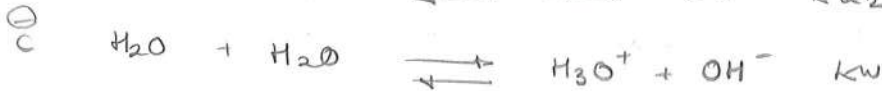
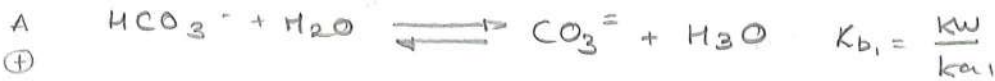
1 L



~~$$K_b = 2 \cdot 10^{-8} = \frac{x^2}{0,05 - x} \quad x = 3,16 \cdot 10^{-5} \quad [H^+] = \frac{K_w}{[OH^-]} = \frac{10^{-14}}{3,16 \cdot 10^{-5}} = 3,16 \cdot 10^{-10}$$~~

~~pH = 9,5~~

⊛



$$K = 10^{-4} = \frac{x^2}{(0,05 - 2x)} \quad x = 2,33 \cdot 10^{-3}$$

$$K_{a1} = 10^{-6,3} = \frac{x \cdot 2,33 \cdot 10^{-3}}{(0,05 - 2 \cdot 2,33 \cdot 10^{-3})} \quad x = 9,75 \cdot 10^{-6}$$

pH = 5,01

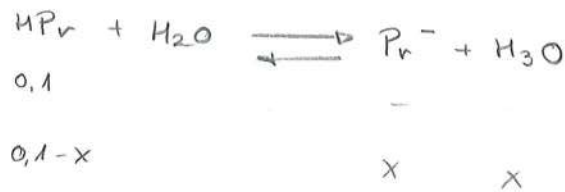
Ex 31. 1

$$K_a = 1,35 \cdot 10^{-5}$$

250 ml HPr 0,1 M $\rightarrow n = M \cdot V = 0,1 \cdot 0,25 = 0,025$ mol

a)

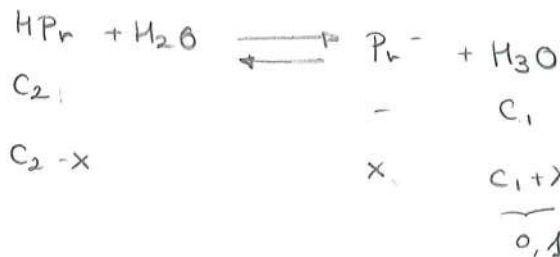
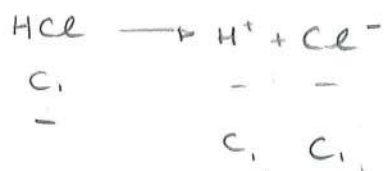
HCl 1 M $pH = 1$ $[H_3O^+] = 10^{-1} = 0,1$



$$K_a = 1,35 \cdot 10^{-5} = \frac{x^2}{0,1-x}$$

$$x = 1,16 \cdot 10^{-3}$$

$pH = 2,93$



$$C_1 + x = 0,1 \quad C_1 \approx 0,1$$

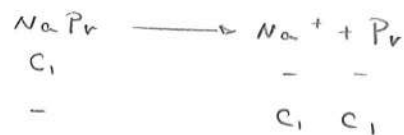
$$C_1 = \frac{1 \cdot V_1}{0,25 + V_1} \rightarrow C_1 = 0,1 = \frac{V_1}{0,25 + V_1}$$

$V_1 = 0,0278$ l

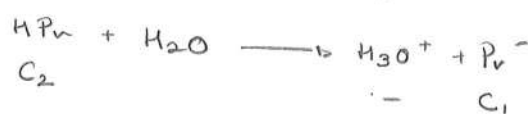
$$C_2 = \frac{0,025}{0,25 + V_1}$$

b)

NaPr 1 M $pH = 4$ $[H_3O^+] = 10^{-4} = 0,0001$



$$C_1 = \frac{1 \cdot V}{V + 0,25}$$



$$C_2 = \frac{0,025}{V + 0,25}$$

$$x = 10^{-4}$$

$$K_a = 1,35 \cdot 10^{-5} = \frac{(C_1 + 10^{-4}) \cdot 10^{-4}}{C_2 - 10^{-4}} = \frac{\left(\frac{V}{V+0,25} + 10^{-4}\right) \cdot 10^{-4}}{\frac{0,025}{V+0,25} - 10^{-4}}$$

$V = 3,34 \cdot 10^{-3}$

c) H_2O $pH = 0,13 + 2,93 = 3,08$ $[H^+] = 8,31 \cdot 10^{-4}$



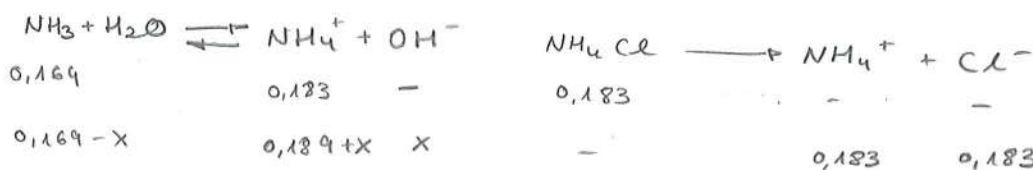
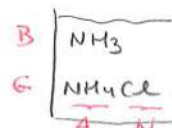
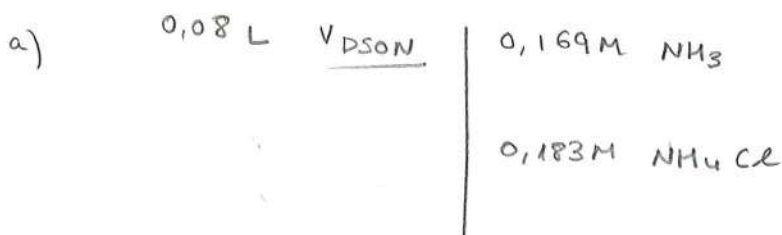
$$C = \frac{0,025}{0,25+V}$$

$$\hookrightarrow x = 8,31 \cdot 10^{-4}$$

$$K_a = 1,35 \cdot 10^{-5} = \frac{(8,31 \cdot 10^{-4})^2}{\frac{0,025}{0,25+V} - 8,31 \cdot 10^{-4}}$$

$$V = 0,23 \text{ L}$$

12



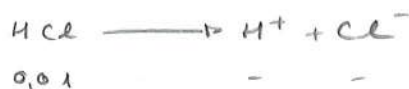
$$pH = 9,2$$

$$K_{b_{NH_3}} = 1,8 \cdot 10^{-5} = \frac{x \cdot (0,189+x)}{(0,169-x)} \qquad x = 1,61 \cdot 10^{-5} \qquad [H^+] = \frac{K_w}{[OH^-]} = \frac{10^{-14}}{1,61 \cdot 10^{-5}} = 6,21 \cdot 10^{-10}$$

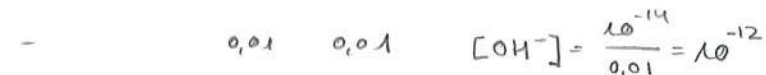
b)

$$0,01 \text{ L HCl } 0,1 \text{ M} \longrightarrow n = M \cdot V = 0,1 \cdot 0,01 = 0,001 \text{ mol}$$

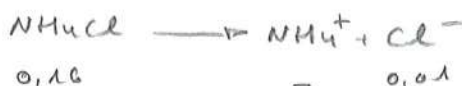
$$[HCl] = \frac{0,001}{0,09} = 0,01 \text{ mol/l}$$



$$[NH_4Cl] = \frac{0,08 \cdot 0,183}{0,09} = 0,16 \text{ mol/l}$$



$$[NH_3] = \frac{0,08 \cdot 0,169}{0,09} = 0,15 \text{ mol/l}$$



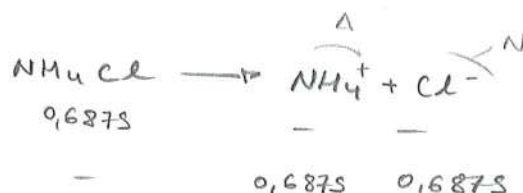
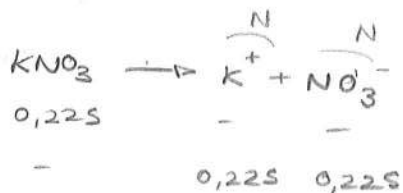
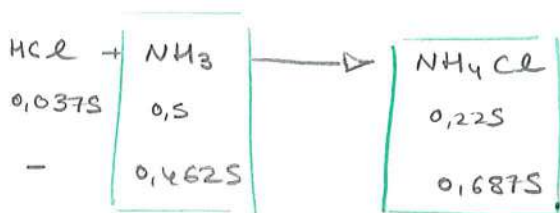
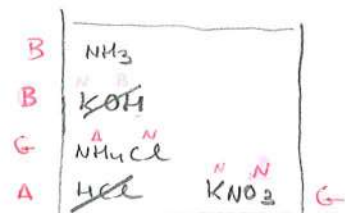
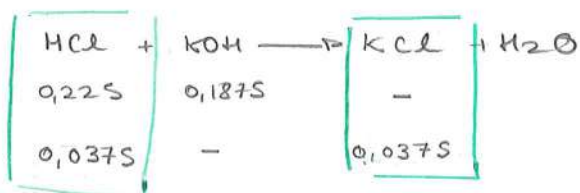
$$K_{b_{NH_3}} = 1,8 \cdot 10^{-5} = \frac{(x+10^{-12}) \cdot (0,16+x)}{(0,15-x)} \Rightarrow$$

$$[H^+] = \frac{10^{-14}}{10^{-12} + 1,68 \cdot 10^{-5}} = 5,95 \cdot 10^{-10} \qquad pH = 9,2$$

$$x = 1,68 \cdot 10^{-5}$$

EJ3 RETORQUE P/LI

200 ml	NH ₃	2,5 M	$n = M \cdot V = 2,5 \cdot 0,2 = 0,5$	$[NH_3] = 0,5 M$
150 ml	KNO ₃	1,5 M	$n = M \cdot V = 1,5 \cdot 0,15 = 0,225$	$[KNO_3] = 0,225 M$
225 ml	NH ₄ Cl	1 M	$n = M \cdot V = 1 \cdot 0,225 = 0,225$	$[NH_4Cl] = 0,225 M$
300 ml	HCl	0,75 M	$n = M \cdot V = 0,75 \cdot 0,3 = 0,225$	$[HCl] = 0,225 M$
125 ml	KOH	1,5 M	$n = M \cdot V = 1,5 \cdot 0,125 = 0,1875$	$[KOH] = 0,1875$
<hr/>				
1				



0,4625 - x		0,6875 + x	x	$K_b = 1,8 \cdot 10^{-5} = \frac{x \cdot (0,6875 + x)}{(0,4625 - x)}$
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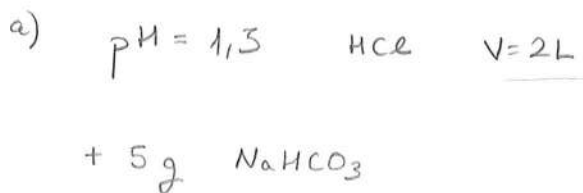
$[H^+] = \frac{10^{-14}}{1,21 \cdot 10^{-5}} = 8,25 \cdot 10^{-10}$

pH = 9,1

$x = 1,21 \cdot 10^{-5}$

AZTERKETA ARIKETAK

2 Ex.33



$$n_{NaHCO_3} = \frac{5}{84} = 0,0595 \text{ mol}$$

$$[NaHCO_3] = 0,0297 \text{ mol/l}$$



0,0316

0,0316 0,0316

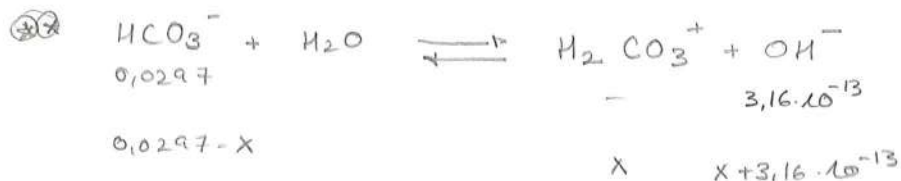
NEUTRO BASIKO



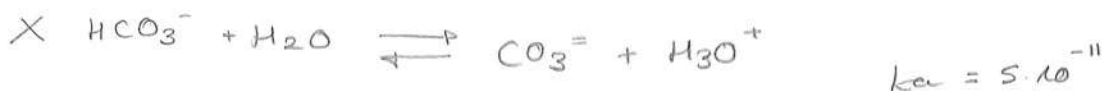
0,0297

0,0297 0,0297

$$[H^+] = 10^{-1,3} = 0,0316 \rightarrow [OH^-] = \frac{10^{-14}}{0,0316} = 3,16 \cdot 10^{-13}$$



$$K_b = \frac{10^{-14}}{K_a} = \frac{10^{-14}}{5 \cdot 10^{-7}} = 2 \cdot 10^{-8}$$



$$K_b = 2 \cdot 10^{-8} = \frac{(x + 3,16 \cdot 10^{-13}) \cdot x}{0,0297 - x} \quad x = 1,879 \cdot 10^{-7}$$

$[OH^-] = 1,879 \cdot 10^{-7} \Rightarrow pH = 7,274$

$[Cl^-] = 0,0316$

$[H^+] = 5,32 \cdot 10^{-8}$

$[HCO_3^-] = 0,0296$

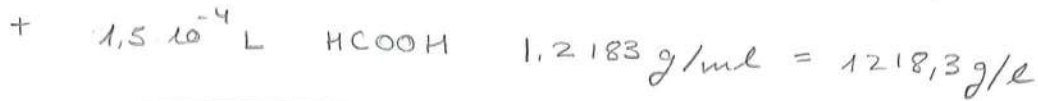
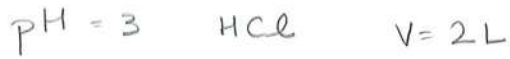
$[H_2CO_3^+] = 1,879 \cdot 10^{-7}$

$[CO_3^{2-}] \Rightarrow 2,78 \cdot 10^{-5}$

$$K_a = \frac{[CO_3^{2-}] \cdot [H^+]}{[HCO_3^-]}$$

$$[CO_3^{2-}] = \frac{[HCO_3^-]}{[H^+]} \cdot K_a = 2,78 \cdot 10^{-5}$$

b)

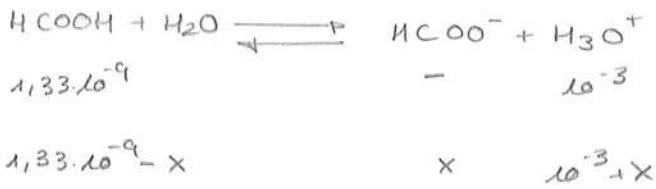
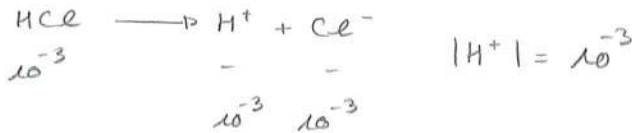


$1 \text{ L} \rightarrow 1218,3 \text{ g}$

$n = \frac{g}{PM} = \frac{1,23 \cdot 10^{-7}}{46} = 2,67 \cdot 10^{-9} \text{ mol}$

$1,5 \cdot 10^{-4} \text{ L} \rightarrow x = 1,23 \cdot 10^{-7} \text{ g}$

$|\text{HCOOH}| = 1,33 \cdot 10^{-9} \text{ mol/l}$

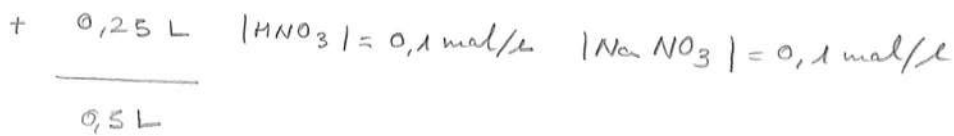
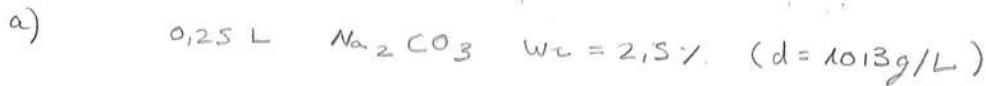


