

**MATHEMATICAL QUESTIONS  
WITH THEIR SOLUTIONS,  
FROM THE "EDUCATIONAL  
TIMES", VOL. XXIX**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649451593

Mathematical Questions with Their Solutions, from The "Educational Times", Vol. XXIX by W. J. C. Miller

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)

**W. J. C. MILLER**

**MATHEMATICAL QUESTIONS  
WITH THEIR SOLUTIONS,  
FROM THE "EDUCATIONAL  
TIMES", VOL. XXIX**



# MATHEMATICAL QUESTIONS

WITH THEIR

## SOLUTIONS,

FROM THE "EDUCATIONAL TIMES,"

WITH MANY

Papers and Solutions not published in the "Educational Times."

EDITED BY

W. J. C. MILLER, B.A.,

REGISTRAR OF THE GENERAL MEDICAL COUNCIL.

VOL. XXIX.

FROM JANUARY TO JUNE, 1878.



LONDON:

C. F. HODGSON & SON, GOUGH SQUARE,

FLEET STREET.

1878.

18753.e.2.

## CORRIGENDA.

### VOL. XXII.

Pages viii. and 27, for No. of Question 4350, read No. 4342

### VOL. XXVIII.

Page 66, last line, for  $(x^2-x^2)$  read  $(x^2-x^2)$ .

Page 69, line 7 from bottom, for  $(R^2-x^2)$  read  $(R^2-x^2)$ †

Page 86, line 9 from bottom, for *inside* read *inside*.

### VOL. XXIX.

Page 40, line 12 from bottom, for No. 138 read 134.

Page 59, line 4 from bottom, after "values" insert "of."

Page 60, line 10, for *LdL* read *L<sup>2</sup>dL*.

Page 61, line 13 from bottom, read "the respective probabilities of the promiscuous occurrence of the two cases are  $\frac{1}{2}$  and  $\frac{1}{2}$ ."

Page 74, line 11, for No. 136 read 137.

Page 80, line 15, for 2, 8, 6 read 2, 3, 6.

Page 99, line 12 from bottom, for No. 137 read 139.

Page 106, line 10, for No. 139 read 140.

---

N.B.—Of this series twenty-nine volumes have now been published, each volume containing, in addition to the papers and solutions that have appeared in the *Educational Times*, about the same quantity of new articles, and comprising contributions, on all branches of Mathematics, from most of the leading Mathematicians in this and other countries.

New Subscribers may have any of these Volumes at Subscription prices.

