

**MEMOIRS AND PROCEEDINGS OF  
THE MANCHESTER LITERARY &  
PHILOSOPHICAL SOCIETY. FOURTH  
SERIES. SIXTH VOLUME. MEMOIR  
OF JAMES PRESCOTT JOULE**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649646333

Memoirs and Proceedings of the Manchester Literary & Philosophical Society. Fourth Series.  
Sixth Volume. Memoir of James Prescott Joule by Osborne Reynolds

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**OSBORNE REYNOLDS**

**MEMOIRS AND PROCEEDINGS OF  
THE MANCHESTER LITERARY &  
PHILOSOPHICAL SOCIETY. FOURTH  
SERIES. SIXTH VOLUME. MEMOIR  
OF JAMES PRESCOTT JOULE**



---

MEMOIRS AND PROCEEDINGS  
OF  
THE MANCHESTER  
LITERARY & PHILOSOPHICAL SOCIETY.

*FOURTH SERIES.*

SIXTH VOLUME.



George Fahrenheit, A.R.A. pinx. 1863.

Jan. Wilhelms. fecit.

J. Harrison sc.

*P* That the quantity of heat capable of increasing the temperature of a lb of water (weighed in vacuum, and taken at between 55 and 60°) by one degree Fahrenheit, requires for its evolution the expenditure of a mechanical force represented by the pressure of 772 lbs through the space of one foot.

*J. P. Joule*

# MEMOIR

OF

## JAMES PRESCOTT JOULE,

D.C.L. (OXON.), LL.D. (DUBL. ET EDIN.), F.R.S., HON. F.R.S.E.,  
PRESIDENT OF THE LITERARY AND PHILOSOPHICAL SOCIETY  
OF MANCHESTER,

F.C.S., DOC. NAT. PHIL. LUND. BAC., SOC. PHIL. CANTAB.,  
SOC. PHIL. GLASC., INST. MACH. ET NAUP, SCOT. ET SOC. ANTIQ. PERTH,  
SOC. HONOR. INST. FR. (ACAD. SCI.),  
CORRESP. SOC. REG. DAN. HAVN. TAURIN, BOLON., SOC. PHIL. NAT. BASIL.,  
SOC. PHYS. FR. PAR. ET IIAL.,  
ET ACAD. AMER. SCI. ET ARTIB. ADSOC. HONOR.

BY

OSBORNE REYNOLDS, M.A., LL.D., F.R.S., Mem. Inst. C.E.,

*Honorary Fellow of Queen's College, Cambridge,  
Professor of Engineering, Owens College, Manchester.*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY:  
36, GEORGE STREET.

1892.

# CONTENTS.

## CHAPTER I.

	PAGE
INTRODUCTION.—The Mechanical Foundation of Physical Science.—'Matter, Living Force, and Heat.'—State of the Language and Knowledge of Physical Science in 1838.—No Recognized Measure of Mechanical Effect.—The Materiality of Heat.—Mechanical Origin of Heat.—Contrary Evidence of the Condensing Steam Engine.—Dependence of the Work Developed on Temperature.—Carnot's Law.—The Locomotive Obtrusive.—Suggestions as to Conversion of Heat into Work; Séguin, Mayer, and Colding.—Chemical and Physical Effects.—Discoveries of Oersted, Sturgeon, Ohm, and Faraday.—Invention of Electro-Magnetic Engine.—Evidence of Convertibility of Heat and Work not Recognized... ..	I

## CHAPTER II.

PARENTAGE AND EARLY LIFE.—Sees the First Train.—Education and Companionship with his Brother.—Association with Dalton.—Similarity of the Works of Dalton and Joule.—The Brothers' Vacations.—Their Amusements.—Under Treatment for the Spine.—Commencement of Life.—Continued Companionship.—Visits to Dalton.—Further Instruction in Chemistry.—Intercourse with Sturgeon and Members of this Society.—Joule a Dangerous Companion with a Gun.—British Association.—Dr. Scoresby.—Visit to Bradford.—Interruption of Companionship.—Joule's activity as a Boy... ..	25
--	----



## CHAPTER III.

	PAGE
Joule's First Research.—Starts to improve Sturgeon's Electro-Magnetic Engine.—Increases the Magnetic Force.—Does not realize His Problem.—Effects the Absolute Measure of 'Work.'—Finds that the Speed is Limited.—Seeks for the Limit in the Magnets.—Fails to find it.—Realizes the importance of Measuring the Current.—Constructs a Standard Galvanometer.—Repeats his Experiments.—Discovers Fundamental Law of Electro-Magnetic Attraction.—Contemplates Perpetual Motion.—Explains Law of Electro-Magnetic Attraction.—Measures Current, Velocity, Resistance, and estimates Zinc Consumed in Producing the Current.—Obtains 'Duty' per lb. of Zinc.—Realizes Resistance to the Current Induced by the Motion of the Magnet.—Refers to Faraday, Ohm, &c.—Determines Law of Induced Resistance.—Discovers Equivalence of Mechanical Effect to the Electric-Action, and Chemical-Action expended in its Production.—Introduces Absolute Electric Measurement.—Concludes that the Electro-Magnetic Engine can never compete with the Steam Engine.—Sees a great Philosophical Discovery before him.	33