$K_a = 10^{-3,74} = \frac{|\text{HCOO}^-| \cdot |\text{H}_3\text{O}^+|}{|\text{HCOOH}|} =$
 $1,82 \cdot 10^{-4} = \frac{x \cdot (10^{-3} + x)}{(1,33 \cdot 10^{-9} - x)} = 2,05 \cdot 10^{-10}$

$|\text{H}_3\text{O}^+| = 0,001$

$\boxed{\text{pH} = 3}$

2 Ex. 35



$\cdot 0,25 \text{ L} \xrightarrow{d} 253,25 \text{ g Na}_2\text{CO}_3 = 6,33 \text{ g} \quad n = \frac{g}{PM} = 0,0597 \text{ mol}$

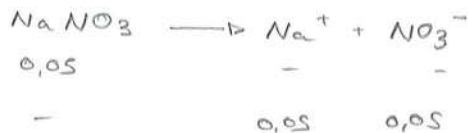
$\cdot n_{\text{HNO}_3} = M \cdot V = 0,25 \cdot 0,1 = 0,025 \text{ mol} \quad n_{\text{NaNO}_3} = 0,1 \cdot 0,25 = 0,025 \text{ mol}$

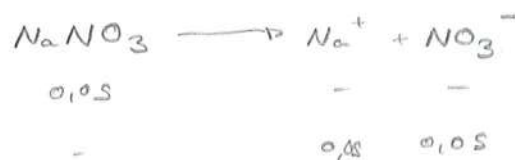
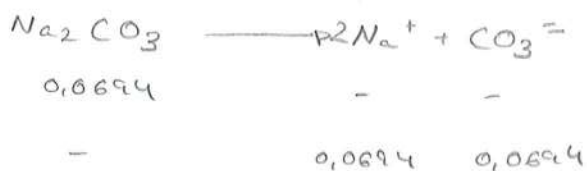
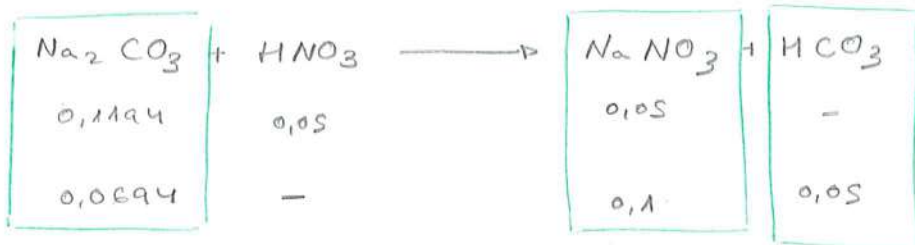
$|\text{Na}_2\text{CO}_3| = 0,1194 \text{ mol/l} \quad |\text{HNO}_3| = 0,05 \text{ mol/l} \quad |\text{NaNO}_3| = 0,05 \text{ mol/l}$

GATZ

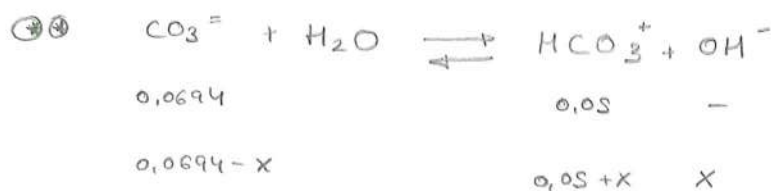
NEUTRO BASICO	
Na_2CO_3	
AZIDO	
HNO_3	
NEUTRO NEUTRO	
NaNO_3	

GATZ





$$K_b = \frac{10^{-14}}{5 \cdot 10^{-7}} = 2 \cdot 10^{-8}$$

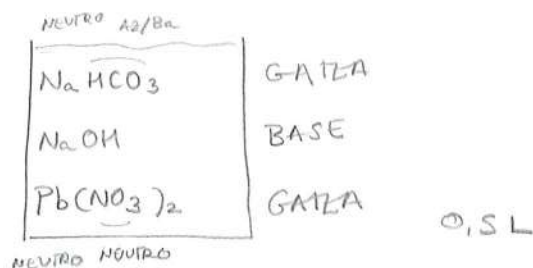
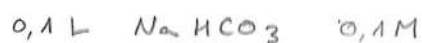


$$K_b = \frac{10^{-14}}{5 \cdot 10^{-11}} = 2 \cdot 10^{-4}$$

$$K_b = 2 \cdot 10^{-4} = \frac{x \cdot (0,05 + x)}{0,0694 - x} \quad x = 2,78 \cdot 10^{-4}$$

$\text{pH} = 0,44$	$ \text{CO}_3^{2-} = 0,0694 \text{ M}$
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b)



$$n = M \cdot V = 0,1 \cdot 0,1 = 0,01 \text{ mol } \text{NaHCO}_3$$

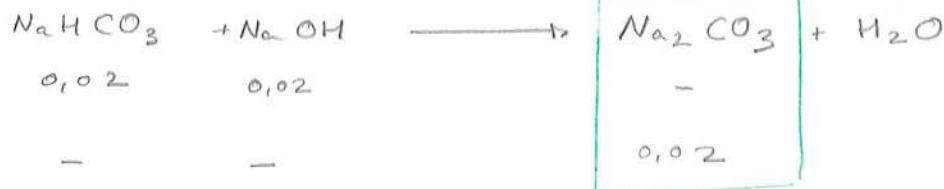
$$|\text{NaHCO}_3| = 0,02 \text{ mol/l}$$

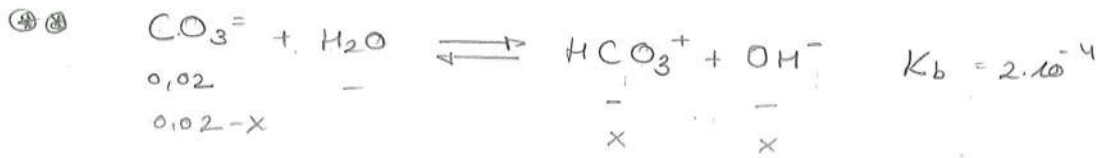
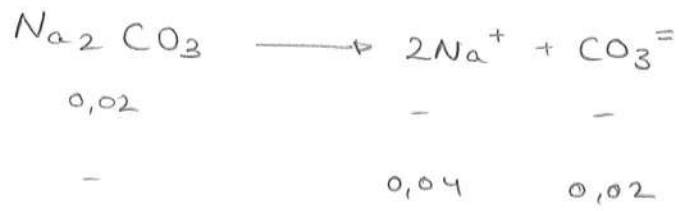
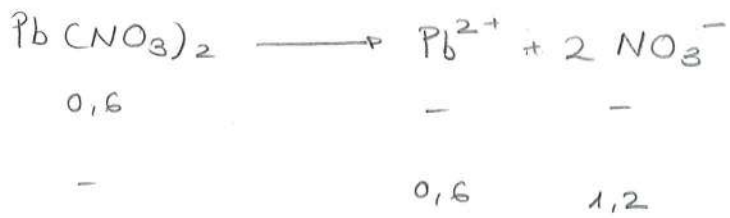
$$n = M \cdot V = 0,1 \cdot 0,1 = 0,01 \text{ mol } \text{NaOH}$$

$$|\text{NaOH}| = 0,02 \text{ mol/l}$$

$$n = M \cdot V = 0,3 \cdot 1 = 0,3 \text{ mol } \text{Pb}(\text{NO}_3)_2$$

$$|\text{Pb}(\text{NO}_3)_2| = 0,6 \text{ mol/l}$$





$$K_b = \frac{x^2}{0,02 - x} = 2 \cdot 10^{-4} \quad x =$$

1

$$V = 125 \text{ cm}^3 = 0,125 \text{ L} \quad \text{HNO}_2 \quad d = 1205 \text{ g/L} \quad w_L(\text{HNO}_2) = 30\%$$

$$+ \quad \frac{0,125 \quad \text{H}_2\text{O}}{0,25 \text{ L}}$$

$$0,125 \text{ L} \xrightarrow{d} 150 \text{ g} \xrightarrow{\cdot 30} 45 \text{ g}$$

$$n = \frac{g}{PM} = \frac{45}{47} = 0,957 \text{ mol}$$

$$|\text{HNO}_2| = \frac{0,957}{0,25} = 3,83 \text{ mol/l}$$



$$K_a = 10^{-3,38} = \frac{x^2}{3,83 - x} \quad x = 0,0397$$

$$= 4,16 \cdot 10^{-4} = \frac{x^2}{3,83 - x}$$

$$\boxed{\text{pH} = 1,4}$$

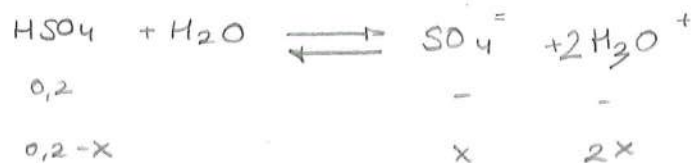
2

$$0,2 \text{ M } \text{H}_2\text{SO}_4$$



$$K_a = 1,26 \cdot 10^{-2} = \frac{2x^2}{0,2 - x}$$

$$x = 0,03295$$

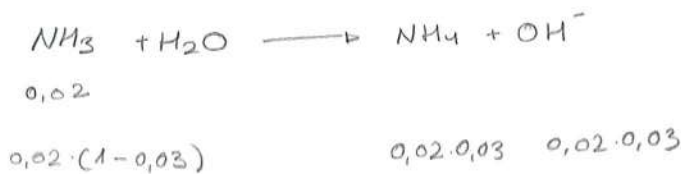


$$\text{pH} = -\log(2 \cdot 0,03295) = \boxed{1,18 = \text{pH}}$$

3

$$0,250 \text{ L} \quad \text{NH}_3 \quad 0,02 \text{ mol/l} \quad \alpha = 0,03$$

a)



$$K_b = \frac{10^{-14} \cdot |\text{NH}_4^+|}{|\text{NH}_3|} =$$

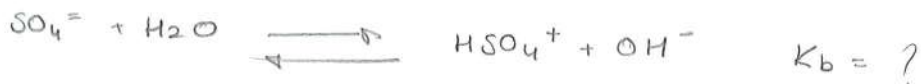
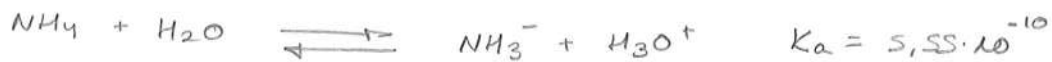
$$= \boxed{1,85 \cdot 10^{-5} = K_b}$$

$$\text{pH} = -\log\left(\frac{10^{-14}}{0,02 \cdot 0,03}\right) = \boxed{10,78 = \text{pH}}$$

b)

$$n = 0,002 \text{ mol } (\text{NH}_4)_2 \text{SO}_4$$

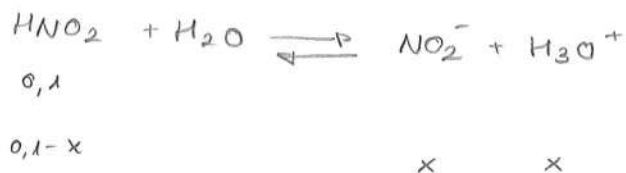
$$|(\text{NH}_4)_2 \text{SO}_4| = 0,008 \text{ mol/l}$$



6

$$\text{HNO}_2 \quad 2,35 \text{ g} \quad V = 0,5 \text{ L}$$

$$n = \frac{g}{PM} = \frac{2,35}{47} = 0,05 \text{ mol} \quad |\text{HNO}_2| = 0,1 \text{ mol/l}$$



$$K_a = 4,6 \cdot 10^{-4} = \frac{x^2}{0,1-x}$$

$$x = 6,55 \cdot 10^{-3}$$

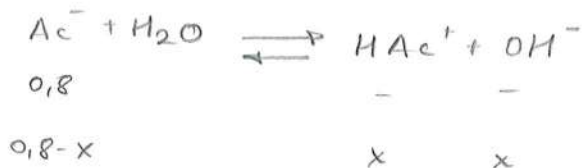
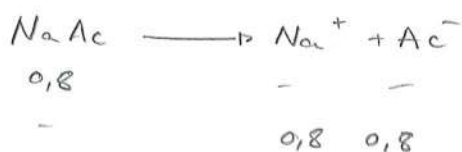
$$\boxed{\text{pH} = 2,18}$$

$$\alpha = \frac{6,55 \cdot 10^{-3}}{0,1} = 0,0655 = \boxed{6,55\% = \alpha}$$

8

$$\text{NaAc} \quad 20 \text{ g} \quad 0,3 \text{ L}$$

$$n = \frac{20}{82} = 0,24 \text{ mol} \quad |\text{NaAc}| = 0,8 \text{ mol/l}$$



$$\text{pH} = -\log\left(\frac{10^{-14}}{2,12 \cdot 10^{-5}}\right) = 9,33$$

$$K_b = \frac{10^{-14}}{K_a} = 5,55 \cdot 10^{-10} = \frac{x^2}{0,8-x} \quad x = 2,12 \cdot 10^{-5}$$

$$\boxed{\text{pH} = 9,33}$$

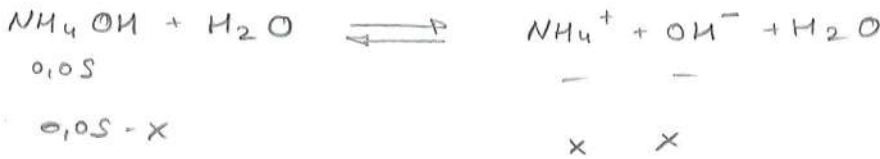
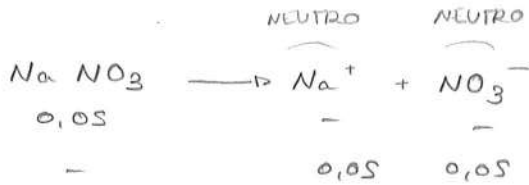
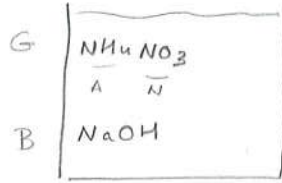
10



0,2

|NH₄NO₃| = 0,05 mol/l

|NaOH| = 0,05 mol/l



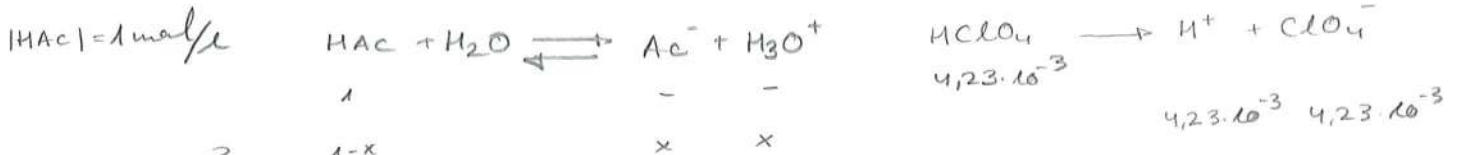
Kb = 1,8 . 10⁻⁵ = x² / (0,05 - x) x = 9,39 . 10⁻⁴

pH = -log(10⁻¹⁴ / (9,39 . 10⁻⁴)) PH = 10,97

11



1L -> 60g n = 60/60 = 1



Ka = 1,8 . 10⁻⁵ = x² / (1 - x)

x = 4,23 . 10⁻³ [pH = 2,37]

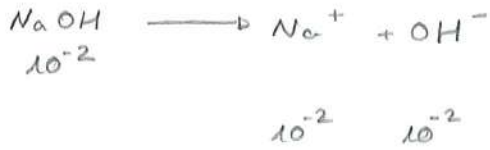
|HClO₄| = n/V = 4,23 . 10⁻³

n = 4,23 . 10⁻³ mol -> g = 0,423g

x . 0,15 = 0,423 x = 0,423 / 0,15 = 2,82g -> 0,00232 l

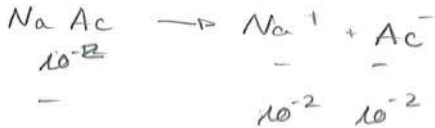
11

$V = 1\text{ L}$ NaOH $\text{pH} = 12$ \longrightarrow $\text{pH} = 4,7$



$[\text{H}^+] = 10^{-12}$

$[\text{OH}^-] = 10^{-2}$



$$K_b = \frac{10^{-14}}{1,8 \cdot 10^{-5}} = 5,55 \cdot 10^{-10} = \frac{5012 \cdot 10^{-10} \cdot (C \cdot 10^{-2})}{10^{-2}}$$

