

# **THE SECOND LAW OF THERMODYNAMICS: MEMOIRS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9781760577094

The second law of thermodynamics: memoirs by W. F. Magie & William Thomson Kelvin

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**W. F. MAGIE & WILLIAM THOMSON KELVIN**

**THE SECOND LAW OF  
THERMODYNAMICS:  
MEMOIRS**



*phys.*  
*thermodyn.*

# THE SECOND LAW OF THERMODYNAMICS

MEMOIRS BY CARNOT, CLAUSIUS  
AND THOMSON

TRANSLATED AND EDITED

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48846  
22/10/00

NEW YORK AND LONDON  
HARPER & BROTHERS PUBLISHERS  
1899

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**HARPER & BROTHERS, PUBLISHERS.**

## PREFACE

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AFTER the invention of the steam-engine in its present form by James Watt, the attention of engineers and of scientific men was directed to the problem of its further improvement. With this end in view, the young Sadi Carnot, in 1824, published the *Réflexions sur la Puissance Motrice du Feu*, of which the translation is given in this volume. In this really great memoir, Carnot examined the relations between heat and the work done by heat used in an ideal engine, and by reducing the problem to its simplest form and avoiding all special questions relating to details, he succeeded in establishing the conditions upon which the economical working of all heat-engines depends. It is not necessary here to animadvert upon the use made by Carnot of the substantial theory of heat, and the consequent failure of the proof of his main proposition when the true nature of heat was appreciated. It is sufficient to say that though the proof was invalid, the proposition remained true, and carried with it the truth of such of Carnot's deductions as were based solely upon it.

Carnot's memoir remained for a long time unappreciated, and it was not until use was made of it by William Thomson (now Lord Kelvin), in 1848, to establish an absolute scale of temperature, that the merits of the method proposed in it were recognized. In his first paper on this subject Thomson retained the substantial theory of heat, but the evidence in favor of the mechanical theory became so strong that he soon after adopted the new view. Applying it to the questions treated by Carnot, he found that Carnot's proposition could no longer be proved by denying the possibility of "the perpetual motion," and was led to lay down a second fundamental principle to serve in the demonstration. This principle is now called the Second Law of Thermodynamics. A part of the memoir in which this

## PREFACE

principle is stated and many of its consequences developed is given in this volume. It was published in March, 1851.

In the previous year Clausius published a discussion of the same question as that treated by Thomson, in which he lays down a principle for use in the demonstration of Carnot's proposition, which, while not the same in form as Thomson's, is the same in content, and ranks as another statement of the Second Law of Thermodynamics. His paper is also given in this volume. While not so powerful or so inclusive as Thomson's, it deserves attention for the clearness and simplicity of its form. Clausius followed up this paper by others, and subsequently published a book in which the subject of Thermodynamics was given a systematic treatment, and in which he introduced and developed the important function called by him the entropy.

The science of Thermodynamics, founded by the labors of these three illustrious men, has led to the most important developments in all departments of physical science. It has pointed out relations among the properties of bodies which could scarcely have been anticipated in any other way; it has laid the foundation for the Science of Chemical Physics; and, taken in connection with the kinetic theory of gases, as developed by Maxwell and Boltzmann, it has furnished a general view of the operations of the universe which is far in advance of any that could have been reached by purely dynamical reasoning.



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REFLECTIONS ON  
THE MOTIVE POWER OF HEAT

BY

SADI CARNOT

Paris, 1824