## CHAPTER IV.

SECOND RESEARCH.—Communicates Results to the Royal Society.—Joule's Motive.—Attributes Proportionality of Chemical and Mechanical Effects to their respective Quantitative Relations to the Electric Action.—Heat in Metallic Conductors.—Proportional to the Square of the Current.—Absolute Measures of Heat, Current, and Electromotive Force.—Heat Equivalent of Electrical Effect.—Heat Developed during Electrolysis.—Electric Origin of Heat.—Heats of Combustion and Electrolysis.—Intensity of Chemical Affinity of Combustibles.—Permanent and Transitory Voltaic Intensity.—Dependence of Affinity on Gaseous or Liquid States.—First Paper before the
---

CONTENTS.

v

	PAGE
Society.—The British Association.—Joint Research with Scoresby.—Heat Evolved during Electrolysis of Water.—Summary of Results.—Approaches Generalization.—Commences Third Research ... ..	45

CHAPTER V.

THIRD RESEARCH.—Heat Generated or Transferred?—Arrangement not Generation of Heat in Voltaic Apparatus.—The Heat Developed in the Entire Circuit by Magneto-Electricity not the Result of Arrangement.—Discovers Heat in the Revolving Armature.—Determines Relation between Heat and Electric-Action; the Same as with Voltaic Current.—Generation and Destruction of Heat by Mechanical Means by the Agency of Magneto-Electricity.—Constant Ratio between the Heat and the Power.—First Determination of the Mechanical Equivalent of Heat.—The Climax of Joule's Researches.—Attends British Association at Cork, 1843.—Dazzled by Possibility of Practical Results.—Conclusions not altogether Justified.—Postscript.—Mechanical Effect Converted into Heat by Friction.—Law of Conservation Realized ... ..	59
---	----

CHAPTER VI.

EFFORTS TO CONVINCe THE SCIENTIFIC WORLD.—Pre-eminence in Knowledge of Physical Science.—General Silence; the Highest Tribute to the Greatness of the Advance.—Friendly Sympathy.—Oakfield.—Researches in his New Laboratory.—Rarefaction and Condensation of Air.—Difficulties.—No Latent Heat.—Convertibility of Free Heat into "Work."—Dynamical Theory of Heat.—Development of Davy's Dynamical Theory of Gases.—New Theory of the Steam Engine.—Criticism of Carnot's Theory.—Heat Discharged into the Condenser.—Discussion of Results.—Joule ignores the Truth of Carnot's Theory.—Indestructibility of Caloric Proved.—Definite Dynamical Theory of Gases.—Imperfect

	PAGE
acquaintance with Mechanical Philosophy.—Absolute Zero of Temperature.—First Determination with the Paddle.—Realization of Dynamical Significance of "Work."—Extent of Experimental Work.—Research with Scoresby; Visits to Bradford.—Essay to the Institute of France.—Research on Effect of Magnetism on the Dimensions of Iron and Steel.—Joint Research with Sir Lyon Playfair; Atomic Volumes...	74

## CHAPTER VII.

THE YEAR 1847.—Lecture at St. Ann's Church Reading Room.—Conservation of "Force."—Fresh Determination of Equivalent.—Verification of Laplace's Theory of Sound.—Joule's Paper accepted by the Institute of France.—Meeting of British Association at Oxford.—First Public Recognition of Joule's Discoveries.—Joule's Account.—Sir William Thomson's Account.—Marriage.—Shooting Stars.—The Adoption of Herapath's Hypothesis.—Determination of Velocities of Molecules of Gases and Theoretical Specific Heats ... ..	103
--	-----

## CHAPTER VIII.

<p>JOULE'S VIEWS ACCEPTED BY THOMSON, RANKINE, AND CLAUDIUS.—Effect of Publication of Regnault's Researches.—Thomson's First Paper on Mechanical Effect by Thermal Agency.—Maintains Inconvertibility of Heat.—Note on Joule's Views.—Conversion of Heat into Work Denied.—Work into Heat Accepted.—Second Paper.—Greater Deference.—Accepts Joule's Difficulties as to Carnot's Axiom.—Thomson's Courage in Expressing his Doubts.—Discovery of Dissipation of Energy.—Rankine's Hypothetical Theory of Heat.—Acknowledges Joule's Hypothesis.—Hypothetical Foundation obscures General Laws.—Accepts Joule's Views.—Criticises Joule's Experiments.—Apology and Acceptance of Joule's Equivalent.—Joule suggests the form of Carnot's function.—Clausius Theory—Based on Joule's and Carnot's discoveries—Contains Hypotheses.—</p>	
---	--