

**TRANSACTIONS**

**OF THE**

**ROYAL SOCIETY OF EDINBURGH.**

TRANSACTIONS  
OF THE  
ROYAL SOCIETY  
OF  
EDINBURGH.

VOL. XX.

---

EDINBURGH:  
PUBLISHED BY ROBERT GRANT & SON, 82 PRINCES STREET.  
AND WILLIAMS & NORGATE, 14 HENRIETTA STREET, COVENT GARDEN, LONDON.

---

MDCCCLIII.

PRINTED BY NEILL AND COMPANY, EDINBURGH.

# CONTENTS.

## PART I.

	PAGE
I. <i>On the Volcanic Geology of the Vivarais (Ardèche).</i> By JAMES D. FORBES, Esq., F.R.S., Sec. R.S. Ed., Professor of Natural Philosophy in the University of Edinburgh. (With Six Plates.) . . . . .	1
II. <i>On a Process in the Differential Calculus, and its application to the Solution of certain Differential Equations.</i> By the Rev. P. KELLAND, M.A., F.R.S.S. L. & E., F.C.P.S., late Fellow of Queen's College, Cambridge; Professor of Mathematics, &c., in the University of Edinburgh, . . . . .	39
III. <i>On the Constitution of Codeine and its Products of Decomposition.</i> By THOMAS ANDERSON, M.D., . . . . .	57
IV. <i>On the Equilibrium of Elastic Fluids.</i> By Mr JAMES CLERK MAXWELL, . . . . .	87
V. <i>Dissertation on a Peruvian Musical Instrument like the Syrinx of the Ancients.</i> By THOMAS STEWART TRAILL, M.D., F.R.S.E., Professor of Medical Jurisprudence in the University of Edinburgh. (With a Plate.) . . . . .	121
VI. <i>Some Remarks on the Theories of Cometary Physics.</i> By C. PIAZZI SMYTH, Esq., F.R.S.E., F.R.A.S., Professor of Practical Astronomy in the University of Edinburgh, and Astronomer-Royal for Scotland, . . . . .	131
VII. <i>On the Mechanical Action of Heat, especially in Gases and Vapours.</i> By WM. J. M. RANKINE, Civil Engineer, F.R.S.E., F.R.S.S.A., &c., . . . . .	147

## PART II.

	PAGE
VIII. <i>Note as to the Dynamical Equivalent of Temperature in Liquid Water, and the Specific Heat of Atmospheric Air and Steam; being a Supplement to a Paper On the Mechanical Action of Heat. By WM. J. M. RANKINE, Civil Engineer, F.R.S.E., F.R.S.S.A., &amp;c.,</i>	191
IX. <i>On the Power and Economy of Single-Acting Expansive Steam Engines, being a Supplement to the Fourth Section of a Paper On the Mechanical Action of Heat. By WM. J. M. RANKINE, Civil Engineer, F.R.S.E., F.R.S.S.A., &amp;c.,</i>	195
X. <i>On the Economy of Heat in Expansive Machines, forming the Fifth Section of a Paper On the Mechanical Action of Heat. By WM. J. M. RANKINE, Civil Engineer, F.R.S.E., F.R.S.S.A., &amp;c. (With a Plate.)</i>	205
XI. <i>Notes on the Geology of the Eildon Hills, in Roxburghshire. By JAMES D. FORBES, F.R.S., Sec. R.S. Ed., Professor of Natural Philosophy in the University of Edinburgh. (With a Plate.)</i>	211
XII. <i>On a new Source for obtaining Capric Acid, and Remarks on some of its Salts. By Mr THOMAS HENRY ROWNEY, F.C.S. Communicated by Dr T. ANDERSON,</i>	219
XIII. <i>On certain Salts and Products of Decomposition of Comenic Acid. By Mr HENRY HOW. Communicated by Dr T. ANDERSON,</i>	225
XIV. <i>On the Products of the Destructive Distillation of Animal Substances. Part II. By THOMAS ANDERSON, M.D., F.R.S.E.,</i>	247
XV. <i>On the Dynamical Theory of Heat, with numerical results deduced from Mr JOULE'S Equivalent of a Thermal Unit, and M. REGNAULT'S Observations on Steam. By WILLIAM THOMSON, M.A., Fellow of St Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow,</i>	261
XVI. <i>On a Method of Discovering experimentally the Relation between the Mechanical Work spent, and the Heat produced by the Compression of a Gaseous Fluid. By WILLIAM THOMSON, M.A., Fellow of St Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow,</i>	289

