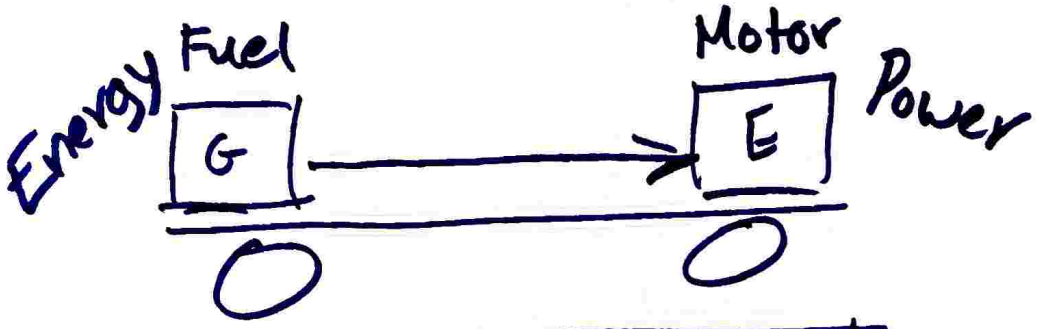
EECS 16A
Module 2, Lecture 3

- Energy & Power
- 2D Resistive Touchscreen



$$P = \frac{\Delta E}{\Delta t} = \frac{dE}{dt}$$

$$E = P \cdot \Delta t = \int_0^{\Delta t} P(t)\,dt$$

Power P $[W]$

Energy E $[J] = [W \cdot s]$

Light Bulb Ex.

PG&E: $0.19/kWh

10 W, 1 hr = 10 W·h

E = 10 W · 1 hr

= 10 W · 3600 s

= 36,000 W·s

= 36,000 J

= 36 kJ

E = 10 w · 10 h = 100 Wh

Battery : Stores energy

"Energy" →

$$24000\,[mAh] = C_{bat}$$

"AA" battery $V = 1.5V$

Energy = $V \cdot C_{bat}$

$= 1.5V \times 2000\ mAh$

$= 3KV \cdot mAh$

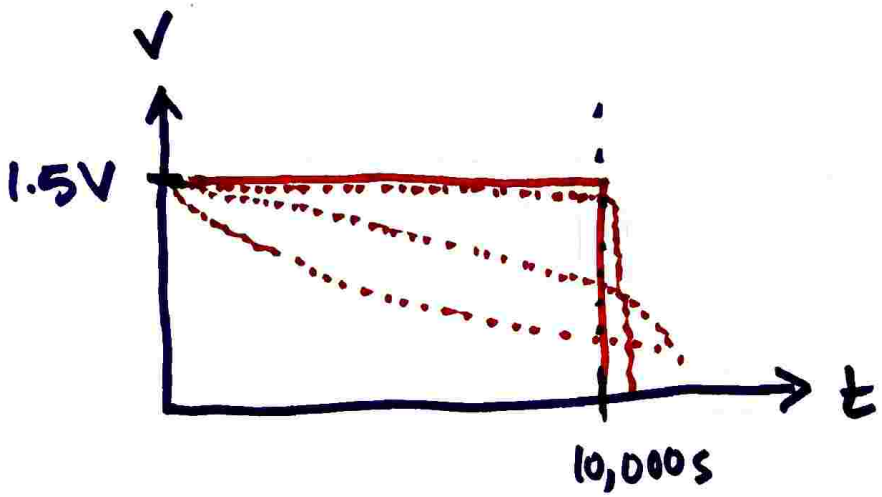
$= 3\ VAh$

$= 3\ Wh$

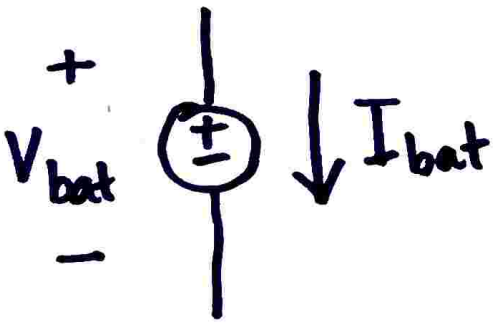
Battery (cont')

$3\ Wh = 3 \cdot 3600\ W \cdot s$

$= 10{,}000\ Ws$



1 Ah
@ 250 mA ⇒ 4hr
@ 2A ⇒ 30 min



P.S.C.