## LIST OF CONTRIBUTORS.

- ALDIN, J. B., M.A.; H.M. Inspector of Schools.  
 ALLMAN, GEO. S., LL.D.; Professor of Mathematics in the Queen's University, Galway.  
 ARMENANTE, Professor, Pesaro.  
 BALL, ROBT. STANWELL, LL.D., F.R.S.; Professor of Astronomy in the University of Dublin.  
 BATTAGLINI, GIUSEPPE; Professore di Matematiche nell' Università di Roma.  
 BELTRAMI, Professor; University of Pisa.  
 BERG, F. J. VAN DER; Professor of Mathematics in Delft Polytechnic School.  
 BREANT, W. H., M.A.; Cambridge.  
 BRICH, Rev. J. G., M.A.; Birmingham.  
 BLACKWOOD, ELIZABETH; Boulogne.  
 BLISSARD, Rev. J., B.A.; The Vicarage, Hampstead Norris, Berks.  
 BOCHARDT, Dr. C. W.; Victoria Strasse, Berlin.  
 BOASQUET, B. H., M.A.; Fellow of St. John's College, Oxford.  
 BROOKS, Professor B., Millersville, Pennsylvania.  
 BROWN, A. CHRM. D.Sc.; Edinburgh.  
 BROWN, COLLIN, Professor in the Andersonian University, Glasgow.  
 BUCHHEIM, ARTHUR; New College, Oxford.  
 BURNBIDE, W. S., M.A.; Fellow and Tutor of Trinity College, Dublin.  
 CAMPBELL, Capt. FRID.; Notting Hill, London.  
 CARR, G. S.; Osnab College, Cambridge.  
 CAREY, JOHN, LL.D., F.R.S.; Prof. of Higher Mathematics in the Catholic Univ. of Ireland.  
 CAVALLIN, O. B. S.; University of Upsala.  
 CAYE, A. W., B.A.; Magdalen College, Oxford.  
 CAYLER, A., F.R.S.; Sadlerian Professor of Mathematics in the University of Cambridge; Member of the Institute of France, &c.  
 CHADWICK, W.; Fellow of Christ Ch., Oxford.  
 CHAKRAYARTI, BYOMKESHA; Presidency College, Calcutta.  
 CHASE, PLYM EARLE, LL.D., Prof. of Philosophy in Harvard College.  
 CLARKE, Colonel A. R., C.B., F.R.S.; Director of the Ordnance Survey, Southampton.  
 CLIFFORD, W. K., M.A., F.R.S.; late Fellow of Trinity College, Cambridge; Prof. of Applied Mathematics in University College, London.  
 COCHER, Professor; Paris.  
 COCKLE, Hon. Sir J., Knt., M.A., F.R.S.; Chief Justice of Queensland; President of the Queensland Philosophical Society.  
 COHEN, ARTHUR, M.A., Q.C.; London.  
 COLSON, C. G., M.A.; University of St. Andrew's.  
 CONSTABLE, S.; Grammar School, Drogheda.  
 COTTRELL, J. H., M.A.; Royal School of Naval Architecture, South Kensington.  
 COTTRELL, THOS., M.A.; London, late Fellow of St. John's College, Cambridge.  
 CREMONA, LUIGI; Direttore della Scuola degli Ingegneri, S. Pietro in Vincoli, Rome.  
 CROFTON, M. W., B.A., F.R.S.; Professor of Mathematics and Mechanics in the Royal Military Academy, Woolwich.  
 CUTYERWELL, R. P., B.A.; Scholar of Trinity College, Dublin.  
 DARBOUT, Professor; Paris.  
 DAVIS, R. F., B.A.; Wandsworth Common.  
 DAVIS, WILLIAM BARNETT, B.A. London.  
 DAY, Rev. H. G., M.A.; Riverside, Sevenoaks.  
 DICK, G. E., M.A.; Fellow of Caius Coll., Camb.  
 DOBSON, T., B.A.; Head Master of Hexham Grammar School.  
 DRAGE, S. M.; Barnsbury Street, London.  
 DUPAY, J. C.; Professeur au Lycée d'Angoulême.  
 DYER, J. M., B.A.; Cheltenham College.  
 EASTERTY, W., B.A.; Grammar School, St. Asaph.  
 EASTON, BELLE; Lockport, New York.  
 EDMUNDSON, GEORGE; Brasenose Coll., Oxford.  
