

TERMODINAMIKAREN ZERO PRINTZIPIOA

TENPERATURA

1.5

* OREKA TERMIKOA

- (SISTEMA, NORMA, INGURUNEA) TIURKOTEAREN KASU BEREZIA
ADIABATIKOA ISOLAMENDUA
DIATERMANOA

1.5

* TERMODINAMIKAREN ZERO PRINTZIPIOA

1.6

* TENPERATURA KONZEPtua

- ESPERIENTZIAN OINARRITURIKO METODOA : PROPIETATE KOMUNA
- MATEMATIKAN OINARRITURIKO METODOA : BALIO KOMUNA
 - LERRO ISOTERMANOAK
 - LERRO ISOTERMANO KORRESPONDENTEAK
 - TENPERATURA :

1.7

* SISTEMEN TENPERATURA

1.8

- TENPERATURA ESKALA

1.9

- TERMOMETROA

1.10

- SISTEMA-MOTA

1.11

- SISTEMA KONKRETUA

- ALDAGAI TERMOMETRIKOA

- FUNTzio TERMOMETRIKOA

- PROPORZIONALTASUN-KONSTANTEA : PUNTU FIKOA

- TENPERATURAREN NEURKETA

- TERMOMETRO-MOTAK

- TENPERATURA-ESKALAK

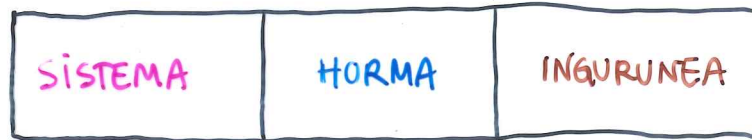
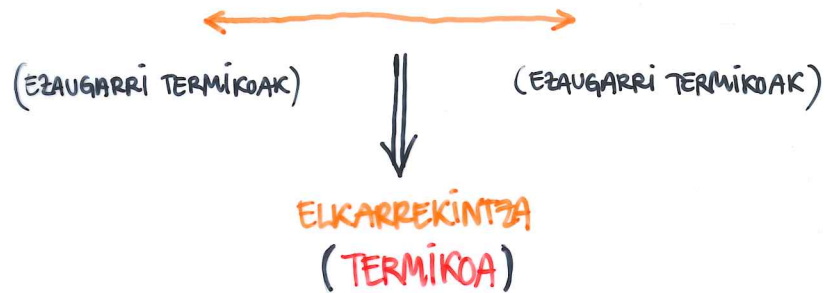
- GAS IDEALAREN TENPERATURA-ESKALA

- CELSIUS ESKALA

- KELVIN ESKALA

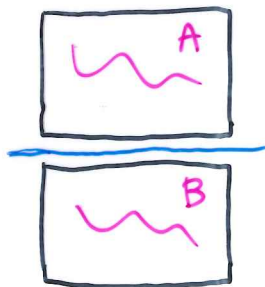
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OREKA TERMÍKOA



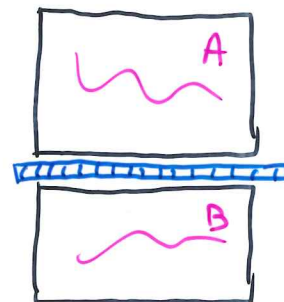
BAI

HORMA DIATERMANOA
ISOLAMENDU EZA TERMÍKOA



EZ

HORMA ADIABATÍKOA
ISOLAMENDUA TERMÍKOA



OREKA TERMÍKOA :

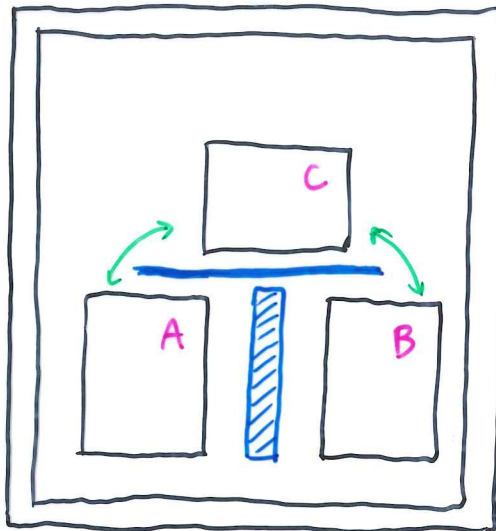
HORMA DIATERMÍKOAAREN BIDEZ 'LOTURÍKO' BI SISTEMEK LORTUKO DUTEN
EGOERA ALDAEZINA (HOTTS; OREKA-EGOERA)

- Aldagai termodinamikak
aipatu; $\{X, Y, Z, \dots\}$
ez dute biren balioak
aldatuko; edo, bai.

