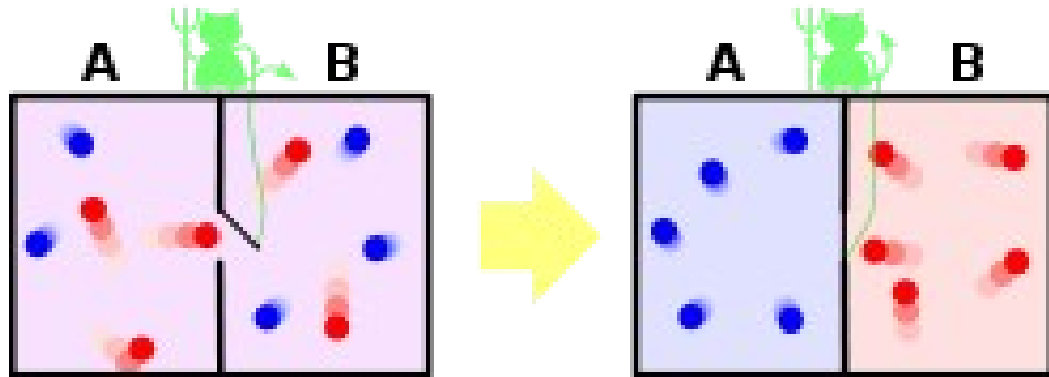# Information entropy and physical entropy

„ in an isolated system, entropy never decreases." Second Law of Thermodynamics

The Maxwell demon

Temperature of A decreses, B increases → Violation of the Second Law ?

