TERMODINAMIKA

1. AZTERKETA (L)

1. ADB. 0'1L

→ 0'2M HCl
50ml
+
0'2M NaOH
50ml

$\Delta U = q + W$ $W = 0$ da prozesua isokorra delako

$q_{kal} = C_{kal} \cdot \Delta T$

$1'178\ KJ = C_{KAL} \cdot 3'65$

$C_{kal} = 1'178 / 365 = 0'487\ KJ/C^\circ = 487\ J/C^\circ$

$\Delta U = q_v / n$

$q_{kal} = 0'487 \cdot 1'26 = 0'61 KJ$

$q_{kal} = -q_{erreakzio}$ $q_{erreakzio} = 0'61 KJ$

$0'2\ mol/l \cdot \frac{0'05l}{1l} = 0'01\ mol$

$\Delta U = 0'61 / 0'01 = \boxed{-61\ KJ/mol}$

2. ADB. Kirchoffen lezea

glutamato + NH_4^+ ⟶ glutamina + H_2O $\Delta H_{60^\circ err.} = ?$

$\Delta H_r^\circ = 21'8 KJ/mol$ (25°C)

C_p (A, aq) glutamina = 177 J/K·mol

C_p (glutamato, aq) = 187 J/K·mol

$\Delta H^\circ_{T_2} = \Delta H^\circ_{T_1} + \Delta C_p \cdot (T_2 - T_1)$

$\Delta H^\circ_{60^\circ} = \Delta H^\circ_{25^\circ} + (C_{p\,H_2O} + C_{p\,glutamina} - C_{p\,glutamato} - C_{p\,NH_4^+}) \cdot (60 - 25)$

$\Delta H^\circ_{60} = 21800\ J/mol + (75'291 + 187 - 177 - 79'9)(60 - 25)$

$\boxed{\Delta H^\circ_{60} = 21'991\ KJ/mol}$

3. ADB (10. arik.)

$2C_2H_5OH(l) \xrightarrow{H_2SO_4} C_2H_5-O-C_2H_5(l) + H_2O(l)$

0'05 l C_2H_6OH

Tvap $C_2H_5-O-C_2H_5 = 35'8°C$

a) askatzen den beroa

T = 298'15 K

P = kte.

C_2H_5OH atomoak bananduu $C_2H_5-O-C_2H_5$ eratu lotuak

- konbustioa (erorga) + lot. energia.

• Bi konposaturen formakuntza (eta alderantzizkoa) kontuan.

$\Delta H°_{err} = \Sigma n\Delta H°_{fp} - \Sigma n\Delta H°_{ferr}$

$\Delta H°_{err} = \Sigma n\Delta H°_{fp} - \Sigma n\Delta H°_{ferr}$

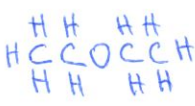
$\Delta H°_{err} = \Delta H°_{f\,C_2H_5-O-C_2H_5} + \Delta H°_{f\,H_2O} - \Delta H°_{f\,C_2H_5OH} \cdot 2$

1 → $\Delta H°_{err\,(etanol)} = \Delta H°_f CO_2 \cdot 2 + 3 \cdot \Delta H°_f H_2O - \Delta H°_f C_2H_5OH$

$C_2H_5OH(l) + 3O_2(g) \longrightarrow 2CO_{2(g)} + 3H_2O(l)$

$\Delta H°_{f\,C_2H_5OH} = +2\Delta H°_f CO_2 + 3\Delta H°_f H_2O - \Delta H°_{err} = 188'1 + 204'96 - (+326'72) = -66'34 kcal/mol$

2 →



2 C-C lotura

10 C-H lotura

2 C-O lotura

* ADI GAS → LIKIDO

$4C + 10H_2 + 1/2\,O_2 \longrightarrow C_2H_5-O-C_2H_5(l)$ ↑ $-\Delta H°_{vap}$

$4C + 10H + O \longrightarrow C_2H_5-O-C_2H_5(g)$

$\Delta H°_{f\,C_2H_5} = 4 \cdot \Delta H°_f C + 10\Delta H°_f H + 1\Delta H°_f O - 10(C-H) - 2(C-C) - 2(C-O)$

$\Delta H°_{f\,C_2H_5} = 4 \cdot 171'7 + 10 \cdot 52'09 + 59'16 - 10 \cdot 98'7 - 2 \cdot 83'2 - 2 \cdot 85'6 - \Delta H°_{vap} = -64'25 kcal/mol$

3 → $\Delta H°_{err} = -64'25 - 68'32 + 266'34 = 0'11 kcal/mol$

$50 ml\ etanol \cdot \frac{0'78 g}{1 ml} \cdot \frac{1 mol}{46'05 g} = 0'856 mol\ etanol$

0'856 mol etanol —— x

2 mol —— 0'11 kcal

$x = 47'11 cal$

$\Delta H°_{err} = 47'11 cal$

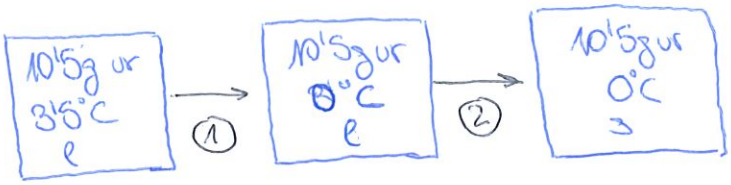
3. ADB. (10.ark)

b) $\Delta H = +$ beraz endotermikoa da, beraz surgatzeko du

Ura hoztu egiten da.

$10'5\,g\,H_2O$
$35\,^\circ C$

$q_{ura} + q_{esr} = 0 \quad q_{ura} = -q_{esr} = -47'11\,cal$



1: $nC_{p(l)}\Delta T = q_1$

$10'5\,g\,H_2O \cdot \frac{1\,mol\,H_2O}{18\,g\,H_2O} \cdot 0'583\,mol$

$0'583\,mol \cdot C_p \cdot (273 - 276'5) = -36'75\,cal$

$-47'11\,cal - (-36'75\,cal) = -10'36\,cal$

2: $q_2 = m(-\Delta H_{fus})$

$m = -10'36\,cal / -80\,cal = 0'1295\,g$ izoztuko da ura

T finala = 0°C

4. ADB. (16. ariketa)

25°C
V = kte (isokorikoa)

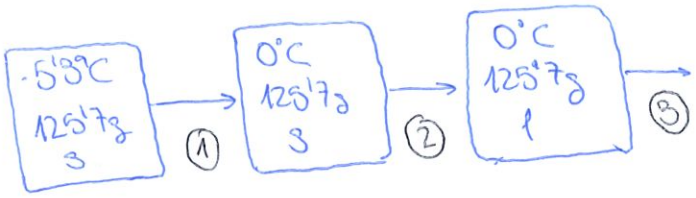
$CH_3COCl(l) + CH_3CH_2OH(l) \longrightarrow CH_3COOC_2H_5(l) + HCl(g)$ $\quad -47'1\,kJ$

$\Delta H^\circ_{err} =$

	50 cm³	34'1 cm³
	(0'05 l)	(0'0341 l)

a) -5'3°C

125'7 g H_2O = 6'98 mol



1. $q_1 = nC_p\Delta T$

$q_1 = 6'98 \cdot 37'56 \cdot (0-(-5'3)) = 1393'19\,J$

$-47'1\,kJ = -47100\,J$

$-47100\,J + 1393'19 = -45706'8\,J$

2. $q_2 = n(-\Delta H^\circ_{fus}) = 6'98\,(5'025) = +42'05\,kJ$

$-45706'8\,J + 42050\,J = -3652'3\,J$

3. $-3652'3\,J = 6'98 \cdot 75'31\,\Delta T = 6'98 \cdot 75'3 \cdot (T_2 - 273)$

$T_2 = 280\,K \qquad \Delta T = 7\,K$

$\boxed{T_F = 7^\circ C}$

b) · Lehenengo erreaktibo mugatzaile zein den jakitea

$n_{acet} = 50\,ml \cdot 1'105\,g/ml \cdot \frac{1\,mol}{78'49\,g} = 0'70\,mol$

1:1 estekiometria dagoenez etanol mugatzaile.