TERMODINAMIKAREN ZERO PRINTZIPIOA

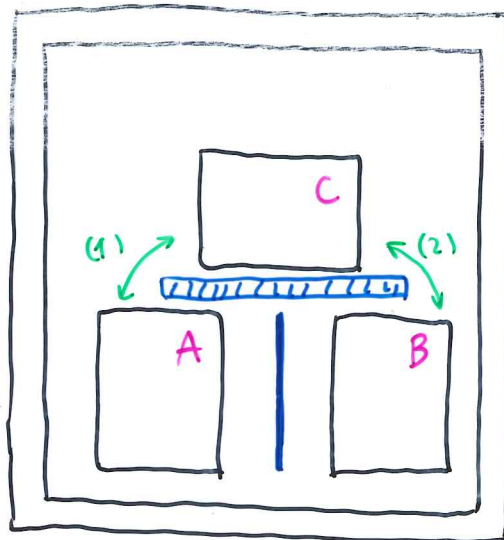
(7,8 orr.)

(a)



BIAK ALDIBEREAN

(b)

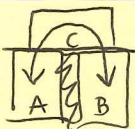


LEHENENGO BAT,
GERO BESTEA

TERMODINAMIKAREN ZERO PRINTZIPIOA :

ESKU ARTEAN DITUGUN A ETA B SISTEMAK, C SISTEMAREKIN OREKA TERMIKUAN BADAUDE (BAKUTZA BEHE ALDETIK), ELKARREN ARTERO OREKA TERMIKUAN DAUDE

(i)



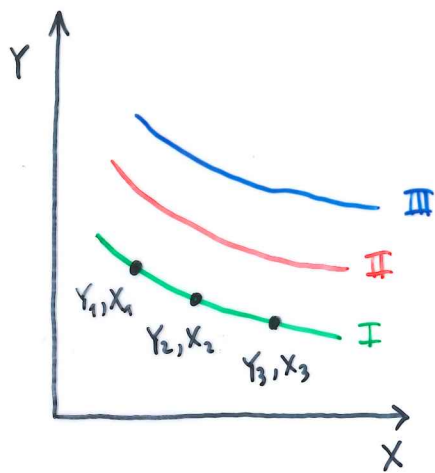
propietate
transitiboa

(ii)