$10^{-2} = x$

$C \cdot 10^{-2} + x$



$\text{pH} = 4,7$

$C = 2,12 \cdot 10^{-2} \text{ mol/l}$

$[\text{H}^+] = 10^{-4,7}$ $[\text{OH}^-] = 5,012 \cdot 10^{-10}$

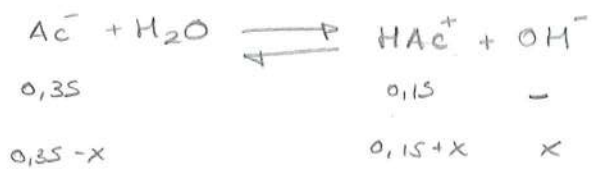
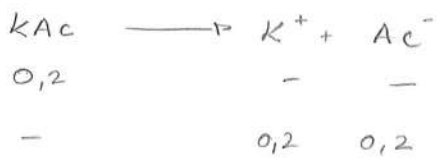
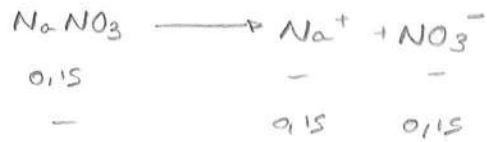
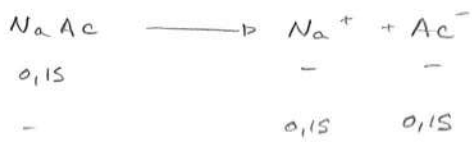
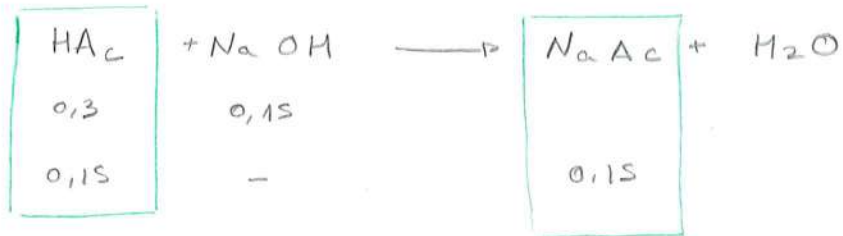
$n = M \cdot V = 2,12 \cdot 10^{-2} \cdot 1 = 2,12 \cdot 10^{-2} \text{ mol}$

$g = n \cdot \text{PM} = 2,12 \cdot 10^{-2} \cdot 60 = 1,272 \text{ g}$

$\text{HAc} = 1,272 \text{ g}$

24

0,3 L	HAc	1 M	n = 0,3 mol	HAc = 0,3 M	A
0,1 L	NaNO ₃	1,5 M	n = 0,15 mol	NaNO ₃ = 0,15 M	G (N,N)
0,15 L	NaOH	1 M	n = 0,15 mol	x NaOH = 0,15 M	B
0,2 L	KAc	1 M	n = 0,2 mol	KAc = 0,2 M	G (N,B)
0,25 L	H ₂ O				
1 L					



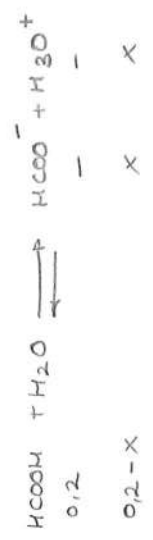
$\text{pH} = 5,13$

$$K_b = \frac{10^{-14}}{10^{-9,75}} = 5,75 \cdot 10^{-10} = \frac{x(0,15+x)}{0,35-x}$$

$$x = 1,34 \cdot 10^{-9}$$

pH?

200 ml HCOOH = 0,2 M
pKa = 3,65



$$K_a = 10^{-3,65} = 2,24 \cdot 10^{-4} = \frac{x^2}{0,2 - x}$$

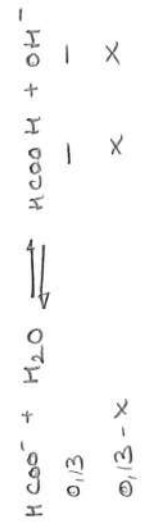
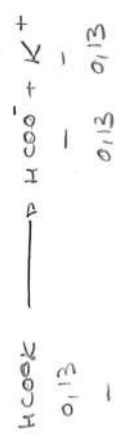
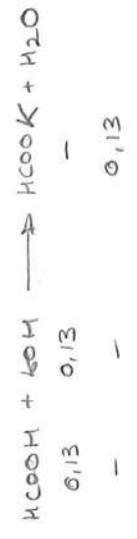
$$x = 6,58 \cdot 10^{-3}$$

pH = 2,18

pH?

200 ml HCOOH 0,2 M
100 ml KOH 0,4 M
0,3 L

n = M · V = 0,04 mol |HCOOH| = 0,13 M
n = M · V = 0,04 mol |KOH| = 0,13 M



$$K_b = \frac{10^{-14}}{10^{-3,65}} = 4,47 \cdot 10^{-11} = \frac{x^2}{0,13 - x}$$

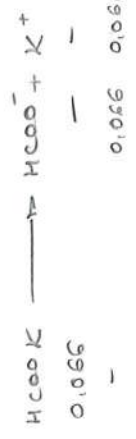
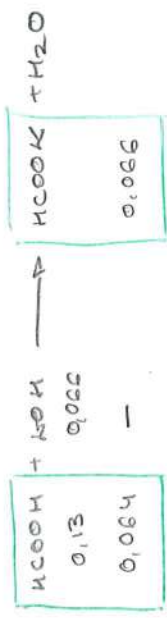
$$x = 2,41 \cdot 10^{-6}$$

pH = 8,38

pH?

200 ml HCOOH 0,2 M
100 ml KOH 0,2 M
0,3 L

n = M · V = 0,04 mol |HCOOH| = 0,13 M
n = M · V = 0,02 mol |KOH| = 0,06



$$K_b = 4,47 \cdot 10^{-11} = \frac{x(x + 0,064)}{0,066 - x}$$

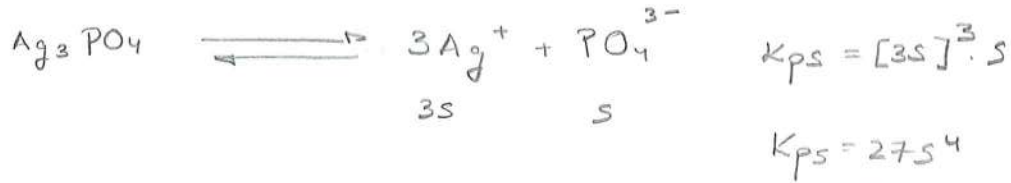
$$x = 4,61 \cdot 10^{-11}$$

pH = 3,66

SOLUBILIDAD
AZTERKETARAKO ADIKETAK

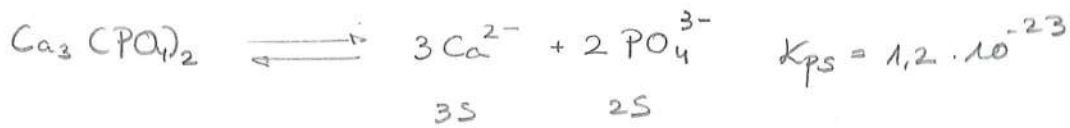
1

a) Ag_3PO_4 $S = 8,5 \cdot 10^{-4} \text{ g/l} = 8,5 \cdot 10^{-3}$



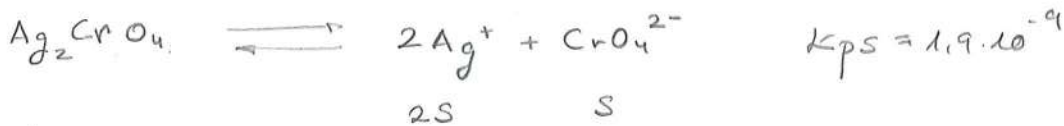
$K_{ps} = 1,4 \cdot 10^{-7}$

2



$$K_{ps} = [3S]^3 \cdot [2S]^2 = 27S^3 \cdot 4S^2 = 108S^5 \quad S = \sqrt[5]{\frac{K_{ps}}{108}} \quad \boxed{S = 1,02 \cdot 10^{-5}}$$

3



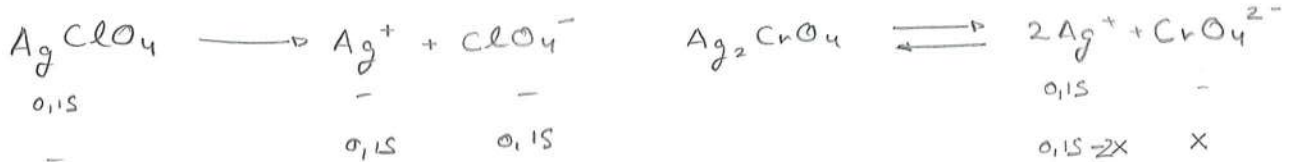
a) 4L H₂O

$$K_{ps} = [2S]^2 \cdot S = 4S^3 \quad S = \sqrt[3]{\frac{K_{ps}}{4}} = \sqrt[3]{\frac{1,9 \cdot 10^{-9}}{4}} = 7,8 \cdot 10^{-4} \text{ mol/l}$$

$$\frac{n}{4L} = 7,8 \cdot 10^{-4} \text{ mol/l} \quad n = 3,12 \cdot 10^{-3} \text{ mol} \quad g = n \cdot PM = 1,035 \text{ g}$$

$Ag_2CrO_4 = 1,035 \text{ g}$

b)



$$K_{ps} = 1,9 \cdot 10^{-9} = x \cdot (0,15 - 2x)^2 \Rightarrow x = 8,44 \cdot 10^{-8}$$

$$n = S \cdot V = 8,44 \cdot 10^{-8} \cdot 4L = 3,37 \cdot 10^{-7} \quad g = n \cdot PM = 1,12 \cdot 10^{-4}$$

$Ag_2CrO_4 = 1,12 \cdot 10^{-4} \text{ g}$

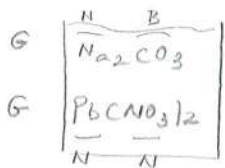
4

0,1 L Na₂CO₃ 0,12M

s Pb?

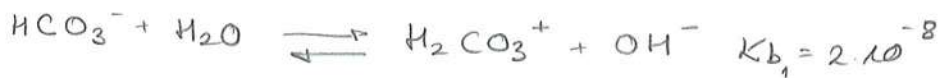
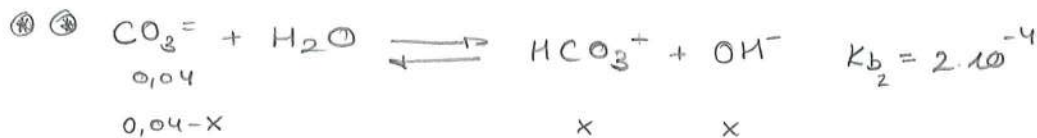
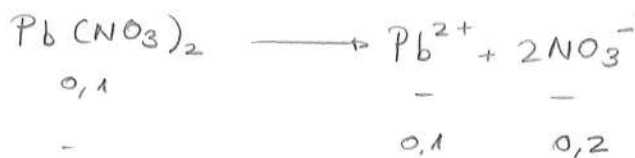
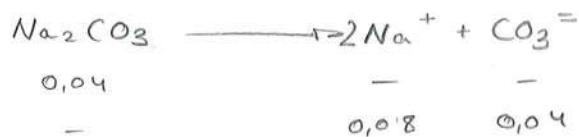
0,2 L Pb(NO₃)₂ 0,15M
 0,3 L

K_{ps} (PbCO₃) = 1,5 · 10⁻¹³

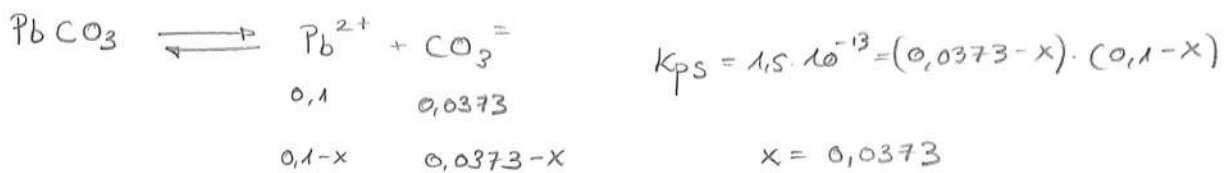


n = M · V = 0,012 mol |Na₂CO₃| = 0,04 M

n = M · V = 0,03 mol |Pb(NO₃)₂| = 0,1 M



K_b = 2 · 10⁻⁴ = $\frac{x^2}{0,04 - x}$ x = 2,73 · 10⁻³ |CO₃⁼| = 0,0373 M



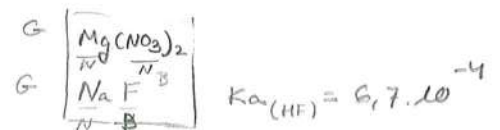
|CO₃⁼| = $\frac{1,5 \cdot 10^{-13}}{0,1 - 0,0373} = 2,39 \cdot 10^{-12} = |CO_3^{=}|$

5

Mg F₂ 0,1 L Mg(NO₃)₂ 0,25 M

K_{ps} (MgF₂) = 8 · 10⁻⁸

0,025 L NaF 0,2 M
 0,125 L

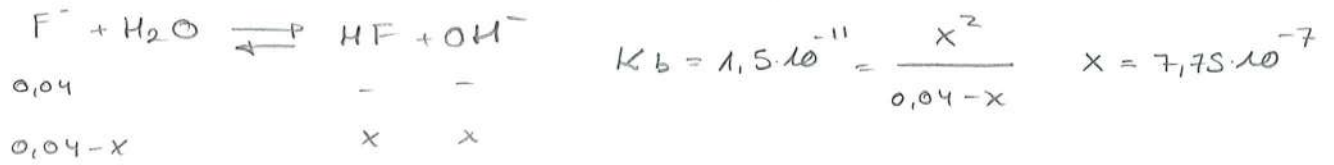
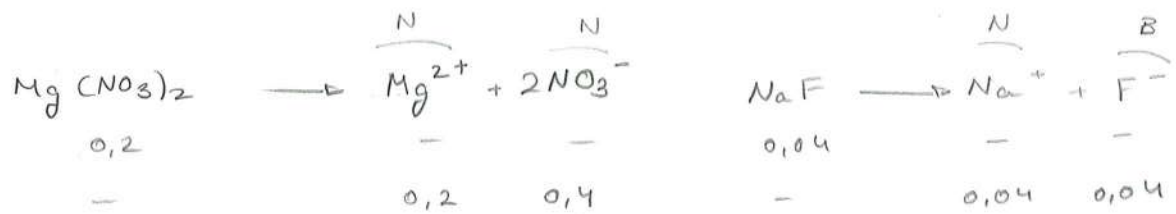


n = M · V = 0,025 M

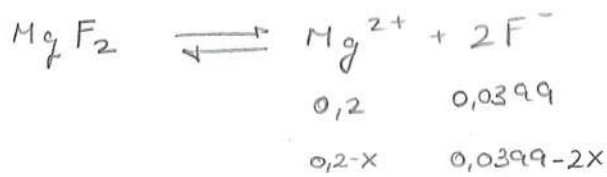
|Mg(NO₃)₂| = 0,2

n = M · V = 0,005 M

|NaF| = 0,04 M



$$[\text{F}^-] = 0,0399$$



$$Q_{ps} = 3,18 \cdot 10^{-4} > K_{ps} = 8 \cdot 10^{-8}$$

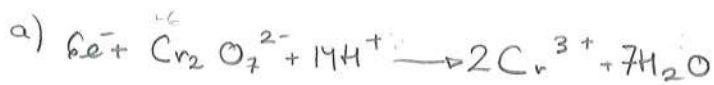
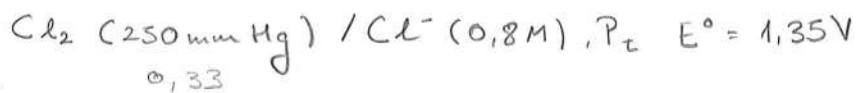
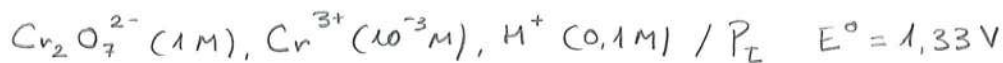
VA A PREZIPITAR