$n_{etanol} = 34'1\,ml \cdot 0'789\,g/ml \cdot \frac{1\,mol}{46'05\,g} = 0'584$

$\Delta U = q_V/n = -47'01/0'584 = -80'6\,kJ/mol$

$\Delta U = q_V/n$

$\Delta H = -80'6 + 8'314 \cdot 10^{-3} \cdot 298 \cdot 1 = \boxed{-78'15\,kJ/mol}$

$\Delta H = \Delta U + RT\Delta n_g$ (mol gas)

ADB

4. ADB (16. aneta)

c) $\Delta H^\circ_{er} = -78'15\,kJ/mol \longrightarrow \Delta H^\circ_f(CH_3COOC_2H_5) \longrightarrow (C=O)D$

$CH_3COCl_{(l)} + CH_3CH_2OH_{(l)} \longrightarrow CH_3COOC_2H_5(l) + HCl_{(g)}$

$\Delta H^\circ_{er} = \Delta H^\circ_{f\,etaz} + \Delta H^\circ_{f\,HCl} - \Delta H^\circ_{f\,Acl} - \Delta H^\circ_{f\,et.}$

• $\Delta H^\circ_{f\,CH_3COCl\,(Acl)}$ $\quad 2C_{(graf)} + \frac{3}{2}H_{2(g)} + \frac{1}{2}O_{2(g)} + \frac{1}{2}Cl_{2(g)} \longrightarrow CH_3COCl_{(l)}$

$\Delta S^\circ_f = \Sigma_n S^\circ_{pr.} - \Sigma_m S^\circ_{err.}$

$\Delta S^\circ_f = 200'8 - 2\cdot 5'74 - \frac{3}{2}\cdot 130'57 - \frac{1}{2}\cdot 205'03 - \frac{1}{2}\cdot 222'96 = -220'53\,J/K\,mol$

$\Delta H^\circ_f = \Delta G^\circ_f + T\Delta S^\circ_f \qquad \Delta H^\circ_f = -145'7 + 298(-220'53\cdot 10^{-3}) = \boxed{-211'45\,kJ/mol}$

$\Delta G^\circ = \Delta H^\circ - T\Delta S$

• $\Delta H^\circ_{f\,CH_3CH_2OH\,(et.)}$

$CH_3CH_2OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ $\quad$ +ikus. 3. ADB

$\Delta H^\circ_{f\,CH_3CH_2OH} = \boxed{-273'81\,kJ/mol}$

→ $\Delta H^\circ_{f\,CH_3COOC_2H_5}$

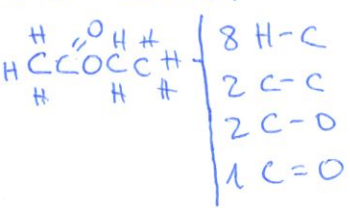
$-78'15 = \Delta H^\circ_{f\,etaz} + (-72'31) + 211'45 + 273'81$

$\Delta H^\circ_{f\,etaz} = -471'1\,kJ/mol$

• $D(C=O)$

- formazio ekuazioa: $4C_{(grafito)} + O_{2(g)} + 4H_{2(g)} \longrightarrow CH_3COOC_2H_5(l)$

$4C_{(g)} + 2O_{(g)} + 8H_{(g)} \longrightarrow CH_3COOC_2H_5(g)$ $\quad \uparrow -\Delta H^\circ_{vap.}$



8 H-C
2 C-C
2 C-O
1 C=O

$\Delta H^\circ_{f\,etaz} = 4\Delta H^\circ_f C + \Delta H^\circ_f O + 8\Delta H^\circ_f H - 8D(H-C) - 2D(C-C) - 2D(C-O) - D(C=O) - \Delta H^\circ_{vap\,etaz.}$

$\boxed{D(C=O) = 723'1\,kJ/mol}$

ENTROPIA ETA GIBBS

1.ADB. 20L, 5kPa N_2 20°C → 400°C v=k-te

$\Delta S_{(N_2)} = ?$

$\Delta S = n C_v \ln T_2/T_1$

$PV = nRT$

$5 \cdot 20 = n \cdot 8'314 \cdot 293$

$n = 0'04 mol$

$\Delta S = 0'04 \cdot 20'81 \ln 673/293$

$\Delta S = 0'69 J/mol \cdot K$

2.ADB (3.ADB)

$$CO_2(g) + H_2O(l) \underset{ez}{\rightleftharpoons} H_2CO_3(aq)$$

$\Delta_r S^\circ = \Delta S^\circ_{err} = S^\circ(H_2CO_3, aq) - S^\circ(CO_2, g) - S^\circ(H_2O, l)$

OREKA KIMIKOA

1.ADB. $\frac{1}{2}H_2(g) + \frac{1}{2}I_2(s) \rightleftharpoons HI(g)$ $\Delta G^\circ_r = 1'7\,kJ/mol$

$25^\circ C = 298K$

$K_{or} = ?$

$\Delta G^\circ_{er} = -RT \ln K_p$

$\ln K_p = \Delta G^\circ_{er} / -RT$

$K_p = e^{\Delta G^\circ_{er}/-RT} = 0'5$

2.ADB. K_p eta K_c ren adierazpenak

- $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

$$K_p = \left[\frac{P^2_{NH_3}}{P_{N_2} \cdot P^3_{H_2}}\right]_{oreka} = \frac{P^2_{NH_3}}{P_{N_2} \cdot P^3_{H_2}} \qquad K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{K_p}{(RT)^{-2}} \rightarrow \frac{ber\ 2}{ber\ 4}\ \ 2-4=-2$$

- $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

$$K_p = \left[\frac{P^4_{NO} \cdot P^6_{H_2O}}{P^4_{NH_3} \cdot P^5_{O_2}}\right]_{or.} = \frac{P^4_{NO} \cdot P^6_{H_2O}}{P^4_{NH_3} \cdot P^5_{O_2}} \qquad K_c = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5} = \frac{K_p}{(RT)^1} \qquad 1 = (6+4) - (4+5)$$

3.ADB

$400^\circ C$ $\quad 2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\quad K_p = 3'1 \cdot 10^4$ $\quad K_c = ?$

$K_p = K_c (RT)^{\Delta n}$ $\quad K_c = K_p / (RT)^{\Delta n}$

$K_c = 3'1 \cdot 10^4 / (8'314 \cdot 10^{-2} \cdot 673)^{2-2-1} = 1734549'82 \simeq 1'73 \cdot 10^6$

4. ADB. $Glucosa_{(aq)} + H_2PO_4^-{}_{(aq)} \rightleftharpoons G6P_{(aq)}$ $\Delta G_r^\circ = 14 kJ$ $37^\circ C$

$\Delta G_r^\circ = -RT\ln K$

$$\ln K = -\frac{\Delta G_r^\circ}{RT} = -\frac{14000}{8'314 \cdot 310} = -5'422$$

$$K = 4 \cdot 37 \cdot 10^{-3}$$

5. ADB. (6. ADB)

$2P_{(g)} + 5Cl_{2(g)} \rightleftharpoons 2PCl_{5(g)}$

$2P_{(g)} + 3Cl_{2(g)} \rightleftharpoons 2PCl_{3(g)}$ K_1

$(PCl_3 + Cl_{2(g)} \rightleftharpoons PCl_{5(g)}) \times 2 \rightarrow K^2$

$2P_{(g)} + 5Cl_{2(g)} \rightleftharpoons 2PCl_{5(g)}$ $K = K_1 \cdot K_2^2$

8. ADB $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$ $K = 4 \cdot 10^{18}$ 500K

$P_{(H_2)} = 0'42$ mPa

$P_{(Cl_2)} = 0'83$ mPa

$$K = \frac{P_{HCl}^2}{P_{H_2} \cdot P_{Cl_2}} \qquad P_{HCl} = \sqrt{K \cdot P_{H_2} P_{Cl_2}} = 11'8 \text{ bar} = 11'8 \cdot 10^3 \text{ mPa}$$

9. ADB. 783K $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ $\Delta G^\circ = -15'73 kJ/mol$

$$Q = \frac{P_{HI}^2}{P_{H_2} \cdot P_{I_2}} = 1 \qquad \Delta G = -RT\ln K$$

$K = 11'55$

$Q < K$ desez erreakzioa eskumaldera, HI eratuz

P_p bakoitza $= 0'55$ kPa

10. ADB. 500ml

3'12g PCl_5 $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ $K = 78'3$

250°C

Zenbateraino c orekan deskonposatuko PCl_5 prop.

$$P_{PCl_{5,0}} = \frac{nRT}{V} = \frac{0'01498 \cdot 8'314 \cdot 523K}{0'5 \cdot 10^{-3} m^3} = 1'3 \cdot 10^5 Pa = 1'3 bar$$

$$3'12g\ PCl_5 \cdot \frac{1mol}{208'24g} = 0'01498\ mol$$

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$

P_0 — —

$P_0 - x$ x x

$$K = \frac{x^2}{P_0 - x} \quad (P_0 - x)K = x^2$$

$$x^2 + Kx - P_0K = 0 \quad x = \frac{-K \pm \sqrt{K^2 - 4(-P_0)}}{2}$$

$x_1 = -79'6$ x ezerk

$x_2 = 1'28$

$$P_{PCl_{5\,oreka}} = 1'3 - 1'28 = 0'02 bar$$

$$\frac{n}{V} = M = P/RT \quad 0'46M = [PCl_5]_{or}$$

$$P_{Cl_3} = P_{Cl_2} = 1'28 bar \rightarrow 29'4M = [PCl_3]_{or} = [Cl_2]_{or}$$

$$\frac{1'28}{1'30} \times 100 = \%98'5\text{a deskonposatuko da } PCl_5$$

11. ADB.

$2N_2(g) + O_2(g) \rightleftharpoons 2N_2O(g)$ $n_{0N_2} = 0'482 mol$ $n_{0O_2} = 0'933 mol$ 10L 800K $K = 3'2 \cdot 10^{-28}$

$$P_{N_2} = \frac{n_{N_2}RT}{V} = \frac{0'482 mol \cdot 8'314 \cdot 10^2 bar \cdot l/K\,mol \cdot 800K}{10L} = 3'21 bar$$