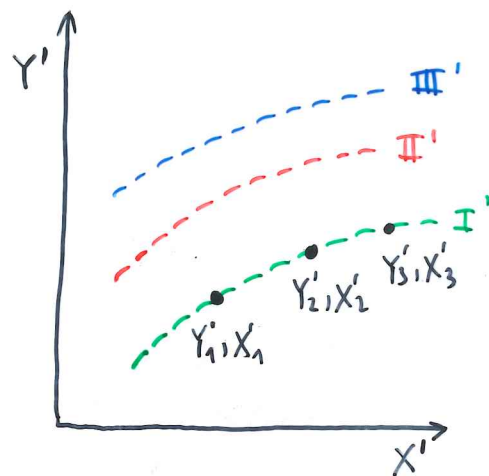


TENPERATURA

(a) ESPERIENTZIAN OINARRITUTAKO "METODOA" **TENPERATURA** DEFINITZEKO



A SISTEMA



B SISTEMA

"**LERRO**" ISOTERMANOA

LERRO ISOTERMANO KORRESPONDENTEAK

TENPERATURA: PROPIETATE KOMUNA

(b) MATEMATIKAN OINARRITUTAKO "METODOA" **TENPERATURA** DEFINITZEKO
 $\{A, B, C\}$ SISTEMAK

$\{A, C\}$ OREKA TERMIKOA

$$f_{AC}(X_A, Y_A; X_C, Y_C) = 0$$

$\{B, C\}$ OREKA TERMIKOA

$$f_{BC}(X_B, Y_B; X_C, Y_C) = 0$$

$$f_{AC}(X_A, Y_A; X_C, Y_C) = 0 \Rightarrow Y_C = g_{AC}(X_A, Y_A; X_C)$$

$$f_{BC}(X_B, Y_B; X_C, Y_C) = 0 \Rightarrow Y_C = g_{BC}(X_B, Y_B; X_C)$$

$$g_{AC}(X_A, Y_A; X_C) = g_{BC}(X_B, Y_B; X_C)$$

$\{A, B\}$ OREKA TERMIKOA

$$f_{AB}(X_A, Y_A; X_B, Y_B) = 0$$

$$g_{ABC}(X_A, Y_A; X_B, Y_B; X_C) = 0$$

X_C SOBERAN

$$h_A(X_A, Y_A) = h_B(X_B, Y_B)$$

$$h_A(X_A, Y_A) = h_B(X_B, Y_B) = h_C(X_C, Y_C)$$

$$\text{TENPERATURA : } t = h_A(X_A, Y_A) = h_B(X_B, Y_B) = h_C(X_C, Y_C)$$

OROKORTUZ ...

$$h_i = h_i(x_i, y_i, z_i, \dots)$$

$$i = A, B, C \dots$$

$$t = h_A(x_A, y_A, z_A, \dots) = \dots = h_i(x_i, y_i, z_i, \dots) = \dots$$

SISTEMAK

ALDAGAIAK

FUNTZIOAK

} DESBERDINAK

(SISTEMA-MOTA ERE DESBERDINA IZAN DAITE)

OREKA TERMIKOAN BADAUDE

"TEMPERATURA BEREAN DAUDE"

FUNTZIOAK BALIO BAKARRA DU (BALIO KOMUNA DU)

HAUXE DA LERRO ISOTERMANOAREN SORTARI BALIOA

ZEIN BALIO DA HORI? (ZEIN ZENBAKI DA HORI?)

BALIOAK FINKATEKO TEMPERATURA-ESKALA DEFINITU BEHAR DA

TEMPERATURA-ESKALA / TEMPERATURAREN NEURKETA

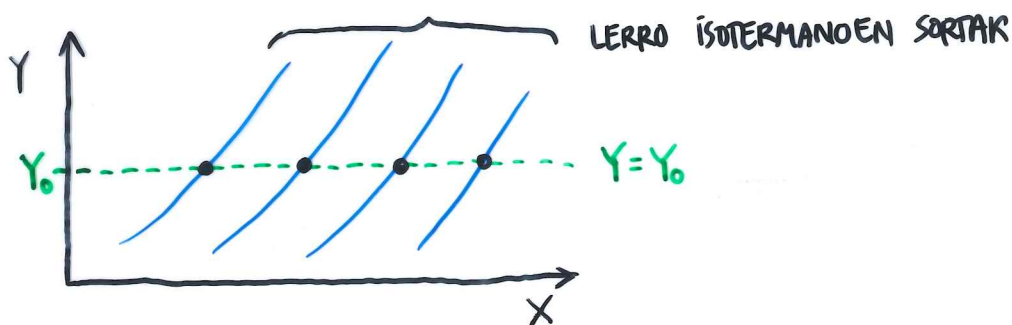
- BALIOA FINKATREKO PROZEDURA OROKORRA

- | | | |
|---------------------------|-----------|-------------------------|
| 1 - SISTEMA-MOTA | } FINKATU | } TERMOMETROA (PATROIA) |
| 2 - SISTEMA KONKRETUA | | |
| 3 - ALDAGAI TERMOMETRIKOA | | |
| 4 - FUNTZIO TERMOMETRIKOA | | |
| 5 - PUNTU FINKOAK | | |