	PAGE
XVII. <i>On the Weight of Aqueous Vapour which is condensed on a Cold Surface, under given conditions.</i> By JAMES DALMAHOY, Esq., F.R.S.E., . . . . .	299
XVIII. <i>On some remarkable Marine Invertebrata new to the British Seas.</i> By EDWARD FORBES, F.R.S., F.L.S., Professor of Botany, King's College, London; and J. GOODSIR, F.R.S.S.L. & E., Professor of Anatomy in the University of Edinburgh. (With Two Plates.)	307

---

 PART III.

XIX. <i>On the Total Intensity of Interfering Light.</i> By Professor STOKES,	317
XX. <i>Some Observations on the Charr (Salmo umbla), relating chiefly to its Generation and Early Life.</i> By JOHN DAVY, M.D., F.R.S.S. L. & E., Inspector-General of Army Hospitals, . . . . .	326
XXI. <i>On the Total Eclipse of the Sun, on July 28, 1851, observed at Göteborg; with a Description of a new Position Micrometer.</i> By WILLIAM SWAN, F.R.S.E. (With a Plate.) . . . . .	335
XXII. <i>Researches on some of the Crystalline Constituents of Opium.</i> By THOMAS ANDERSON, M.D., F.R.S.E., . . . . .	347
XXIII. <i>On a Necessary Correction to the Observed Height of the Barometer depending upon the Force of the Wind.</i> By Captain HENRY JAMES, R.E., F.R.S., M.R.I.A., F.G.S., &c. . . . .	377
XXIV. <i>Defence of the Doctrine of Vital Affinity.</i> By WILLIAM PULTENEY ALISON, M.D., &c. &c., Professor of the Practice of Medicine in the University of Edinburgh, . . . . .	385
XXV. <i>On Meconic Acid and some of its Derivatives.</i> By Mr HENRY HOW, Assistant to Dr ANDERSON. Communicated by Dr T. ANDERSON, . . . . .	401
XXVI. <i>Notice of an Antique Marble Bust.</i> By ANDREW COVENTRY, Esq.,	417

	PAGE
XXVII. <i>On the Centrifugal Theory of Elasticity, and its Connection with the Theory of Heat.</i> By WM. J. M. RANKINE, C.E., F.R.S.E., F.R.S.S.A., &c. . . . .	425
XXVIII. <i>On the Computation of the Specific Heat of Liquid Water at various Temperatures, from the Experiments of M. REGNAULT.</i> By WM. J. M. RANKINE, C.E., F.R.S.E., F.R.S.S.A., &c.	441
XXIX. <i>On the Red Prominences seen during Total Eclipses of the Sun.</i> Part I. By WILLIAM SWAN, F.R.S.E., . . . . .	445
XXX. <i>On the Red Prominences seen during Total Eclipses of the Sun.</i> Part II. By WILLIAM SWAN, F.R.S.E. (With a Plate.)	467
XXXI. <i>On the Dynamical Theory of Heat.</i> Part V. <i>On the Quantities of Mechanical Energy contained in a Fluid in Different States as to Temperature and Density.</i> By WILLIAM THOMSON, M.A., Professor of Natural Philosophy in the University of Glasgow,	475
XXXII. <i>On two New Processes for the Detection of Fluorine when accompanied by Silica; and on the Presence of Fluorine in Granite, Trap, and other Igneous Rocks, and in the Ashes of Recent and Fossil Plants.</i> By GEORGE WILSON, M.D., . . . . .	483
XXXIII. <i>Contributions to a Knowledge of the Phenomena of the Zodiacal Light.</i> By Professor C. PIAZZI SMYTH. (With a Plate.)	489
XXXIV. <i>On the Total Solar Eclipse of 1851.</i> By Professor C. PIAZZI SMYTH. (With a Plate.) . . . . .	503