$P_{O_2} = 6'21 bar$

$2N_2 + O_2 \rightleftharpoons 2N_2O$

P_{N_2} P_{O_2} —

$P_{N_2} - 2x$ $P_{O_2} - x$ $2x$

$$K = \frac{P_{N_2O}^2}{P_{N_2}^2\ P_{O_2}}$$

ADB9

12. ADB $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ $K = 78'3$

(10a) orekan → 0'02 1'28 1'28 P → 0'01 mol Cl_2 gehitzean oreka bonko P.

$$P_{Cl_2} = 1'28\,bar + \frac{0'01\,mol \cdot 8'3145\,J/K\,mol \cdot 523K}{5 \cdot 10^{-3}\,m^3} \cdot 10^{-5} = 2'15\,bar \quad (PV = nRT)$$

→ sistemak erreakziora sortzera

	PCl_5	$\rightleftharpoons PCl_3$	$+ Cl_2$
t_0 (bar)	0'02	1'28	2'15
t_∞	0'02+x	1'28-x	2'15-x

$$78'3 = \frac{(1'28-x)(2'15-x)}{0'02+x} \quad \begin{cases} x_1 = 81'72 \text{ ezinezko} \\ x_2 = 0'0145\,bar \end{cases}$$

- Oreka bonko presioak:

$P_{PCl_5} = 0'0345\,bar$

$P_{PCl_3} = 1'2655\,bar$

$P_{Cl_2} = 2'13555\,bar$

13. ADB. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ 298K $K = 6'8 \cdot 10^5$

400K $K = ?$

$$\ln\frac{K_1}{K_2} = \frac{-\Delta H^\circ}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Van't Hoff

$\Delta H^\circ_r = 2 \cdot \Delta H^\circ_{f(NH_3)} - \Delta H^\circ_{f(N_2)} - 3\Delta H^\circ_{f(H_2)}$

$\Delta H^\circ_r = -92'22\,kJ/mol$

$$\ln\frac{6'8 \cdot 10^5}{K_2} = \frac{92'22}{8'3145}\left(\frac{1}{298} - \frac{1}{400}\right) \quad \boxed{K_2 = 51}$$

erreakzioa exotermikoa denez $T \uparrow$ $K \downarrow$

FASE ORETAN

1. ARIKETA $P_{V\,etanol} = 13'3\,kPa$ $34'9°C$

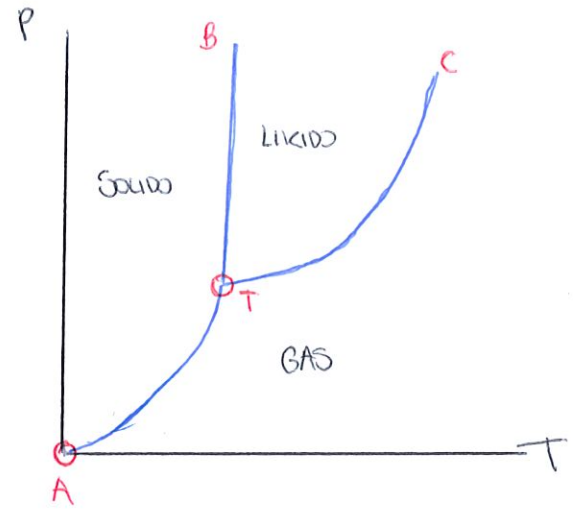
T_{ira} normala = ? → 1atm = 101'325kPa

$$\ln \frac{P_{V(T_1)}}{P_{V(T_2)}} = \frac{-\Delta H^{\circ}_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln \frac{P_{V(T_1)}}{P_{V(T_2)}} = -\frac{\Delta H^{\circ}_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$T_2 = T_{ira} = 349'8K = 76'8°C$

+ FASE DIAGRAMA



A-T solido - bapore oreka

$P_{V(solido)}$ $T_{sub.}$

T-C Likido - bapore oreka

$P_{V(likido)}$ $T_{vap.}$

T-B Solido likido oreka

T_{fus} (lerro ia bertikala)

T puntu hirukoitza 3 faseak oreka.

ZINETIKA KIMIKOA

1. ADB. $Hb_{(aq)} + O_2 \rightarrow HbO_{2(aq)}$

$[Hb]_0 = 1'2 \cdot 10^{-6}$ mmol/l

$[Hb]_1 = 8 \cdot 10^{-7}$ mmol/l

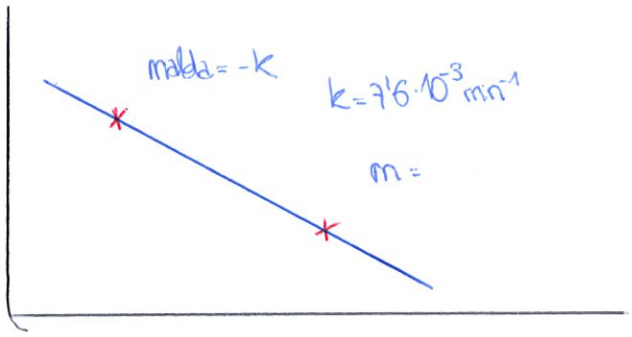
$0'1\mu s = T$ bataz besteko abadura? $\bar{v} = \frac{\Delta c}{\Delta t}$

$$\bar{v} = \frac{\Delta c}{\Delta t} = \frac{(1'2 \cdot 10^{-6} - 8 \cdot 10^{-7})\ mmol/L}{0'1\mu s} = 4 \cdot 10^{-6}\ mmol/l \cdot \mu s = \boxed{4 \cdot 10^{-2} M/s}$$

2. ADB.

t(min)	c(mM)
30	699
60	622
120	413
150	292
240	152
360	80
480	24

t(mn)	ln C
30	6'55
60	6'43
120	6'02
...	...



$V = k = 7'6 \cdot 10^{-3}\ [Droga]/min$

V = abadura ekuazioa

→ ln[ ] / t zuzena 1. ordena

$\frac{1}{[\ ]}$ / t zuzena 2. ordena

$$\ln[A] = \ln[A]_0 - kt$$

$$\frac{1}{[A]} = \frac{1}{[A]_0} - kt$$

5. ADB.

$K = 2 \cdot 10^{-4}\ s^{-1}$

$t_{1/2}\ \ln 2 / k$

$t_{1/2} = \ln 2 / 2 \cdot 10^{-4}\ s^{-1} = 3466\ s = 57'7\ min$

$\tau = 1/k$

$\tau = 1/2 \cdot 10^{-4} / s^{-1} = 5000\ s = 583'3\ min$

TERMO 1. ATALA

1. 25°C = 298K
2'25L

$2A(g) \longrightarrow C(g) + 2D(s)$

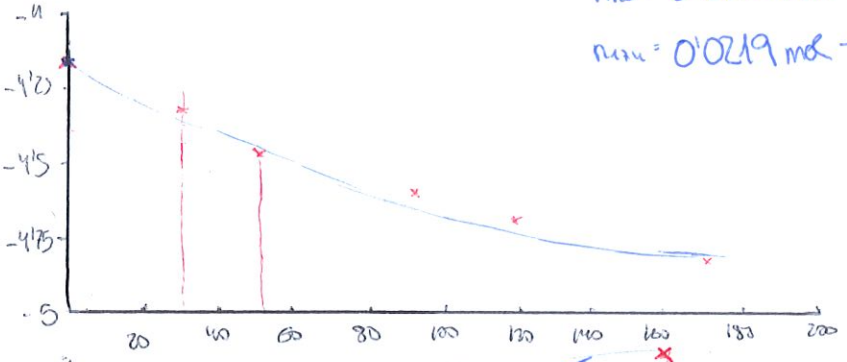
$PV = nRT \quad n = PV/RT$

2) $V = k[A]^a$

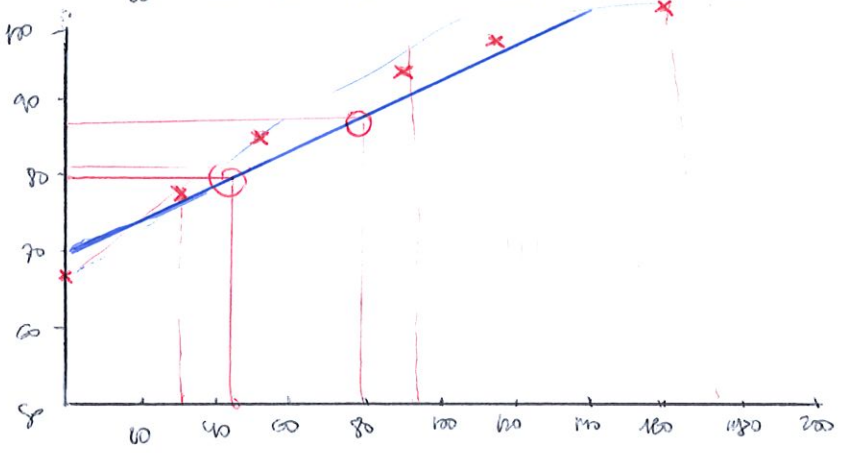
t(min)	P(mmHg)	t(min)	M[ ]
0	285	0	0'015
30	240	30	0'0128
52	221	52	0'0116
96	200	96	0'0106
120	193	120	0'0101
174	181	174	0'0097

$n_0 = 0'0345 mol \rightarrow 0'015 M$
$n_{30} = 0'029 mol \rightarrow 0'0128 M$
$n_{52} = 0'026 mol \rightarrow 0'0116 M$
$n_{96} = 0'024 mol \rightarrow 0'0106 M$
$n_{120} = 0'0234 mol \rightarrow 0'0101 M$
$n_{174} = 0'0219 mol \rightarrow 0'0097 M$

t(min)	ln[ ]
0	-4'19
30	-4'35
52	-4'45
96	-4'54
120	-4'57
174	-4'63



t(min)	1/[A]
0	66'6
30	78'125
52	86'2
96	94'34
120	98'15
174	103'1



$4V = K2^x \quad 4 = 2^x \quad x = 2$ 2. mailako erreakzioa da.