 EDWARDS, D.; Edgware.  
 ELLIOTT, E. B., M.A.; Fellow of Qui. Coll., Oxon.  
 ELLIS, ALEXANDER, J., F.R.S.; Kensington.  
 ESCOTT, ALBERT, M.A.; Head Master of the Royal Hospital School, Greenwich.  
 EVANS, Prof. A. B., M.A.; Lockport, New York.  
 EVERETT, J. D., D.C.L.; Professor of Natural Philosophy in the Queen's University, Belfast.  
 FICELIN, JOSEPH; Professor of Mathematics and Astronomy in the University of Missouri.  
 FORDE, S., M.A.; Oxford.  
 FORSY, H., M.A.; Ballyva, Madras Presidency.  
 FRY, Colonel JOHN B.; New York.  
 FORTES, H.; University of Naples.  
 GALBRAITH, J., M.A.; Fellow of Trin. Coll., Dublin.  
 GALTON, FRANCIS, M.A., F.R.G.S.; London.  
 GALLATLY, W., B.A.; Highgate.  
 GARDNER, MARTIN; late Professor of Mathematics in St. John's College, Sydney.  
 GIBBER, E. W., M.A.; Sc. of St. John's Coll., Camb.  
 GIBBONS, H. T., B.A.; Christ Church, Oxford.  
 GLAISHER, J. W. L., M.A., F.R.S.; Fellow of Trinity College, Cambridge.  
 GLASMAN, J. C., M.A.; Stratford, Ontario.  
 GODFRAY, HUGH, M.A.; Newnham, Cambridge.  
 GODWARD, WILLIAM; Chelsea.  
 GREENFIELD, Rev. W. J., M.A.; Dulwich College.  
 GREENWOOD, JAMES M.; Kirkavilla, Missouri.  
 GREFFITH, W.; Superintendent of Public Schools, New London, Ohio, United States.  
 GRIFFITHS, J., M.A.; Fellow of Jesus Coll., Oxon.  
 HALL, Professor ASAFF, M.A.; Naval Observatory, Washington.  
 HAMMOND, J., M.A.; King Edward's Sch., Bath.  
 HARMON, C.; University of St. Peterburgh.  
 HARRIS, Rev. ROBERT, F.R.S.; Vice-Master of Mill Hill Grammar School.  
 HARRIS, H. W., B.A.; Trinity College, Dublin.  
 HART, Dr. DAVID S.; Stonington, Connecticut.  
 HART, H.; R.M. Academy, Woolwich.  
 HENDRICKS, J. E., M.A.; Des Moines, Iowa.  
 HERMITE, CH.; Membre de l'Institut, Paris.  
 HILL, Rev. E. B., M.A.; St. John's College, Camb.  
 HINTON, C. H.; Cheltenham College.  
 HIRST, Dr. T. A., F.R.S.; Director of Studies in the Royal Naval College, Greenwich.  
 HOPKINS, Rev. G. H.; Bgham, Surrey.  
 HOPKINSON, J., D.Sc., B.A.; Manchester.  
 HUDSON, C. T., LL.D.; Manilla Hall, Chilton.  
 HUDSON, W. H. H., M.A.; Fellow of St. John's College, Cambridge.  
 INGLEBY, C. M., M.A., LL.D., London.  
 JELLY, J. O., B.A.; Magdalen College, Oxford.  
 JENKINS, MORGAN, M.A.; London.  
 JENKINS, J. S.; Merton College, Oxford.  
 JOHNSON, M. B.A.; Radley College, Abingdon.  
 JOHNSON, W. W.; Annapolis, Maryland.  
 JOHNSON, SWIFT; Trin. Coll., Dublin.  
 JONES, L. W., B.A.; Merton College, Oxford.  
 KELLAND, PHILIP, M.A.; Professor of Mathematics in the University of Edinburgh.  
 KING, G. W.; Royal Hospital Sch., Greenwich.  
 KIRKMAN, Rev. T. P., M.A., F.R.S.; Orest Rectory, near Warrington.  
 KITCHIN, Rev. J. L., M.A.; Newritse, Exeter.  
 KITUDGE, LIRIE A.; Boston, United States.  
 KNIBBLE, Rev. U. J.; Newcomersdown, Ohio, U.S.  
 KNOWLES, R., L.C.P.; Fumkville.  
 LADD, CHRISTINE; Professor of Natural Sciences and Mathematics, Union Springs, New York.  
 LAVERTY, W. H., M.A.; Public Examiner in the University of Oxford.  
 LAWRENCE, E. J.; formerly Fellow of Trinity College, Cambridge.