Information entropy and physical entropy

„ in an isolated system, entropy never decreases." Second Law of Thermodynamics

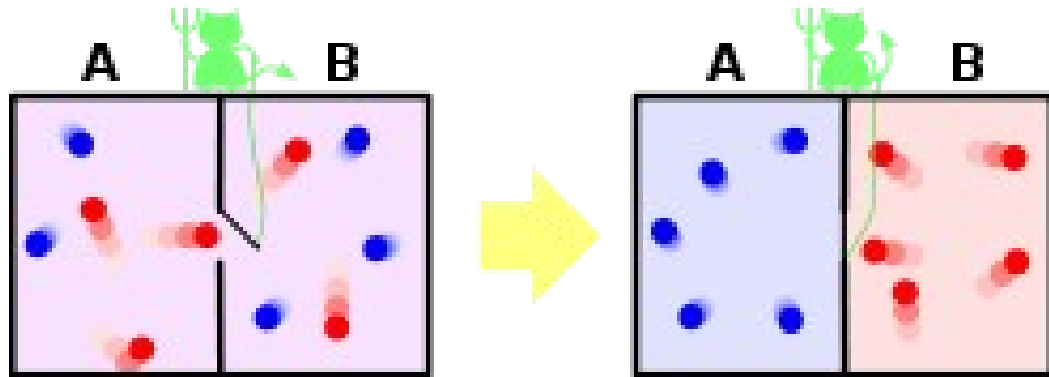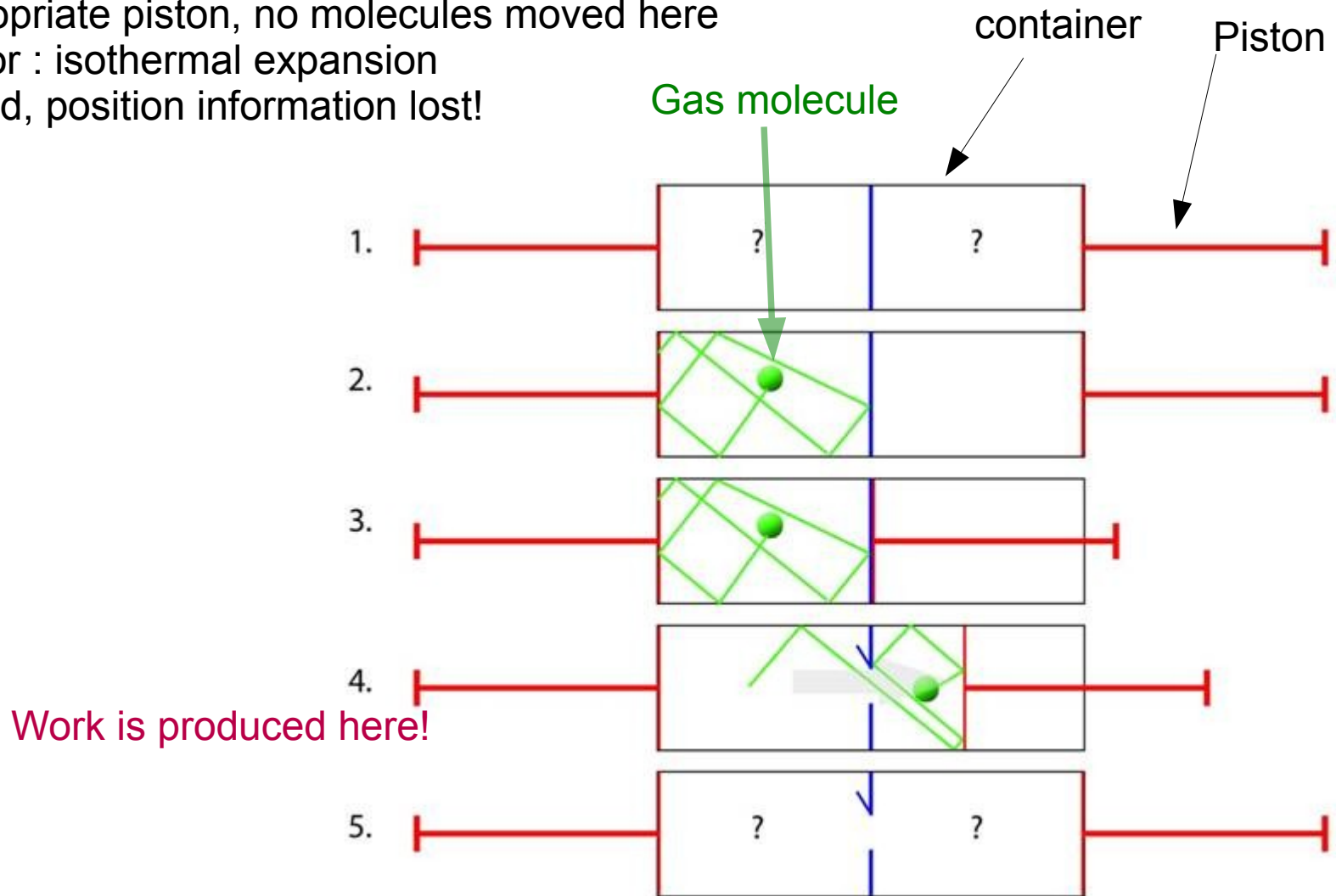The Maxwell demon

Temperature of A decreses, B increases → Violation of Law II. ?

Solution: NO, since the demon interacts with the system, it must be considered. The demon acquires *information*, and this changes it's state!

Information entropy and physical entropy

1. : molecule's position unknown
2. : measure position, information = 1 bit
3. : move appropriate piston, no molecules moved here
4. : release door : isothermal expansion
5. : door opened, position information lost!

Gas molecule

container

Piston

1.

2.

3.

4.

Work is produced here!

5.

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Isothermal expansion:

$$W_{A \to B} = NkT \ln\left(\frac{V_A}{V_B}\right)$$

In this case:
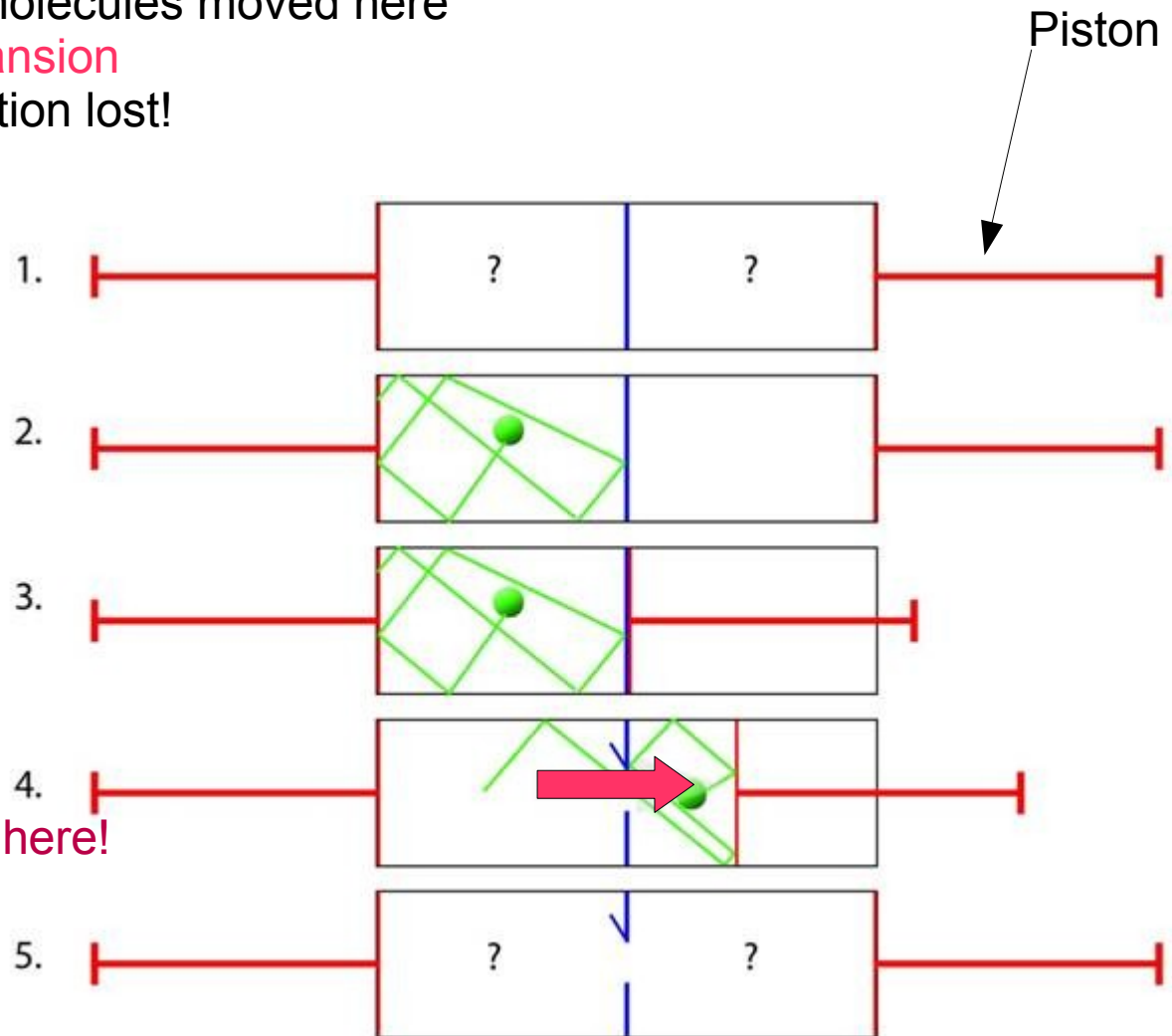N=1
$V_A/V_B = 2$

Hence

W = kT ln(2)   Work is produced here!

Piston

1.

2.