$$K_{ps} = 8 \cdot 10^{-8} = (0,2-x) \cdot (0,0399-2x)^2 \qquad x = 0,019617$$

$$[\text{F}^-] = 6,65 \cdot 10^{-4} \text{ M} \qquad [\text{NO}_3^-] = 0,4 \text{ M}$$

$$[\text{Mg}^{2+}] = 0,18 \text{ M} \qquad [\text{Na}^+] = 0,04 \text{ M}$$

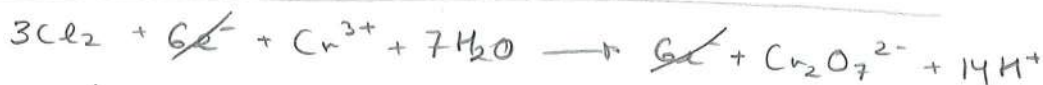
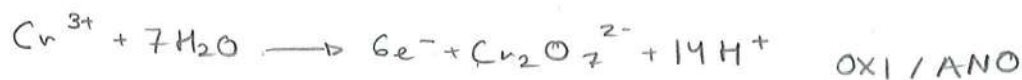
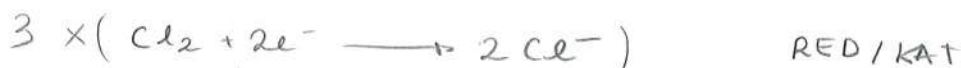
1



$$E^{\text{red}} = 1,33 - \frac{0,0257}{6} \ln \frac{|\text{Cr}^{3+}|^2}{|\text{H}^+|^{14} \cdot |\text{Cr}_2\text{O}_7^{2-}|} \Rightarrow E = 1,25\text{V}$$



$$E^{\text{red}} = 1,35 - \frac{0,0257}{2} \ln \frac{|\text{Cl}^-|^2}{P_{\text{Cl}_2}} \Rightarrow E = 1,34\text{V}$$



$$E_{\text{pila}}^{\text{red}} = E_{\text{KAT}}^{\text{red}} - E_{\text{ANO}}^{\text{red}} = 1,34 - 1,25 = 0,09\text{V} \quad \text{RISPON.}$$

b)

$$E_{\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}}^{\text{red}} > 1,34 = 1,33 - \frac{0,0257}{6} \ln \frac{|10^{-3}|^2}{|\text{H}^+|^{14} \cdot |1|} \quad |\text{H}^+| = 0,44\text{M}$$

$$\boxed{\text{pH} < 0,35}$$

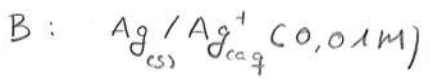
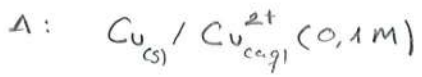
c) $V = 1\text{L}$

$$I = 0 \quad |\text{Cr}^{3+}| \rightarrow I = Z \quad \frac{|\text{Cr}^{3+}|}{2} = 5 \cdot 10^{-4} \text{ mol/l}$$

$$n_{\text{Cr}^{3+}} = 5 \cdot 10^{-4} \text{ mol}$$

$$5 \cdot 10^{-4} \text{ mol} \cdot \frac{6 \text{ mol } e^-}{2 \text{ mol } \text{Cr}^{3+}} \cdot 96500 = 144,75\text{C} \quad \boxed{Q = 144,75\text{C}} = \text{Ans}$$

Ex. 21.3

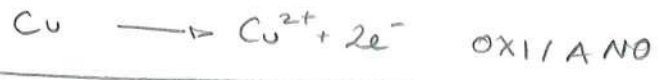


$E^{\text{red}} = 0,342 - \frac{0,0257}{2} \ln \frac{1}{0,1} \Rightarrow E^{\text{red}} = \underline{0,312\text{V}}$



$E^{\text{red}} = 0,799 - \frac{0,0257}{1} \ln \frac{1}{0,01} \Rightarrow E^{\text{red}} = \underline{0,68\text{V}}$

a)



$E^{\text{red}}_{\text{pila}} = E^{\text{red}}_{\text{KAT}} - E^{\text{red}}_{\text{ANO}} = 0,68 - 0,312 = 0,368\text{V}$ ESPONTANEOA

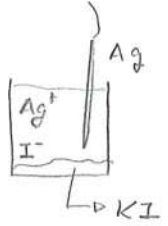
$E^{\circ}_{\text{pila}} = E^{\circ}_{\text{KAT}} - E^{\circ}_{\text{ANO}} = 0,799 - 0,342 = 0,457\text{V}$

$E^{\text{red}}_{\text{pila}} = E^{\circ}_{\text{pila}} - \frac{0,0257}{n} \ln Q$

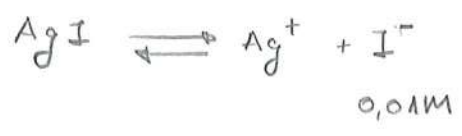
$0 = 0,457 - \frac{0,0257}{2} \ln K$

$K = 2,78 \cdot 10^5$

d)



$K_{ps}(\text{AgI}) = 8,3 \cdot 10^{-17} = |\text{Ag}^+| \cdot |\text{I}^-| = |\text{Ag}^+| \cdot 0,01$

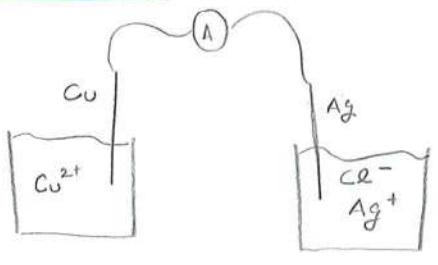


$|\text{Ag}^+| = 8,3 \cdot 10^{-15}$

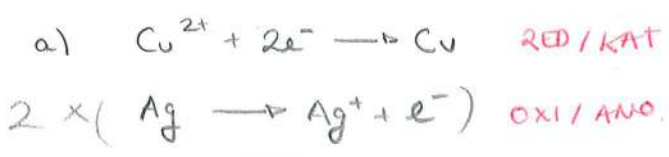
$E_{\text{Ag}/\text{Ag}^+} = 0,799 - \frac{0,0257}{1} \ln \frac{1}{8,3 \cdot 10^{-15}} \Rightarrow E^{\text{red}} = \underline{\underline{-0,034}}$

NORABIDEA ALDATUKO DA $E^{\text{red}}_{\text{Ag}/\text{Ag}^+} < E^{\text{red}}_{\text{Cu}/\text{Cu}^{2+}}$

Ex. 19.5



$$E_{red} = 0,79 - \frac{0,0257}{1} \ln \frac{1}{|Ag^+|} = 0,212 \text{ V}$$

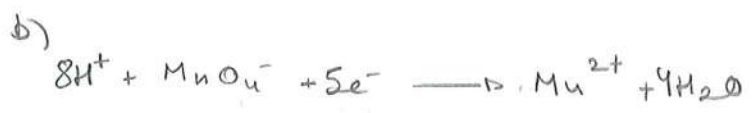


$$K_{ps}(AgCl) = 1,7 \cdot 10^{-10} = \underbrace{|Cl^-| \cdot |Ag^+|}_{1M}$$

$$|Ag^+| = 1,7 \cdot 10^{-10} \text{ M}$$



$$E_{red} = 0,34 - \frac{0,0257}{2} \ln \frac{1}{5} = 0,36 \text{ V}$$



$$|Mn^{2+}| = 0,02 \text{ M}$$

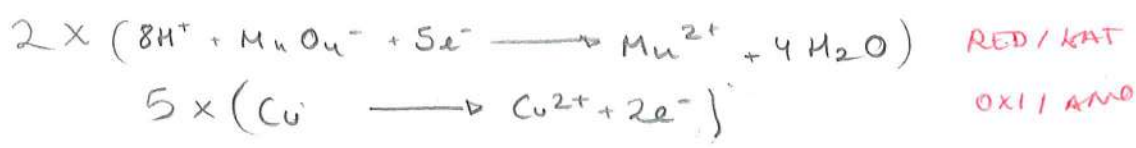
$$|MnO_4^-| = 0,1 \text{ M}$$

$$|H^+| = 10^{-3} \text{ M}$$

$$E = 1,51 \text{ V} - \frac{0,0257}{5} \ln \frac{|Mn^{2+}|}{|MnO_4^-| \cdot |H^+|^8}$$

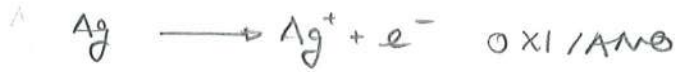
$$E_{red} = 1,44 \text{ V}$$

$$E_{red\ pila} = E_{red\ kat} - E_{red\ ano} = 1,44 - 0,36 = \boxed{1,08 \text{ V} = E_{red\ pila}}$$



1c

a) REDUCE \longrightarrow CONCENTRADA

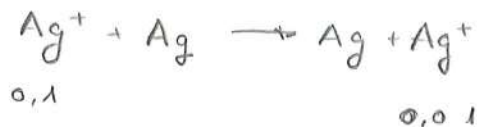


b)

$$E_{\text{med pile}} = 0 - \frac{0,0257}{1} \ln \frac{0,01}{0,1}$$

$$E_{\text{med pile}} = 0,059 \text{ V}$$

c) $V = 0,5 \text{ l}$



$$0 = - \frac{0,0257}{1} \times \ln K \quad K=1$$

$$K=1 = \frac{0,01+x}{0,1-x}$$

$$x = 0,045 \text{ mol/l ekuivalenatv.}$$

$$0,5 \cdot 0,045 = 0,0225 \text{ mol}$$

$$0,0225 \cdot \frac{1 \text{ mol } e^-}{1 \text{ mol } \text{Ag}^+} \cdot 96300 = 2171,25 \text{ C}$$

$$A \cdot t = \frac{2171,25}{3600} = 0,60 \text{ A} \cdot \text{h}$$

3

$$E^{\circ}_{Ag^+/Ag} = 0,799V \quad E^{\circ}_{Cu^{2+}/Cu} = 0,345V \quad K_{ps}(AgCl) = 2,8 \cdot 10^{-10}$$

$$K_{ps}(CuCl) = 10^{-40}$$

a)



$$E = 0,799 - \frac{0,0257}{1} \ln \frac{1}{[Ag^+]}$$

$$E_{med}^{Ag^+/Ag} = 0,33V //$$

$$K_{ps}(AgCl) = 2,8 \cdot 10^{-10} = [Ag^+] \cdot [Cl^-]$$

$$[Ag^+] = 1,4 \cdot 10^{-8} M$$

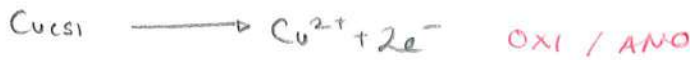
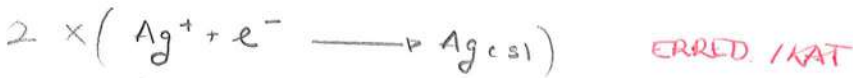


$$E_{med} = 0,345 - \frac{0,0257}{2} \ln \frac{1}{[Cu^{2+}]}$$

$$E_{med}^{Cu^{2+}/Cu} = -0,8 //$$

$$K_{ps}(CuCl) = 10^{-40} = [Cu^{2+}] \cdot [Cl^-]^2$$

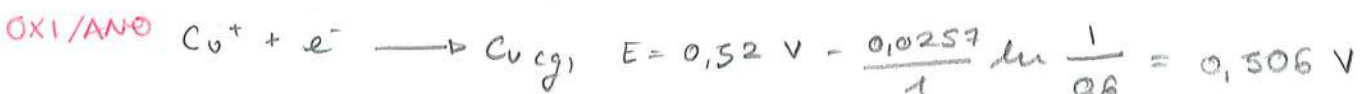
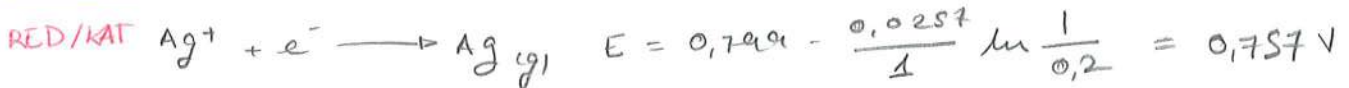
$$[Cu^{2+}] = 2 \cdot 10^{-39} M$$



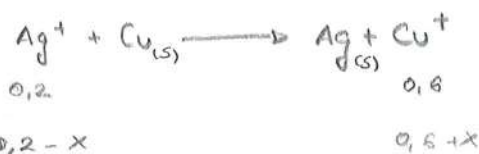
b)

$$E_{pila}^{med} = 0,33 - (-0,8) = 1,13V$$

Ex. 23.4



$$E_{pila}^{med} = 0,757 - 0,506 = 0,251 \quad (\cdot 0,85) \quad E_{pila}^{med} = 0,213V$$

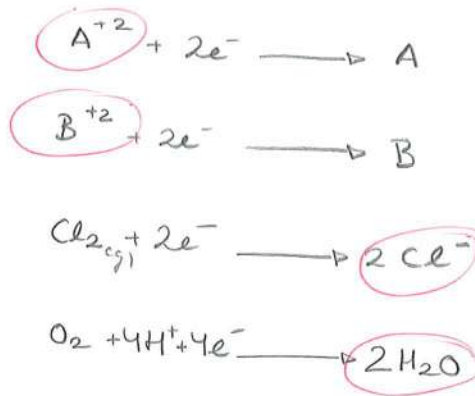
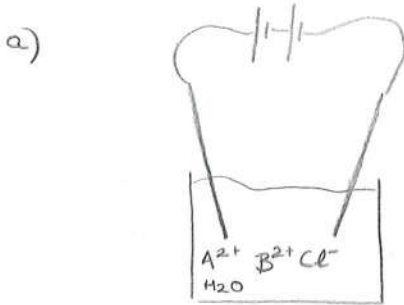
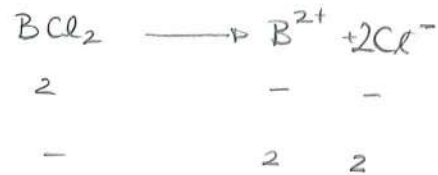
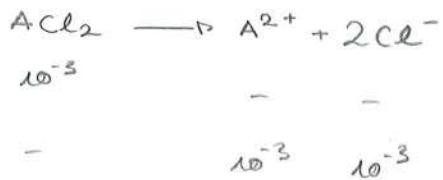


$$0,213 = 0,279 - \frac{0,0257}{1} \ln \frac{|0,6+x|}{|0,2-x|}$$

$$x = 0,143$$

$$[Ag^+] = 0,2 - 0,143 = 0,057M = [Ag^+]$$

13 ELEKTROLISIS



b)

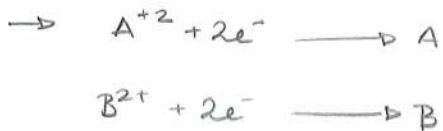
$$E_{A^{2+}/A}^{need} = -0,14 - \frac{0,0257}{2} \ln \frac{1}{10^{-3}} = -0,22 \text{ V}$$

$$E_{B^{2+}/B}^{need} = -0,28 - \frac{0,0257}{2} \ln \frac{1}{2} = -0,27 \text{ V}$$

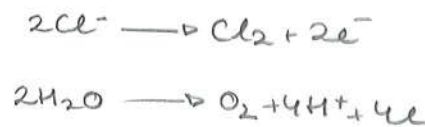
$$E_{Cl_2/Cl^-}^{need} = 1,36 - \frac{0,0257}{2} \ln \frac{(2 \cdot 10^{-3})^2}{P_{Cl_2} \cdot 1 \text{ atm}} = 1,34 \text{ V}$$

$$E_{O_2/H_2O}^{need} = 1,23 - \frac{0,0257}{4} \ln \frac{1}{P_{O_2} \cdot (10^{-7})^4} = 0,81 \text{ V}$$

