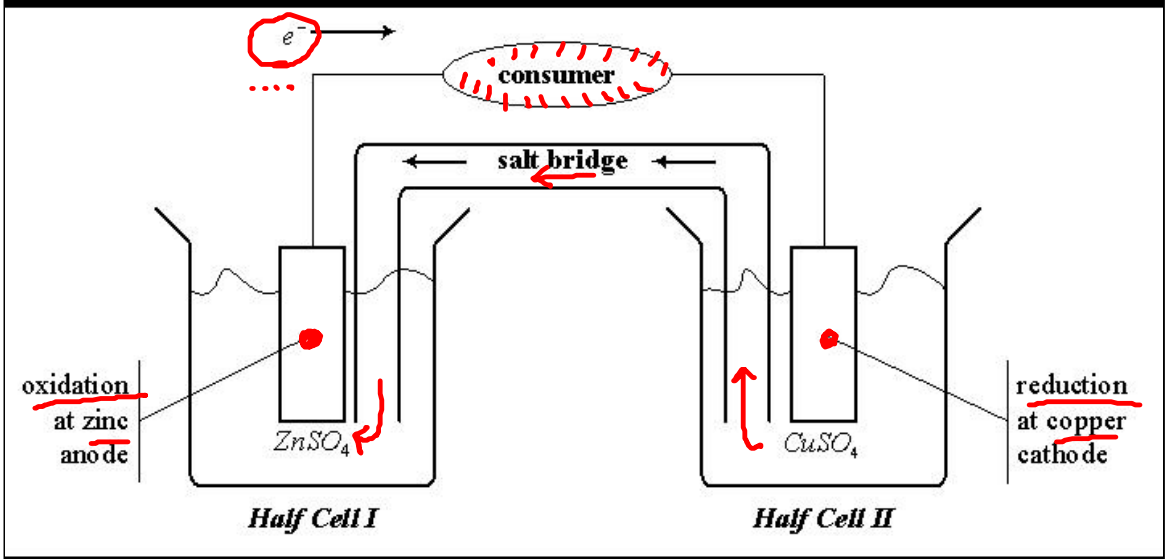
Batterien

- 1990 Nickel metal hydride (NiMH)
- 1991 Lithium ion
- 1992 ladbare alkalinische
- 1999 Lithium ion polymer
- ⋮ Blei

Die Elektrochemische Zelle



Handbatterie

Alu Kupfer

Elektrochemische Reihe

(gewinnen Elektronen)

- Gold
- Quecksilber
- Silber
- Kupfer
- Blei
- Nickel
- Cadmium

- Eisen
- Zink
- Aluminium
- Magnesium
- Natrium
- Potasium
- ***Lithium***

(verlieren Elektronen)

- Nickel cadmium
- Nickel metal hydride
- Alkaline
- Lithium ion
- Lithium ion polymer
- Lead acid

Reaktionen in einer NiMH Batterie:

1. $NiOOH + H_2O + e^- \Rightarrow Ni(OH)_2 + OH^-$

2. $MH + OH^- \Rightarrow M + H_2O + e^-$

$MH + NiOOH \Rightarrow M + Ni(OH)_2$

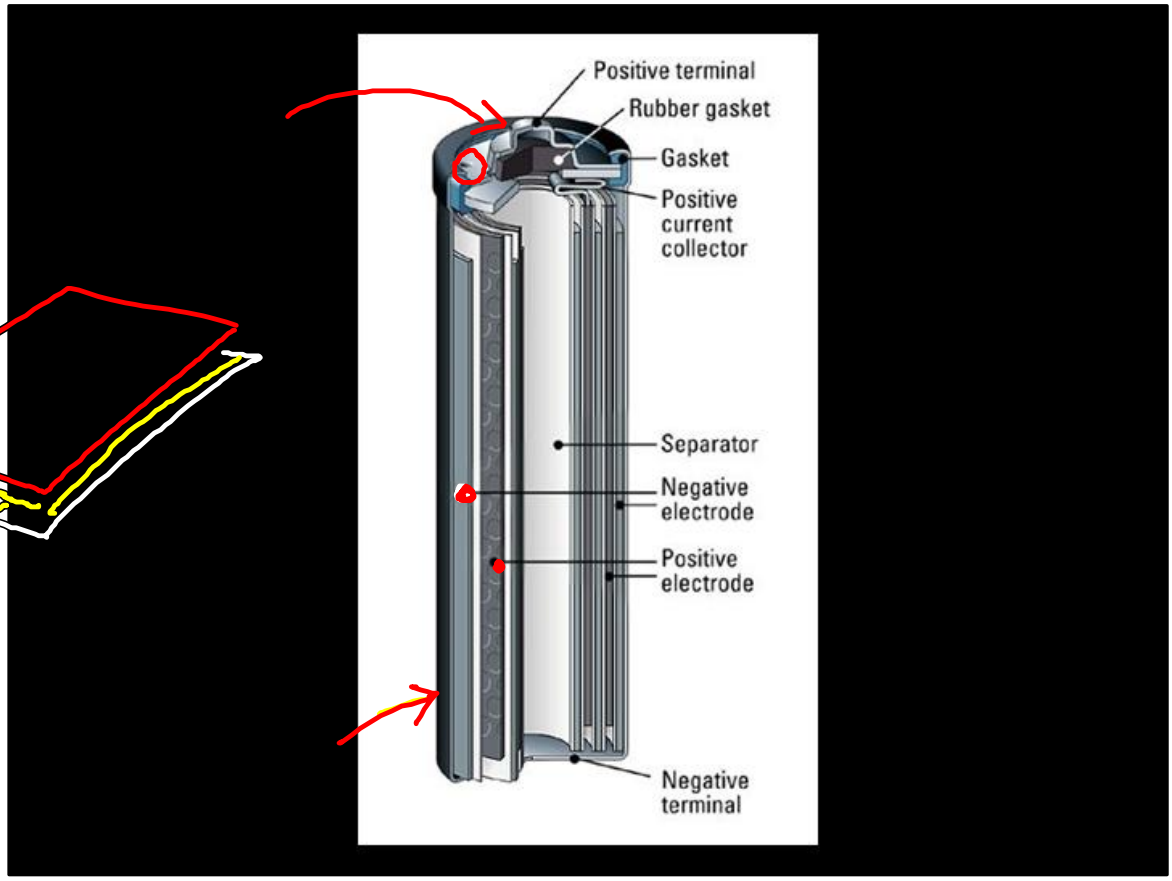
(Insgesamt E = 1.35 V)