1 - S SISTEMA-MOTA $S = S(X, Y, Z, \dots)$ $\{X, Y, Z, \dots\}$

2 - SISTEMA KONKRETUA $S(X, Y)$

3 -



X DA ALDAGAI TERMOMETRIKOA $\{X; Y_0\}$
(HAUKE DA TEMPERATURAREKIN BATERA ALDATUKO DENA)

4 - $\theta(X) = aX$ FUNTZIO TERMOMETRIKOA $a?$

5 - PUNTU FINKOAK ARBITRARIOKI FINKATU X_0 FINKATU $\theta_0 = \theta(X_0)$ } a FINKATU $a = \frac{\theta_0}{X_0}$

$$\theta = \left[\frac{\theta_0}{X_0} \right] X$$

1.8. COMPARACION DE TERMOMETROS

Aplicando los principios descritos en los apartados anteriores a los tres primeros termómetros relacionados en la Tabla 1.1 tenemos tres métodos diferentes de medir temperaturas. Así, para un gas a volumen constante,

$$\theta(P) = 273.16 \text{ K} \frac{P}{P_{PT}} \quad (V \text{ const.});$$

para una resistencia eléctrica,

$$\theta(R') = 273.16 \text{ K} \frac{R'}{R'_{PT}};$$

y para un termopar

$$\theta(\mathcal{E}) = 273.16 \text{ K} \frac{\mathcal{E}}{\mathcal{E}_{PT}}.$$

Imaginemos ahora una serie de pruebas en las cuales se mide simultáneamente la temperatura de un sistema dado con cada uno de los tres termómetros. El resultado de tal comparación se indica en la Tabla 1.2. Las iniciales PEN representan el *punto de ebullición normal*, que es la temperatura a la cual hierve un líquido a la presión atmosférica; las letras PFN representan el *punto de fusión normal*, las PSN el *punto de sublimación* y

Tabla 1.2. Comparación de termómetros

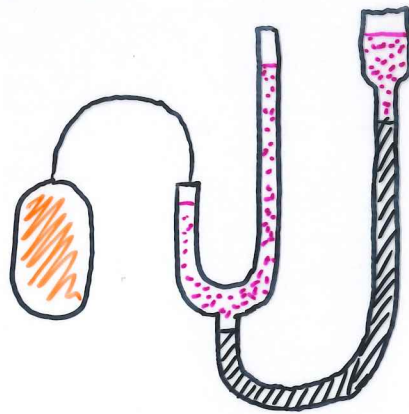
Punto fijo	Termopar, cobre-constantán		Termómetro de resistencia de platino		Termómetro de H_2 a volumen constante		Termómetro de H_2 a volumen constante	
	$\mathcal{E}$, mV	$\theta(\mathcal{E})$	R' , ohms	$\theta(R')$	P , kPa*	$\theta(P)$	P , kPa*	$\theta(P)$
N_2 (PEN)	0.73	32.0	1.96	54.5	184	73	29	79
O_2 (PEN)	0.95	41.5	2.50	69.5	216	86	33	90
CO_2 (PSN)	3.52	154	6.65	185	486	193	73	196
H_2O (PT)	$\mathcal{E}_{PT} = 6.26$	273	$R'_{PT} = 9.83$	273	$P_{PT} = 689$	273	$P_{PT} = 101$	273
H_2O (PEN)	10.05	440	13.65	380	942	374	139	374
Sn (PFN)	17.50	762	18.56	516	1287	510	187	505

* 1 Pa = 1 N/m², 1 atm = 101.3 kPa.

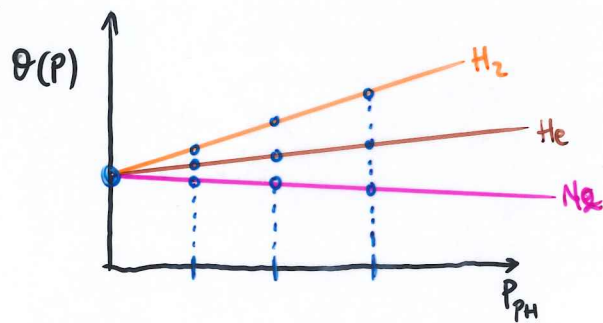
$$\theta(X) = \left(\frac{273.16}{X_{PT}} \right) \cdot X \text{ K}$$