- LEIDHOLD, R. M.A.; Finsbury Park.  
 LEVETT, R. M.A.; King Edward's School, Birmingham.  
 LEUBENROFF, C. M.A.; Fellow of Pembroke College, Oxford.  
 LONG, W. S. F.; St. John's College, Cambridge.  
 MCADAM, D. S.; Washington, Pennsylvania.  
 MCCAY, W. S. M.A.; Fellow and Tutor of Trinity College, Dublin.  
 MCCOLL HUGH; Rue Sibiquin, Boulogne.  
 McDOWELL, J. M.A.; Pembroke Coll., Camb.  
 McLEOD, J. M.A.; K.M. Academy, Woolwich.  
 MACKENZIE, J. L. B.A.; Inst. College, Taunton.  
 MADDER, W. M.; Trinity Parsonage, W. Wickfield.  
 MALET, J. C. M.A.; Trinity College, Dublin.  
 MANHEIM, M.; Professor & l'École Polytechnique, Paris.  
 MARTIN, ARTHUR, M.A.; Editor and Publisher of the *Mathematical Visitor*, Erie, Pa.  
 MARTIN, Rev. H. D.D., M.A.; Examiner in Mathematics in the University of Edinburgh.  
 MATHEWS, P. C. M.A.; London.  
 MATZ, P. P. M.A.; Reading, Pennsylvania.  
 MERRIFIELD, C. W., F.R.S.; Brook Green.  
 MERRIFIELD, J., LL.D., F.R.S.; Plymouth.  
 MERRICK, THOS.; Kensington Square, London.  
 MILLER, W. J. C. B.A.; 56, Netherwood Road, West Kensington Park, London, W.  
 MITCHELL, G. M. M.A.; Prof. in Cooper's Hill Coll.  
 MITCHESON, T., B.A., L.C.P.; City of London Sch.  
 MONCK, H. STANLEY, M.A.; Prof. of Moral Philosophy in the University of Dublin.  
 MORGENTHAU, Professor; Paris.  
 MOORE, ROBERT, M.A.; late Fellow of Queen's College, Cambridge, Cleveland Sq., London.  
 MORSE, Professor; Paris.  
 MORLEY, THOS., L.C.P.; Bromley, Kent.  
 MOUTON J. P. M.A.; Fellow of Christ's College, Cambridge.  
 MURPHY, HUGH; Head Master of the Incorporated Society's School, Dublin.  
 NARENDRA LAL DRY; Presidency Coll., Calcutta.  
 NASH, A. M., B.A.; Professor of Nat. Phil. and Astronomy, Presidency College, Calcutta.  
 NELSON, B. J. M.A.; Naval School, London.  
 O'BRIEN, JOHN; New Street, Limerick.  
 OCHSNER, E. L. B.A., L.C.P.; Hampstead.  
 PANTON, A. W. M.A.; Fellow of Trinity College, Dublin.  
 PHILLIPS, F. B. W.; Balliol College, Oxford.  
 PILLAI, C. K.; Trinity, Madras.  
 PIRIE, A. M.A.; University of St. Andrews.  
 POLIGNAC, Prince CAMILLE DE; Paris.  
 POLLACKER, H. B.A.; Windermere College.  
 PRUDDEN, FRANCIS E.; Lockport, New York.  
 RAWSON, ROBERT; Havant, Hants.  
 RENSCHAW, S. A.; Nottingham.  
 RILEY, R. E., B.A.; Bournemouth.  
 RIPPIN, CHARLES E., M.A.; Woolwich Common.  
 ROBERTS, R. A., B.A.; Scholar of Trinity College, Dublin.  
 ROBERTS, SAMUEL, M.A.; Tufnell Pk., London.  
 ROBERTS, Rev. W. M.A.; Senior Fellow Trinity College, Dublin.  
 ROBERTS, W. R., M.A., B.S.; Scholar of Trinity College, Dublin.  
 ROSENTHAL, I. H.; Scholar of Trin. Coll., Dublin.  
 ROYDS, J., L.C.P.; Sheffield.  
 ROCKE, A. W. B.A.; Professor of Mathematics in the Yorkshire College of Science, Leeds.  
 RUGGERO, SIMONELLI; Università di Roma.  
 RUTTER, EDWARD; Sunderland.  
 SALMON, Rev. G. D.D., F.R.S.; Regius Professor of Divinity in the University of Dublin.  
 SANDERS, J. B.; Bloomington, Indiana.  
 SANDERSON, Rev. T. J. M.A.; Royston, Cambs.  
 SANKAR, NILKANTHA, B.A.; Presidency College, Calcutta.  
 SAVAGE, THOMAS, M.A.; Fellow of Pembroke College, Cambridge.  
 SCHEFFER, Professor; Des Moines, Iowa, U.S.  
 SCOTT, JESIAH; Judge of the Ohio Supreme Court, Bucyrus, United States.  