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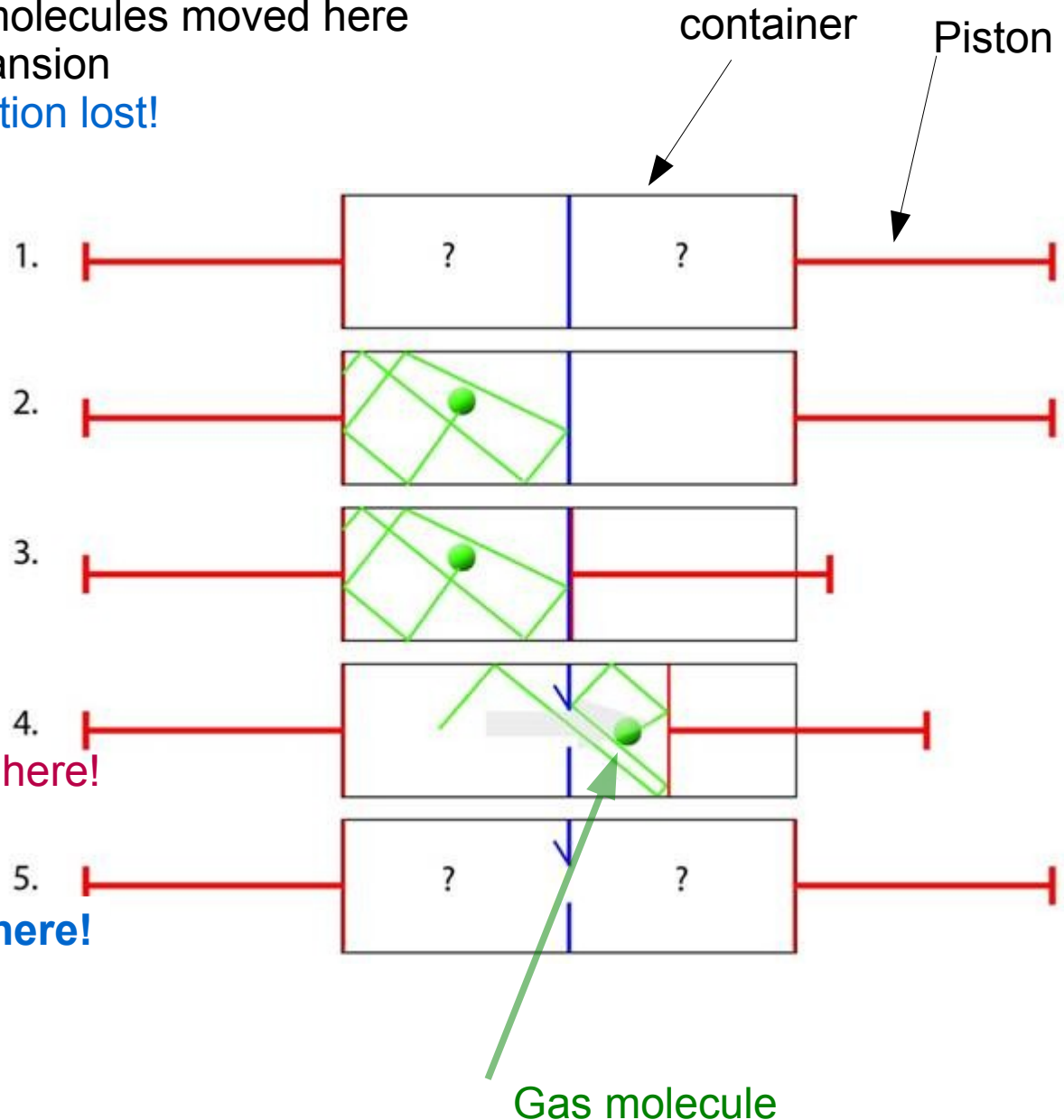$$W_{A \to B} = NkT \ln\left(\frac{V_A}{V_B}\right)$$

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Hence

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Information is lost here!

container   Piston

1.

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Gas molecule

Information entropy and physical entropy

Leo Szilárd:

From Law II. taking into account that $W = T\Delta S$

$$W_{\text{produced by piston}} = W_{\text{loss of information}}$$

$$T\Delta S_{\text{inf}} = kT \ln 2$$

$$\Delta S_{\text{1bit}} = k \ln 2$$

Ereasing 1 bit of information increases physical entropy by *k·ln2*

(Landauer 1971, logically irreversible processes, eg. AND-gate)