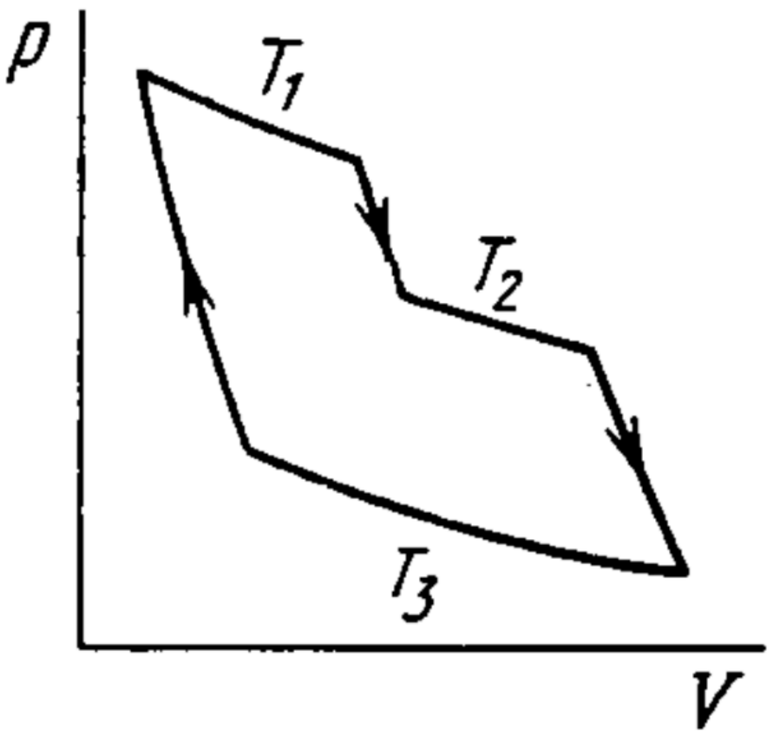
Exercise - 3

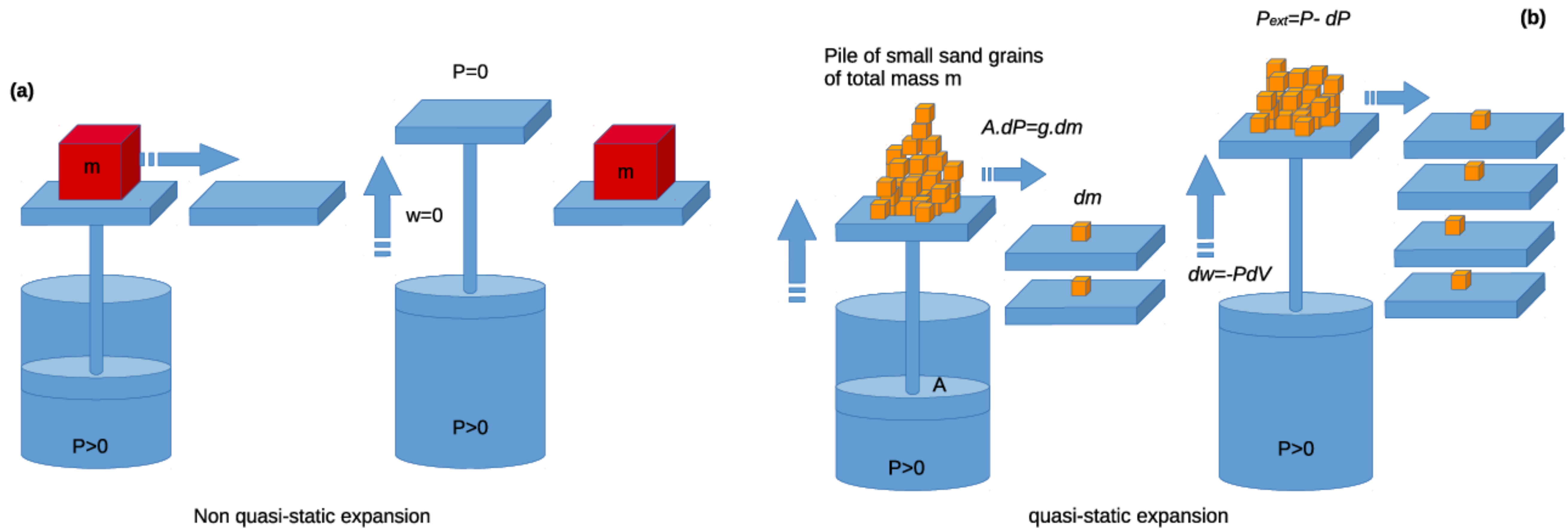


An ideal gas goes through a cycle consisting of alternate isothermal and adiabatic curves. The isothermal processes proceed at the temperatures T_1, T_2, and T_3. Show that the efficiency of such a cycle can be written as