 SCOTT, R. F. M.A.; Fellow of St. John's College, Cambridge.  
 SEITZ, E. B.; Greenville, Ohio, United States.  
 SEBERT, Professor; Paris.  
 SHARP, W. J. C. M.A.; Grosvenor Square.  
 SHARPE, J. W. M.A.; The Charterhouse.  
 SHARPE, Rev. H. T., M.A.; Cherry Marham.  
 SHEPHERD, A. J. F.; Queen's College, Oxford.  
 SIBBS, J. J.; Rue des Vieillards, Boulogne.  
 SIVERLY, WALTER; Oil City, Pennsylvania.  
 SMITH, C. M.A.; Sidney Sussex Coll., Camb.  
 SPOTTISWOODE, WILLIAM, M.A., F.R.S.; Grosvenor Place, London.  
 STEIN, A.; Venice.  
 STEPHEN, ST. JOHN, B.A.; Caius Coll., Cambridge.  
 SYMONS, R. W.; University Coll., Oxford.  
 STYLLMEYER, J. J., LL.D., F.R.S.; Professor of Mathematics in Johns Hopkins University, Member of the Institute of France, Ac.  
 TAIT, P. G., M.A.; Professor of Natural Philosophy in the University of Edinburgh.  
 TAYLOR, H. W. L., M.A.; Prof. of Mathematics and Physics, R. A. College, Cirencester.  
 TEMPLTON, FRANCIS A., M.A.; Fellow of Trinity College, Dublin.  
 TAYLOR, Rev. C. M.A.; Fellow of St. John's College, Cambridge.  
 TAYLOR, H. M. M.A.; Fellow and Assistant Tutor of Trinity College, Cambridge.  
 TAYLOR, J. H. B.A.; Cambridge.  
 TEBAY, SEYMOUR, B.A.; Kearsley, Bolton.  
 THOMSON, F. D., M.A.; late Fellow of St. John's Coll., Camb., Brinkley Rectory, Newark.  
 THOMSON, J. E.; Lockport, New York.  
 TODDUSTON, ISAAC, F.R.S.; Cambridge.  
 TOMLINSON, H.; Christ Church, Oxford.  
 TORRELLI, GABRIEL; University of Naples.  
 TORRY, Rev. A. F. M.A.; St. John's College, Cambridge.  
 TOWNSEND, Rev. R., M.A., F.R.S.; Professor of Nat. Phil. in the University of Dublin, &c.  
 TRAILL, ANTHONY, M.A., M.D.; Fellow and Tutor of Trinity College, Dublin.  
 TROWBRIDGE, DAVID; Waterbury, New York.  
 TUCKER, E. M.A.; Mathematical Master in University College School, London.  
 TURRELL, I. H.; Cincinnati, Ohio.  
 VINCENZO, CROCHINI; University of Rome.  
 VINCENZO, JACOBINO; University of Rome.  
 VOSSE, G. B.; Professor of Mechanics and Civil Engineering, Washington, United States.  
 WALSH, W. H.; Mem. Phys. Society, London.  
 WALLER, J. J. M.A.; Vice-Principal of University Hall, Gordon Square, London.  
 WALKMAY, J. B.A.; Eccles, Manchester.  
 WARD, ISABELLA M.; Capecur, Boulogne.  
 WARREN, E., M.A.; Trinity College, Dublin.  
 WATSON, SYDNEY; Haydonbridge.  
 WATSON, Rev. H. W., M.A.; late Fellow of Trinity College, Cambridge.  
 WERTSCH, Fr.; Weimar.  
 WHITE, J. E., B.A.; Worcester Coll., Oxford.  
 WHITE, Rev. J. M.A.; Woolwich.  
 WHITWORTH, Rev. W. A., M.A.; Fellow of St. John's Coll., Camb.; St. John's Vicarage, Bournemouth.  
 WILKINS, W.; Scholar of Trin. Coll., Dublin.  
 WILKINSON, Rev. M. M. U.; Norwich.  
 WILLIAMS, S. F.; Liverpool College.  
 WILLIAMSON, B. M.A.; Fellow and Tutor of Trinity College, Dublin.  
 WILSON, J. M., M.A.; Rugby School.  
 WILSON, Rev. J., M.A.; Rector of Bannockburn Academy.  
 WILSON, Rev. J. R., M.A.; Royston, Cambs.  
 WILSON, Rev. B., D.D.; Chelsea.  
 WOLSTENHOLME, Rev. J., M.A.; Professor of Mathematics in Cooper's Hill College.  
 WOOLHOUSE, W. S. B., F.R.S., Ac.; London.  
 WRIGHT, Dr. S. H., M.A.; Penn. Yaz., New York.  
 WRIGHT, E. B.A.; Dunsannon.  
 WRIGHT, Rev. W. J., Ph.D.; Pennsylvania.  
 YOUNG, J. B.; London.