$V = k[A]^2 \quad m = k = \frac{y_2 - y_1}{x_2 - x_1} = \frac{86 - 80}{80 - 45} = \frac{6}{35} = 0'17 = k$

b) $\frac{1}{[A]_{110}} - \frac{1}{[A]_0} = kt \quad \frac{1}{[A]_{110}} - \frac{1}{0'015M} = 110 \cdot 0'17$

$1/[A]_{110} = kt - [A]_0 \quad \frac{1}{kt + [A]_0} = [A]_{110} = 0'0117$

$P = \frac{nRT}{V} = 0'2859 atm = 217 atm$

$285 - 217 = 68 mmHg \; P_c$

2. V=kte.

1.034g CH_3CH_2OH $\quad CH_3CH_2OH(l) + 3O_2(g) \longrightarrow 2CO_{2(g)} + 3H_2O(l)$

20°C = 293K

a) V=kte

$\Delta U = q_v/n \quad q_v = m C_v \Delta T \quad 1'034g \cdot \frac{1mol}{46g\ et} = 0'0225\ mol$

$\Delta H = \Delta U + \Delta n RT$

$\Delta H_r = 2\Delta H_f^\circ CO_2 + 3\Delta H_f^\circ H_2O - \Delta H_f^\circ CH_3CH_2OH$

• $\Delta H_f^\circ\ CO_2$

$C_{(gr.)} + O_2 \rightarrow CO_{2(g)}\ (O=C=O)$

$C \quad 2O \longrightarrow CO_{2(g)}$

$\Delta H_f^\circ(CO_2) = \Delta H_f^\circ C + 2\cdot\Delta H_f^\circ O - 2O(C=O) =$

$\Delta H_f^\circ(CO_2) = 716'68 + 2\cdot 249'17 - 2\cdot 803 = -390'98\ KJ/mol$

• $\Delta H_f^\circ\ H_2O$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O(l) \quad \Delta H^\circ = -285'83\ KJ/mol^{-1} = \Delta H_f^\circ(H_2O)$

$\rightarrow \Delta H_r^\circ = 2(-390'98) + 3(-285'83) - (-285'31) = -1404'14\ KJ/mol$

$-1404'14\ KJ/mol \cdot \frac{0'0225mol}{1mol} = -31'59\ KJ = -31590\ J$

$-31590 = \Delta U + \Delta n_g\ 8'314 \cdot 293$

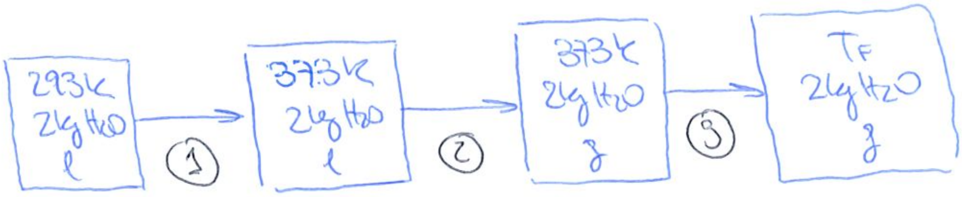
$\Delta U = -33926'002\ J = -33926\ KJ$

$q_v = -33'926\ KJ$

b) ↓

b) 2L H_2O

$20°C = 293K$



1. $-33'926$ kJ askatzen dira, $2kg\ H_2O \cdot \frac{1 mol\ H_2O}{18 g\ H_2O} = 111\ mol\ H_2O$

$q = m C_p \Delta T$

$q_1 = 2000 \cdot 4'18 \cdot (373-293)$

$q_1 = 668800 J$ → ez da hainbeste bestela

$+33926 = 2000 \cdot 4'18 (T_2 - 293)$

$T_2 = 297'06K = 24'058°C$

3. a) $NH_4HS(s) \longrightarrow NH_3(g) + H_2S(g)$

$\Delta G = \Delta H - T\Delta S$ $\Delta G > 0$ ez esp $T\uparrow$ jeitsi.

$\Delta G < 0$ esp. $T\downarrow$ K ori igotzen bada

Ez. T jaistean K jeitsiz gero $\Delta G = \Delta G° + RT\ln K$ adierazpenean oinarrituz zera deduzi dezakegu, ΔG-ren balioa ez murriztuko dela, beraz erreakzioak espontaneoa izateko jasoa izango dela. T igotzean, ordea K ere igo egingo da, kontrako efektua eraginez; erreakzioaren espontaneotasuna jaitsi. Beraz erreakzioa T oso altuetan ez espontaneoa izan daiteke.

b) $CO_2(g) + C(gr) = 2CO(g)$

Ez. $\Delta U = q_v/n$ } batean landu egingo da bestean ez

$q_p = \Delta U - W$

c) CH_3CONH_2

- Izan liteke $\Delta H_r (CH_3CONH_2)$ eta produktuen ΔH_f
- Edo C-H, C-C, C=O, C-N, N-H } lotura energiak
- Edo ΔS_r eta produktuen S°

Az (4) TxB

1. $2AsH_3(g) \rightarrow 2As(s) + 3H_2(g)$ T=298K

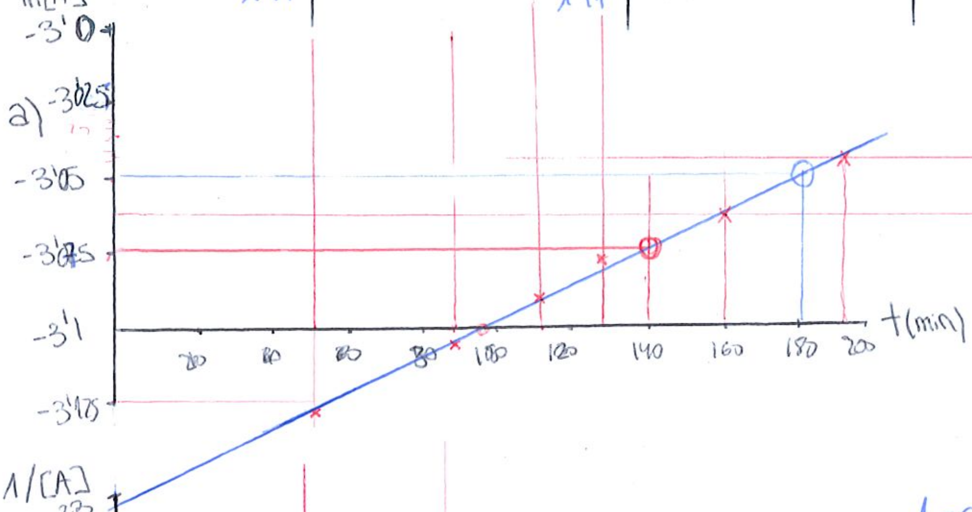
$\frac{P_A}{RT} = [A]$

t(min)	[ ](M)
52	0'0439
88	0'0449
112	0'0455
127	0'046
160	0'0468
191	0'0476

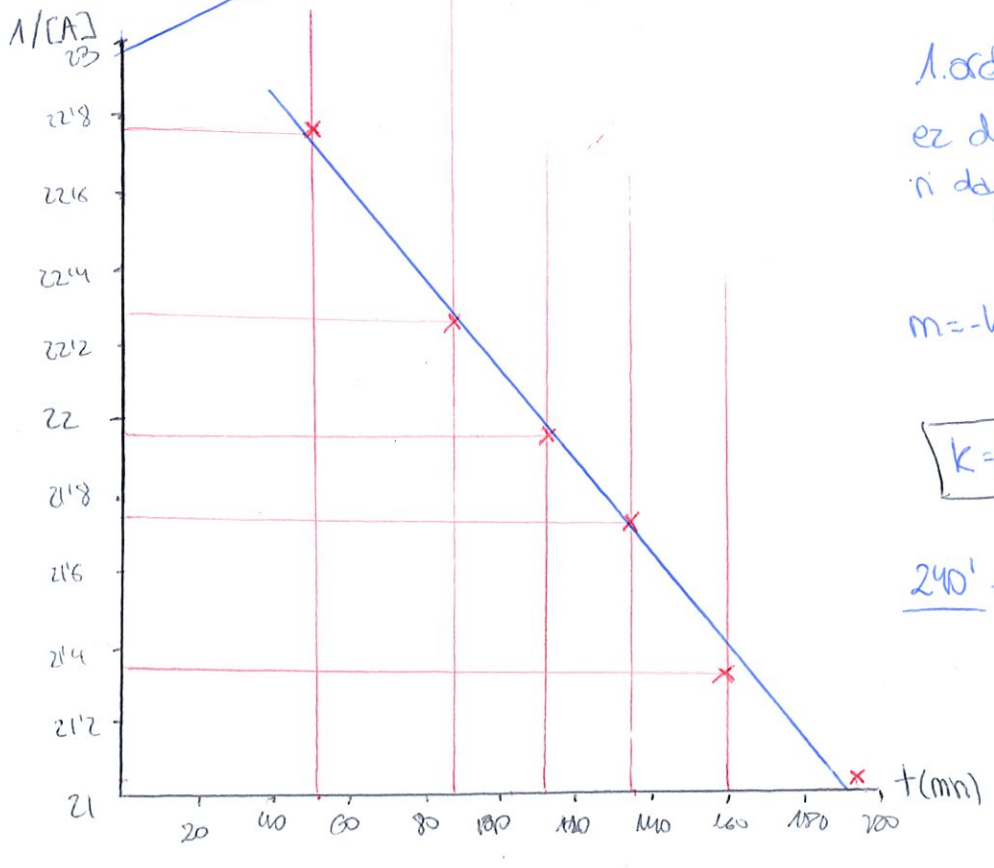
t(min)	ln[A]
52	-3'126
88	-3'103
112	-3'09
127	-3'078
160	-3'062
191	-3'045

t(min)	1/[A]
52	22'78
88	22'27
112	21'98
127	21'74
160	21'37
191	21'01

a)