E, P ⟶ V, I

Define:

$$V_{ab} = \frac{dE_{ab}}{dQ} = [V]$$

↑ charge

Charge $Q \equiv$ electrons $[C]$

Current: $I = \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$ $[A]$

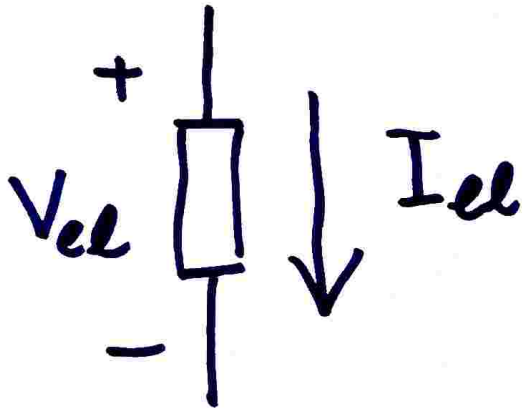
$$1\,A = \frac{1\,C}{1\,s}$$

$$1C = 6.2 \times 10^{18} \text{ electrons}$$

$\sim 10^9$ people

$$P = \frac{dE}{dt} = \underbrace{\frac{dE}{dq}}_{V} \cdot \underbrace{\frac{dQ}{dt}}_{I} = V \cdot I$$

Passive Sign Convention (P.S.C.)



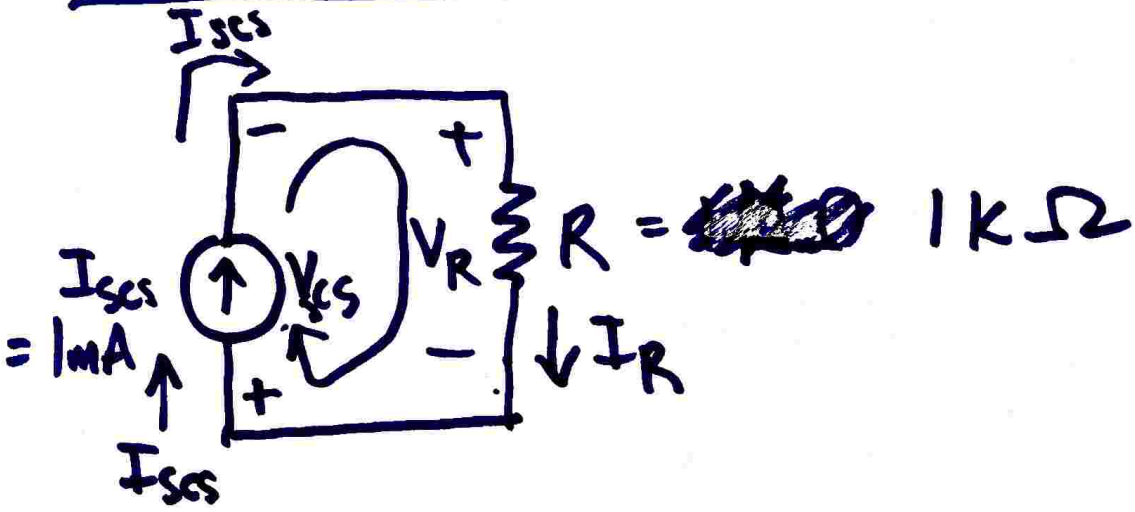
e.g. (resistor)