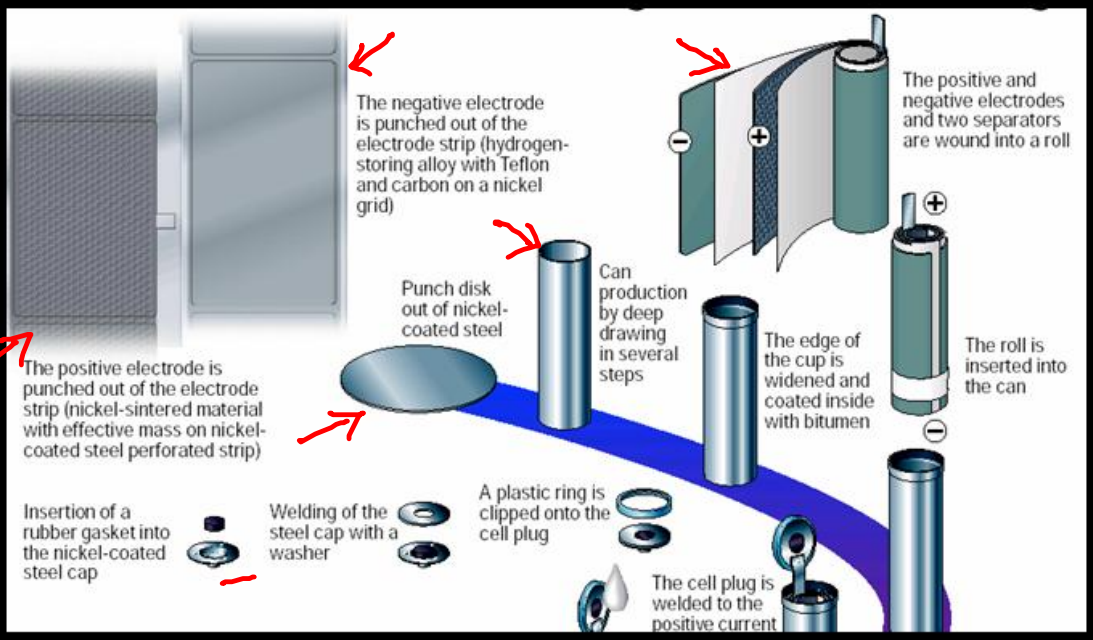
$8 \times 1{,}3 \approx 10$ V

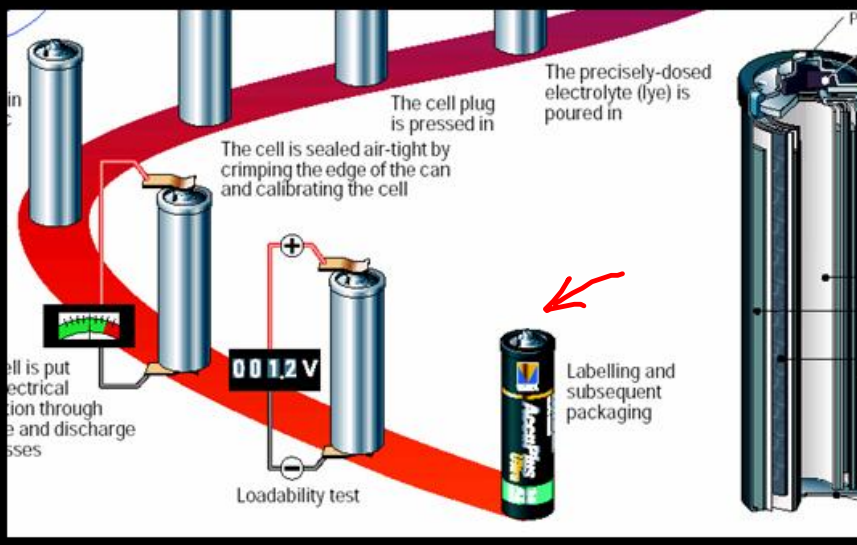
6V

– Flüssigkeit Elektrolyt

- Kontakt fläche
- Ladevorgang (Memory Effekt)







nominale C < reales C

Battery Capacity

Type	Capacity (mAh)	Density (Wh/kg)
Alkaline AA	2850	124
Rechargeable	1600	80
NiCd AA	750	41
NiMH AA	1100	51
Lithium ion	1200	100

→ Lead acid	2000	30	
ion polymer		<100	2003
			10%

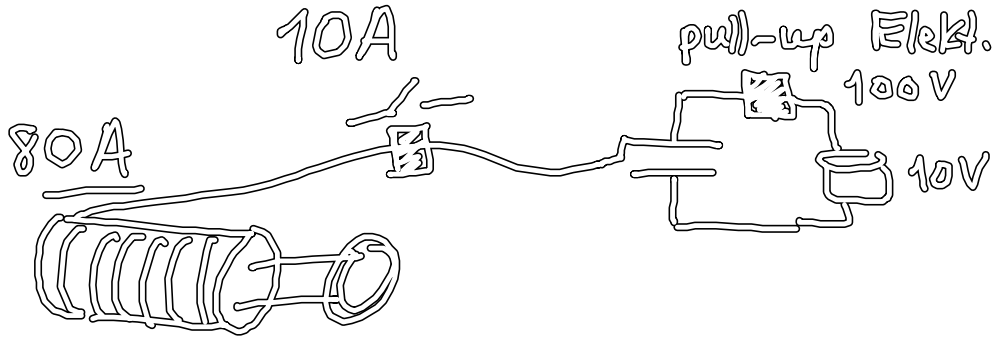
16 mAh
(halbes Aspirintablett)

→ Discharge Rates

Type	Voltage	Peak Drain	Optimal Drain
Alkaline	1.5	0.5C	< 0.2C
NiCd	1.25	20C	1C
Nickel metal	1.25	5C	< 0.5C
Lead acid	2	5C	0.2C
Lithium ion	3.6	2C	< 1C