140min ln[A]=-3'075
180min ln[A]=-3'05



1.ordena. zuzenak bestela ez dugulako t=0 [A]₀=785mmHg ri dagokion puntua mostatu.

$m = -k = \frac{-3'075 - (-3'05)}{180 - 140}$

$k = 6'25 \cdot 10^{-4}$

240' → $[A] = [A]_0 - kt$

$[A]_{240} = 0'0423 - k \cdot 240$

$= -0'1077$

beraz guztiz deskonposatuta da.

2. 2'46atm $NH_4HS(s) \longrightarrow H_2S(g) + NH_3(g)$

298K

486cm³ = 0'486l

5'324g NH_4HS

a) 288K $\Delta G^\circ = -RT \ln K$ $\Delta G^\circ = \Delta H - T\Delta S$

$\Delta H_r^\circ = \Delta H_f^\circ(NH_3) + \Delta H_f^\circ(H_2S) - \Delta H_f^\circ(NH_4HS)$

- $\Delta H_f^\circ(NH_3)$

$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$

$\Delta H_f^\circ(NH_3)$

6. ZK (5)

$A(g) \longrightarrow B(g) + C(g)$ 423K

2K = 2V

$2 = 2^x \quad x = 1$

→ $V = k[A]^1$

$2A(g) \longrightarrow C(g) + 2D(s)$

λ: 25 K

2,26 K

16. V=kte $CH_3COCl(l) + CH_3CH_2OH(l) \longrightarrow CH_3COOC_2H_5(l) + HCl(g)$

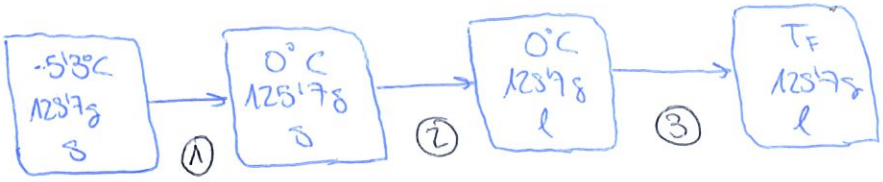
298K

0'05l CH_3COCl

0'034l CH_3CH_2OH

$\Delta H = -47'1 kJ$

a)



1. $q_1 = mc_p\Delta T$ $n = 6'78 mol$

$q_1 = 1393'86 J$

$+ 45706'14 J$ sobran

2. $q_2 = n(+\Delta H_{fus}) = n 6025 kJ = n 6025 J =$

$3651,65 J$ sobran

3. $3651'6 = 6'78 \cdot 75'31 \cdot (T_2 - 273)$

$T_2 = 279'25$ $\Delta T = 6'24°C$

b) $\Delta H^\circ_R = \Delta H^\circ_f(CH_3COOC_2H_5) + \Delta H^\circ_f(HCl) - \Delta H^\circ_f(CH_3COCl) - \Delta H^\circ_f(CH_3CH_2OH)$

- mugatzaileen jarkatu

5

DISOLUZIOAK AND THE OREKA

2. AZTERKETA(Os)

1ADB. 5g NaCl -
95g H_2O-T
25 ml met
0'9g NaCl
100ml

→ 0'892g KC

KCl : %m
X_{KCl}
M
molal

$dents_{met} = 0'79g$

$$\%\ masa = \frac{soluto\ masa\,(g)}{disoluzio\ masa\,(g)} \cdot 100 = \%1'61$$

$$X_{KCl} = \frac{mol\ KCl}{mol\ disoluzio} = \frac{m_{KCl}/pm_{KCl}}{\frac{m_{KCl}}{pm_{KCl}} + \frac{m_{met}}{pm_{met}}} = 0'0067$$

$$M = 0'173 \qquad m = 0'219 = \frac{mol\ KCl}{kg\ disolbatzaile}$$

2ADB

a) 20°C $P_{vap\ H_2O} = 17'54\,mmHg$

zenbat glukosa gehitu $P_{v\,H_2O} = 16'8$ izan dadin

$$X_{H_2O} = \frac{P_{disol}}{P^{\circ}_{H_2O}} = 16'8/17'54 = 0'957$$

$$X_{H_2O} = n_{H_2O}/n_{H_2O + gluk} \Rightarrow n_{gluk} = n_{H_2O}\frac{1 - X_{H_2O}}{X_{H_2O}} = 2'84 \cdot \frac{1 - 0'957}{0'957} = 0'125\ mol\ glukosa$$

b) —

3. ADB

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \quad K = 54'3$

$[H_2]_0 = 0'00623\,M$

$[I_2]_0 = 0'00114\,M$

$[HI]_0 = 0'0224\,M$

H_2	+ I_2	$\rightleftharpoons$	$2HI$
M_0	M_1		M_2
$M_0 - x$	$M_1 - x$		$M_2 + 2x$

$$K = \frac{(M_2 - x)^2}{(M_0 - x)(M_1 - x)} \rightarrow$$

$x_1 = 0'0114$ erroneo

$x_2 = 0'00166$

$x_2 = 0'00166 \rightarrow$ correcto [ ]

AZIDO BASE OREKA

1. ADB. Az monoprotiko ahul bat uretan disolbatzen da: pH?

$$HA + H_2O \rightleftarrows A^- + H_3O^+$$
$$H_2O + H_2O \rightleftarrows H_3O^+ + OH^-$$

→ masa balantzea

$$M_{HA_2} = [HA] + [A^-] = 0'1M$$

→ protoi balantzea

$$[H_3O^+] = [OH^-] + [A^-]$$

(A^- disolbatu baitz: $[H_3O^+] + [HA] = [OH^-]$

H_2A disolbatuko baitz: $[H_3O^+] = [OH^-] + [HA^-] + 2[A^{-2}]$ ↳ galdutako H^+ kop.)

→ oreka ktea.

$$K_a = \frac{[A^-][H_3O^+]}{[HA]}$$

→ Uraren autoprotolisia

$$K_W = [H_3O^+][OH^-] = 10^{-14}$$

+Hurbilketak

→ masa balantzea.

$$M_{HA} = [HA] + \boxed{[A^-]}$$ → ordezkoan azido ahula = espezie protonatua nagusia

→ Proto balantzea

$$[H_3O^+] = \boxed{[OH^-]} + [A^-]$$ → Azidoen kontzentrazioen kasuetan kasu basa

→ kalkulua

$$K_a = \frac{[A^-][H_3O^+]}{[HA]} = \frac{[H_3O^+]^2}{M_{HA}} \qquad [H_3O^+] = \sqrt{K_a M_{HA}}$$

+Hurbilketen zuzentzea (<%5eko errorea)

$\frac{5}{100}[HA] >> [A^-]$ | BAI = FINIX

$\frac{5}{100}[A^-] >> [OH^-]$ | EZ = ERREPIKATU HURBILKETAGE.

2. ADB (Neutr. ADB)

0'01 mol NH_3 + 0'01 mol HA_z (1L) pH=?