KAT / ERRE



ANO / OXI



A lebih mudah oksidasi

c)

$$-0,27 = -0,14 - \frac{0,0257}{2} \ln \frac{1}{[A^{2+}]}$$

$$[A^{2+}] = 4,03 \cdot 10^{-5} M$$

d)

$$I = 0,5 A \quad \eta = 95\% \quad 56 \text{ cm}^3 \text{ gas}$$

$$56 \text{ cm}^3 = 0,056 \text{ dm}^3 = 0,056 \text{ l} \longrightarrow x = 0,0025 \text{ mol}$$

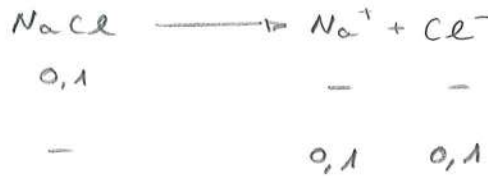
$$22,4 \text{ l} \longrightarrow 1 \text{ mol}$$

$$0,0025 \text{ mol} \cdot \frac{4 e^- \text{ mol}}{1 \text{ mol O}_2} \cdot 96500 = 965 \text{ C} = Q$$

$$Q = I \cdot t \longrightarrow t = \frac{Q}{I \cdot \eta} = \frac{965}{0,5 \cdot 0,95} = 1833,5 \text{ s} = \boxed{30,56 \text{ min}}$$

O₂-gaseloo
ANODO Elektr.-an

14



$$\textcircled{+} \textcircled{+} \quad E_{\text{red}} = 1,44 \text{ V} \quad \text{Cl}_2 + 2e^- \longrightarrow 2\text{Cl}^- \quad E_{\text{red}} = 1,36 - \frac{0,0257}{2} \ln \frac{10,11^2}{P_{\text{Cl}_2} \cdot 1 \text{ atm}} = 1,41 \text{ V} + 0,03 =$$

$$\text{Na}^+ + e^- \longrightarrow \text{Na} \quad E_{\text{red}} = -2,71 - \frac{0,0257}{1} \ln \frac{1}{0,1} = -2,77 \text{ V} = E_{\text{red}}$$

$$\textcircled{+} \textcircled{+} \quad E_{\text{red}} = 1,67 \text{ V} \quad \text{O}_2 + 4\text{H}^+ + 4e^- \longrightarrow 2\text{H}_2\text{O} \quad E_{\text{red}} = 1,23 - \frac{0,0257}{4} \ln \frac{1}{P_{\text{O}_2} \cdot [H^+]^4} = 0,82 + 0,85 =$$

$$\textcircled{+} \textcircled{+} \quad 2\text{H}_2\text{O} + 2e^- \longrightarrow \text{H}_2 + 2\text{OH}^- \quad E_{\text{red}} = -0,83 - \frac{0,0257}{2} \ln \frac{P_{\text{H}_2} \cdot 10\text{M}^2}{1} = -0,41$$

$$\text{KAT/RED} \quad 2\text{H}_2\text{O} + 2e^- \longrightarrow \text{H}_2 + 2\text{OH}^- \quad E_{\text{red}} = -0,478 \text{ V}$$

$$\text{ANO/OXI} \quad 2\text{Cl}^- \longrightarrow \text{Cl}_2 + 2e^-$$

$$E_{\text{red}}^{\text{pila}} = -0,478 - 1,44 = \boxed{-1,918 \text{ V} = E_{\text{red}}^{\text{pila}}}$$

15) AURREKO ARIKETAREN ELEKTROLIS BERDINA

$$I = 3000 \text{ A} \quad \eta = 90\% \quad E = 4,2 \text{ V} \quad \left. \begin{array}{l} \text{NaOH?} \\ \text{Cl}_2? \end{array} \right\}$$



a)

$$Q = I \cdot t \rightarrow \begin{cases} I = 3000 \text{ A} \\ t = 24 \cdot 3600 \end{cases} \quad Q = 3000 \cdot 24 \cdot 3600 \cdot 0,90 = 2,33 \cdot 10^8 \text{ C}$$

$$\underline{\text{NaOH}} : \quad 2,33 \cdot 10^8 \cdot \frac{1}{96500} \cdot \frac{2 \text{ mol NaOH}}{2 \text{ mol } e^-} = 2414,5 \text{ mol}$$

$$g = n \cdot \text{PM} \rightarrow 2414,5 \cdot 40 = \underline{96580 \text{ g NaOH}}$$

Cl₂

$$2,33 \cdot 10^8 \cdot \frac{1}{96500} \cdot \frac{1}{2} = 1207,25 \text{ mol}$$

$$V = n \cdot 22,4 \rightarrow 1207,25 \cdot 22,4 = \underline{27042,4 \text{ L Cl}_2}$$

b)

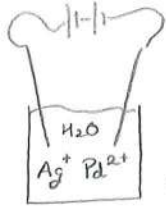
$$\boxed{E = q \cdot V} \rightarrow E = 2,33 \cdot 10^8 \text{ C} \cdot 4,2 \text{ V} = \boxed{1,08 \cdot 10^9 \text{ J (W} \cdot \text{S)} = E}$$

Ex. 2G. 2



$$A = 0,1^2 = 0,01 \text{ m}^2$$

$$V = 0,01 \cdot 0,0001 = 10^{-6} \text{ m}^3 = 10^{-3} \text{ L}$$



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

a)

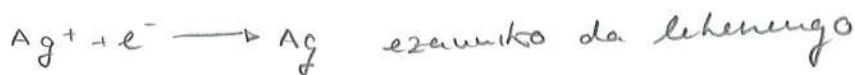


$$E_{\text{red}} = 0,799 - \frac{0,0257}{1} \ln \frac{1}{10,91} = 0,79$$



$$E_{\text{red}} = 0,915 - \frac{0,0257}{2} \ln \frac{1}{10^{-5}} = 0,76$$

KATODO / ERRED.



b)

$$t = 3600 \text{ s} \quad \eta = 90\%$$

$$V = 10^{-3} \text{ L} = 10^{-3} \text{ dm}^3 = 1 \text{ cm}^3 \longrightarrow 10,49 \text{ g Ag} \quad n = \frac{g}{\text{PM}} = \frac{10,49}{107,9} = 0,097 \text{ mol}$$

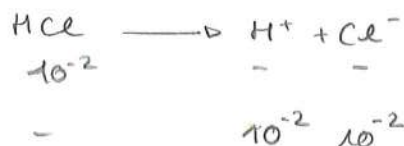
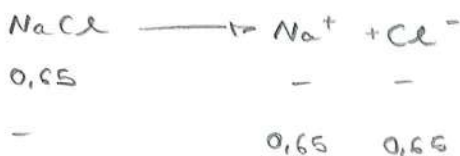
$$0,097 \text{ mol Ag} \cdot \frac{1 \text{ mol } e^-}{1 \text{ mol Ag}} \cdot 96500 = 9360,5 \text{ C}$$

$$Q = I \cdot t \longrightarrow I = \frac{Q}{t} = \frac{9360,5}{3600 \cdot 0,9} = \boxed{2,88 \text{ A} = I}$$

c)

$$38 \text{ g NaCl} \longrightarrow n = \frac{38}{23+35,5} = 0,65 \text{ mol} \quad |\text{NaCl}| = 0,65 \text{ M}$$

$$\text{HCl} \longrightarrow \text{pH} = 2 \Rightarrow |\text{H}^+| = 10^{-2}$$



$$|Cl^-| = 0,65 + 10^{-2} = 0,66 \text{ mol/l}$$

$$K_{ps} = 1,77 \cdot 10^{-10} = |Cl^-| \cdot |Ag^+| = 0,66 \cdot |Ag^+| \rightarrow |Ag^+| = 2,68 \cdot 10^{-10} \text{ mol/l}$$

$$E_{\text{red}} = 0,799 - \frac{0,0257}{1} \ln \frac{1}{2,68 \cdot 10^{-10}} = 0,23$$

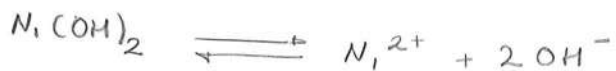
$$E_{Ag^+/Ag} < E_{Pd^{2+}/Pd} \quad \text{Bigamun estaldura garzatu da}$$

Ex. 15.3

1. KASUA

$$pH = 6 \quad \longrightarrow \quad pH = 7$$

$$V = 20 \text{ dm}^3 = 20 \text{ L}$$



$$K_{ps} = |Ni^{2+}| \cdot |OH^-|^2 =$$

$$= 5,48 \cdot 10^{-16} = |Ni^{2+}| \cdot |10^{-8}|^2$$

$$1) \quad n = M \cdot V = 5,48 \cdot 20 = 109,6 \text{ mol}$$

$$1.) \quad |Ni^{2+}| = 5,48 \text{ mol/l}$$

$$2) \quad n = M \cdot V = 0,0548 \cdot 20 = 1,096 \text{ mol}$$

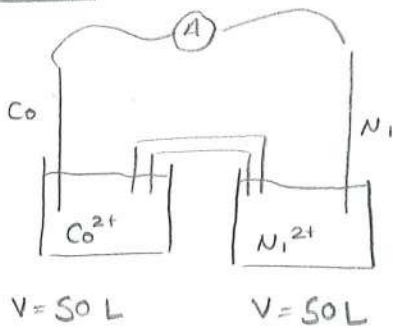
$$K_{ps} = 5,48 \cdot 10^{-16} = |Ni^{2+}| \cdot |10^{-7}|^2$$

$$109,6 - 1,096 = 108,504 \text{ mol} \\ \text{hausprestatu}$$

$$2.) \quad |Ni^{2+}| = 0,0548 \text{ mol/l}$$

$$n_{Ni^{2+}} = 108,504 \text{ mol} \\ \text{hausprestatu}$$

2. KASUA



$$|Co^{2+}| = 0,5 M \quad |Ni^{2+}| = 2,5 M$$



$$E_{red} = -0,28 - \frac{0,0257}{2} \ln \frac{1}{0,5} = -0,289 V$$



$$E_{red} = -0,257 - \frac{0,0257}{2} \ln \frac{1}{2,5} = -0,245 V$$

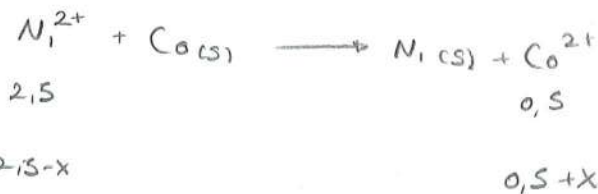


$$E_{red \text{ pile}} = -0,245 - (-0,289) = 0,044 V$$

$$0 = E_{red \text{ pile}} - \frac{0,0257}{2} \ln K$$

$$E_{red \text{ pile}} = -0,257 - (-0,28) = 0,023 V$$

$$\frac{0,023}{\frac{0,0257}{2}} = K \quad K = 5,988$$



$$K = \frac{|Co^{2+}|}{|Ni^{2+}|} = \frac{0,5+x}{2,5-x} = 5,988$$

$$x = 2,07 \text{ mol/l}$$

$$n = 2,07 \cdot 50 L = 103,5 \text{ mol}$$

HAUSPELATI DEN Ni^{2+} kopunua
103,5 mol dina

3. KASVA

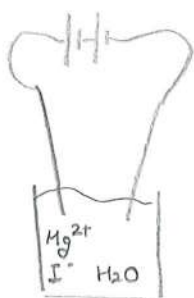
$I = 3A$ $\eta = 0,85$ $t = 10 \cdot 3600 = 36.000s$

$Q = I \cdot t = 3 \cdot 0,85 \cdot 36.000 = 91800 C$ $Ni^{2+} + 2e^- \rightarrow Ni$

$91800 \cdot \frac{1}{96500} \cdot \frac{mol}{2mol e^-} = 0,475 mol$

Ex. 33.3

a)



$V = 0,5L$

$[MgI_2] = 0,2M$

$pH = 7$



$Q_{ps} = [Mg^{2+}] \cdot [OH^-]^2 = 0,2 \cdot (10^{-7})^2 = 2 \cdot 10^{-15}$

$Q_{ps} < K_{ps}$ EZ du kauspeatzem

$Mg^{2+} + 2e^- \rightarrow Mg$ $E = -2,37 - \frac{0,0257}{2} \ln \frac{1}{0,2} = -2,39 V //$

$I_2 + 2e^- \rightarrow 2I^-$ $E = 0,53 - \frac{0,0257}{2} \ln 0,2 = 0,55 V //$

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ $E = -0,83 - \frac{0,0257}{2} \ln (10H^{-1} \cdot P_{H_2}) = -0,42 V$
 $E_{med} = -0,42 - 0,44 = -0,86 V //$ 10^{-7} $1 atm$

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ $E = 1,23 - \frac{0,0257}{4} \ln \frac{1}{[H^+]^4 \cdot P_{O_2}} = 0,82 V$
 $E_{med} = 0,82 + 0,71 = 1,53 V //$ 10^{-7} $1 atm$

KATI ERRED.

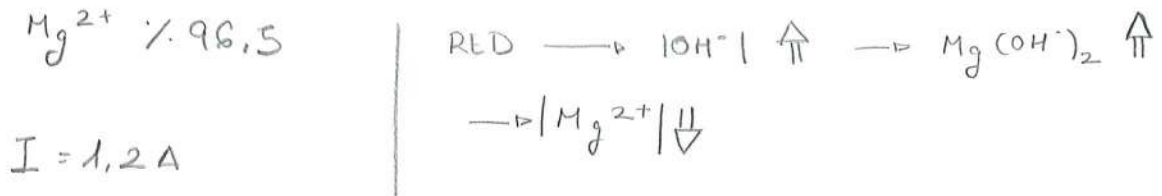
ANO/OXI



$E_{pila}^{med} = -0,86 - 0,55 = -1,41 V$



b)



$$|\text{Mg}^{2+}| = 0,2 \cdot 0,965 = 0,193 \text{ mol/l}$$

$$* K_{PS}(\text{Mg}(\text{OH})_2) = |\text{Mg}^{2+}| \cdot |\text{OH}^-|^2 = 1,2 \cdot 10^{-11} = 0,193 \cdot |\text{OH}^-|^2$$

$$|\text{OH}^-| = 7,88 \cdot 10^{-6} \text{ mol/l}$$

$$\text{disolbatuta} \rightarrow n_{\text{OH}^-} = 3,94 \cdot 10^{-6} \text{ mol}$$

$$* 0,2 \cdot \frac{3,5}{100} \cdot \frac{2 \text{ mol OH}^-}{1 \text{ mol Mg}^{2+}} \cdot 0,5 \text{ L} = 0,007 \text{ mol OH}^- \rightarrow \text{gatzana}$$

$$* 10^{-7} \cdot 0,5 = 5 \cdot 10^{-8} \text{ mol kasimena.}$$

$$[\text{HASIERA} - \text{GATZA} + \text{SORTU} = \text{ORERA}]$$

$$5 \cdot 10^{-8} - 0,007 + \text{SORTU} = 3,94 \cdot 10^{-6} \rightarrow \text{SORTU} = 0,007 \text{ mol}$$