$C = \frac{1000}{1\,MAh} = 1Ah$

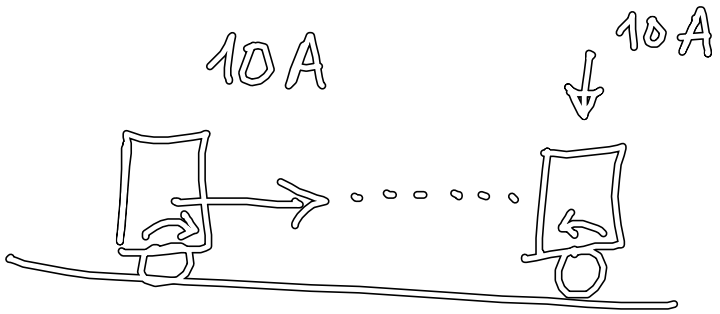
$\frac{1}{2}A$ ..... $< \frac{1}{5}A$

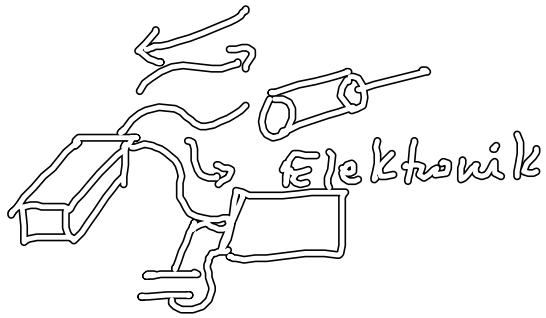


$C = 2000\,mAh$ $\underline{80A}$

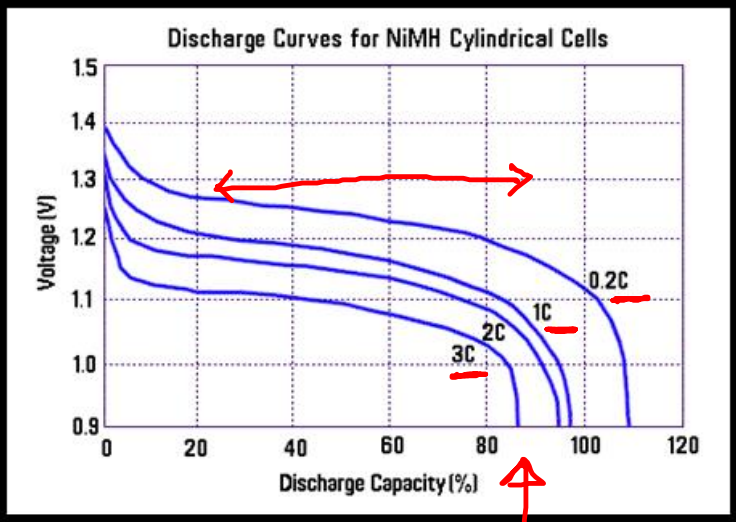
Spitzen = SC = $\boxed{10A}$

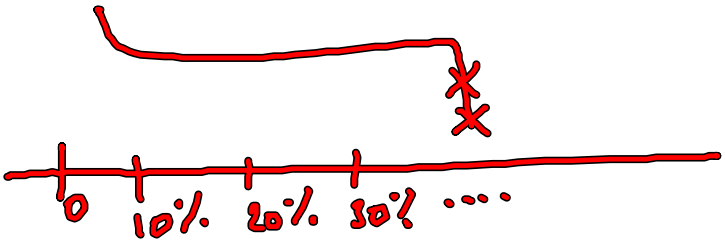
$\underline{1A}$ $\underline{100\,mA}$

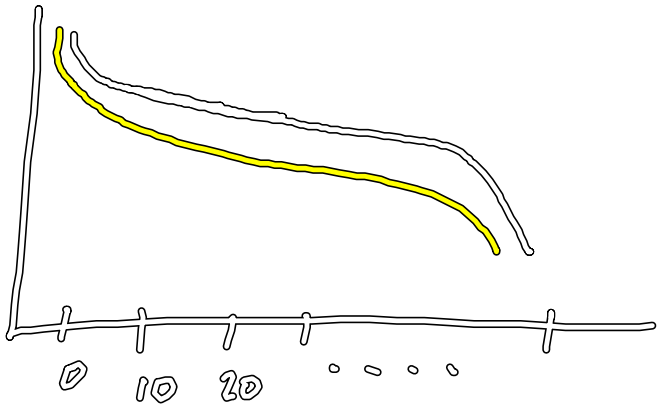




