

Carnot Cycle Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/carnot-cycle/>

Name: _____ Date: _____

Learning objectives

- Describe the four steps of the Carnot cycle.
- Compute Carnot efficiency from reservoir temperatures.
- Explain the second-law limit on heat engines.

Variables to change

- Hot reservoir temperature
- Cold reservoir temperature

Procedure

1. Run the cycle and identify the two isothermal and two adiabatic steps.
2. Raise the hot-reservoir temperature and observe the efficiency.
3. Lower the cold-reservoir temperature and observe the efficiency.

Observations

Record the efficiency for several combinations of hot and cold temperatures.

Questions

1. Write the Carnot efficiency.
2. How do you raise a Carnot engine's efficiency?
3. Can any real engine beat the Carnot efficiency between the same reservoirs?
4. Why can't efficiency reach 100%?

5. Name the four processes of the Carnot cycle.

Answer key (instructors)

- **1.** $\eta = 1 - T_c/T_h$, with temperatures in kelvin.
- **2.** Increase the hot-reservoir temperature or decrease the cold-reservoir temperature.
- **3.** No — Carnot sets the maximum possible efficiency; real engines fall short due to irreversibility.
- **4.** That would need $T_c = 0 \text{ K}$ (unreachable) or $T_h \rightarrow \infty$; the second law forbids converting all heat to work.
- **5.** Isothermal expansion, adiabatic expansion, isothermal compression, adiabatic compression.

The Carnot cycle — two isothermal and two adiabatic steps — is the most efficient possible engine between two reservoirs, with $\eta = 1 - T_c/T_h$. Real engines fall short, and the second law forbids 100% efficiency.