$$1 - \frac{2T_3}{T1 + T2}$$

if in each isothermal expansion the gas volume increases in the same proportion.

Reversible and irreversible processes

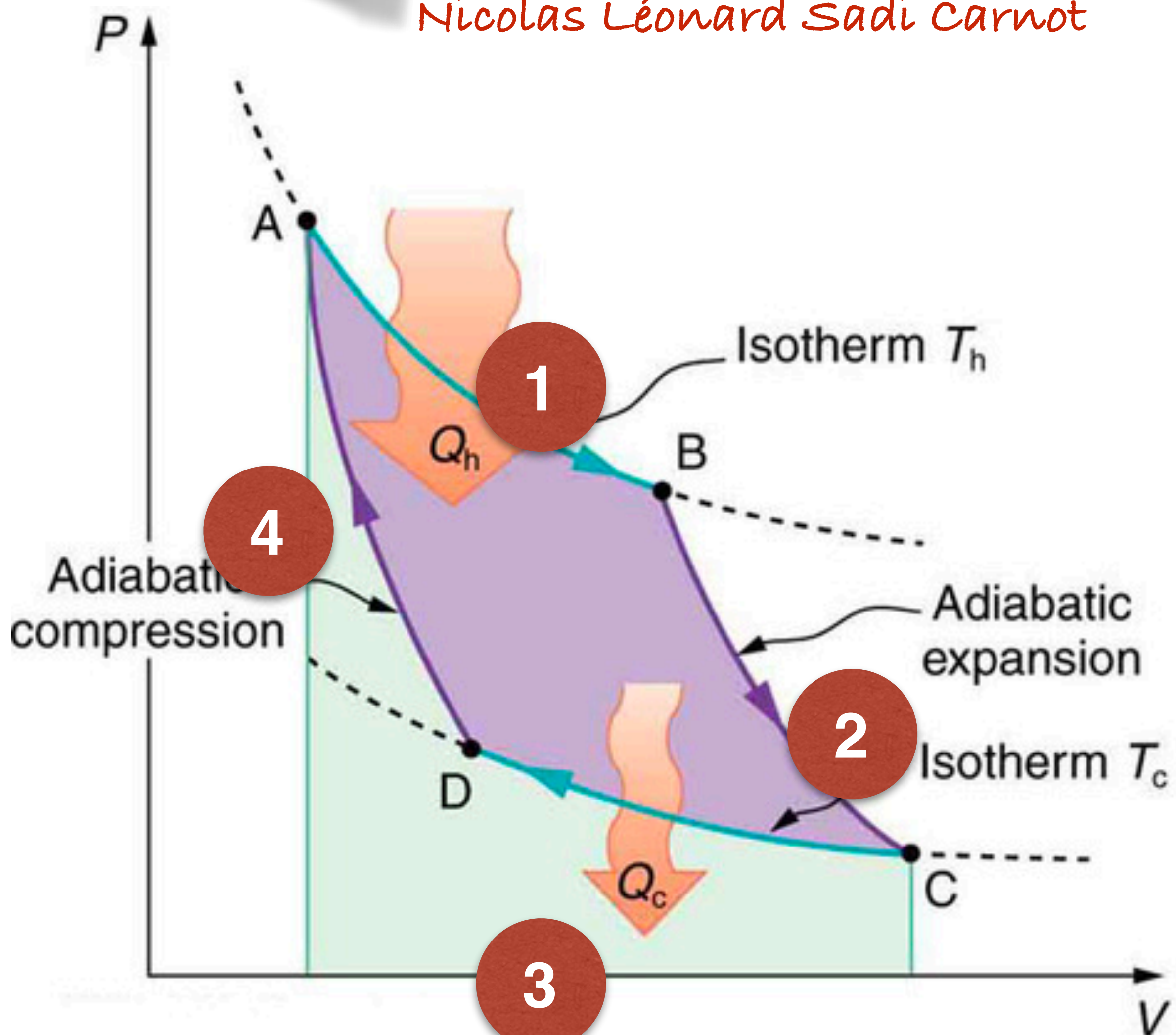


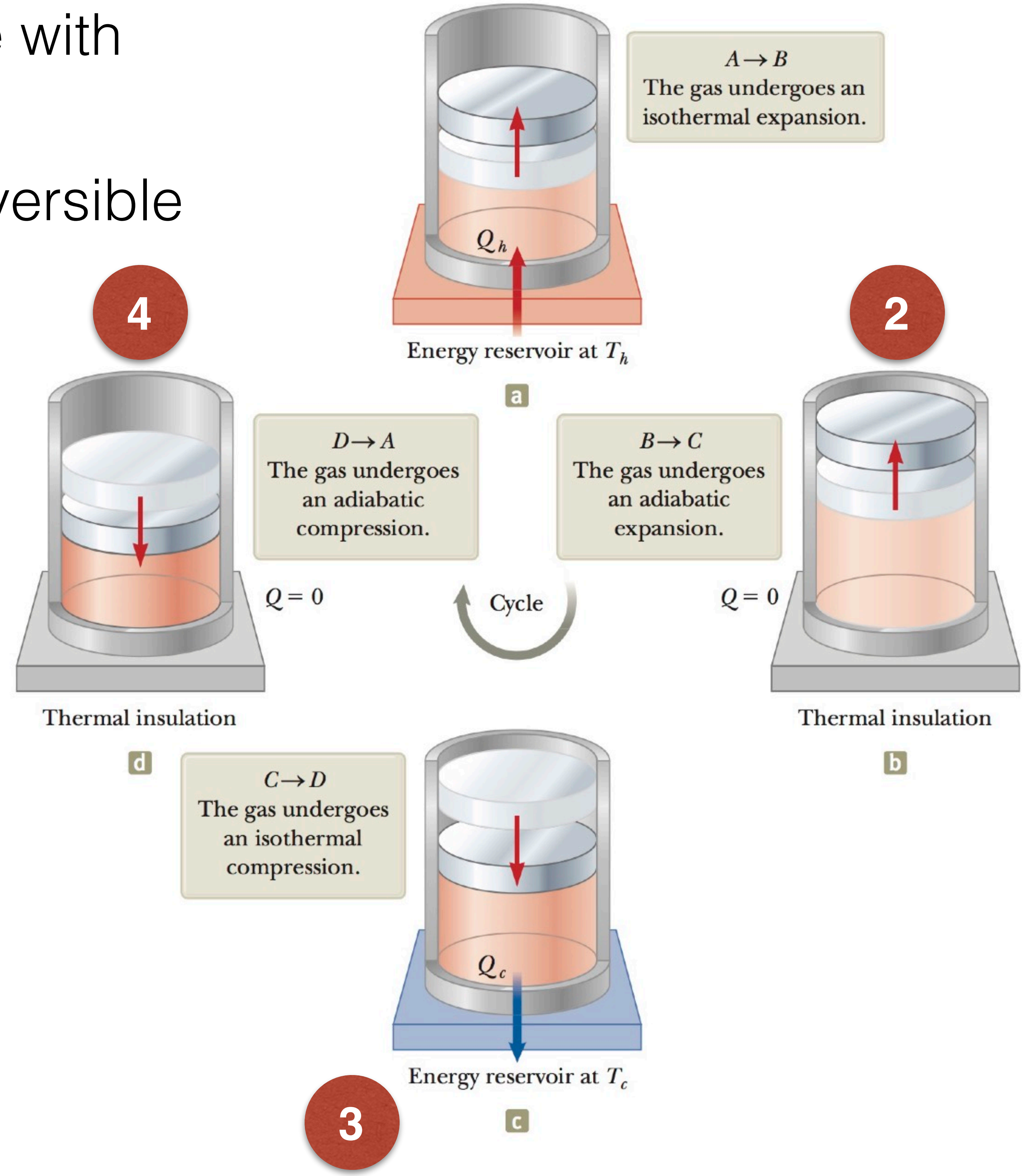
Carnot engine

Consider the engine with the following cycle:

Note: Carnot is a reversible process

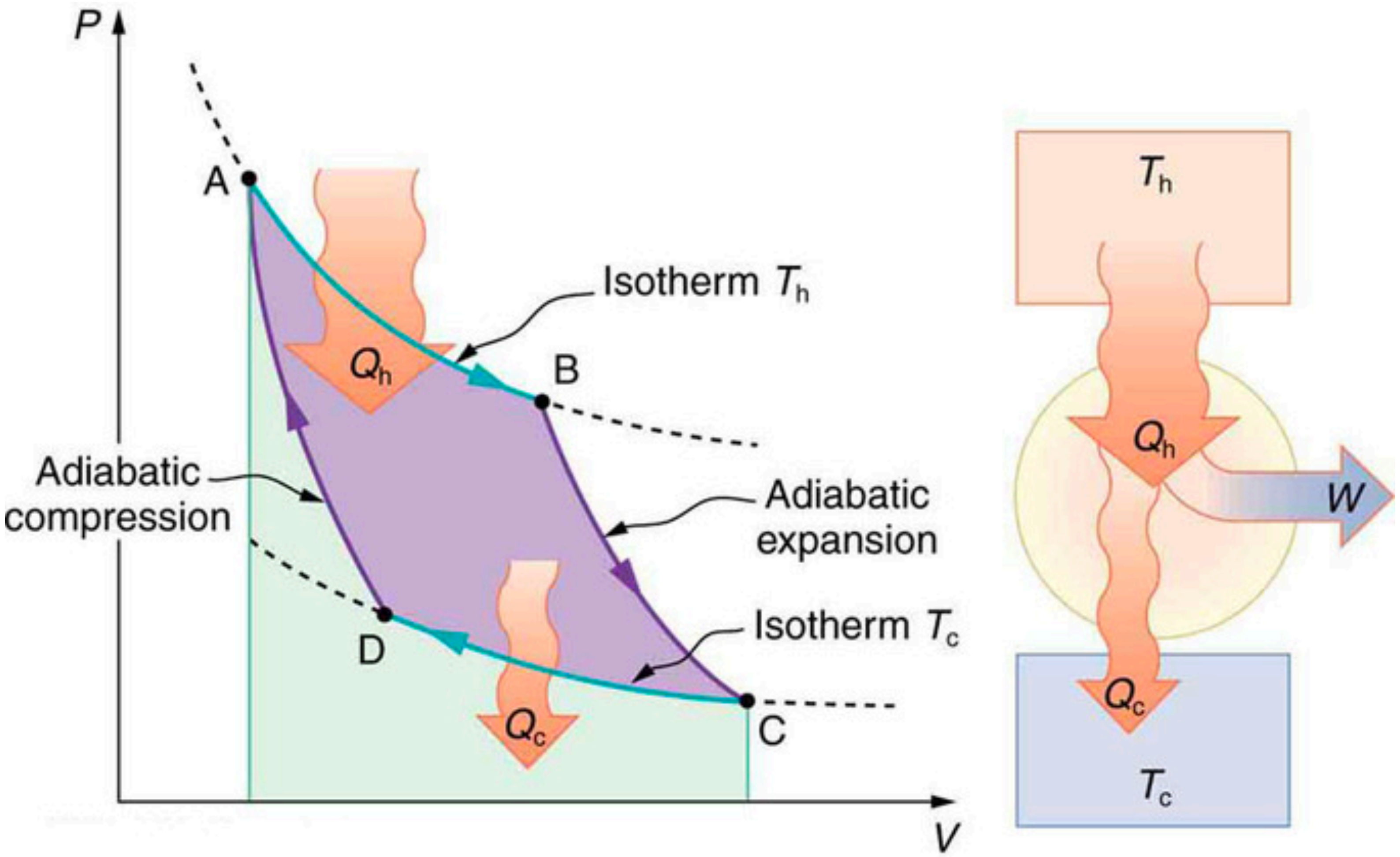
Nicolas Léonard Sadi Carnot





https://courses.lumenlearning.com/boundless-physics/chapter/the-second-law-of-thermodynamics/

Carnot engine



Thermal efficiency of the engine:

$$e = 1 - \frac{|Q_C|}{|Q_H|}$$

Exercise - 4

An ideal gas is taken through a Carnot cycle. The isothermal expansion occurs at 250°C, and the isothermal compression takes place at 50.0°C. The gas takes in 1.20×10^3 J of energy from the hot reservoir during the isothermal expansion. Find (a) the energy expelled to the cold reservoir in each cycle and (b) the net work done by the gas in each cycle.