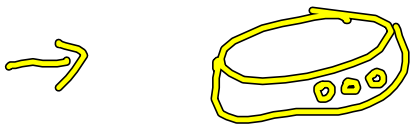
1,25





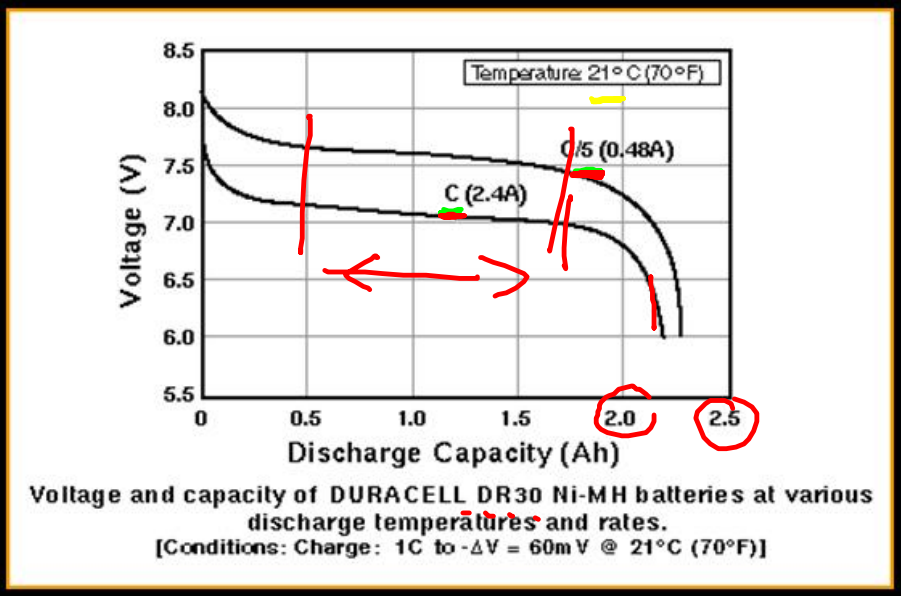


→ smart batteries



Ah

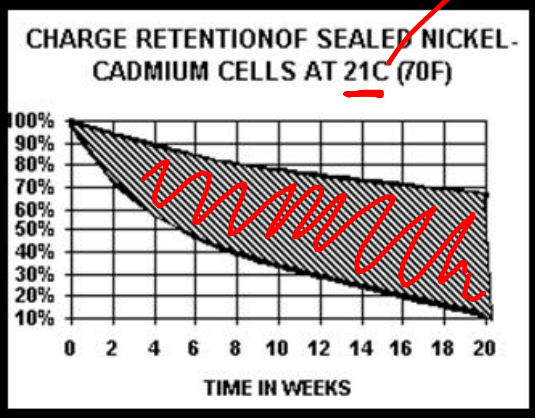
V

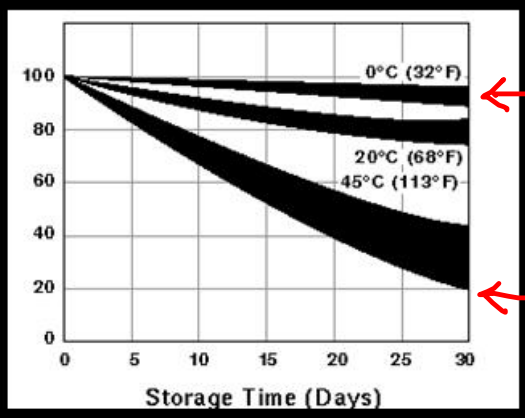


Voltage and capacity of DURACELL DR30 Ni-MH batteries at various discharge temperatures and rates.
[Conditions: Charge: 1C to -ΔV = 60mV @ 21°C (70°F)]