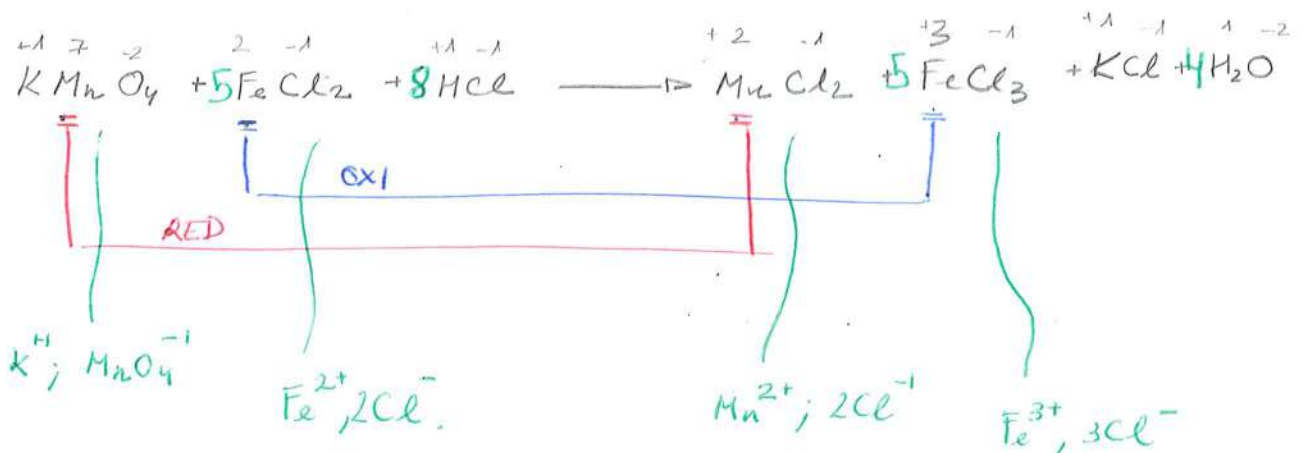
$$0,007 \text{ mol} \cdot \frac{2 \text{ mol OH}^-}{2 \text{ mol OH}^-} \cdot 96500 \cdot \frac{1}{1,2} = 562,91 \text{ s}$$

$$\boxed{T = 562,91 \text{ s}}$$

REDO X

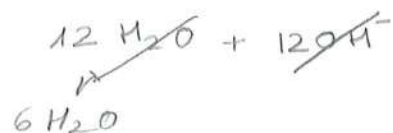
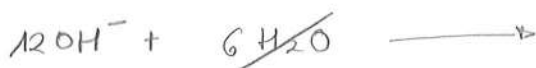
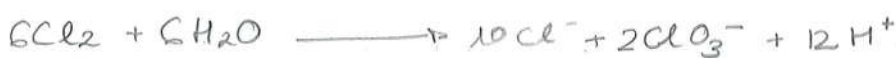
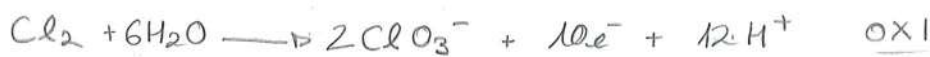
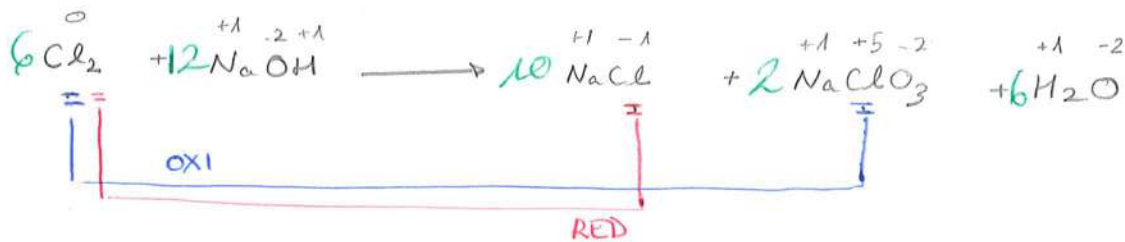
AZTERKETAKO ARIKETAK

1 AJUSTE

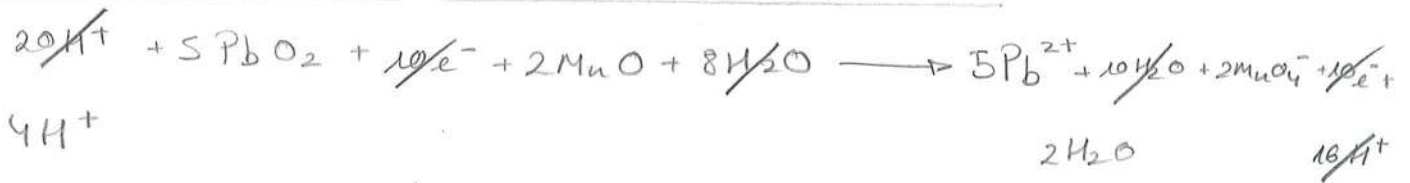
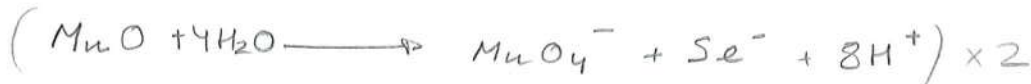
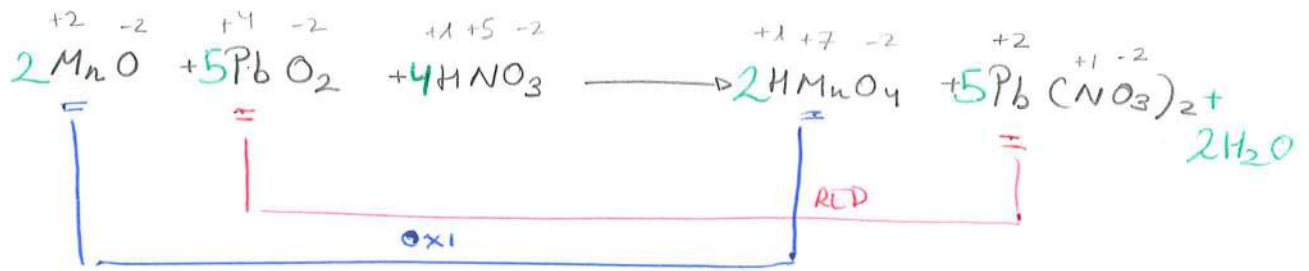


MEDIO
ACIDO

2



3

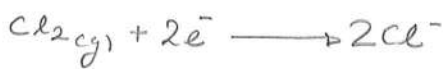


1. ESPECIE

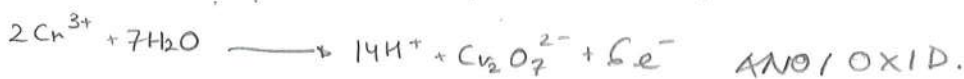
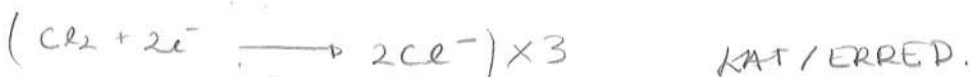
a)



$$E_{\text{red}} = 1,33 - \frac{0,0257}{6} \ln \frac{10^{-3} |\text{Cr}^{3+}|^2}{|\text{H}^+|^{14} \cdot |\text{Cr}_2\text{O}_7^{2-}|} = 1,25 \text{V} \quad E_{\text{red}} = 1,25 \text{V} \text{ ANO}$$



$$E_{\text{red}} = 1,35 - \frac{0,0257}{2} \ln \frac{|\text{Cl}^-|^2}{P_{\text{Cl}_2}} = 1,34 \quad E_{\text{red}} = 1,34 \text{V} \text{ KAT}$$



$$E_{\text{pila}} = E_{\text{KAT}} - E_{\text{ANO}} = 1,34 - 1,25 = 0,09 \text{V} \quad \text{Espontanea}$$

$$E_{\text{pila}} = 0,09 \text{V}$$

b)

$$E_{\text{red}}^{\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}} > 1,34 \text{ V}$$

$$1,33 - \frac{0,0257}{6} \ln \frac{(10^{-3})^2}{|\text{H}^+|^{14} \cdot 1} = 1,34 \text{ V} \quad |\text{H}^+| = 0,44 \text{ M}$$

$$\boxed{\text{pH} < 0,356} \quad \leftarrow \text{pH} = 0,356$$

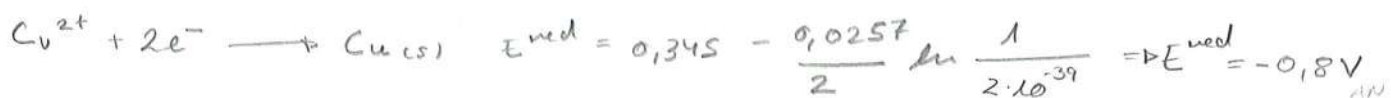
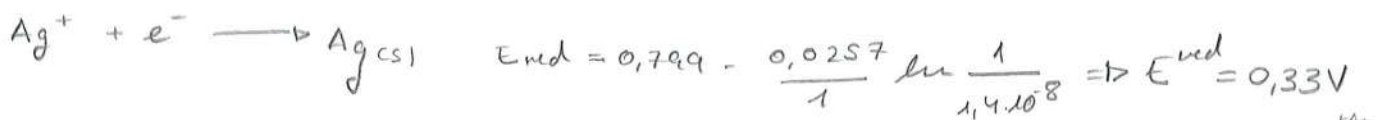
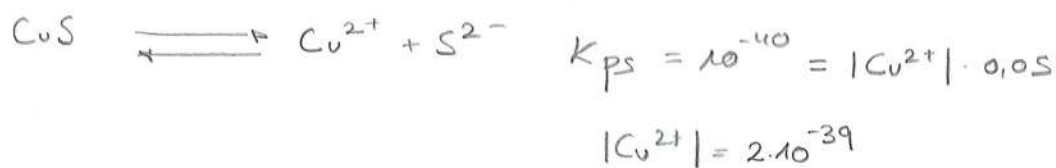
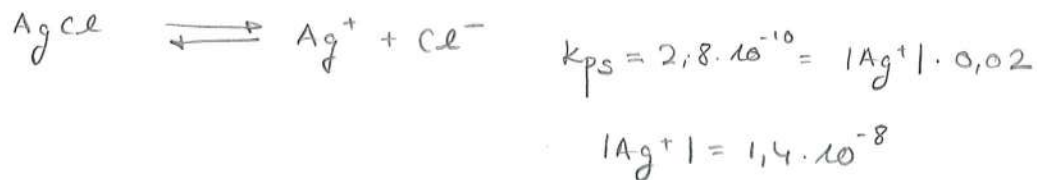
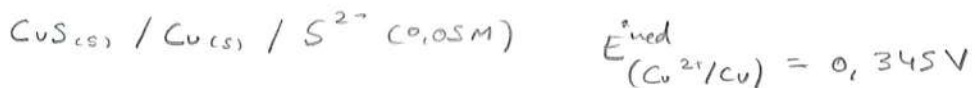
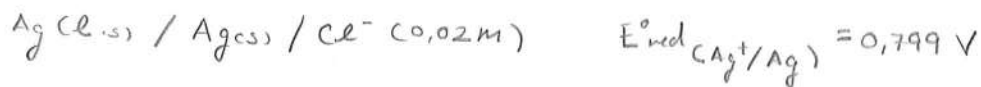
c)

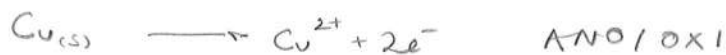
$$V = 1 \text{ L} \quad \text{ESPECIE RED: } \text{Cr}^{3+}$$

$$\begin{aligned} Z = 0 \quad |\text{Cr}^{3+}| &= 10^{-3} \\ Z = 2 \quad |\text{Cr}^{3+}| &= \frac{10^{-3}}{2} = 5 \cdot 10^{-4} \end{aligned} \quad \rightarrow \quad n = M \cdot V = 5 \cdot 10^{-4} \cdot 1 = 5 \cdot 10^{-4} \text{ mol}$$

$$5 \cdot 10^{-4} \cdot \frac{6 \cdot 96500}{2} = 144,75 \quad \boxed{Q = 144,75 \text{ C}}$$

3. 2. ESPECIE



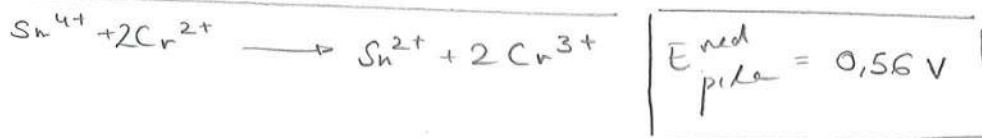
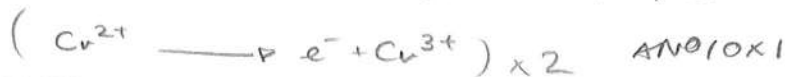
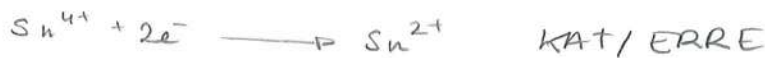


$$E_{\text{pila}}^{\text{red}} = E_{\text{KAT}}^{\text{red}} - E_{\text{ANO}}^{\text{red}} = 0,33 + 0,8 = 1,13 \text{ V} \quad \boxed{E_{\text{pila}}^{\text{red}} = 1,13 \text{ V}}$$

7] 3. ESPECIE

$$T = 298 \text{ K}$$

a) b)



c)

$$0 = 0,56 - \frac{0,0257}{2} \ln K \quad \boxed{K = 8,44 \cdot 10^{18}}$$

d)

$$E_{\text{pila}}^{\text{red}} = 0,56 - \frac{0,0257}{2} \ln \frac{|Cr^{3+}|^2 \cdot |Sn^{2+}|}{|Sn^{4+}| \cdot |Cr^{2+}|^2} \quad \boxed{E_{\text{pila}}^{\text{red}} = 0,589 \text{ V}}$$

e)

$$V = 1 \text{ L} \quad Q = 482,44 \text{ C}$$

$$|Sn^{4+}| = 482,44 \text{ C} \cdot \frac{1}{96500 \text{ C/mol}^-} \cdot \frac{1}{2} \cdot \frac{1}{1} = \boxed{0,0025 \text{ M} = |Sn^{4+}|}$$

$$|Cr^{3+}| = 482,44 \text{ C} \cdot \frac{1}{96500 \text{ C/mol}^-} \cdot \frac{1}{1} \cdot \frac{1}{1} = \boxed{0,005 \text{ M} = |Cr^{3+}|}$$

6 CONCENTRACION



$$E_{\text{pila}}^{\text{red}} = E_{\text{pila}}^{\text{red}} - \frac{0,0257}{1} \ln \frac{|\text{Ag}^+|_{0,01}}{|\text{Ag}^+|_{0,1}}$$

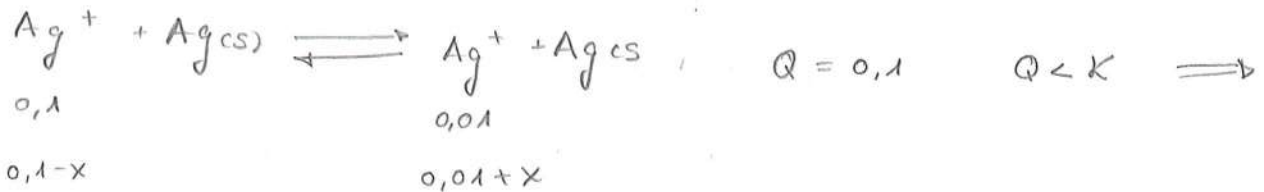
$$E_{\text{pila}}^{\text{red}} = - \frac{0,0257}{1} \ln \frac{0,01}{0,1} = 0,0592$$

$$E_{\text{red, KAT}}^{\circ} - E_{\text{ANO}}^{\circ} = 0$$

$$E_{\text{pila}}^{\text{red}} = 0,0592 \text{ V}$$

a)

$V = 0,5 \text{ l} \quad 0 = - \frac{0,0257}{1} \ln K \quad K = 1$

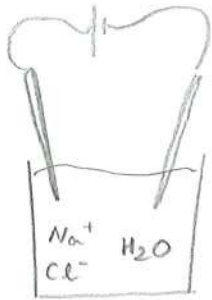


$$K = 1 = \frac{(0,01+x)}{(0,1-x)} \quad x = 0,045$$

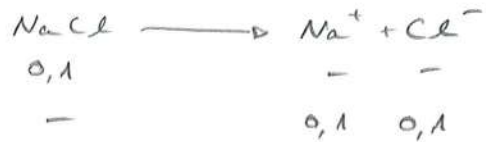
$|\text{Ag}^+| = 0,045 \text{ mol/l} \rightarrow n = M \cdot V = 0,045 \cdot 0,5 = 0,0225 \text{ mol}$

$$Q = 0,0225 \cdot \frac{1 \text{ e}^- \text{ mol}}{1 \text{ Ag}^+ \text{ mol}} \cdot 96500 \text{ C/mol e}^- = 2171,25 \text{ C} = Q$$