## CONTENTS.

### Mathematical Papers, &c.

No.	Page
131 Notes on Random Chords. By the Editor. ....	17
132 Contraposition: By Alexander J. Ellis, F.R.S. ....	34
133 To find the Directrix of the Parabola $(ax + by)^2 + 2dx + 2ey + f = 0$ . By W. Gallatly, B.A. ....	37
134 On the Random Chord Question. By Helen Thomson. ....	40
135 Note on Mr. Woolhouse's Solution of his Question 5502. By Professor Monk, M.A. ....	61
136 Miss Blackwood's Reply to Helen Thomson's Verses on "Random Chords." ....	62
137 Conic Constructions. By E. J. Lawrence, M.A. ....	74
138 Note on Question 5458. By the Editor. ....	94
139 On the Sign of any Term of a Determinant. By G. R. Dick, M.A. ....	99
140 Note on Professor Monk's Solution of Question 5502. By W. S. B. Woolhouse, F.R.A.S. ....	108

### Solved Questions.

4253. (H. S. Monk, M.A.)—A series of Pythagorean triangles with the difference between the hypotenuse and one side equal to $n$ , can always be obtained by beginning with the triangle $3n, 5n, 4n$ , and taking the upper figures as negative in each odd term of the series given in Quest. 4102. Find in what cases a distinct series with the same difference can be obtained. ....	23
4382. (F. C. Wace, M.A.)—At the extremities of the horizontal diameter of a circular wire are fixed two small rings, a third ring can slide on the wire, a string passes through the two rings and supports two weights $w, w'$ hanging vertically; find the position of the moveable ring when it is in equilibrium. ....	52
4870. (Professor Cayley, F.R.S.)—Given three conics passing through the same four points; and on the first a point A, on the second a point B, and on the third a point C. It is required to find on the first a point A', on the second a point B', and on the third a point C', such that the intersections of the lines A'B' and AC, A'C' and AB, lie on the first conic; B'C' and BA, B'A' and BC, lie on the second conic; C'A' and CB, C'B' and CA, lie on the third conic. ....	20

	Page
4902. (C. W. Merrifield, F.R.S.)—Can a sphere be touched by more than twelve other equal spheres? .....	85
5067. (S. Tebay, B.A.)—Let $x_1 + x_2 + \dots + x_n = 1$ , where $x_1 > x_2 > \dots > x_n$ ; find the mean value of $r^2$ . ....	25
5090. (C. Leudesdorf, M.A.)—Evaluate (1) the equation $(ax^2 + by^2 + c + 2fy + 2gx + 2axy)(ax'^2 + by'^2 + c + 2fy' + 2gx' + 2ax'y')$ $= [(ax' + hy' + g)x + (hx' + by' + f)y + (gx' + fy' + c)]^2$ , when $lx' + my' = 0$ , and $x'$ and $y'$ become infinite; and (2) give the geometrical interpretation.....	63
5101. (A. Martin, M.A.)—An anger-hole is made through the centre of a sphere; show that the average of the volume removed is, in parts of the volume of the sphere, $1 - \frac{1}{3}\pi$ . ....	39
5111. (Professor Wolstenholme, M.A.)—1. If $\alpha, \beta$ be two angles such that $[1 + 2(\cos \alpha)^2][1 + 2(\cos \beta)^2] = 9$ ..... (A), prove that $\frac{(1 - 8 \cos^4 \alpha)^{\frac{1}{2}}}{\sin^2 \alpha \cos \alpha} = \frac{(1 + 8 \cos^4 \beta)^{\frac{1}{2}}}{\sin^2 \beta \cos \beta}$ .	
2. A circle and a rectangular hyperbola each passes through the centre of the other, and $\alpha, \beta$ are the two acute angles of intersection of the curves at their two real common points; prove that $\alpha, \beta$ will satisfy the equation (A), and that the squares of their latera recta are in the ratio $(1 + 8 \cos^4 \alpha)^{\frac{1}{2}} : 8 \sin^2 \alpha \cos \alpha$ ..... (B).	
3. If a circle and a parabola be such that the circle passes through the focus of the parabola, and its centre lies on the directrix, prove that their angles of intersection satisfy the equation (A), and their latera recta are in the ratio (B).	
4. If a rectangular hyperbola and a parabola be such that the centre of the hyperbola is the focus of the parabola, and the directrix of the parabola touches the hyperbola; then, if their acute angles of intersection be $\alpha - 2\alpha, \alpha - 2\beta$ , prove that $\alpha, \beta$ will satisfy the equation (A), and that the squares on the latera recta are in the ratio (B). ....	31
5146. (S. Roberts, M.A.)—Given a pencil of rays and a system of concentric circles; prove (1) that if one set of intersections range on a straight line, the other intersections lie on a circular cubic, having a double point at the origin of the pencil and the double focus at the common centre of the circles; and (2) determine therefrom, with reference to a system of parabolas having the same focus and axis, the locus of the points the normals at which intersect in a fixed point. ....	58
5173. (H. T. Gerrans, B.A.)—Find the sums of the infinite series $\frac{x^0}{2} + \frac{x^2}{5} + \frac{x^4}{8} + \frac{x^6}{11} + \frac{x^8}{14} + \dots$ , $\frac{x^4}{3} - \frac{x^6}{3.5} + \frac{x^8}{5.7} - \frac{x^{10}}{7.9} + \dots$ . ....	39
5192. (H. T. Gerrans, B.A.)—AB is a fixed diameter of a circle, OA a chord, ON an ordinate of the diameter, AP a line drawn so that $\angle OAP = \angle OAN$ , and $AP = AN$ ; find the locus of P. ...	30
5212. (Professor Wolstenholme, M.A.)—A circle is drawn touching both branches of a fixed hyperbola in P, P', and meeting the asymptotes in L, L', M, M'; prove that (1) $LL' = MM'$ = major	

