# TREATISE ON THERMODYNAMICS

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Treatise on Thermodynamics by Peter Alexander



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BY

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# PREFACE.

THIS TREATISE is a new development of all the details of the subject directly from the two laws, and thus exhibits the science as *an organic unity*, instead of so many *detached propositions* developed *from mathematical rather than physical considerations*. This is done by first obtaining mathematical expressions of the two laws in *general* forms applicable to *any elementary cycle*, and then from these general forms deriving the particular forms characteristic of the particular elementary cycles. When this has been done, the whole system of mathematical formulæ embodying the details of the science has been obtained. All this is first exhibited in forms in terms of *any* scale of temperatures, and is afterwards transformed into forms in terms of the *absolute* scale.

In Chapter VI. is exhibited for the first time (as far as I am aware) the *general extension of the Second Law* in terms of *any* scale of temperatures, and equation (39) exhibits Carnot's Function *in a new form much more general than any hitherto given*, which is derived from the said general extension of the Second Law.

Chapters X. and XI. are specially interesting, showing as they do that the absolute scale of temperatures *is often*

*mis-defined*, and that, if the specific heat of air under constant pressure *has a constant value* (or rather *does not vary with p*), *the numbers on the absolute scale either do not differ from the corresponding numbers on the scale of the constant-pressure air thermometer, or differ from them by a quantity which is the* SAME THROUGHOUT THE SCALES. It is also shown that the result derived by Joule and Thomson, from their experiments on the flow of gases through porous plugs, *is inconsistent with the constancy or even slow variation* of the specific heats of gases under constant pressures.

In Chapter XVI. the fog that has up till now hung over the subject of reversibility and irreversibility is cleared away by introducing the *new notions* of *intrinsic irreversibility* and *conditional irreversibility*, and by showing that no transformation is really (*i.e.* intrinsically) irreversible, during which the body undergoing transformation has at every instant the same pressure and temperature throughout all its parts.

Chapters XVI. and XVII. also clear away some haziness from the subjects of Motivity and Dissipation of Energy by pointing out that, when the integral $\int \frac{dH}{t}$ is spoken of as having zero value for reversible cycles, and negative values for irreversible cycles, $t$ does not denote the temperature of the working body, but that of the external body from which it is receiving heat, or to which it is imparting heat. On the other hand, it is shown that, if $t$ denote *the temperature* (*throughout*) *of the working body*, $\int \frac{dH}{t}$ is *always* zero for a cycle.

Chapter XVIII. extends *the ordinary definition of entropy to a body or system in which the temperature or pressure, or both, are not the same throughout the body or system, and thus opens up a mode of dealing with intrinsically irreversible transformations the same as that followed when the transformations are reversible.*

Throughout these pages the principle of the "Conservation of Energy" has been *tacitly assumed*, and terms whose meanings are supposed to be generally understood have not been defined. To remedy this a list of definitions is prefixed. Also, except in Chapter XV., entropy is supposed to be numbered so that the addition of $\frac{\tau}{J}$ units of heat to unit mass of a substance of temperature $\tau$ causes its entropy to increase by unity. This has been done to secure the advantage of having the diagram divided into equal areas, *each representing a unit of work*, by a network of isotherms and isenergs numbered by two arithmetical series *whose common difference is unity*. In Chapter XV. the isentropes are numbered, so that the addition of $\tau$ units of heat to unit mass of a substance of temperature $\tau$ causes its entropy to increase by unity. This has been done for the purpose of obtaining the equations in the *usual forms*.

QUEEN MARGARET COLLEGE, GLASGOW,
*September, 1898.*

# CONTENTS.