GAS IDEALAREN TEMPERATURA-ESKALA

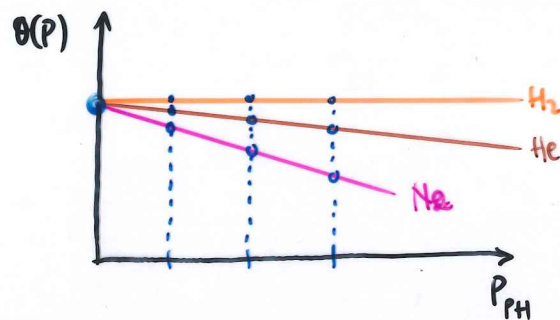
(a) TRESNA



(b) PROZEDURA



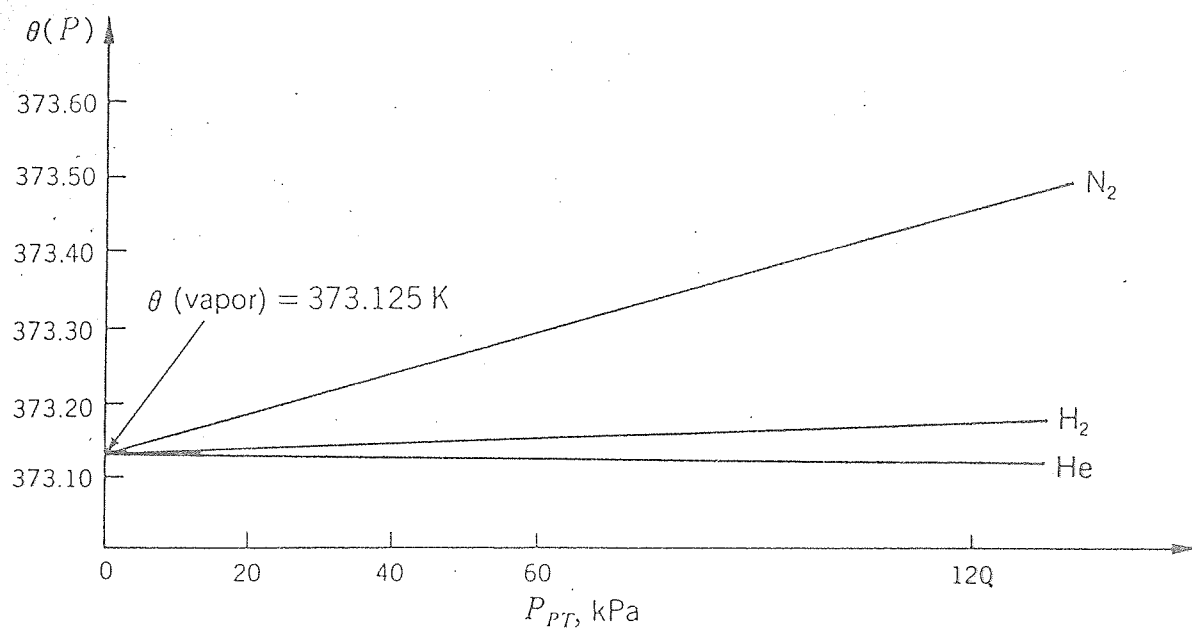
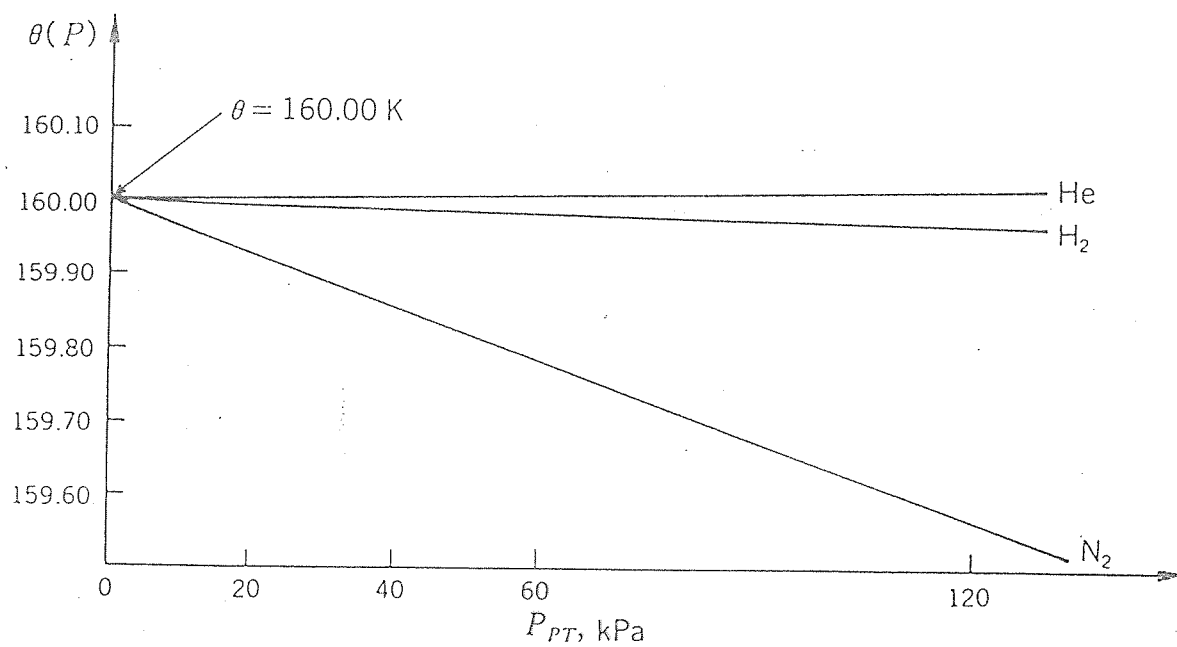
1 EGOKERA TERMIKOA