NiCd v NiMH Self-Discharge

Celsius



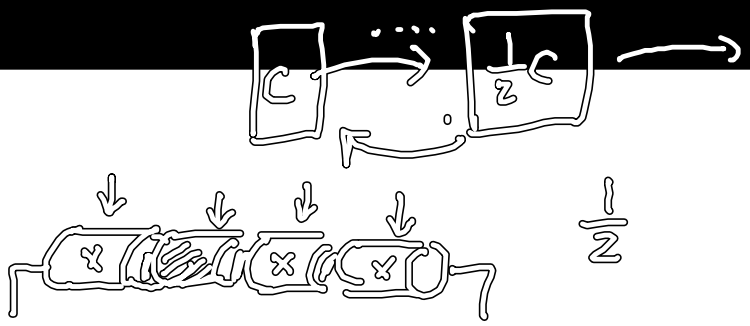


NiCd

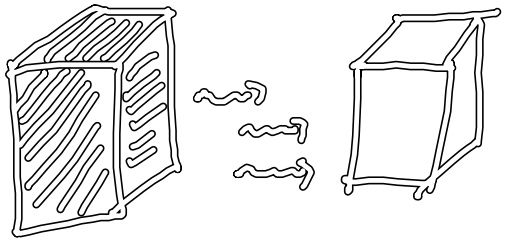
Ni MH

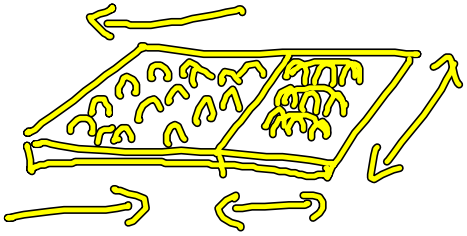
NiMH Ladevorgang

- Less prone to memory than NiCd
- Shallow discharge better than deep
  - Degrades after 200-300 deep cycles
  - Need regular full discharge to avoid crystals
- Self discharge 1.5-2.0 more than NiCd
- Longer charge time than for NiCd
  - To avoid overheating