$A_z^- + H_2O \rightleftharpoons HA_z + OH^-$
$NH_3 + H_3O^+ \rightleftharpoons NH_4^+ + H_2O$
} $HA_z + NH_3 \rightleftharpoons A_z^- + NH_4^+$ → $A_z^- + H_2O \rightleftharpoons HA_z + OH^-$
$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

$M_{HAz} = [HA_z] + [A_z^-] = 0'01M$ (with $[HA_z]$ crossed out)

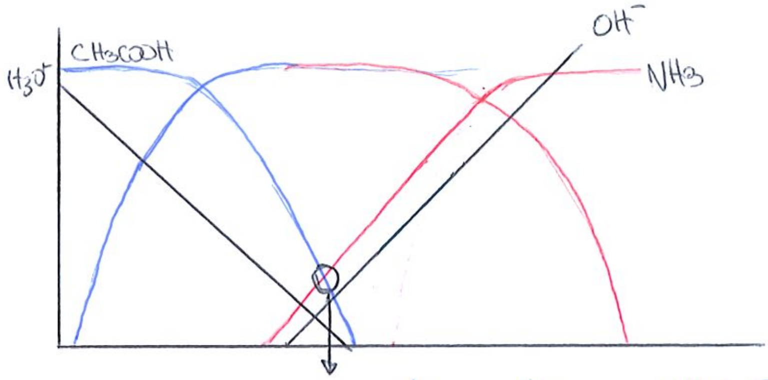
$[A_z^-] = [NH_4^+]$

$M_{NH_4^+} = [NH_3] + [NH_4^+] = 0'01M$ (with $[NH_3]$ crossed out)

- suposatu = ordorostutako duzu pH neutroa dela → $[H_3O^+]$ eta $[OH^-]$ oso baxuak

protoi balantzea

$[NH_3] + [OH^-] = [HA_z] + [H_3O^+]$ (with $[OH^-]$ and $[H_3O^+]$ crossed out)



$$pH = \frac{pka_{HAz} + pka_{NH_3}}{2} = \frac{4'65 + 9'25}{2} = 6'95$$

$Ka_{HAz} = 10^{-4'65}$ pka = 4'65

$Ka_{NH_3} = 10^{-9'25}$ pka = 9'25

$$\hookrightarrow \frac{[H_3O^+][A_z^-]}{10^{-4'65}} = \frac{10^{9'25}[NH_4^+]}{[H_3O^+]}$$

$[H_3O^+] = 10^{-6'95}$ pH = 6'95

$[HA_z] = 10^{-4'3}M$
$[H_3N] = 10^{-4'3}M$
} kontzentrazioak berdinak

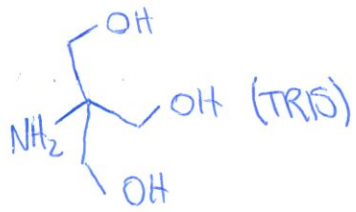
3. ADB (disoluciones)

$pH = 8$ ← $+ 0'005\,M = [H^+]$

$[TRIS] = 0'1\,M$

$pK_{a\,TRIS} = 8'1$

$pH_2 = ?$



a) Hasierakoa

$pH = 8 \quad M_{TRIS} = [TRIS] + [HTRIS] = 0'1\,M \quad TRIS + H_2O \rightleftharpoons HTRIS + OH^-$

$$[TRIS] = \frac{10^{-8'1}}{10^{-8}}[HTRIS] = 0'79(0'1 - [TRIS])$$

$[TRIS] = 0'044\,M \quad [HTRIS] = 0'056\,M$ (oreka)

b) $+ 0'005\,M\,[H^+]$

$TRIS + H^+ \rightleftharpoons HTRIS$

$[TRIS] = (0'044 - 0'005)\,M = 0'039\,M$

$[HTRIS] = (0'056 + 0'005)\,M = 0'061\,M$

c) pH berriaren

$$pH = pK_a + \log\frac{[TRIS]}{[HTRIS]} = 7'9$$

pH aldaketa $\Delta pH = (8 - 7'9) = 0'1$

4. ADB. (ind.) #2

pH = 6
0'1M [Tris]

0'005M $[H^+]$

$pKa_{TRIS} = 8'1$

$pH_2 = ?$

a) Habrá que

pH = 6 $M_{Tris} = [Tris] + [HTris] = 0'1M$ $K_a = \frac{[Tris][H^+]}{[HTris]} = 10^{-8'1}$

$[Tris] = \frac{10^{-8'1}}{10^{-6}} [HTris] = 0'0079(0'1 - [Tris])$

$[Tris] = 0'0007M$ $[HTris] = 0'0993M \approx 0'1M$

b) 0'005M $[H^+]$

$[H^+]_{sobran} = [H^+] - [Tris] = (0'005 - 0'0007)M = 0'0043M$

c) pH bc

$-\log 0'0043 = 2'36$ $pH_2 = 2'36$

$\Delta pH = 6 - 2'4 = 3'6$

ADB 19

HAUSPERTZE ØREKV

1.ADB. 9g Ag_2SO_4 1LUr $Ksp = 1'2 \cdot 10^{-5}$

$Ag_2SO_4(s) \rightleftharpoons 2Ag^+ + SO_4^{-2}$

$9g\ Ag_2SO_4 \cdot \frac{1mol\ Ag_2SO_4}{311'4g\ Ag_2SO_4} = 0'0289\ mol\ Ag_2SO_4$

$2 \cdot 0'0289mol = 0'0578mol\ Ag$

$0'0289mol\ SO_4^{-2}$

$IKB = [Ag^+]^2 \cdot [SO_4^{-2}] = 0'0577^2 \cdot 0'0289 = 9'655 \cdot 10^{-5}$

$9'655 \cdot 10^{-5} > 1'2 \cdot 10^{-5}$ IKB>Ksp hauspeketa egongo da.

2.ADB.

zenbat Ag^+ eta SO_4^{-2} ioi disolbatuta

$Ag_2SO_4^{-2} \rightleftharpoons 2Ag^+ + SO_4^{-2}$ $\quad Ksp = (2s)^2 \cdot s = 4s^3 = 1'2 \cdot 10^{-5}$

2s s

$s = 0'0144M \quad [Ag^+] = 0'0288M$

$[SO_4^{-2}] = 0'0144M$

3. ADB (Hauspeatze kuantitatiboa)

- Bandeeta kuantitatiboa: ioi baten %99'9 hauspeatzen denean bestea hauspeatzen hasi aurretik

X^- Cl^- ioiak kuantitatiboki bana daitezke Ag^+ erabiliz?

0'05M

$K_{sp(AgCl)} = 1'62 \cdot 10^{-10}$

$K_{sp(AgX)} = 5 \cdot 10^{-7}$

$K_{spAgCl} < K_{sp(AgX)}$ AgCl hauspeatzea lehenago izango da

%99'9 hauspeatzean AgX hauspeatu?

$$[Cl^-] = \frac{0'1}{100} \cdot 0'05M = 0'00005M$$

$$[Ag^+] \cdot [Cl^-] = K_{sp} = 1'62 \cdot 10^{-10} \rightarrow [Ag^+] = \frac{1'62 \cdot 10^{-10}}{0'00005} = 3'24 \cdot 10^{-6} M$$

X^- hauspeatzen hasi da?

$$[Ag^+] \cdot [X^-] = 1'62 \cdot 10^{-7} < K_{sp} = 5 \cdot 10^{-7}$$

ez, beraz bandeeta posible da.

ERREDOX

1. ADB (14. Ar. zbirzuma)

$MnO_4^-, H^+, Mn^{2+} \mid Pt \quad E^\circ = 1'51V$ → especie oxo 1M

a) $[MnO_4^-] = 0'00005M = 5 \cdot 10^{-5}M \quad [Mn^{2+}] = 10^{-2}M$

$MnO_4^- (5 \cdot 10^{-5}M), H^+(x), Mn^{+2} (10^{-2}M) \mid Pt \quad E = 1'361V$

$\rightarrow MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

298k-tan

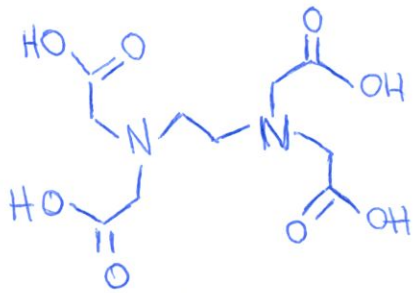
$$E = E^\circ - \frac{0'059}{n} \log \frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$$

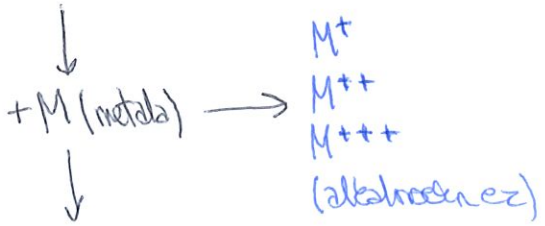
$[H^+] = 5'12 \cdot 10^{-2}$

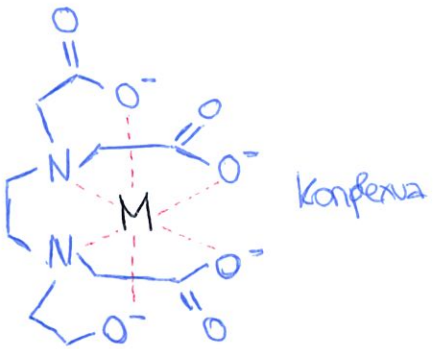
$\boxed{pH = 1'29}$

KONPLEXUEN FORMAZIO OREKA

EDTA:







Konplexua

$EDTA^{4-}$

↓

$HEDTA^{3-}$
H_2EDTA^{2-}
H_3EDTA^{-}
H_4EDTA
H_5EDTA^{+}
H_6EDTA^{+2}

} koldatziadesk → konpl. = koldatu

ADB20

K ANAL

1. $NaCOOH_{(s)}$ %98 puro $P_m = 68\,g/mol$ $pK_a(HCOOH/HCOO^-) = 3'77$

$HCl_{(l)}$ %37 puro $P_m = 36'5\,g/mol$ $d = 1'2\,g/ml$

$NaCOOH + HCl \rightleftharpoons HCOOH + NaCl$

$0'25M = [HCOOH] + [HCOO^-]$

$[H^+] = 10^{-3'5}$

$0'25 - [HCOOH] = \frac{10^{-3'77}[HCOOH]}{10^{-3'5}}$

$10^{-3'77} = \frac{[HCOO^-] + [H^+]}{[HCOOH]}$

$[HCOOH] = 0'163M$

$[HCOO^-] = 0'087\,M$

$[NaCOOH]_0 = 0'25M = 0'125mol$

$[HCl]_0 = 0'163\,M = 0'0815mol$

$NaCOOH + HCl \rightleftharpoons HCOOH + NaCl$

$0'25 \quad M_{01} \quad - \quad -$

$0'087 \quad 0'163 \quad 0'163$

$0'125mol\ NaCOOH \cdot \frac{68g}{1mol} \cdot \frac{98}{100} = \boxed{8'33g\ NaCOOH}$

$0'0815mol\ HCl \cdot \frac{36'5g}{1mol} \cdot \frac{1ml}{1'2g} \cdot \frac{37}{100} = \boxed{0'217ml\ HCl}$

b) 200ml

$pH = 3'5$

$0'001M\ [NaOH]$

$HCOO^- + NaOH \rightleftharpoons HCOOH + OH^-$

$2 \cdot 10^{-4}mol$

$0'087M \quad - \quad 0'163 \quad -$

$0'087 - 0'01 \qquad 0'163 + 0'01 = 0'173$

$0'077$

$pH = pK_a + log\frac{0'077}{0'173} = \boxed{3'41}$

$\Delta pH = 0'082$

2. 10ml Sn^{+2} 0'015M $\quad E^\circ_{(Fe^{+3}/Fe^{+2})} = 0'77V$

25ml Fe^{+3} 0'012M $\quad E^\circ_{(Sn^{4+}/Sn^{2+})} = 0'15V \quad E^\circ_{(Sn^{2+}/Sn)} = -0'14$

$$Sn^{+2} + 2Fe^{+3} \rightleftarrows 2Fe^{+2} + Sn^{+4}$$

M_1	M_{12}		–	–
$M_1 - x$	$M_{12} - 2x$		$2x$	x

$$0'015M \cdot \frac{0'01\ell}{1\ell} = 0'00015mol\ Sn^{+2} \rightarrow 0'043M$$

$$0'012mol \cdot \frac{0'025dl}{1\ell} = 0'0003mol\ Fe^{+3} \rightarrow 0'086M$$

$$E^\circ_{Fe^{+3}/Fe^{+2}} + 0'059 \log \frac{[Fe^{+3}]}{[Fe^{+2}]} = E^\circ_{Sn^{+4}/Sn^{+2}} + 0'059 \log \frac{[Sn^{+4}]}{[Sn^{+2}]}$$

$$0'77 + 0'059 \log\left(\frac{0'086 - 2x}{2x}\right) = 0'15 + 0'059 \log\left(\frac{x}{0'043 - x}\right)$$

$$0'62 = -0'059 \log\left(\frac{0'086 - 2x}{2x}\right) + 0'059 \log\left(\frac{x}{0'043 - x}\right)$$

$$0'62 = 0'059\left(\log\left(\frac{x}{0'043 - x}\right) - \log\left(\frac{0'086 - 2x}{2x}\right)\right)$$

$$10'51 = \log\left(\frac{x}{0'043}\right) - \log\left(\frac{0'086 - 2x}{2x}\right)$$

2. 10ml Sn^{+2} 0'015M $E^\circ(Sn^{+4}/Sn^{+2}) = 0'15V$

25ml Fe^{+3} 0'012M $E^\circ(Fe^{+3}/Fe^{+2}) = 0'77V$

$$Sn^{+2} + 2Fe^{+3} \rightleftharpoons Sn^{+4} + 2Fe^{+2}$$

M_{OS}	M_{OF}	–	–
$M_{OS}-x$	$M_{OF}-2x$	x	$2x$
$\simeq 0$	$\simeq 0$		

10ml 0'015M → 0'00015mol

25ml 0'012M → 0'0003mol

35ml → 0'00428M / 0'00857M

$x = 0'00428M$ $\quad [Sn^{+4}]_{eq} = 0'00428M$

$[Fe^{+2}]_{eq} = 0'00857$

$$E = \frac{n_A E_A + n_B E_B}{n_A + n_B}$$

$$E = \frac{1 \cdot 0'15 + 2 \cdot 0'77}{3} = 0'563V$$

$$E = E^\circ + \frac{0'059}{n} \log \frac{[A_{ox}]}{[A_{red}]}$$

$$0'563V = E = E^\circ_{Fe^{+3}/Fe^{+2}} + 0'059 \log \frac{[Fe^{+3}]}{0'00857}$$

$$\frac{0'563 - 0'77}{0'059} = \log \frac{[Fe^{+3}]}{0'00857} \qquad [Fe^{+3}] = 2'66 \cdot 10^{-6} M$$

$$0'563V = 0'15 + \frac{0'059}{2} \log \frac{0'00428}{[Sn^{+2}]} \qquad [Sn^{+4}] = 4'28 \cdot 10^{-17} M$$

$[Sn^{+4}] = 0'00428M$

$[Sn^{+2}] = 4'28 \cdot 10^{-17} M$

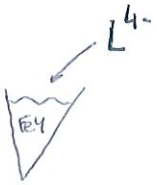
$[Fe^{+3}] = 2'66 \cdot 10^{-6} M$

$[Fe^{+2}] = 0'00857M$

galdesak

1.

2. $\log([FeL]) = 25'1$
$\log([FeY]) = 15'9$



3. 0'01M $A + B \rightarrow Pb^{+2}$
$\downarrow$
Ag^{+}

B daburoa lehenago hauspeatu.

$pKsp(AgBr) = 12'06 \rightarrow Ksp = 10^{-12'06}$ → lehenago hauspeatu Ksp txikiagoa = disolbagarriagoa txikiago
$pKsp(PbBr_2) = 5'68 \rightarrow Ksp = 10^{-5'68}$ beraz errezago hauspeatuko da.

$Ksp = n^m n^n s^{(m+n)}$ | Ksp ↓ S ↓ |

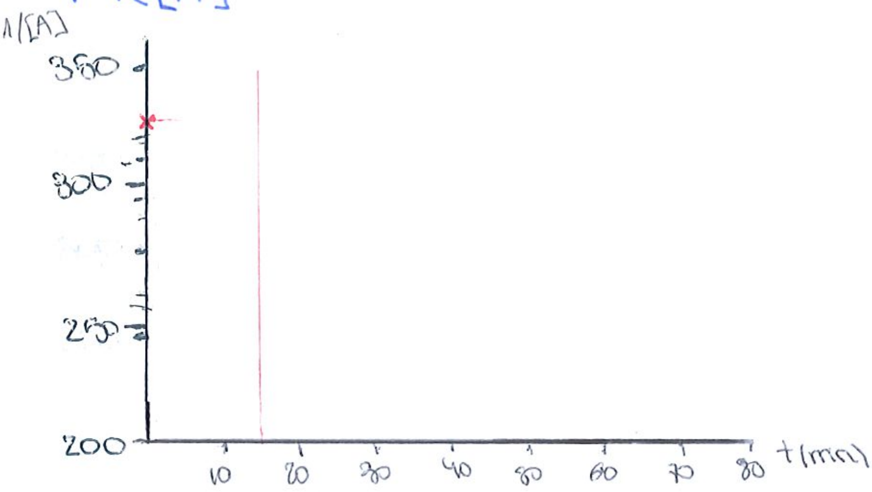
4. E = 0'5V

AZT. JUN.

1. $2A(g) \longrightarrow B(g) + 2C(s)$

$t_{1/2} = \frac{1}{[A]_0 K}$ (ald. prop). 2. ordena

$V = K[A]^2$



$\frac{325 mmHg}{760 mmHg} \cdot V = nRT \quad 0'4276 = nRT/V$

2. $\log[FeY^-] = 15'9 \quad Y = EDTA \rightarrow K_1 = 10^{15'9} \qquad K_1 = \frac{[FeY^-]}{[Fe^{+3}][Y^{-4}]}$

$\log[FeL^-] = 25'1 \rightarrow K_2 = 10^{25'1} \qquad K_2 = \frac{[FeL^-]}{[Fe^{+3}][L^{-4}]}$

$Fe^{+3} + Y^{-4} \rightleftharpoons FeY^- \quad K_3 = 1/K_1$

$FeY^- \rightleftharpoons Fe^{+3} + Y^{-4}$

$Fe^{+3} + L^{-4} \rightleftharpoons FeL^-$

$\cancel{Fe^{+3}} + L^{-4} + FeY^- \rightleftharpoons \cancel{Fe^{+3}} + Y^- + FeL^-$

$L^{-4} + FeY \rightleftharpoons Y^- + FeL^- \qquad \frac{1}{K_1} \cdot K_2 = K = 1'58 \cdot 10^{9}$

$Fe^{+4} + L^{-4} \rightleftharpoons$ [illegible]

$K_{Fel} =$

14 ejercicio.

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

$E = E^\circ + \frac{0'059}{n} \log \frac{[Mn^{+2}]}{[MnO_4^-][H^+]^8}$ $\quad 1'51V = 1'3361V + \frac{0'059}{5} \log \frac{10^{-2}}{5 \cdot 10^{-3} \cdot [H^+]^8}$

$[H^+] = 0'03 \quad pH = 1'52$

13.