14 ELEKTROLISIS



$$[\text{NaCl}] = 0,1 \text{ M}$$



$$\text{Cl}_2 + 2e^- \longrightarrow \underline{2\text{Cl}^-} \quad E_{\text{red}} = 1,36 - \frac{0,0257}{2} \ln \frac{1}{\frac{0,1}{[\text{Cl}^-]^2} \cdot \frac{P_{\text{Cl}_2}}{1}} = 1,42 \text{ V}$$

$$E_{\text{red}} = 1,42 + 0,03 \text{ V} \longrightarrow \boxed{E_{\text{red}} = 1,45 \text{ V}}$$

$$\underline{\text{Na}^+} + e^- \longrightarrow \text{Na} \quad E_{\text{red}} = -2,71 - \frac{0,0257}{1} \ln \frac{1}{0,1} = -2,77 \text{ V}$$

$$\boxed{E_{\text{red}} = -2,77 \text{ V}}$$

$$\text{O}_2 + 4\text{H}^+ + 4e^- \longrightarrow \underline{2\text{H}_2\text{O}} \quad E_{\text{red}} = 1,23 - \frac{0,0257}{4} \ln \frac{1}{\frac{10^{-7}}{[\text{H}^+]^4} \cdot \frac{P_{\text{O}_2}}{1}} = 0,816 \text{ V}$$

$$E_{\text{red}} = 0,816 + 0,85 = 1,67 \text{ V} \quad \boxed{E_{\text{red}} = 1,67 \text{ V}}$$

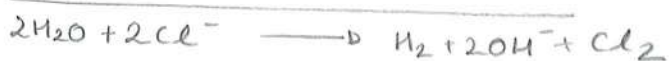
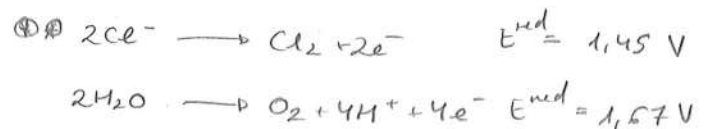
$$\underline{2\text{H}_2\text{O}} + 2e^- \longrightarrow \text{H}_2(\text{g}) + 2\text{OH}^- \quad E_{\text{red}} = -0,83 - \frac{0,0257}{2} \ln \frac{1}{\frac{10^{-7}}{[\text{OH}^-]^2} \cdot \frac{P_{\text{H}_2}}{1}} = -0,416$$

$$E_{\text{red}} = -0,416 - 0,068 = -0,484 \text{ V} \quad \boxed{E_{\text{red}} = -0,484 \text{ V}}$$

KAT



ANO



$$\boxed{E_{\text{red pila}} = -1,93 \text{ V}}$$

$$E_{\text{red pila}} = -0,484 - 1,45 = -1,93 \text{ V}$$

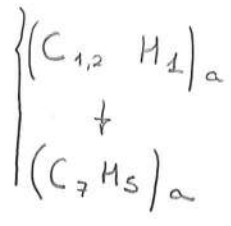
17.

$$\left. \begin{array}{l} [Naf] = 0,25M \\ \text{CLOROFORMO} \end{array} \right\} \rightarrow T_{e_{DSO_N}} = 61,81^{\circ}C \quad \begin{array}{l} Naf \\ \hline \end{array} \left| \begin{array}{l} 6,35\% \text{ H} \\ 93,75\% \text{ C} \end{array} \right. \\ d = 1,52 \text{ g/cm}^3$$

FORMULA MOLECULAR ?
 1.) PPCION n
 2.) PM

$$1.) 100g \rightarrow \left| \begin{array}{l} 6,35g \text{ H} \\ 93,75g \text{ C} \end{array} \right.$$

$$\Rightarrow \frac{7,813}{6,35} = 1,2 \\
 \frac{6,35}{6,35} = 1$$



$$\Rightarrow n_H = \frac{6,35}{1} = 6,35 \text{ mol} \\
 n_C = \frac{93,75}{12} = 7,813 \text{ mol} \quad \left. \right\} \Rightarrow$$

2.)

$$\Delta T_e = k_{fe} \cdot m \rightarrow \Delta T_e = T - T^{\circ} = k_{fe} \cdot m \Rightarrow$$

$$\Rightarrow 61,81 - 61,20 = 3,63 \cdot m \rightarrow m = 0,165 \text{ mol/kg}$$

$$\bullet 1L = 1dm^3 \xrightarrow{\quad\quad\quad} 1520g \text{ DSON} \rightarrow DVTEg + 510g$$

$$\bullet n_{Naf} = M \cdot V = 0,25 \text{ mol}$$

$$\bullet 0,165 \rightarrow 1000g$$

$$0,25 \rightarrow x = 1515,15g \text{ DVTE}$$

$$1520 = 1515,15 + 510g \quad \cdot 510g = 4,85g$$

$$\rightarrow PM_{Naf} = 19,4 \text{ g/mol}$$

$$3) (C_7 H_5)_a = 19,4 \rightarrow (12 \cdot 7 + 5 \cdot 1)_a = 19,4$$

29

PLASMA | URA 1,90 g

SANGRE / [NaCl] g = 0,91%
ISOTONIKAS

$\alpha = 0,9$

a) $\pi_{\text{SANGRE}} (37^\circ\text{C})$ $\pi_{\text{SANGRE}} = \pi_{\text{NaCl}}$

$\pi_{\text{NaCl}} = MRTi$ | $M = \frac{\text{mol}}{\text{l}}$

1L NaCl \rightarrow 1kg = 1000g D50W

STO : 9,1g



$n = \frac{g}{PM} = \frac{9,1}{58,4} = 0,156 \text{ mol}$

n - n α n α n α

$M = \frac{0,156}{1L} = 0,156 \text{ mol/l}$

$i = \frac{n(1-\alpha) + n\alpha + n\alpha}{n} = \frac{n(1-\alpha + \alpha + \alpha)}{n} = 1 + \alpha = 1,9$

$\pi = 0,156 \cdot 0,082 \cdot 310 \cdot 1,9 = \boxed{7,53 \text{ atm} = \pi}$

b)

$\Delta T_c = K_c \cdot m \rightarrow \Delta T_c = T_c^\circ - T_c = K_c \cdot m$

↑	↑	↑	↑	
0	?	1,86	L	mol/kg
URA				

m? | $d_{\text{D50W}} = 1050 \text{ g/L} \rightarrow 1L = 1050 \text{ g} = 945 \text{ g} + \text{STO}$
D50W

1L $\rightarrow M = 0,156 \text{ mol/l} \rightarrow 0,156 \text{ mol STO}$

$m = \frac{0,156}{0,945} = 0,165$

$-T = 1,86 \cdot 0,165$ $T_c = -0,31^\circ\text{C}$

5) LIK-LIK

MEZCLA | 60%_n hex. T = 60° kondensativ
 40%_n diox. P^o_{hex} = 680 mm Hg
 P^o_{diox} = 199 mm Hg

a)

P_{PROCLIO} : y_n = 0,6 y_d = 0,4

$$P = P_A^o X_A + P_B^o X_B \quad / \quad P_A = P \cdot y_A \rightarrow P_A^o X_A = P \cdot y_A \rightarrow X_A = \frac{P \cdot y_A}{P_A^o}$$

$$P_B = P \cdot y_B \rightarrow X_B = \frac{P \cdot y_B}{P_B^o}$$

$$X_A + X_B = 1 \rightarrow \frac{P \cdot y_A}{P_A^o} + \frac{P \cdot y_B}{P_B^o} = 1$$

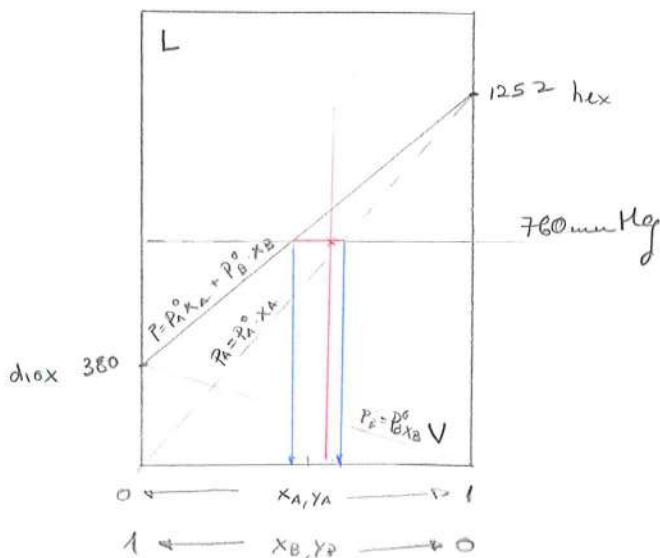
$$P = \frac{1}{\frac{y_A}{P_A^o} + \frac{y_B}{P_B^o}} = \frac{1}{\frac{0,6}{680} + \frac{0,4}{199}} = \boxed{345,73 \text{ mmHg} = P_{\text{PROCLIO}}}$$

b)

P_{BUNBUD} : P = X_A · P_A^o + X_B · P_B^o

$$P = 0,6 \cdot 680 + 0,4 \cdot 199 = \boxed{487,6 \text{ mmHg} = P_{\text{BUNBUD}}}$$

c)



P_{TOT} = 760 mmHg

$$P = 760 = X_A \cdot P_A^o + X_B \cdot P_B^o$$

$$X_A = 0,436$$

$$P \cdot y_A = P_A = P_A^o \cdot X_A$$

$$y_A = 0,702$$

PALANCA

$$\% L = \frac{0,702 \cdot 0,6}{0,702 - 0,436} \cdot 100 = 38,3 \%$$

8

$$T_e = 85^\circ\text{C} \quad P = 1 \text{ atm} \quad P_p^\circ = 246 \text{ mmHg} \quad P_t^\circ = 970 \text{ mmHg}$$

$$P_{\text{DSON}} = 760 \text{ mmHg}$$

a)

$$P_{\text{DSON}} = P_p^\circ \cdot x_p + P_t^\circ \cdot x_t = 246 \cdot x_p + 970 \cdot (1 - x_p) = 760$$

$$\Rightarrow 760 = 246 x_p + 970 - 970 x_p \Rightarrow 210 = 724 x_p$$

$$x_p = \frac{210}{724} = \boxed{0,29 = x_p} \quad \boxed{x_t = 0,71}$$

1 mol \rightarrow

$$0,29 \text{ mol } p \Rightarrow n \cdot PM = g = 48,14 \text{ g}$$

$$0,71 \text{ mol } t \Rightarrow n \cdot PM = g = 109,34 \text{ g}$$

$$w_z(p) = 30,5\%$$

$$w_z(h) = 69,5\%$$

b)

$$P \cdot y_A = x_A \cdot P_A^\circ \rightarrow y_A = \frac{x_A \cdot P_A^\circ}{P} = \frac{0,29 \cdot 246}{760} = 0,0938$$

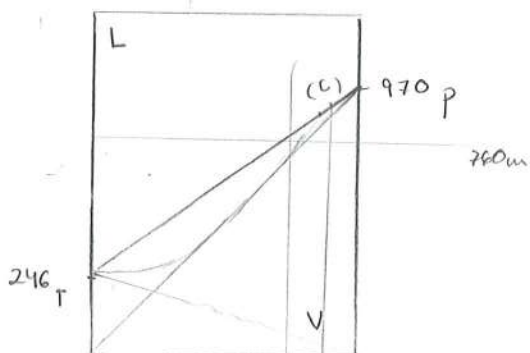
$$n[y_p] = 9,38\%$$

$$n[y_t] = 90,61\%$$

c)

$$P_{\text{bunbul}} = 0,0938 \cdot 246 + 0,9061 \cdot 970 = \boxed{901,99 = P_{\text{bunbul}}}$$

d)



30

$\left\{ \begin{array}{l} \text{NaCl} \\ \text{Sacarosa (C}_{12}\text{H}_{22}\text{O}_{11}) \end{array} \right.$
250 ml DSLU

$\pi_{\text{DSL}} = 7,32 \text{ atm } (23^\circ\text{C})$
 $\Delta P = 0,1183 \text{ mm Hg}$
 $P_{\text{H}_2\text{O}}^\circ (23^\circ\text{C}) = 21,085 \text{ mm Hg}$

$d = 1 \text{ kg/l}$

$PM(\text{NaCl}) = 58,44 \text{ g/mol}$ $PM(\text{saca.}) = 342 \text{ g/mol}$

$\pi = MRT \rightarrow 7,32 = M \cdot 0,082 \cdot 296 \quad M = 0,302 \text{ mol/l}$

$0,302 \text{ mol stO} / 1 \text{ L DSLU} \rightarrow \left| \begin{array}{l} 250 \text{ ml DSLU} - 0,0755 \text{ mol stO} \quad (*) \\ \downarrow d \\ \hline 250 \text{ g DSLU} \end{array} \right. \quad (*)$

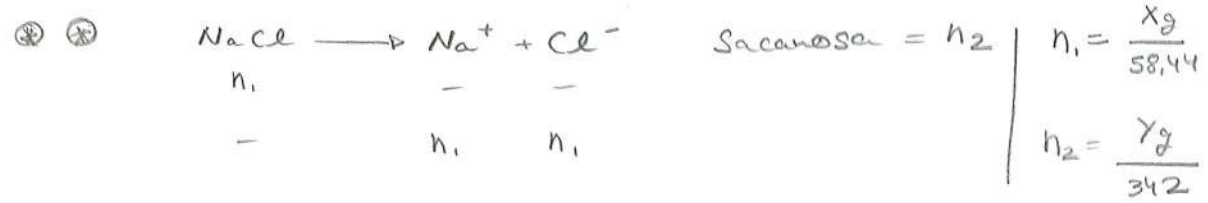
$\Delta P = X_s \cdot P_d^\circ \rightarrow 0,1183 = X_s \cdot 21,085 \rightarrow X_s = 0,00561$

$X_s = \frac{n_s}{n_s + n_d} = 0,00561 = \frac{0,0755}{n_d + 0,0755} \quad n_d = 13,38 \text{ mol}$

$n_d = \frac{g}{PM} \Rightarrow g = PM \cdot n_d \rightarrow g = 18 \cdot 13,38 = 240,88 \text{ g H}_2\text{O}$

$250 - 240,88 = 9,113 \text{ g stO}$

$w_z(\text{SAL}) = 3,64\%$



$0,0755 = (n_1 + n_1) + n_2 = 2n_1 + n_2 =$

$\left[\frac{2X_g}{58,44} + \frac{Y_g}{342} = 0,0755 \right]$

$X_g + Y_g = 9,113$

$X_g = 1,528 \text{ g NaCl}$
 $Y_g = 7,905 \text{ g SACAROSA}$

6

2:1
H₂ O₂

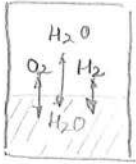
$$P_{\text{TOT}} = 3,95 \text{ atm (23}^\circ\text{C)}$$

$$K_{\text{H}_{\text{O}_2}} = 4,6 \cdot 10^4 \text{ atm}$$

$$P_{\text{H}_2\text{O}}^\circ = 15,2 \text{ mm Hg}$$

$$K_{\text{H}_{\text{H}_2\text{O}}} = 7,77 \cdot 10^4 \text{ atm}$$

a) (%) Val



$$P_{\text{TOT}} = P_{\text{H}_2\text{O}}^\circ + P_{\text{O}_2} + P_{\text{H}_2} \rightarrow 3,95 = \frac{15,2}{760} + P_{\text{O}_2} + P_{\text{H}_2}$$

$$\cdot P_{\text{O}_2} + P_{\text{H}_2} = 3,93 \text{ atm}$$

$$P_{\text{H}_2} = Y_2 \cdot P \rightarrow \begin{array}{l} \text{H}_2 : \text{O}_2 \\ 2 : 1 \text{ en Val} \end{array} \left| \begin{array}{l} 3 \text{ mol tot} \\ Y_{\text{H}_2} = \frac{2}{3} \\ Y_{\text{O}_2} = \frac{1}{3} \end{array} \right.$$

$$P_{\text{H}_2} = \frac{2}{3} \cdot 3,93 = 7,77 \cdot 10^{-4} \cdot X_{\text{H}_2} \quad X_{\text{H}_2} = 3,37 \cdot 10^{-5}$$

$$X_{\text{H}_2} = 3,37 \cdot 10^{-5} = \frac{n_{\text{H}_2}}{n_{\text{H}_2} + n_{\text{O}_2} + n_{\text{H}_2\text{O}}} = \frac{n_{\text{H}_2}}{n_{\text{H}_2\text{O}}} \Rightarrow 3,37 \cdot 10^{-5} \frac{\text{mol H}_2}{\text{mol H}_2\text{O}}$$

$$n = \frac{g}{PM} \quad g = n \cdot PM \quad \xrightarrow{d} 1g \rightarrow 10^{-3} L$$

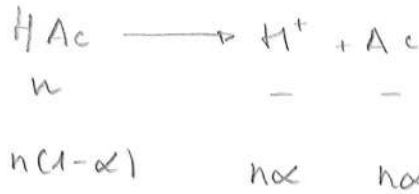
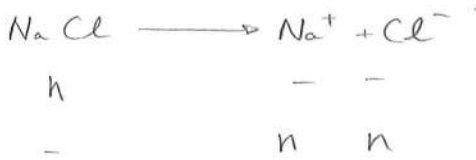
$$3,37 \cdot 10^{-5} \frac{\text{mol H}_2}{\text{mol H}_2\text{O}} = \frac{1,87 \cdot 10^{-5} \text{ mol H}_2}{\frac{18g}{\text{mol}}} = \frac{1,87 \cdot 10^{-5} \text{ mol H}_2}{18 \cdot 10^{-3} L} = 1,04 \cdot 10^{-3} \text{ mol/L H}_2$$

FASE OREKA

AZTERKETAKO ARIKETAK

1 Vant Hoff

$\Delta T_c = K_c \cdot m \cdot i$ $\Delta T_e = K_e m i$ $\Delta P = P_d^\circ \times S i$ $P = P_d^\circ \times d$ $\pi = MRT i$	<p>- NO SE DISOCIA $\longrightarrow i = [i = 1]$ [NO ELEKTROLITO]</p> <p>- SE DISOCIA $\longrightarrow i \neq 1$ $\cdot \alpha$</p>
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$$i = \frac{2n}{n} = \boxed{2 = i}$$

$$i = \frac{n(1-\alpha) + n\alpha + n\alpha}{n} = \frac{n - n\alpha + n\alpha + n\alpha}{n} = \frac{n(1+\alpha)}{n} = \boxed{1 + \alpha = i}$$

17 FORMULA MOLECULARRA

DSO: Naft. en clorj.