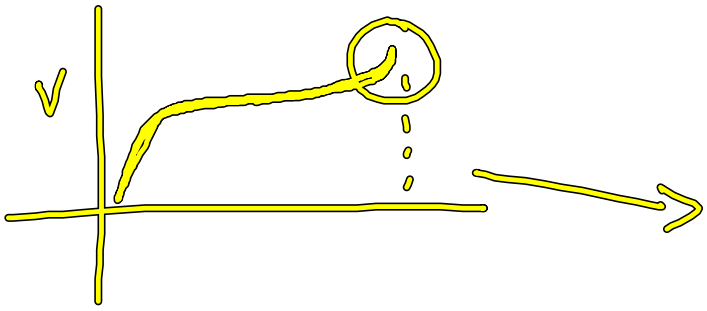


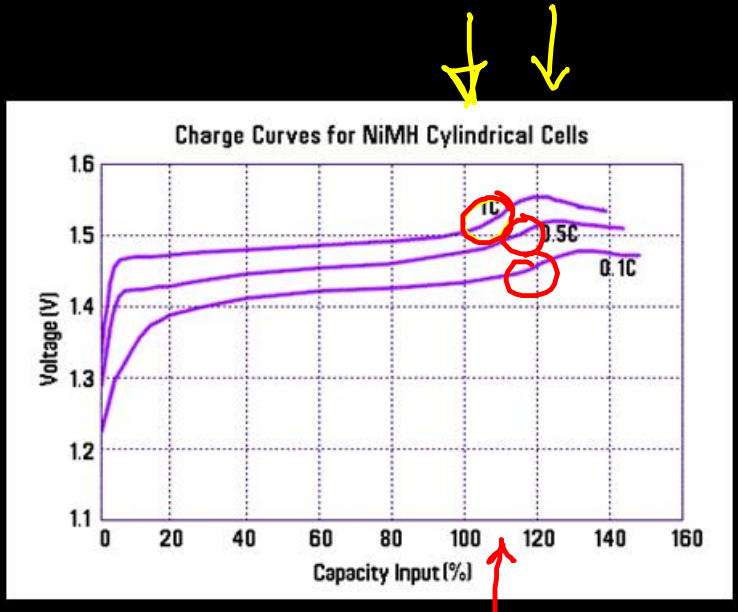
Memory Effekt





{ Entladung → Ladung

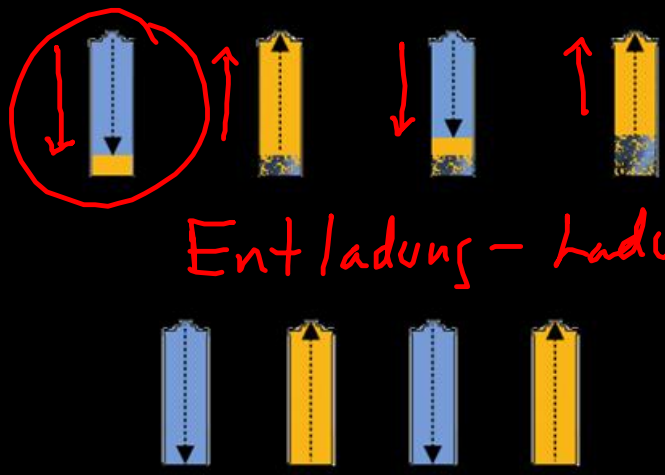




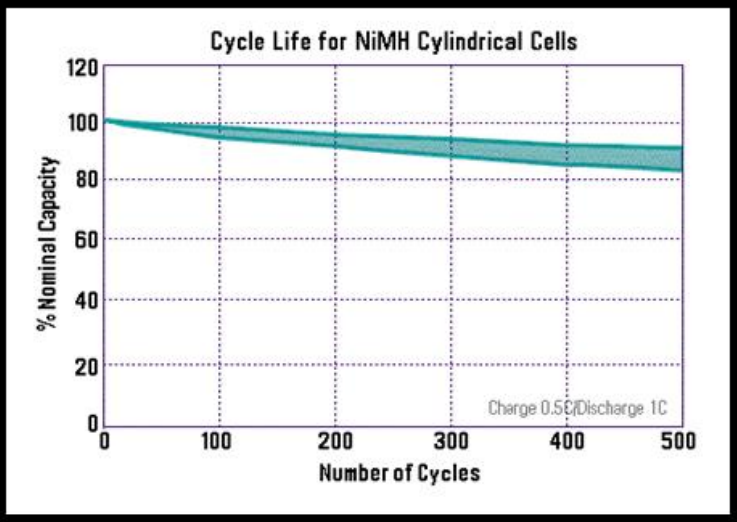
1C

0,05C

Memory Effekt



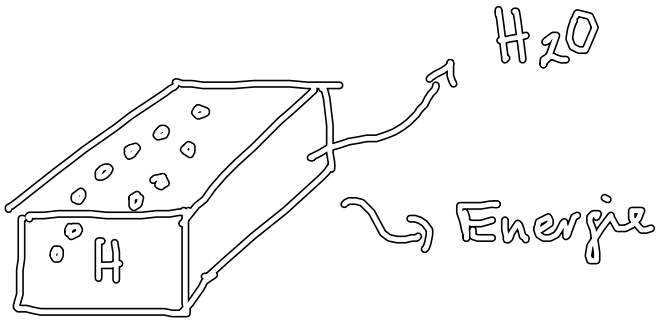
Entladung – Ladung

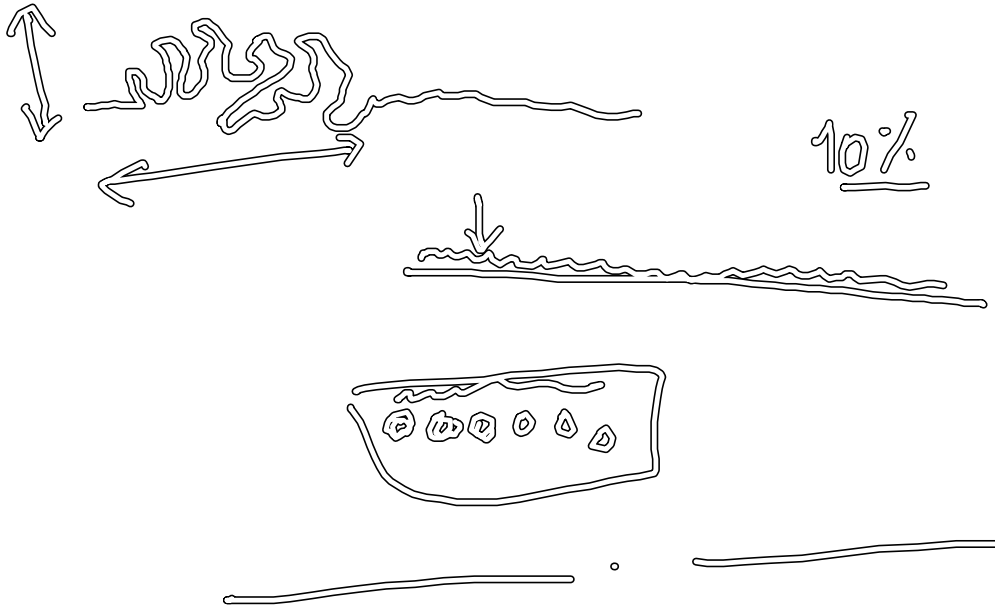