$P_{dissipation} = V_{ee} \cdot I_{ee}$

↑

$P_{delivered}$

Power Example 1



$$I_R = I_{CS}$$

$$V_R = I_R R$$

$$= (1mA)(1k\Omega)$$

$$= 1V$$

Resistor

Power:

$$P_R = I_R \cdot V_R$$

$$= (1mA)(1V)$$

$$= 1mW \Rightarrow \text{dissipated!}$$

Apply KVL:

$$V_{SCS} + V_R = 0$$

$$V_{SCS} = -V_R = -1\,V$$

Current Source

$$P_{SCS} = I_{SCC} \cdot V_{SCS}$$

$$= (1mA) \cdot (-1V)$$

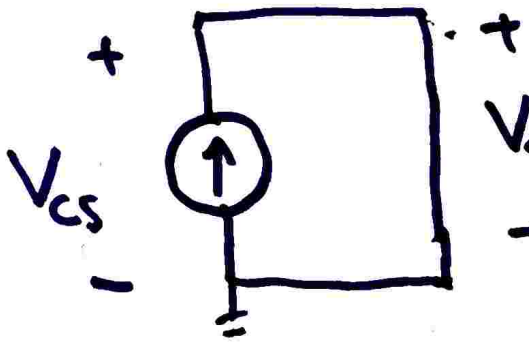
$$= -1\,mW \Rightarrow \text{delivered!}$$

Energy is conserved, so:

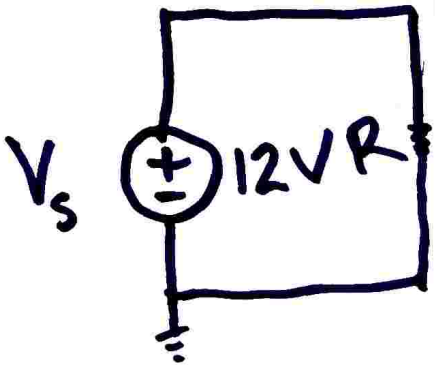
$$P_R + P_{SCS} = 0$$

$$1mW + (-1mW) = 0 \checkmark$$

Short Circuit



$$P_{CS} = V_{CS} \cdot I_{CS} = 0 \cdot I_{SC} = 0$$

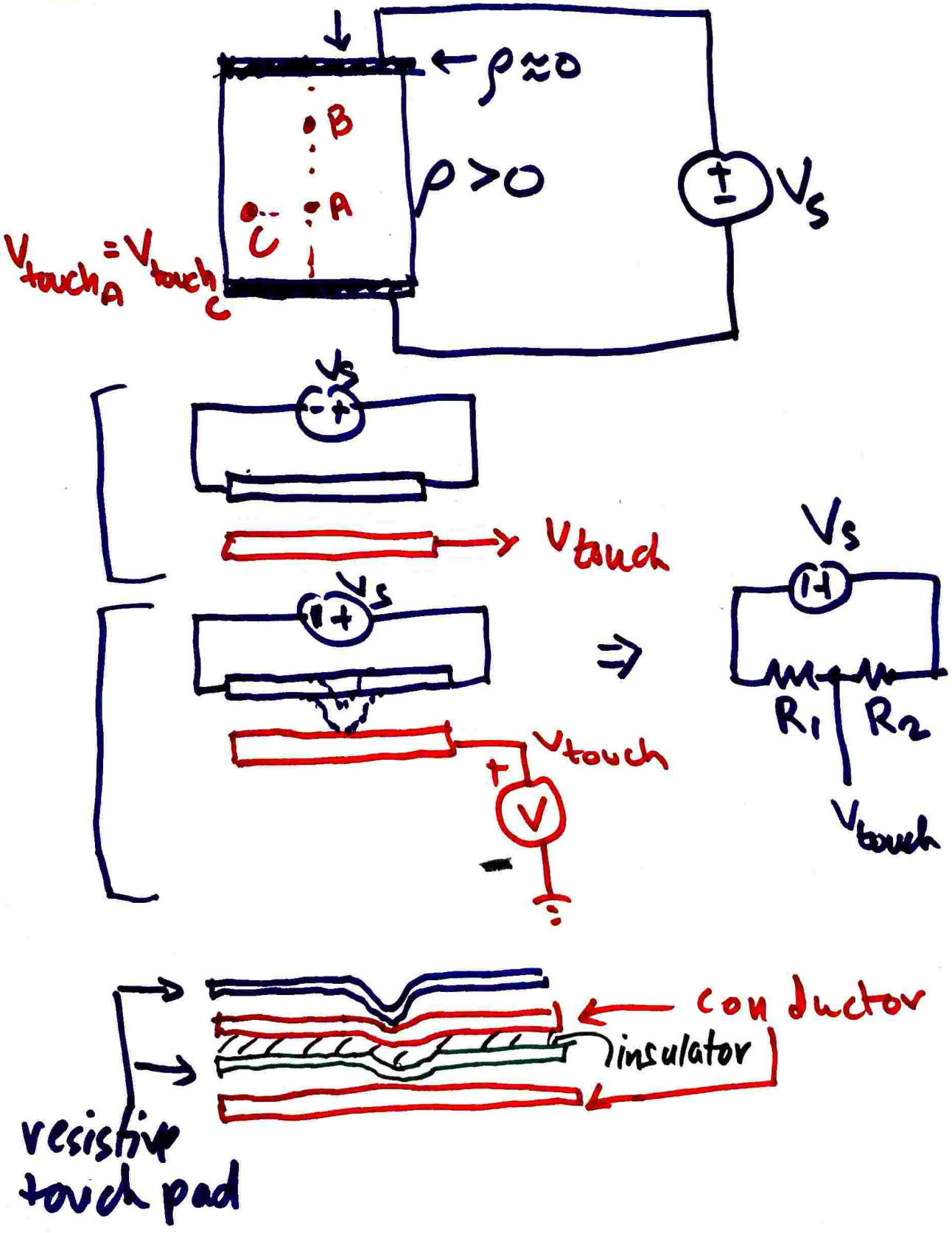


$$V = IR$$

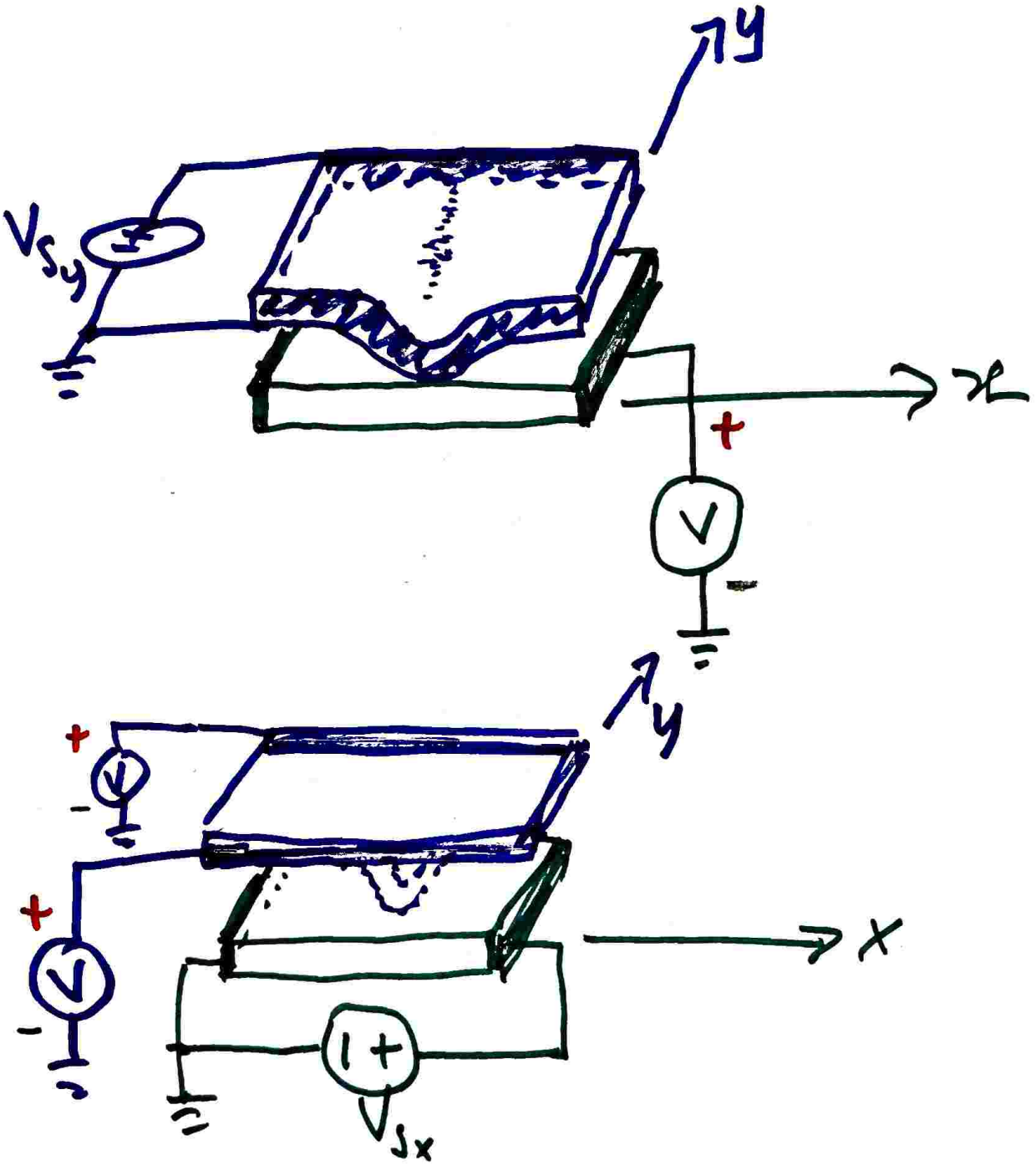
$$I = \frac{V_S}{R} = \frac{12V}{1\ \mu\Omega} = 12{,}000{,}000\ A$$