$MI = 0,25 \text{ mol/e}$

$T_e = 61,81^\circ\text{C} \quad T_e^\circ = 61,20^\circ\text{C}$

$d = 1,52 \text{ g/cm}^3 = 1520 \text{ g/L}$

$w\%(\text{Naft}) = 6,25\%$

$w\%(\text{Cl/r}) = 93,75\%$

- 1. malak?
- 2. PM?

$\Rightarrow 100 \text{ g} \left\{ \begin{array}{l} 6,25 \text{ g Naft.} \rightarrow n = \frac{g}{PM} = 6,25 \text{ mol} \rightarrow 1 \times 4 \\ 93,75 \text{ g Cl/r} \rightarrow n = \frac{g}{PM} = 7,81 \text{ mol} \rightarrow 1,25 \times 4 \end{array} \right.$

$\rightarrow (C_5H_{10})_n$

$$\Delta T_e = k_{fe} \cdot m \rightarrow T_e - T_e^{\circ} = k_{fe} \cdot m \quad m = \frac{T_e - T_e^{\circ}}{k_{fe}} = \frac{0,61}{3,63} =$$

$$= m = 0,168 \text{ mol/kg}$$

$$1 \text{ kg dsrte} \rightarrow 0,168 \text{ mol STO}$$

$$0,25 \text{ mol} \rightarrow 1 \text{ l DSLU}$$

$$0,168 \text{ mol} \rightarrow x = 0,672 \text{ L DSLU}$$

$$1 \text{ L} \rightarrow 1520 \text{ g}$$

$$0,672 \text{ L} \rightarrow x = 1021,44 \text{ g DSLU}$$

$$g_{\text{DSL}} - g_{\text{Dsrte}} = g_{\text{STO}} \rightarrow [g_{\text{STO}} = 21,44 \text{ g STO}]$$

$$PM = \frac{g}{\text{mol}} = \frac{21,44}{0,168} = 127,62 \text{ g/mol}$$

$$(C_5H_4)_n = 127,62 \rightarrow (12 \cdot 5 + 4)_n = 127,62 \quad n \approx 2$$

$$(C_{10}H_8) \text{ FORMULA MOLEKULAR}$$

29 SOLIDO LIKIDO

SANGRE

ISOTONIKA $\pi_s = \pi_{\text{DSL}}$

DSL:

w(NaCl) = 0,91%

$\alpha = 0,9 \quad d = 1000 \text{ g/L}$

$T = 37^{\circ}\text{C} = 310 \text{ K}$

a) $\pi_s ?$

$$\pi_s = 0,1558 \cdot 0,082 \cdot 310 \cdot 1,9 = 7,52$$

$$\pi_{\text{DSL}} = M \cdot R \cdot T \cdot i$$

$$\frac{n}{V} \rightarrow 0,1558$$

$$V \rightarrow 1 \text{ L}$$

$$\pi_s = 7,52 \text{ atm}$$

$$1000 \text{ g DSL} \rightarrow 9,1 \text{ g NaCl}$$

$$1 \text{ L DSL}$$

$$n_{\text{NaCl}} = \frac{g}{PM} = \frac{9,1}{58,4} = 0,1558$$



n

$$n(1-\alpha) \quad n\alpha \quad n\alpha$$

$$i = \frac{n(1-\alpha + \alpha + \alpha)}{n} = 1 + \alpha = 1,9$$

b)

SANGRE	$w_T (H_2O) = \% 90$ $\pi = 7,52 \text{ atm}$ $d = 1050 \text{ g/L}$ $K_c = 1,86$
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$$1L \rightarrow 1050 \text{ g DSLV} \rightarrow \% 10 \text{ STO} \rightarrow 105 \text{ g STO}$$

$$\rightarrow 945 \text{ g DSTE}$$

$$\pi = \frac{n}{V} RT \rightarrow \frac{\pi V}{RT} = n = 0,2958 \text{ mol}$$

$$m = \frac{0,2958}{0,945} = 0,313 \text{ mol/kg}$$

$$\Delta T_c = K_c \cdot m \rightarrow T_c^\circ - T_c = K_c \cdot m \quad T_c = T_c^\circ - K_c \cdot m$$

$$T_c = 0 - 1,86 \cdot 0,313$$

$T_c = -0,582^\circ \text{C}$

P1 LIKIDO - GAS

BOTELLA	$V = 0,33L$ $P_v = 3 \text{ atm}$
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a) % CO₂ en la lata abierta
 a 25°C ≡ 298K P_{atm} = 1 atm

$$K_h (N_2) = 1538 \text{ mol/atm l}$$

$$(O_2) = 769,23 \quad ''$$

$$(CO_2) = 29,41 \quad ''$$

% Val AIRE: O₂ % 21

N₂ % 78,968

CO₂ % 0,032

1) ITXITA

$$C_g = K_h \cdot P = 29,41 \cdot 3 = 88,23 \text{ mol/l}$$

$$n = 29,12 \text{ mol}$$

IREKITA

$$P_{v,CO_2} = Y_{CO_2} \cdot P_{atm} = 3,2 \cdot 10^{-4} \cdot 1 = 3,2 \cdot 10^{-4} \text{ atm} \quad C_g = K_h \cdot P_v = 29,41 \cdot 3,2 \cdot 10^{-4} =$$

$$= 9,41 \cdot 10^{-3} \text{ mol/l}$$

$$Y_{CO_2} = 0,00032 = 3,2 \cdot 10^{-4}$$

$$n = 0,0031 \text{ mol}$$

$0,01 \% = \text{GERATZEN DA}$

$$\frac{0,0031}{29,12} = 0,01 \%$$

b)

$$P_{O_2} = Y_{O_2} \cdot P_{atm} = 0,21 \cdot 1 = 0,21 \text{ atm}$$

$$P_{N_2} = Y_{N_2} \cdot P_{atm} = 0,78968 \cdot 1 = 0,78968 \text{ atm}$$

$$C_{O_2} = 769,23 \cdot 0,21 = 161,54 \text{ mol/l} \quad n_{O_2} = 53 \text{ mol} \quad \boxed{g_{O_2} = 1696 \text{ g}}$$

$$C_{N_2} = 1538 \cdot 0,78968 = 1214,53 \text{ mol/l} \quad n_{N_2} = 400 \text{ mol} \quad \boxed{g_{N_2} = 11200 \text{ g}}$$

P2 SOLIDO-LIKIDO

$$\left. \begin{array}{l} PM = 100 \text{ g/mol} \\ T_c = -5 \end{array} \right\} \begin{array}{l} d = 1050 \text{ g/L} \\ K_c = 1,86 \\ k_{te} = 0,52 \end{array}$$

a) $T_c^\circ - T_c = K_c \cdot m \rightarrow \frac{5}{1,86} = m = 2,69 \text{ mol/kg}$

IZOTUTA $n_{s10} = 2,69 \text{ mol} \quad g_{DSVTE} = 1000 \text{ g}$

HASIERAN $n_{sto} = 2,69 \text{ mol} \quad g_{DSVTE} = 2000 \text{ g}$
 $L \rightarrow g_{s10} = n \cdot PM = 269 \text{ g STO} \quad \left\{ \begin{array}{l} g_{DSLU} = 2269 \text{ g} \end{array} \right.$

$$\left. \begin{array}{l} w_L(STO) = \frac{269}{2269} \cdot 100 = 11,85\% = w_L(STO) \\ \frac{2000}{2269} \cdot 100 = 88,15\% = w_L(DSBE) \end{array} \right\}$$

b) $\Delta T_e = k_{te} \cdot m \quad \Delta T_e = 0,52 \cdot 1,345 = \boxed{0,7^\circ C = \Delta T_e}$

$$m = \frac{\text{mol}_{sto}}{\text{kg}_{DBTE}} = \frac{2,69}{2} = 1,345 \text{ mol/kg}$$

c)

$$\pi = \frac{n}{V} RT$$

$$\pi = \frac{2,69}{1,21} \cdot 0,082 \cdot 268$$

$$\pi = 48,85 \text{ atm}$$

$$h_s = 2,69 \text{ mol}$$

$$V: \quad 1269 \text{ g DSLU} \longrightarrow X = 1,21 \text{ L}$$

$$1050 \text{ g} \longrightarrow 1 \text{ L}$$

5. LIKIDO - LIKIDO

$$P_h^{\circ} = 680 \text{ mmHg} \quad Y_h = 0,6 \quad T = 60^{\circ}\text{C}$$

$$P_p^{\circ} = 199 \text{ mmHg} \quad Y_p = 0,4$$

a)

$$\underline{P_{\text{ROCIO}}}: \quad X_A + X_B = 1 \quad \left| \quad X_A = \frac{P_A}{P_A^{\circ}} = \frac{Y_A \cdot P}{P_A^{\circ}} \right.$$

$$1 = \frac{Y_A \cdot P}{P_A^{\circ}} + \frac{Y_B \cdot P}{P_B^{\circ}}$$

$$X_B = \frac{P_B}{P_B^{\circ}} = \frac{Y_B \cdot P}{P_B^{\circ}}$$

$$1 = P \cdot \left(\frac{Y_A}{P_A^{\circ}} + \frac{Y_B}{P_B^{\circ}} \right) \quad P = \frac{1}{\frac{Y_A}{P_A^{\circ}} + \frac{Y_B}{P_B^{\circ}}} = \frac{1}{\frac{0,6}{680} + \frac{0,4}{199}} = 345,73$$

$$P_{\text{ROCIO}} = 345,73 \text{ mmHg}$$

b)

$$\underline{P_{\text{BURBUJA}}}: \quad Y_A + Y_B = 1 \quad \left| \quad Y_A = \frac{P_A}{P} = \frac{X_A \cdot P_A^{\circ}}{P} \right.$$

$$1 = \frac{1}{P} (X_A \cdot P_A^{\circ} + X_B \cdot P_B^{\circ})$$

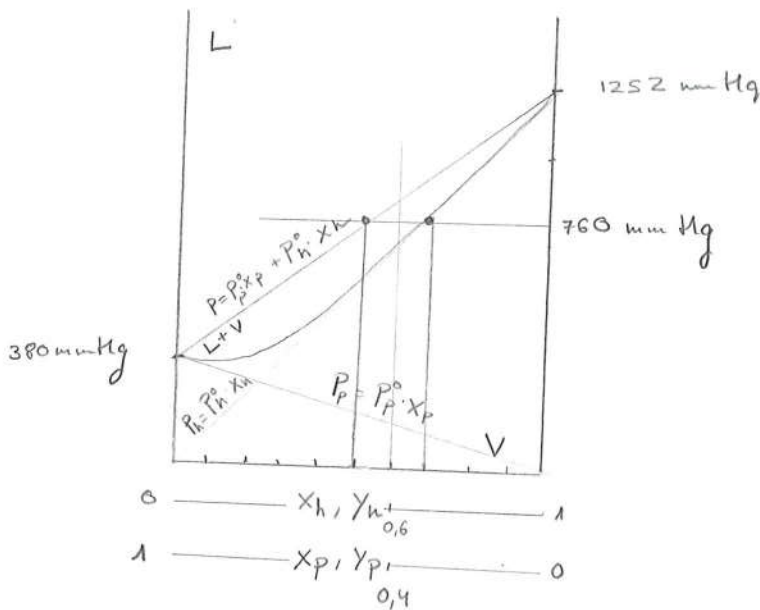
$$Y_B = \frac{P_B}{P} = \frac{X_B \cdot P_B^{\circ}}{P}$$

$$P = X_A P_A^{\circ} + X_B P_B^{\circ} = 0,6 \cdot 680 + 0,4 \cdot 199 = 487,6$$

$$P_{\text{BURBUJA}} = 487,6 \text{ mmHg}$$

c) $T = 80^\circ\text{C}$ $P_h^\circ = 1252$

$P_p^\circ = 380$



$P_{\text{tot}} = 760 \text{ mmHg}$

$P_{\text{tot}} = X_A \cdot P_A^\circ + X_B \cdot P_B^\circ$

$760 = X_A \cdot 1252 + (1 - X_A) \cdot 380$

$X_A = 0,436$

$P_A = Y_A \cdot P_{\text{tot}} \quad P_{\text{tot}} = \frac{P_A}{Y_A} = \frac{X_A \cdot P_A^\circ}{Y_A} = P_{\text{tot}}$

$Y_A = \frac{X_A \cdot P_A^\circ}{P_{\text{tot}}} = \frac{0,436 \cdot 1252}{760} = 0,718$

PALANCA

$\% L = \frac{0,718 - 0,6}{0,718 - 0,436} \cdot 100 = 41,84\%$

$L = 41,84\%$

$G = 58,16\%$

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$T = 85^\circ\text{C}$ $P_{\text{BURBUJA}} = 760 \text{ mmHg}$

$P_p^\circ = 246 \text{ mmHg}$ $P_t^\circ = 970 \text{ mmHg}$

a) $P = P_p^\circ \cdot x_p + P_t^\circ \cdot x_t \Rightarrow 760 = 246 \cdot x_p + 970 \cdot (1 - x_p)$

$x_p = 0,29$

$x_t = 0,71$

100 mol \rightarrow 29 mol P

$g = n \cdot PM = 4814 \text{ g}$

71 mol T

$g = n \cdot PM = 10934 \text{ g}$

$w_z(\text{C}_2\text{Cl}_2) = 30,57\%$

$w_z(\text{CCl}_4) = 69,43\%$

b)

$$P_A = Y_A P \quad Y_A = \frac{P_A}{P} = \frac{P_A^\circ \cdot X_A}{P} = \frac{246 \cdot 0,29}{760} = \boxed{\begin{matrix} 0,094 = Y_P \\ 0,906 = Y_T \end{matrix}}$$

c)

$$P_{\text{BURBUJA}} = X_P \cdot P_P^\circ + X_T \cdot P_T^\circ = 0,094 \cdot 246 + 0,906 \cdot 970$$

$$\boxed{P_{\text{BURBUJA}} = 901,94}$$

d)