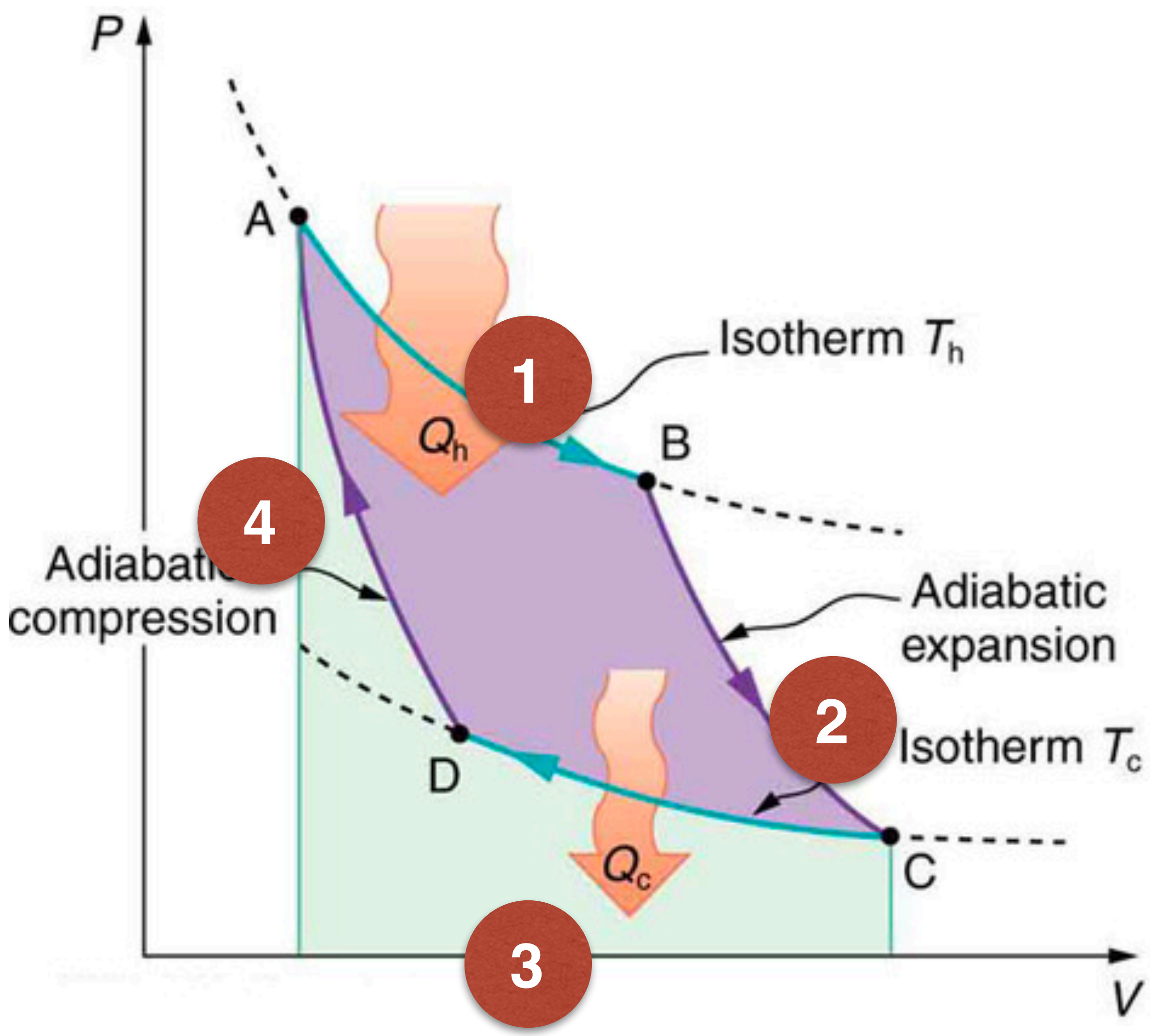
Exercise - 5

In which case will the efficiency of a Carnot cycle be higher:
When the hot body temperature is increased by ΔT, or when the cold body temperature is decreased by the same magnitude?