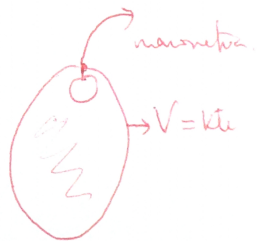
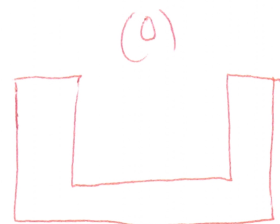
2 EGOKERA TERMIKOA

$$\theta = 273.16 \lim_{P_{PH} \rightarrow 0} \left(\frac{P}{P_{PH}} \right) \quad V = K_{te}$$

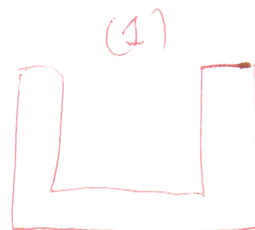
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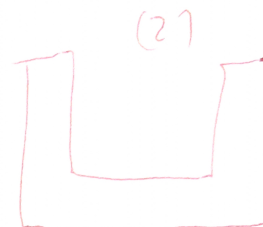
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Referenčni stanje
273.16 K (nična točka!)



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m_1	$(m_1, V,$	$\left[\begin{smallmatrix} (0) \\ \end{smallmatrix} \right] \Rightarrow P_{ph}^1$	$(m_1, V, \left[\begin{smallmatrix} (1) \\ \end{smallmatrix} \right] \Rightarrow P^1$	$\Theta(1) = \frac{273.16}{P_{ph}^1} \cdot P^1$
✓	#	#		
m_2	$(m_2, V,$	$\left[\begin{smallmatrix} (0) \\ \end{smallmatrix} \right] \Rightarrow P_{ph}^2$	$(m_2, V, \left[\begin{smallmatrix} (1) \\ \end{smallmatrix} \right] \Rightarrow P^2$	$\Theta(2) = \frac{273.16}{P_{ph}^2} \cdot P^2$
✓	#	#		
m_3	$(m_3, V,$	$\left[\begin{smallmatrix} (0) \\ \end{smallmatrix} \right] \Rightarrow P_{ph}^3$		
⋮				
$m_n \approx 0$	$(m_n, V,$	$\left[\begin{smallmatrix} (0) \\ \end{smallmatrix} \right] \Rightarrow P_{ph}^n$		

