UNIVERSITY MECHANICAL ENGINEERING • EXERCISE SHEET

# 5.4 Second law and entropy

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

**KEY WORDS** entropy • Carnot cycle • lost work

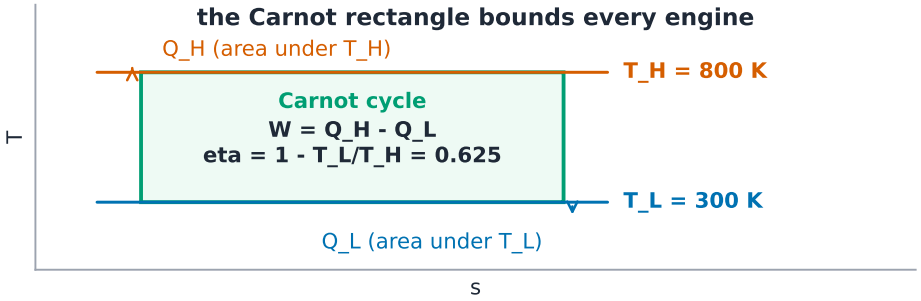
## Objective

Use the second law: the Carnot bound from reservoir temperatures, the entropy balance with production, and lost work as $T_0\sigma$.

## 1 Key knowledge and worked examples

■ **The judge**

$\eta_C = 1 - T_L/T_H$ (absolute temperatures); $\sigma \geq 0$ for every process; lost work $= T_0\sigma$; reversible heat is T-s area.




*The Carnot rectangle bounds every engine

■ **Worked example. The burn-transfer**

$\sigma = Q(1/800 - 1/2000) = 0.75$ kJ/K; lost work $= 300 \times 0.75 = 225$ kJ ✓ - exactly the exergy destroyed.

## 2 Practice

All temperatures absolute; $T_0 = 300$ K unless stated.

**2.1** The Carnot efficiency between reservoirs at 900 K and 320 K (three decimals), and whether a claimed 0.67 engine between them is possible (one sentence). [3]

**2.2** A Carnot engine takes 2000 kJ from the 900 K reservoir and rejects to 320 K: the work, the heat rejected (one decimal, kJ) and the entropy change of each reservoir (three decimals, kJ/K). [5]

**2.3** Heat 1500 kJ is transferred directly from a 600 K reservoir to a 300 K one: the entropy produced (two decimals, kJ/K) and the lost work at $T_0 = 300$ K (kJ). [4]

**2.4** One sentence each: why must $ds = \delta q_{rev}/T$ use a reversible path, and why does a throttling valve produce entropy even though it is adiabatic? [2]