CONTENTS.

No.		Page
	axis; (2) the tangents at L, M meet in one focus, and those at L', M' in the other, and the angle between either pair is constant, supplementary to the angle between the asymptotes; (3) the directrices bisect LM, L'M'; (4) PP' bisects LL', MM', L'M, L'M'; (5) the tangents at L, L' intersect on a rectangular hyperbola passing through the foci and having one of its asymptotes coincident with MM' (because $\angle CSL + \angle CSL' =$ angle between the asymptotes); (6) LM, L'M touch parabolas having their foci at the foci of the hyperbola, and the tangents at their vertices the directrices of the hyperbola. ....	29
5224.	(Rev. H. G. Day, M.A.)—On each of $n$ pillars, whose heights, in ascending order of magnitude, are $e_1, e_2, e_3, \dots, e_n$ , points are taken at random; find the chance of the point so taken on the $r$ th pillar being the highest. ....	34
5268.	(E. H. Seitz.)—Two equal circles, each of radius $r$ , are drawn on the surface of a circle of radius $2r$ ; show that the average area common to the two circles is $(1 - \frac{16}{3\pi^2})\pi r^2$ . ....	84
5299.	(L. H. Rosenthal.)—Solve the simultaneous equations, $x^2 - ax^2 + (b - 2y)x + ay - c = 0 \dots\dots\dots(1),$ $x^2y - axy - (y^2 - by + d) = 0 \dots\dots\dots(2).$	70
5304.	(Professor Clifford, F.R.S.)—Prove that the negative pedal of an ellipse, in regard to the centre, has six cusps and four nodes; find their positions, and the length of the arc external to the ellipse between two real cusps; and account fully for the apparent reduction of the curve to a circle and two parabolas respectively, in special cases. ....	47
5315.	(Colonel A. B. Clarke, C.B., F.R.S.)—A straight line intersects a cube; show that the chance that the intercepted segment is less than the side of the cube is $\frac{13}{8\pi}$ . ....	111
5320.	(J. J. Walker, M.A.)—If normals to the ellipse $b^2x^2 + a^2y^2 - a^2b^2 = 0$ be drawn from any point on the curve $(a^2x^2 + b^2y^2 - c^2)^2 + 54a^2b^2c^2x^2y^2 = 0,$ prove that they form an harmonic pencil. ....	38
5331.	(Professor Wolstenholme, M.A.)—Prove that (1) the evolute of the first negative focal pedal of the parabola $y^2 = c(2c - x)$ (where $c = 4s =$ the parameter) is the curve $27(y^2 - 8cx - c^2) = 8cx(8x + 9c)^2$ ; (2) the equation of the pedal itself is $27ay^2 = (3a - y)(x + 6a)^2$ ; (3) the normal of the pedal exceeds the ordinate by a fixed length; (4) the arc measured from the vertex to any point is equal to the intercept of the normal on the axis of $y$ ; and (5), if a heavy uniform chain be tied tightly round a curve, such that the pressure per unit is equal to the weight of a unit of length of the chain, this curve must be the first negative focal pedal of a parabola. ....	27
5339.	(Hugh McColl, B.A.)—In the quadratic equation $x^2 + x\theta + y = 0$ , the coefficient $x$ is taken at random between 0 and 3, the coefficient $y$ between $-1$ and $4$ , and the coefficient $s$ between $-3$ and $3$ ; show that the chance that the following	