---

#### PART IV.

XXXV. <i>Observations on the Speculations of Dr BROWN and other recent Metaphysicians, regarding the Exercise of the Senses.</i> By Professor W. P. ALISON, . . . . .	513
XXXVI. <i>Summation of a Compound Series, and its Application to a Problem in Probabilities.</i> By Bishop TERROT, . . . . .	541

	PAGE
XXXVII. <i>On the Optical Phenomena and Crystallisation of Tourmaline, Titanium, and Quartz, within Mica, Amethyst, and Topaz.</i> By Sir DAVID BREWSTER, K.H., D.C.L., F.R.S., and V.P.R.S. Edin. (With a Plate.) . . . . .	547
XXXVIII. <i>On the Production of Crystalline Structure in Crystallised Powders, by Compression and Traction.</i> By Sir DAVID BREWSTER, K.H., D.C.L., F.R.S., V.P.R.S. Edin. . . . .	555
XXXIX. <i>On the Absolute Zero of the Perfect Gas Thermometer; being a Note to a Paper on the Mechanical Action of Heat.</i> By WM. J. M. RANKINE, C.E., F.R.S.E., F.R.S.S.A., &c. . . . .	561
XL. <i>On the Mechanical Action of Heat.</i> By WM. J. M. RANKINE, C.E., F.R.S.E., F.R.S.S.A., &c., . . . . .	565
XLI. <i>On Nitric Acid as a Source of the Nitrogen found in Plants.</i> By GEORGE WILSON, M.D., . . . . .	591
XLII. <i>Some Observations on Fish in relation to Diet.</i> By JOHN DAVY, M.D., F.R.S. Lond. & Ed., Inspector-General of Army Hospitals, . . . . .	599
XLIII. <i>On Circular Crystals.</i> By Sir DAVID BREWSTER, K.H., D.C.L., F.R.S., and V.P.R.S. Edin. (With Two Plates.) . . . . .	607
<i>Proceedings at Statutory General Meetings, &amp;c.,</i> . . . . .	625
<i>List of the present Ordinary Members, in the order of their Election,</i> . . . . .	634
<i>List of Non-Resident and Foreign Members, elected under the Old Laws,</i> . . . . .	641
<i>Honorary Fellows,</i> . . . . .	641
<i>Fellows Deceased, Resigned, or Cancelled, from 1849 to 1853,</i> . . . . .	643
<i>Public Institutions, &amp;c., entitled to receive the Transactions and Proceedings of the Society,</i> . . . . .	645
<i>List of Donations, continued from Vol. XVI., page 648,</i> . . . . .	647
<i>Index,</i> . . . . .	665
<i>Laws of the Society,</i>	



## CONDITIONS OF THE KEITH PRIZE.

---

This Prize, the interest of a sum which now amounts to about £800, left by the late ALEXANDER KEITH, Esq. of Ravelston and Dunnottar, will be awarded by the President and Council of the Royal Society of Edinburgh, on the following conditions :—

I. The author of the best paper on a scientific subject (preference being, in all cases given to a paper containing an important discovery in science made in any part of the world), communicated in the first instance to the Royal Society during the sessions 1851–2, 1852–3, or any two succeeding sessions, shall be entitled to the biennial interest of the KEITH FUND, accruing in the respective periods.\*

II. The form of the Prize shall be a Gold Medal, of not more than Fifteen Guineas value. The remainder of the sum shall be given in money, to be spent in Plate or otherwise, at the discretion of the receiver.

III. The award being duly intimated to the receiver of the Prize, he is to apply forthwith to the Treasurer of the Society for payment of it; and, failing to do so within six months of the date of the intimation, he shall forfeit the money, but shall be entitled to receive the Medal.

\* The proceeds of all preceding biennial periods have, in accordance with the decision of the President and Council, been either awarded to scientific individuals, or added to the capital sum.