} 20%

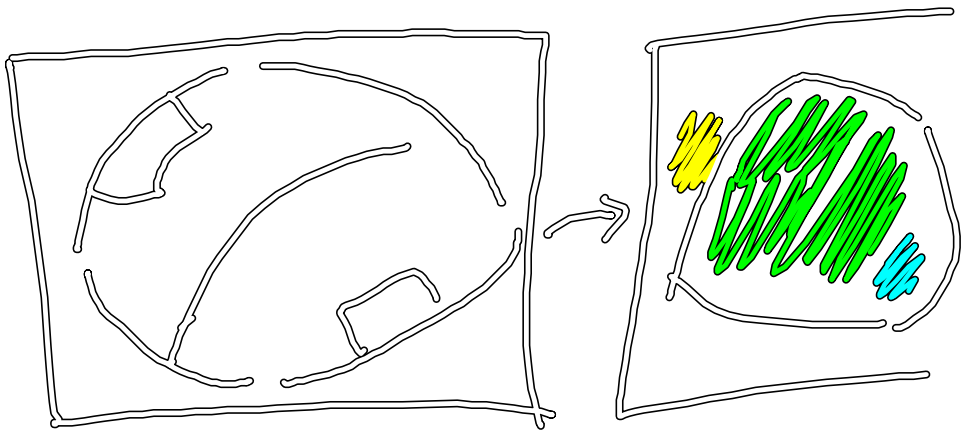
Praxis ⟷ Theorie

* Brennstoffzellen

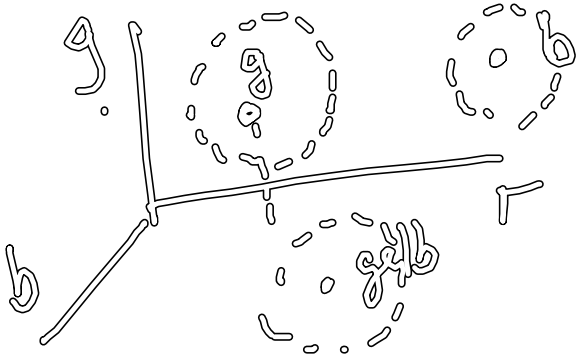




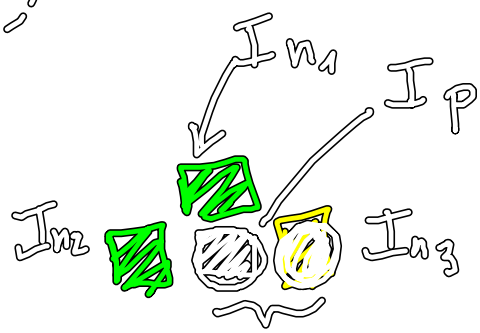
Übungsaufgabe:



→ weissen Linien extrahieren
- grün, gelb und blau segmentieren
- andere Farben → schwarz



Intensität



$I = r + g + b$

$I > 0$

b_{00}

255
255
255
≈ 785