---

11. 1M $Cu(NO_3)_2$ 0'5l
1M $Sn(NO_3)_2$ 0'5l
0'8mol Sn
1l { 0'5 M, 0'5M

$Cu^{+2} + Sn^{+2} + Sn \rightleftharpoons Cu + Sn^{+4} + Cu^+ + Cu^{+2}$ + [illegible]

0'5mol 0'5mol 0'8mol — —

0'5mol 0'5mol

10 Sn^{+2} 10ml 0'015M | 0'035 l | 0'0043M | 1'5·10^{-4}
Fe^{+3} 25ml 0'012M | | 0'0087M | 3·10^{-4} mol

$$2Fe^{+3} + Sn^{+2} \rightleftharpoons 2Fe^{+3} + Sn^{+4}$$

$3·10^{-4}$ $1'5·10^{-4}$ – –

0'0087M 0'0043M $2x$ $x \to 0'0043$

$-2x$ $-x$ $\hookrightarrow 0'0087$

$$E = \frac{0'77 + 2·0'15}{2 + 1} = 0'356 V$$

$$0'356 = 0'77V + 0'059 \log \frac{[Fe^{+3}]}{0'0087} \rightarrow [Fe^{+3}] = 8'367·10^{-10} M$$

$$0'356 = 0'15 + \frac{0'059}{2} \log \frac{0'0043}{[Sn^{+2}]} \qquad [Sn^{+2}] = 4'47·10^{-10} M$$

7. TxB

$$Fe^{+3} + Zn^{+2} + Sn^{+2} \rightleftharpoons Sn^{+4} + Fe^{+2} + Zn^{+2}$$

$$Fe^{+3} + Zn^{+2} + Sn^{+2} \rightleftharpoons Sn^{+4} + Fe^{+2} + Zn^{+2}$$

$$2Fe^{+3} + Sn^{+2} \rightleftharpoons 2Fe^{+2} + Sn^{+4}$$

0'008M 0'015M
0'0010 ✓ 0'015 0'010

$[Fe^{+2}] = 0'05$

[Sn

$$Sn^{+2} + Zn^{+2} \rightleftharpoons Sn^{+4} + Zn^{0}$$

0'05 0'01

0'01 0'01

1. pH = 3'5

HCOONa (s) 98% pur $P_m = 68\ g/mol$ $pK_a = 3'77$

HCl (l) 37% pur $P_m = 36'5\ g/mol$

a) 0'25M

500ml

$HCOONa + HCl \rightleftharpoons HCOOH + NaCl$

0'25M ☐ – –

$HCOO^- + H_3O^+ \rightleftharpoons HCOOH + H_2O$

$[H^+] = 10^{-3'5}$

$[HCOO^-] = 0'25M - [HCOOH]$

$[HCOO^-] = [HCOOH]$

$0'25M = [HCOOH] + [HCOO^-]$

$10^{+3'77} = \frac{[HCOOH]}{[HCOO^-][H^+]}$

$2Fe^{+3} + Sn^{+2} \rightleftharpoons Sn^{+4} + 2Fe^{+2}$

	$0'005M$	$0'01M$	–	–
	$0'005mol$	$0'003mol$	$0'003$	$0'003$
		$0'003mol$		

$Zn^{+2} + Sn^{+2} \rightleftharpoons Sn^{+4} + Zn^0$

$2Fe^{+3} + 2Sn^{+2} + 2Zn^{+2} \rightleftharpoons 2Sn^{+4} + 2Zn^0 + 2Fe^{+2}$

3.

A)

B) B = punto burbuja

D = punto crítico.

L-G

→

TERMO

1. ∘ 19°C = 292K ∘ T_2 ∘ V_2 $T_2 = -51°C$

2'5bar = 2'467atm 1'9bar = 1'875atm $T_1 = 292K$ W =

0'475 mol O_2 V_1 1'9bar = 1'875atm

V_1

$PV = nRT$ 2'467atm · V_1 = 0'475 · 0'082 · 292K 1'875atm · V_2 = 0'475 · 0'082 · 292K

V_1 = 4'61L V_2 = 6'066 l

$P_2V_2 = nRT_2 = P_2V_1$

1'875atm · 4'61L = 0'475mol · 0'082 · T_2

T_2 = 221'9K = -51°C

(~~W = nRT ln V_2/V_1 = 0'475 · 8'31 · 292 ln 6'066/4'61 l = -2628'9J~~)

2. 0'5L H_2O $q = c_p m\Delta T + c_p m\Delta T$ 0'5L H_2O = 0'5kg H_2O

523'4g Al (lapikoa) (ura)

T_1 = 23'2°C

T_2 = 100°C q = 0'9025 J/gK · 523'4 · (372 - 296'2) + 4'184 J/gK · 500g (372 - 296'2)

q: ? q = 196943'5 J = 196'94 kJ

beroaren ze % urera

q = 196'94kJ 196'94kJ ⟶ 100% %85'83

169'03kJ ⟶ x

%85'83 ura berotzeko

3. 24'1g CH_4 W = 0 V kte delako, ez da lanik egiten.

1atm A) V = kte q = m$c_v\Delta T$ = 24'1 · C_v · (363 - 300) =

27°C ⟶ 90°C

$\Delta U = q_v$

$\Delta H = \Delta U + \Delta nRT$ $C_p = C_v + nR$ $C_v = C_p - nR$ = 37'66 - 8'31 · 1'50625

C_v = 25'14

24'1g CH_4 · (1mol CH_4 / 16g CH_4) = 1'50625 mol

4. 1atm

105°C = 378K ⟶ -5'3°C = 267'7K

35L ur (g)

gas → Lícido → sólido $\Delta H_T = \Delta H_{con} + \Delta H_{iz} + \Delta H_{100-100} + \Delta H_{100-0} + \Delta H_{0-(-5'3)}$

$\Delta H_{con} = -\Delta H_{vap} = -40'7\ J/mol = -0'0407\ kJ/mol$ $\quad \Delta H = q_p$ (isobara)

$\Delta H_{iz} = -\Delta H_{fus} = 6'01\ kJ/mol$

$35kg\ H_2O = 35000g\ H_2O \frac{1mol\ H_2O}{18g\ H_2O} = 1944'4mol\ H_2O$

$\Delta H_{105-100} = 33'58\ J/K\,mol \cdot 1944'4mol \cdot (373-378) = -326'464\ J = -326'464\ kJ$

$\Delta H_{100-0} = 75'29\ J/K\,mol \cdot 1944'4mol\ (273-373) = -14639'387\ J = -14.639'38\ kJ$

$\Delta H_{0-(-5'3)} = 36'58\ J/K\,mol \cdot 1944'4mol\ (267'7-273) = -376'81\ kJ$

5. 2Kg hielo (S) + 500g H_2O (l)

0°C = 273K ↓ 60°C = 333K $\quad \Delta H_{fus} = 6'01\ kJ/mol$

1atm

T_F = ?

isobara cont.

$q_{p_1} = 2000g \cdot 2'09\ J/g.K \cdot (T_2 - 333K) =$

$q_{p_2} = 500g \cdot 4'18\ J/g.K \cdot (T_2 - 273K) =$

$\Delta H_{T_2} = \Delta H_{T_1} + \Delta C_p (T_2 - T_1)$

$500 \cdot 4'18 (T_2 - 273) = 2000 \cdot 2'09 (T_2 - 333) + (4'18 - 2'09)(T_2 - 0)$

$-570570 + 2090T_2 = 4180T_2 - 1391940 + 2'09T_2$

$821370 = 4180T_2 - 2090T_2 + 2'09T_2 = 2092'09T_2$

$T_2 = 392'6K$

6. 20°C 0'4L H_2O → 50ml alkohol erre

$C_2H_5OH_{(g)} + 3O_2 \rightarrow 2CO_2 + 3H_2O$

$\Delta H^\circ_{err} = \sum H^\circ_{f(p)} - \sum H^\circ_{f(err)} = 3(-68'32\,kcal/mol) + 2(-93'95\,kcal/mol) - (-56'27\,kcal/mol)$

$\Delta H^\circ_{err} = -336'59\,kcal/mol$

$-336'59\,kcal/mol \cdot \frac{0'85\,mol}{1\,mol} = -287'27\,kcal$ askatuko dira.

$50ml\ C_2H_5OH \cdot \frac{0'7852\,g}{1\,ml\ C_2H_5OH} = 39'26\,g$ $\quad 39'26\,g \cdot \frac{1\,mol}{46\,g} = 0'85\,mol$

$q_1 = 400g \cdot 1\,cal/gK \cdot (100-20) = 32000\,cal = 32\,kcal$ beharko dira

$-287'27 + 32 = -255'27\,kcal$

lurruntzea → $\Delta H_{vap} = 10'086\,kcal/mol \cdot 22'22 = 224'13\,kcal$

$400g\ H_2O \frac{1\,mol}{18\,g} = 22'2\,mol$

→ $-31'14\,kcal$

$q_2 = 400g \cdot 0'44\,cal/gK\,(T_2 - T_1) = -31140\,cal$

$(T_2 - 373) = -176'93\,cal$

$T_2 =$