12 MA

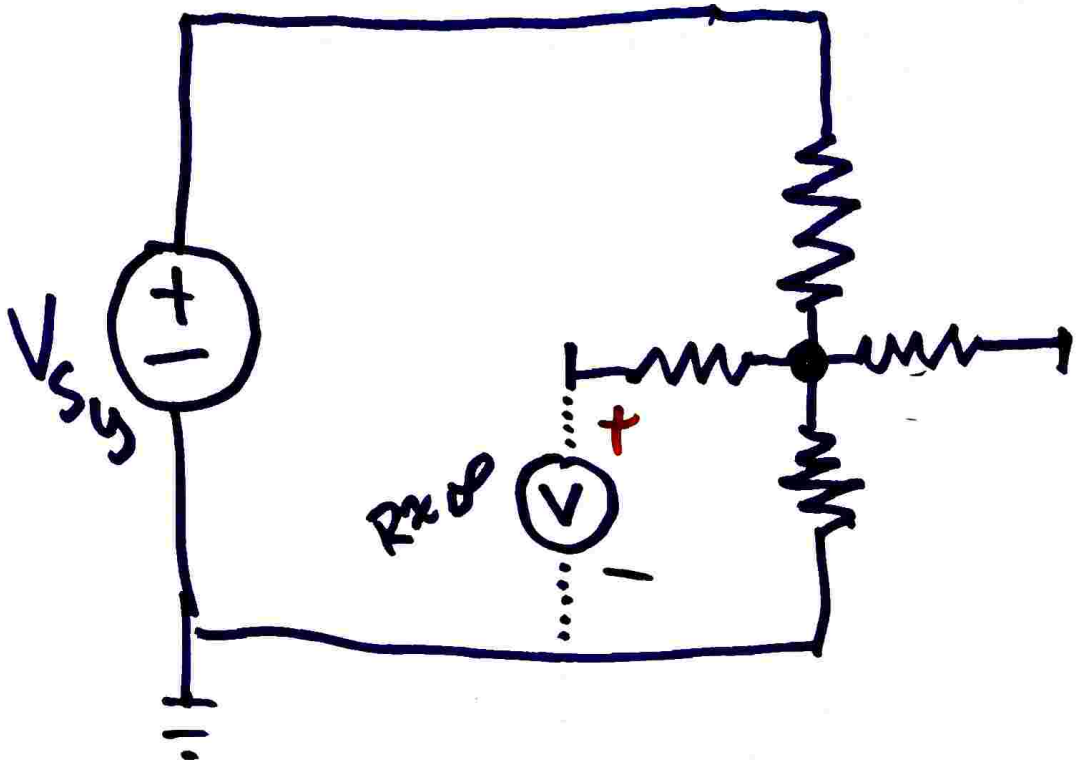
1D Touchscreen → 2D Touchscreen



2.3.10



2.3.11



2.3.12