Carnot's principle

Carnot's principle
"The efficiency of a quasi-static or reversible Carnot cycle depends only on the temperatures of the two heat reservoirs, and is the same, whatever the working substance. A Carnot engine operated in this way is the most efficient possible heat engine using those two temperatures."

Carnot Engine and the Concept of Entropy

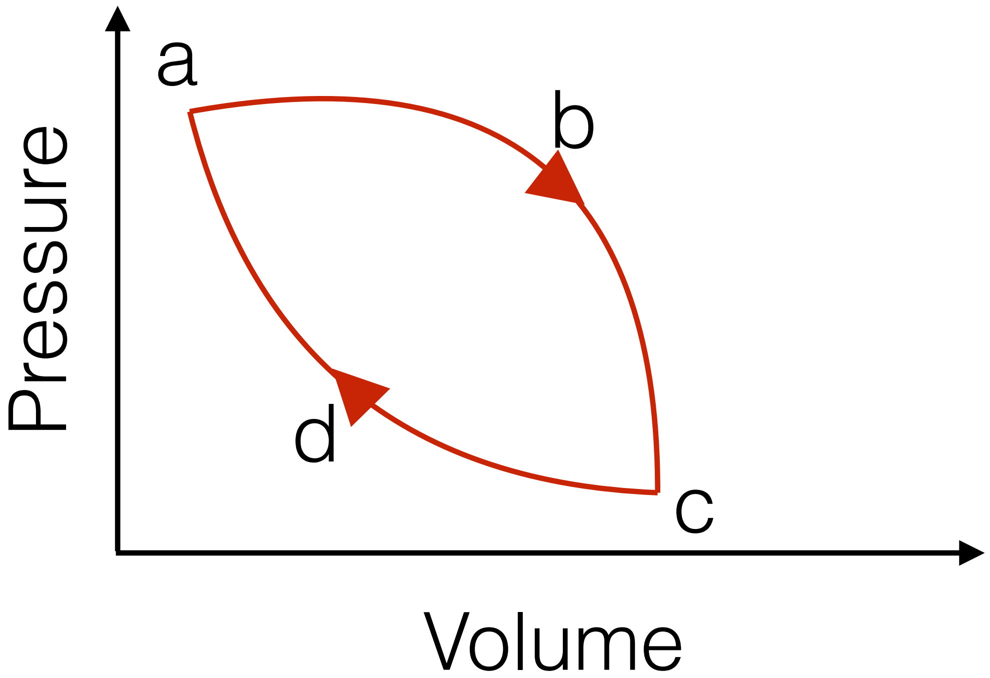


State variables

Do you understand the following statement?

- Internal energy is a state variable
- Heat is not a state variable
- Entropy is a state variable

You can start by considering the cyclic process



https://physics.stackexchange.com/questions/370468

Exercise - 6

Imagine a Carnot engine that operates between the temperatures T_H = 850 K and T_L = 300 K. The engine performs 1200 J of work each cycle, which takes 0.25 s.

(a) What is the efficiency of this engine?

(b) What is the average power of this engine?

(c) How much energy $|Q_H|$ is extracted as heat from the high-temperature reservoir every cycle

(d) How much energy $|Q_L|$ is delivered as heat to the low- temperature reservoir every cycle?

(e) By how much does the entropy of the working substance change as a result of the energy transferred to it from the high-temperature reservoir? From it to the low-temperature reservoir?

Exercise - 6

2nd Law of the Thermodynamics

The second law of thermodynamics states that a closed system has entropy that may

increase: irreversible process

or otherwise

remain constant: reversible process

If

$$\Delta S = \Delta S_{\text{gas}} + \Delta S_{\text{res}}$$

And processes can happen if

$$\Delta S \geq 0$$

Exercise - 7

When a metal bar is connected between a hot reservoir at T_h and a cold reservoir at T_c, the energy transferred by heat from the hot reservoir to the cold reservoir is Q. In this irreversible process, find expressions for the change in entropy of (a) the hot reservoir, (b) the cold reservoir, and (c) the Universe, neglecting any change in entropy of the metal rod.